Introduction to NFV using ETSI Standard

Julie Ann Connary - Technical Leader
Harris Haider – Solutions Architect
BRKNMS-2309
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Flexible, Agile Service Chains utilizing ETSI MANO architecture to realize the full potential of NFV

Multi-tenant
programmable
Scalable
Elastic
Highly Automated
Tech Refresh = new VNF

NFVI = VMWARE, Openstack, CSP

Enterpr ise

Partner Network

IDS   ASA

ASA

IDS   ASA   VPN

ASA

ASA
Agenda

- Foundations of NFV: ETSI MANO Architecture
- Cisco Products for NFV Orchestration
- It’s Real: Use Cases and Demonstration
ETSI NFV Overview
ETSI Network Functions Virtualization Journey

- Founded 2012
  - By SPs

- 2013-2014
  - Release 1
  - Reference Architecture

- 2015-2016
  - Release 2
  - Interface Specifications

- 2017 -
  - Release 3
  - NFV ECO system Studies

 NFVI Interface Standards– Release 2

IFA005: Or-Vi Reference Point
IFA006: Vi-Vnfm Reference Point
IFA007: Or-Vnfm Reference Point
IFA008: Ve-Vnfm Reference Point
IFA009: MANO Architectural Options
IFA010: MANO Functional Requirements
IFA011: VNF Package / VNFD
IFA012: Os-Ma-Nfvo Reference Point
IFA013: Os-Ma-Nfvo Reference Point
IFA014: NSD

http://www.etsi.org/technologies-clusters/technologies/nfv
NFV ECO SYSTEM Studies: Release 3

- Information modelling ([IFA016, IFA017 and IFA024])
- End-to-end multi-site services management ([IFA022])
- Additional considerations on management and orchestration ([IFA020, IFA021 and EVE009])
- Acceleration technologies ([IFA018 and IFA019])
- Charging, billing and accounting ([EVE008])
- License management ([EVE010])
- Security analysis and management ([SEC013, SEC014])
- Reliability and availability considerations ([REL007, REL008])
- DevOps and continuous integration ([TST006])
- Testing ([TST004, TST007])
- Policy management ([IFA023])
- Identification of "Touchpoints" with information Models of other organisations ([IFA024])
Cisco Involvement with ETSI NFV

• Participate in NFV Solutions Working Groups
  • TOSCA/YANG modeling specifications for NFV Lifecycles
  • Interface Specifications

• VNF Plug Tests
  • ETSI/EANTC Plug-test in Madrid in January
  • NFV Interop Testing Report

• Cisco Open NFV Ecosystem
  • cisco nfv on DEVNET

The VNF vendors were:
• Alcatel-Lucent
• Cisco Systems
• Cobham Wireless
• Hitachi Communication Technologies America
• Huawei Technologies
• IneoQuest Technologies
• Juniper Networks
• Metaswitch Networks
• NetNumber
• Netrounds
• Procera Networks
• Sonus Networks
## Cisco VNFs OnBoarded

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<td>AMP (Advanced Malware Protection)</td>
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ETSI NFV Architecture and Cisco Products Mapping
NFV ETSI Architectural Framework
ETSI GS NFV 002 (2014)

OSS/BSS

VNF domain

E/NMS

VNF

E/NMS

VNF

Vn-Nf

Virtualization Layer

NFVI

Hardware Resources

NFV Management and Orchestration (NFV MANO)

NFV Or orchestrator

NFVO

Descriptors

Os-Ma/PSA

Se-Ma

Virtual Network Function (VNF) Manager(s)

VNFM

Virtual Infrastructure Manager(s)

VIM

Or-Vnfm

Vi-Vnfm

Or-Vi

Nf-Vi
NFV or VNF or Service Chain?

• **Network Function Virtualization:**
  • refers to the idea of replacing dedicated network appliances (such as routers and firewalls) with software running on standard servers.
  • Typically includes a Hypervisor and the software runs as a Virtual Machine

• **Virtual Network Function**
  • Collection of 1 or more Virtual Machines performing a single network function

• **Service Chain**
  • Collection of 1 or more VNFs providing a network service
NFV Framework

✓ **OSS/BSS**
  ✓ Operational Support Systems
  ✓ Business Support Systems

✓ **VNF Domain**
  ✓ Collection of 1 or more Virtual Machines performing a single network function
  ✓ Associated Element/Network Management System

✓ **NFVI**
  ✓ Virtualization Layer: Hypervisor
  ✓ Compute
  ✓ Network
  ✓ Storage
NFV Management and Orchestration

✓ **NFVO**
  ✓ Lifecycle management of Network Services
  ✓ Orchestration of NFVI resources at the high level, particularly across multiple VIMs

✓ **Virtual Network Function Manager(s) (VNFM)**
  ✓ Lifecycle management of specific VNFs (possibly composed of multiple VMs)

✓ **Virtual Infrastructure Manager(s) (VIM)**
  ✓ Controls and Manages the NFVI compute, storage and network resources
  ✓ Performs Operations
  ✓ Cloud Computing
Solution Mapped to ETSI NFV Framework

ETSI NFV Framework

NSO
Service Orchestration and Fulfillment

Service Applications

vCSR
vASA
F5

NFVI (UCS/CSP)
KVM / ESXi
Virtual Storage
Open vSwitch VTS/VPP

Virtualization Layer

Hardware Resources
Compute
Storage
Network

ESC
(VNF-M)

OpenStack
/ESXI/CSP
(VIM)

Physical Network

Portal / BSS

NSO
(NFV-O)

On-Ma

On-Vi

OpenStack

NFV Management & Orchestration

Open Service and Orchestration (NSO)

Service Orchestration and Fulfillment

Service Applications

vCSR
vASA
F5

NFVI (UCS/CSP)
KVM / ESXi
Virtual Storage
Open vSwitch VTS/VPP

Virtualization Layer

Hardware Resources
Compute
Storage
Network
Cisco Network Services Orchestrator (NSO)

ETSI NFV MANO
Network Function Virtualization Orchestrator (NFVO)
Solution Mapped to ETSI NFV Framework
Workflow Hierarchy: Network Service Orchestration

**NFVO: Onboard VNF To Catalogue**
- Virtual Network Function Descriptors (VNFD)
- Virtual link Descriptors (VLD) + Connection Points
- Images + Virtual Compute Resources loaded to VIM

**NFVO: Network Service Descriptors (NSD)**
- Define Network Services Flavors
- VNFDs + VLD + SAP

**NFVO: Instantiate via NS-INFO**
- Apply Service Logic to Collect appropriate resources for Network Service and pass VNF-Info to VNFM

**VNFM: Instantiate VNFs using VNF-Info**
- passing it to appropriate VIM
- Manage LifeCycle of VNF
- Inform NFVO of Live Cycle Events

**VIM: Instantiation of the VNF on the NFVI**
- compute, storage and network

**EM: Day1 Configuration and NFVO/VNFM: LCM**
- NSO informed of “service alive” – configure DAY1
- VNFM/NSO maintains LCM
Cisco Network Services Orchestrator Architecture

Agile Automation
- Active network view
- Any service, any device
- Multivendor support

Network Abstraction Layer
- Physical
- Virtual
- Network applications

Northbound APIs
- OSS and BSS
- Third-party applications
- DevOps support
NSO NFVO Function Pack

NFVO Function Pack
A pre-integrated NSO Service

- NB Service
- Tail-f NFVO Service packages
- ESC Device (NETCONF NED)
- OpenStack/VCenter/CSP
NSO also Provisions VNFs!
Key MANO Methodology Concepts

Network Service

- NFVO
  - Manages the NS

- VNFM
  - Manages VNFs
  - Manages VNFCs

- VIM
  - Manages the VMs

Virtualisation Layer

- VNF 1
  - VNF C

- VNF 2
  - VNF C

- VNF 3
  - VNF C

Hardware
Key NFVO Terms

- A **VNFD** is a deployment template describing the VNF in terms of deployment and operational behavioral requirements. Also contains connectivity interface to establish appropriate links between VNF instance and other network functions.

- A **VDU** references a VM image and runtime requirements

- An **NSD** is static information elements used by the NFVO to instantiate a Network Service

- A **NS Info** is a runtime record created by an NSD

- A **VNF Info** is a runtime record created by an NSD instantiating a VNFD
NFVO Terms: How Descriptors and Infos Align

- NSD
  - VNFD
    - VDU
  - VNFD
    - VDU
  - VNFD
    - VDU

+ Runtime Info

- NS Info
  - VNF Info
    - VNFC
  - VNF Info
    - VNFC
  - VNF Info
    - VNFC

Instantiation
How Does a VDU becomes a VNFC?

- VDU is not deployable by itself
- VDU requires day-0 artifacts before it becomes deployable (VNFC)
  - Day-0 configuration
  - Connection Points
  - Virtual Links
  - Etc.
- When VNFC is deployed, the instance is referred to as VNFCi
NSD Service Chain Example: Firewall and Router
Build the VNFD and NSD

nsd id= fw-router

VNFD ASA

Vdu: ASA
1VCPU
3GIG
image

NSD Deployment flavor options= (fw-router-flavor, router-flavor)
NSD Instantiation level options= (bronze, gold)

VNFD CSR

Vdu:CSR1KV
1VCPU
3GIG
Image

sap <sa-oam-mgt>
mgmt <mgmt-ext>
mgmt <mgmt-ext>

VLD
<inside-net>

VLD
<inside-net>

VLD <inside-net>

<mgmt-ext>
<mgmt-ext>
<mgmt-ext>

<mgmt>
<mgmt>
<mgmt>

<outside> <outside> <outside>
<outside> <outside> <outside>

<0> <2> <0> <2> <1> <1>

<0> <1> <2> <1> <2> <2>

<left-ext> <left-ext> <left-ext>
<right-ext> <right-ext> <right-ext>

sap <Internet>
sap <Client-net>

Ephemeral openstack net
<inside-net>

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NSD Can Consist of Multiple Deployment Flavors

NSD id = fw-router

router-flavor

fw-router-flavor (bronze/gold)

ASA vnfd

ephemeral network

CSR vnfd

CSR vnfd

fw-router

router-flavor
Build the NSD-INFO

VNF-info
Deployment_name= fw-router
nsd id= fw-router

VNFD ASA
<Vdu: ASA>
<mgmt>
<mgmt-ext>
<0>
<-outside>
<-outside-ext>
<inside>
<-inside-net>

VNFD CSR
<Vdu:CSR1KV>
<mgmt>
<mgmt-ext>
<0>
<-left-ext>
<-left>
<1>
<right-ext>
<right>
<2>

sa-oam-mgt
boot-time = 600s
recovery-time = 120s
tenant = mano

Image’Flavor’
managed = true
authgroup = csr-group

Day0="CSR.txt"

NSD Deployment flavor options= (fw-router-flavor, router-flavor)
NSD Instantiation level options= (bronze, gold)
Cisco Elastic Services Controller
ETSI NFV MANO Virtual Network Functions Manager (VNFM)
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Solution Mapped to ETSI NFV Framework

- Service Applications
  - NFV Management & Orchestration
  - ETSI NFV Framework
  - Portal / BSS

- NFVI
  - Physical Network
  - KVM / ESXi/CSP
  - Virtual Storage
  - Open vSwitch VTS/VPP

- Virtualization Layer
  - Hardware Resources
    - Compute
    - Storage
    - Network

- Service Orchestration and Fulfillment
  - NSO
    - Vnfm
    - Ve-Nf
    - Vn-Nf
    - Ve-NF-Vnfm

- OpenStack / ESXi/CSP (VIM)

- ESC (VNF-M)

- Nfvo-Vnfm

- On-Vi

- Vnfd-Vi

- Nf-Vi

- Os-Ma

- R-S-Ma

- ✓ Lifecycle management of specific VNFs
Cisco Elastic Service Controller

Capabilities

- VNF lifecycle management (Create, Delete)
- Service / VNF Day-zero configurations
- VM and service monitoring
- VNF auto-healing, recovery and elasticity
- VNF license management (Smart Licensing)
- Customizations (monitoring, actions)
- Complex VNF management
- CRUD Web GUI, API - Netconf, REST
- Multi-VIM Integration – Openstack, VMware vCenter
VNF-Info Multi-Vendor Example
VNF-Info Parameter Example

```
vnfd CSR_External_A
  hostname op-code-ecvrc-001
  vdu id small
  vdu managed
  vdu vcpus 1
  vdu memory-mb 2048
  vdu disk-size-gb 120
  vdu image-name csr1000v-universalk9.03.16.02.S.155-3.S2-ext.qcow5
  vdu bootup-time 600
  vdu interfaces 0
    physical-interface ENC1p10s0
    network-name Management
    connection-point mgmt
    address 172.16.0.23
    netmask 255.255.255.0
    vnic-type access
```

VNF Instantiation Parameters

VNF Interface Parameters
NFVO to VNFM Interaction

VNF lifecycle management (Create, Delete)

VM and service monitoring
Cisco Elastic Service Controller (ESC)

ESC is Cisco’s VNFM, for managing Cisco and 3rd Party VNF’s

- Programmable / Model Driven
  - Netconf and REST Interface
  - YANG data model

- Open and Modular
  - Interop with 3rd party VNF and NFVO
  - Micro services

- Abstracts VIM complexity from service orchestration

* Not supported today, and on radar for future
ESC w Multi-VIMs

- **NSO**
  - 1 : N

- **ESC (Multi-VIMs)**

- **NFVIS Platforms**
  - CSP/NFVIS
  - ENCS
  - NFVIS
  - ESC-Lite

- **Public Cloud**
  - AWS

- **VIM less**
  - libvirt
  - Hzo
  - Host

- **VIM**
  - VIM
    - VMware
    - OpenStack
    - Etc…

- **Embedded ESC**

- **External ESC**
Cisco Cloud Services Platform
ETSI NFV MANO
NFVI + VIM
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VIMs within the MANO Architecture
What is the Cloud Services Platform 2100?

CSP 2100 SW, ConfD, Linux KVM, OVS, PCIe Passthrough, SR-IOV

Cisco UCS 1RU/2RU Modular Platforms, 1 & 10G SFP+ NICs

GUI

CLI

REST
NetConf

API

NSO/ESC

CSR

XRv 9000

ASA v

Third party

Third party

KVM based services
Key Principles

Easy to use
- Turnkey and simple
- Built for network, security, and load balancing teams
- Lifecycle management
- Provision a new service within minutes using GUI or CLI

Automated
- Deploy services as fast as applications
- Use DevOps to automate ACI services
- RESTful API
- NetConf/Yang

Clustering
- Shared pool of resources
- Auto-deploy redundant HA pair
- Scale-out architecture

High Performance
- PCIe Passthrough
- SR-IOV (VEB and VEPA)
Service Deployment in just a few clicks
Service Deployment in just a few clicks

**CONFIGURE**

vNIC Configuration

- vNIC 1
  - Name: vn1
  - VLAN: 119
  - VLAN Type: access
  - VLAN Tagged: false
  - Native VLAN: none
  - Model: e1000
  - Network Name: enp7s0f0
  - **Required fields**

- vNIC 2

- Add vNIC

- Save

**DEPLOY**

Service Creation

- Service Name: linux-123
- Target Host Name: csp2100-a
- Hi Host Name: vdisk5.img.tar.00
- Image Name: Vdisk5.img.tar.00
- Resource Config:
  - 1 core, 4 GB, 2048 MB
- Storage Config:
  - 1 disk
  - 85
- vNIC Password:
- Crypto Bandwidth:
- Serial Port:

- **Required fields**

- Deploy
Use Cases
Create Standard Connectivity Patterns
Standardize and Virtualize Service Chains For Security and Agility

Consumer Access Chain

Provider Access Chain
Use-Case: Isolated Partner DMZ VPN instance

Partner/Cloud Interconnect VPN -1

Secure Agile Exchange POD in Colocation or Customer DataCenter

CSP-1

Nexus

Internal DMZ VRF Active

Nexus

Internal DMZ VRF Standby

Nexus

Internal DMZ VRF Active

Nexus

Internal DMZ VRF Standby

DMZ FW

Partner 2 VRF Active

Partner 2 VRF Standby

CSR

ASAv

Br-Cit

Tenant 1 Service Chain

HSSP-VIP: 192.168.0.1

HSSP-VIP: 192.170.0.1

VLAN 701

VLAN 501

CSP-1

Partner 2 FW

Partner 2 FW/R

Cloud/Partner Site 10.16.0.0/24

Internal DMZ 10.22.0.0/24
Example: Partner VPN Automation by NSO on CSP + Nexus

Day(-1) Gather Resources
- Get VLAN
- Get Management IP
- Modify and Upload Day 0 files for VNFs

Day 0 - Spin up VNF
- Associate Appropriate VNF Qcow image
- Stitch VNFs with appropriate NICs and VLANs
- Create Private Bridge
- Associate Day-0 base Configs
- Spin Up VNFs and wait for it to come up
- Add VNF to NSO

Day 1 - Apply Configuration
- Get IP address and VLAN’s from Resource managers
- Apply Day 1 Configuration to the VNF
- Apply Day 1 configuration to Nexus 9000

Day 2
- Open Physical Firewall Rules
ASA firewall – CSR1KV Service Chain

VNFD and NSD Onboarded into VNFO

Instantiate via NSO-INFO

VNF-INFO to VNFM ESC

Service Chain instantiated on Openstack

VNF READY

VM Alive

Service Alive

VM Boot Success
Build the NSD-INFO

VNF-info
Deployment_name= fw-router
nsd id= fw-router

VNFD ASA

Vdu: ASA

VNFD CSR

Vdu:CSR1KV

nsd id= fw-router

boot-time = 600s
recovery-time = 120s
esc-device = ESC0
tenant = mano

Day0=“CSR.txt
Image’
Flavor’
managed = true
authgroup = csr-
group

NSD Deployment flavor options= (fw-router-flavor, router-flavor)
NSD Instantiation level options= (bronze, gold)
NS-info Walk-Thru

Define the NSD and Flavor

nfvo ns-info esc ns-info CSR1kv-ASA

tenant mano

deployment-name CSR1kv-ASA-Service-Chain

esc ESC0

username admin

name CSR1KV-ASA

description "cloud service router and firewall"

nsd fw-router

flavor router-firewall-HA-flavor

instantiation-level gold

NSD can have multiple flavors; we show single flavor as illustration
NS-info Walk-Thru
VNF-Info contains runtime info for each VNF in the Flavor (Service Chain)

vnf-info ASA
vnfd ASA
vdu firewall
managed
bootup-time 300
reboot-time 300
recovery-wait-time 300
image-name ASA-image
flavor-name ASA-flavor
day0 day0-config
  url http://10.84.46.64/vpc/config/ASA_day0.txt
  variable ADMIN_PWD
  value [ cisco123 ]

variable HOSTNAME
  value [ ASA ]
authgroup asr_group
internal-connection-point mgmt
connection-point-address address 10.84.46.65
connection-point-address netmask 255.255.255.0
connection-point-address start 10.84.46.65
connection-point-address end 10.84.46.66

A Flavor can have 1 or more VNF-Infos
**NS-info Walk-Thru**

A flavor also contains the SAP (and/or Virtual Link) connectivity information

```
sap-info client-net
  network-name client-net
  sap-name ""
  description "client network"
!
sap-info inside-net
  network-name inside-net
  sap-name ""
  description "inside network"
!
sap-info internet
  network-name internet
  description "internet network"
!
sap-info sa-oam-mgt
  network-name sa-oam-mgt
  sap-name ""
  description "management network"
  address 10.84.46.62
!
  state instantiated
!
```
NSO Development Resources

www.cisco.com/go/nsodevnet

DevNet

Public material targeting partners and customers

DevNet open for all
Selected Content

Learning Labs open for all registered users
Training material

GitHub open for all
Shared code

NSO Developer Hub (Jive) open for all registered Cisco employees, Cisco partners & Cisco customers
www.cisco.com/go/nsohub

Community and main repository of content and Q&A
Related Cisco Live Presentations
Continue Your Education

- BRKSDN-2411 - NFV Performance - Challenges and Solutions
  Wednesday, Jun 28, 8:00 a.m. - 10:00 a.m.

- BRKARC-2749: Extending Enterprise Network into Public Cloud with Cisco CSR1000v
  Wednesday, Jun 28, 4:00 p.m. - 5:30 p.m.

- BRKCRS-3447 Network Function Virtualization for Enterprise Networks
  Thursday, Jun 29, 1:00 p.m. - 2:30 p.m.

- BRKARC-2014 - Branch Virtualization - The Evolving NFV Landscape
  Thursday, Jun 29, 1:00 p.m. - 2:30 p.m.

- BRKARC-2112 - Deploy Network Services in Minutes on any Platform with Cisco Enterprise Network Functions Virtualization (NFV)
  Wednesday, Jun 28, 4:00 p.m. - 5:30 p.m.
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• Related sessions
You’re it
# Data Center / Virtualization Cisco Education Offerings

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<th>Cisco Certification</th>
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<td>Introducing Cisco Data Center Networking (DCICN); Introducing Cisco Data Center Technologies (DCICT)</td>
<td>Get job-ready foundational-level certification and skills in installing, configuring, and maintaining next generation data centers.</td>
<td>CCNA® Data Center</td>
</tr>
<tr>
<td>Implementing Cisco Data Center Unified Computing v6.0 (DCUCI)</td>
<td>Obtain professional level skills to design, configure, implement, troubleshoot next generation data center infrastructure.</td>
<td>CCNP® Data Center</td>
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<td>Troubleshooting Cisco Data Center Infrastructure v6.0 (DCIT)</td>
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<td>Product Training Portfolio: DCAC9K, DCINX9K, DCMDS, DCUCS, DCNX1K,</td>
<td>Gain hands-on skills using Cisco solutions to configure, deploy, manage and troubleshoot unified computing, policy-driven and virtualized data center infrastructure.</td>
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<tr>
<td>DCNX5K, DCNX7K, HPLEX200, UCSDF, UCSDACI, DCUC600</td>
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<tr>
<td>Designing the FlexPod® Solution (FPDESIGN); Implementing and Administering the FlexPod® Solution (FPIMPADM)</td>
<td>Learn how to design, implement and administer FlexPod® solutions</td>
<td>Cisco and NetApp Certified FlexPod® Specialist</td>
</tr>
<tr>
<td>Designing the VersaStack Solution (VSDESIGN); Implementing and Administering the VersaStack Solution (VSI</td>
<td>Learn how to design, implement and administer VersaStack solutions</td>
<td></td>
</tr>
</tbody>
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For more details, please visit: [http://learningnetwork.cisco.com](http://learningnetwork.cisco.com)

Questions? Visit the Learning@Cisco Booth
# Network Programmability Cisco Education Offerings

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Cisco Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing with Cisco Network Programmability (NPDEV)</td>
<td>Provides Application Developers with comprehensive curriculum to develop infrastructure programming skills; Addresses needs of software engineers who automate network infrastructure and/or utilize APIs and toolkits to interface with SDN controllers and individual devices</td>
<td>Cisco Network Programmability Developer (NPDEV) Specialist Certification</td>
</tr>
<tr>
<td>Designing and Implementing Cisco Network Programmability (NPDESI)</td>
<td>Provides network engineers with comprehensive soup-to-nuts curriculum to develop and validate automation and programming skills; Directly addresses the evolving role of network engineers towards more programmability, automation and orchestration</td>
<td>Cisco Network Programmability Design and Implementation (NPDESI) Specialist Certification</td>
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<tr>
<td>Programming for Network Engineers (PRNE)</td>
<td>Learn the fundamentals of Python programming – within the context of performing functions relevant to network engineers. Use Network Programming to simplify or automate tasks</td>
<td>Recommended pre-requisite for NPDESI and NPDEV Specialist Certifications</td>
</tr>
<tr>
<td>Cisco Digital Network Architecture Implementation Essentials (DNAIE)</td>
<td>This training provides students with the guiding principles and core elements of Cisco’s Digital Network Architecture (DNA) architecture and its solution components including; APIC-EM, NFV, Analytics, Security and Fabric.</td>
<td>None</td>
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</tbody>
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Questions? Visit the Learning@Cisco Booth
### Cloud Cisco Education Offerings

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Cisco Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding Cloud Fundamentals (CLDFND)</td>
<td>Learn how to perform foundational tasks related to Cloud computing, and the essentials of Cloud infrastructure, administration and operations</td>
<td>CCNA Cloud</td>
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<tr>
<td>Introducing Cloud Administration (CLDADM)</td>
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<tr>
<td>Implementing and Troubleshooting the Cisco Cloud Infrastructure (CLDINF); Designing the Cisco Cloud (CLDDES); Automating the Cisco Enterprise Cloud (CLDAUT); Building the Cisco Cloud with Application Centric Infrastructure (CLDACI)</td>
<td>Obtain professional level skills to design, automate, secure, provision and manage private and hybrid Clouds</td>
<td>CCNP Cloud</td>
</tr>
<tr>
<td>Product Training Portfolio: UCS Director: UCSDF, UCSDACI Prime Service Catalog: PSCF, PSCI, PSCD MetaPod: MPODF20</td>
<td>Gain in-depth hands-on skills using Cisco solutions to configure, deploy, manage and troubleshoot Cloud deployments</td>
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</tbody>
</table>

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