



# Third-Party NFV Ecosystem Certification Test Plan

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## **Document Control**

This is version 1.3.1 published Aug 2017. Address any questions to nfv-ecosystem@cisco.com

## 1 Introduction

## 1.1 Preface

This document addresses the testing requirements forming part of Cisco's open third-party NFV ecosystem. It should be read in conjunction with material describing the ecosystem program found here: <u>https://developer.cisco.com/site/nfv/</u>

Conformance testing is done to determine whether a system meets a specified standard. These test specifications are designed to concentrate on areas critical to Cisco solution interoperability with third-party Virtual Device Under Test (vDUT), including testing an implementation's reaction to erroneous behavior.

## 1.2 Scope

Ecosystem interoperability focuses on certifying single third-party VNF basic functionality and interoperability with NFVIS, CSP and NFVI platforms. Virtual Network Functions Service chaining and inter-VNF interoperability, orchestration, services data modeling, and services life cycle are concepts outside the scope of ecosystem certification.

Some customers may wish a VNF to be tested against these items even though they are outside the scope of the ecosystem testing. In this case, Cisco Advanced Services should be engaged to perform that testing on a bespoke basis. Figure 1 shows the scope of testing Cisco Advanced Services can carry out.

Note: successful customer-driven Advanced Services testing does not provide certification under this program; it does not allow the third party vendor the benefits of this program.

This guide will be updated as the needs of our customers evolve, see the document control section preceding this text for revision details.



Figure 1: VNF Certification Project Phases

## 1.3 Related Documents

• ETSI: Network Functions Virtualisation (NFV); Testing Methodology; Report on NFV Interoperability Testing Methodology

• ETSI: Network Functions Virtualisation (NFV); NFV Security; Security and Trust Guidance

## 2 Third-party VNF Certification

## 2.1 Certification Testing Workflow

We will follow the well-proven testing workflow defined in ISO/IEC 9146 and ETSI validation approach. This standard, which covers the entire testing process, provides an excellent basis for the development of high-quality test specifications.

The following diagram shows the development of test specifications process, depicting a phased approach:



#### Figure 2: Certification Testing Flow

This document focuses on developing a standard checklist of the capabilities supported by the Virtual Device Under Test (vDUT). The checklist also provides an overview of the features and options that are implemented.

A high-level Test Plan is derived from the relevant base checklist or Test Specifications. It provides an informal, easy-to-read description of each test, concentrating on the meaning of the test rather than detailing how it may be achieved. Test Purposes are grouped into a logical Test Suite Structure according to suitable criteria (basic interconnection, error handling, functionality etc.).

A Detailed Test Plan defines the entire collection of Test Cases. Each Test Case specifies the detailed test purpose, and detailed execution procedure.

Internal and External Certification reports detail testing results and summarize findings and deployment recommendations such as timer values, etc.

The Automated Test Suite is an executable set of test cases that can be quickly and easily implemented from shared code repository such as GitHub.

## 2.2 Certification Testing Methodology

### 2.2.1 Overview

There are a number of different terms and concepts that can be used when describing a test methodology. Subsequent sections of this document aim to describe the most important concepts used by these guidelines, which have been categorized either as part of the System Under Test (SUT) or as part of the Test Environment.

The following diagram provides an overview of these basic concepts, which are described in the following sections.



#### Figure 3: Illustration of basic Certification Test Concepts

### 2.2.2 System Under Test (SUT)

In the context of interoperability testing between a Cisco CSP-2100 acting as the NFV Infrastructure platform and a third-party VNF, the System Under Test (SUT) is made of a number of individual components interacting with the vDUT. Platform characteristics are detailed in the following sections.

## 2.2.3 Virtual Device Under Test (vDUT)

This section describes a generic architecture where all the required SUT configurations will fit.

Virtual Device Under Test (vDUT) in the context of NFV, a Function Under Test is a combination of software and/or hardware items which implement the functionality of one or several NFV functional blocks and interact with other vDUTs over one or more reference points.

### 2.2.4 Test interfaces

The interfaces that are made available by the SUT to enable testing are usually known as the test interfaces. These interfaces are accessed by the Test Drivers to trigger and verify the test behavior, as described in Test Driver section.

Other SUT interfaces can be used for external system integration e.g. DNS, NTP, monitoring, log collection and analysis, etc.

In the simplest case, the test interfaces will be the normal user interfaces offered by some of the vDUTs (command line, GUI, web interface, etc.). A vDUT may also offer APIs over which interoperability testing can be performed either manually using dedicated applications, or automatically using programmable test function/scripts.

In some cases, observing and verifying the functional behavior or responses of one vDUT may require analyzing it's logs or records. In that case, it is recommended to pre-define those log messages or records to avoid ambiguity in their interpretation.

Additionally, in the context of interoperability testing, interfaces between the vDUTs are not considered to be 'test interfaces', combining SUTs testing with conformance checks may require monitoring those interfaces to assess the conformance of the exchanged information or messages.

## 2.2.5 Test Environment

Certification testing involves control and observation at the functional (rather than protocol) level. The Test Environment is the combination of equipment, functions and procedures which allow testing the interoperability of the vDUT.

SUT components of the test environment can access vDUTs over designated Test Interfaces. Those components ensure selection, interpretation and execution of the test descriptions, coordination and synchronization of the actions on the test interfaces, and provide mechanisms for logging, reporting, monitoring and observing the interactions among the vDUTs, etc.

External systems such as DNS, NTP, and testing equipment can access the SUT over one or more well-defined test interfaces.

#### 2.2.6 Detailed Test Plan

Detailed Test Plan cases outline 'test description' provides the detailed set of instructions (or steps) that need to be followed in order to perform a test.

Most often, interoperability tests are described in terms of actions that can be performed by the user(s) of the endpoint device(s).

In the case where the test is executed by a human operator; the test will be described in natural language. In the case where the tests are automated, a programming or test language will be utilized implementing the required test description.

The steps in the test description can be of different natures, depending on the kind of action required: trigger a behavior on one vDUT, verify the functional response on the vDUT, configure the SUT (add/remove a vDUT), check a log, etc.

Each step identifies the vDUT and/or the interface targeted by the action.

### 2.2.7 Test Drivers

The test driver realizes the steps specified in a test case description at one specific test interface. Testing efficiency and consistency can be improved by implementing the role of the test driver over an automatic device programmed to carry out the specified test steps. This approach may require standardized test interfaces in the FUTs, or at least well-documented, open interfaces providing the needed functionality.

In any given instance of testing, there may be more than one test interface over which the tests will be executed. In that case, coordination among the different test drivers and synchronization of the actions performed by them will be required. This test coordination role can be played by one of the test drivers, or by and additional entity in the test environment.

## 2.3 Certification Test Specifications

#### 2.3.1 Overview

The main steps involved in the process of developing a VNF certification test specification are as follows:

- Describe a generic architecture for the System Under Test (SUT)
- Collect vDUT Feature Statement (FS)
- Identify SUT configuration and system requirements
- Define a structure for the High-Level Test Plan yields a simple checklist or Test Specification
- Develop the Detailed Test Plan for each item in the High-Level Test Plan.

#### 2.3.2 Generic SUT Architecture

A generic SUT architecture provides an abstract framework within which any specific SUT configuration can fit. The starting point for defining a generic SUT architecture is most often the functional architecture described in the base standards, in combination with pragmatic input on how the industry and open source projects are actually implementing these functional blocks (grouping, bundling, etc.).

In a complex system, it may be required to define several SUT configurations to cover all the specified groups of tests, i.e., multiple test descriptions for same of different SUTs.

Defining the generic architecture and identifying the SUT configurations at an early stage helps to provide a structure for the test descriptions later. The generic test architecture is usually specified as a diagram:



Figure 4: A Generic SUT Architecture

## 2.3.3 Cisco CSP-2100

The Cisco CSP-2100 is one platform on which vendors may certify their VNF. Comparing Generic SUT diagram with Cisco's CSP-2100 as depicted by the following diagram:



#### Figure 5: Cisco CSP-2100 NFV Infrastructure

Cisco<sup>®</sup> Cloud Services Platform (CSP) 2100 is a turn-key, open x86 Linux Kernel-based Virtual Machine (KVM) software and hardware platform for data center network functions

virtualization (NFV). The platform enables users to quickly deploy any Cisco or third-party network virtual service.

Some of CSP-2100 characteristics:

- Red Hat Enterprise Linux (RHEL 7.x) based system.
- Comprised of c-code, python, java, yang, and html
- Cisco Tail-f's ConfD is used as the system database
- Accessible over a GUI, REST APIs, NETCONF, and ConfD CLI
- Secure GUI and REST API over HTTPS
- The basis for the Virtual Machine (vDUT) creation is the Libvirt Manager running QEMU
- Inter-networking is done over soft OpenVswitch (OVS)
- Supported Service image types include: iso, ova, qcow2, and raw
- The CSP specific code is made up of modules:
  - Resources system resource information
  - PNIC Physical Network Interface Card
  - Cluster multiple systems bound together
  - Services network and VM code. It will dynamically create bridges as needed to connect virtual interfaces to PNICs.
- System boots up with a questionnaire asking for all of the management networking information
- All system management interface access is through the ConfD CLI console. There is no exposure to the Linux console to the end user.
- HW is accessible through CIMC interface
- Initial setup is done through CIMC KVM serial console or a physical connection to the serial console on the box
- The CSP-2100 software is version controlled and upgradeable
- CSP-2100 supports such features as LLDP and NTP

CSP-2100 platform provides multiple Test Interfaces. Virtual Devices Under Test (vDUT), and the functional blocks under certification test. Test scope covers two major certification testing aspects:

- Control Plane
- Data Plane

Internal interfaces as shown by the diagram facilitate communication paths between vDUTs and other SUT components. These components should be configured by CLI or API, or it can be driven by data models.

### 2.3.4 Cisco ENCS-5400

The Cisco 5400 Enterprise Network Compute System (ENCS) is a line of compute appliances designed for the Cisco Enterprise Network Functions Virtualization (ENFV) solution. It delivers a new standard of software-defined flexibility and performance, and offers a low total cost of ownership (TCO). The 5400 ENCS is a hybrid platform that combines the best attributes of a traditional router and a traditional server, offering the same functionality with a smaller infrastructure footprint. Offered with the Cisco Integrated Services Virtual Router (ISRv) and NFV Infrastructure Software as the hosting layer, the platform offers a complete solution for a simplified deployment. It also accelerates some functions in hardware such as inter-VM traffic flows, IP Security (IPsec) crypto, and RAID for storage. Built-in lights-out management is also supported with Cisco Integrated Management Controller.

The Cisco 5400 ENCS consists of three models: the 5412, 5408, and 5406. Figure 6 shows the Cisco 5400 Enterprise Network Compute System internal architecture.



Figure 6: Cisco ENCS 5400 Internal Architecture

The philosophy behind the Cisco Enterprise NFV architecture is that there is no lock-in for any specific VNF. Any VNF from any vendor will be hosted on the ENCS 5400 Series.

ENCS loaded with Cisco NFV Infrastructure Software (NFVIS), a pre-packaged Operating System. This customized Linux build provides a consistent environment for hosting and managing enterprise VNFs.

NFVIS integrates multiple components, as shown in Figure 7:

- VNF life cycle management (VNF-M) represented by Cisco Elastic Services Controller Lite (ESC-Lite). Controlling hardware specifics such as storage, memory, network interface connectivity for each instantiated VNF, also provides continuous VNFs health-check mentoring and self-healing capability;
- REST (HTTPS) and NETCONF (SSH) API interfaces to register and deploy services, configure platform, and gather monitoring statistics;
- Open source PNP client used for VNFs Zero Touch Deployment;

• Virtual switching such as vSwitch and SR-IOV.



Figure 7: Cisco NFVIS

While VNFs are the virtual machines that provide networking, functions can be supplied by Cisco, Cisco partners, or any third pary, including end customers or application developers. There are no restrictions on the VNFs that can be hosted as part of the Cisco Enterprise NFV architecture.

The ENC 5400 platform provides multiple Test Interfaces.

### 2.3.5 Suggested Lab Topology

Third-party vDUTs lab requires only a minimal set of equipment. The following diagram depicts Phase I lab topology:



Figure 8: Phase I Lab Topology

## 2.3.6 vDUT Features Statement (FS)

The purpose of a 'Features Statement' is to identify those standardized functions which a vDUT supports, including those which are optional and those which are conditional on the support of other functions.

Where interoperability testing is specified, FS help provide a structure to the test descriptions which may be developed.

In the context of interoperability testing, the FS provides similar functionality to the one provided by the Protocol Implementation Conformance Statement (PICS) for conformance testing. Example of ETSI PICS testing is referenced here: https://portal.etsi.org/mbs/Referenced%20Documents/ts 101 823 02.pdf

The FS can also be used as pro-forma for each vDUT to identify which standardized functions it will support when interoperating with peer vDUTs from other third-party suppliers. Standardized functions and interoperable features are compiled by analyzing the base standards, use cases, flows.

The FS provides the means to compile and organize all the following information. We suggest the following table as a guide which it should be repeated for every vDUT Feature:

<b>Functional Block</b>	VNF	Supports (Yes/No)
vDUT Identification		
Feature ID		
Feature Description		
Reference to base on Standard ETSI Specification		
Feature Status: Mandatory (M), Optional (O), Conditional (C)		
Implementations Requirements such as feature day0 and bootstrap support		
Supported Interoperable Features: VNF on-board, VNF update, PNP ZT, Smart Licensing, etc.		
Supported Options, i.e., Resource commitment Model		
Applicable reference Point		
Supported Test Interfaces		

## 2.3.7 SUT Configuration and System Requirements

The Test Specification clearly identifies and eventually provides a diagram for each valid configuration derived from the generic SUT architecture. A valid configuration is a specific subset of the generic SUT architecture to which a given group of test descriptions apply. Identifying and describing valid SUT configurations at an early stage in the Test Specification development process helps to:

- Structure the test specifications in groups.
- Understand the applicability and scope of each test group. The SUT configurations clearly identifies:
  - The required Functions Under Test;
  - The observed interfaces exposed/consumed by the vDUT
  - Well Defined test interfaces.

vDUT Requirement	Resources	Comments
VIM		
vCPUs		
Memory (RAM)		
Storage		
Bridging Type (Linux, OVS, or SR-IOV)		
Network/Interfaces(s)		
Licensing		
VNF Image format		
VNFM		
Day0/1/2 handing		
Orchestration (CLI, and supported APIs)		
High Availability – Function Clustering support		
Ethernet and other PHY Drivers		

#### System Requirement is to define vDUT compute resources and other limitations:

#### Table 2: VNF System Requirements

vDUT system requirements must be continuously matched with NFVI (CSP-2100) compute resources availability.

#### 2.3.8 Test Plan

The test plan comprises the individual tests listed in the tables that follow. 'Test applicability' defines when the particular individual test will be applied.

- Initial Certification: When a VNF is first on boarded into the ecosystem program
- Vendor re-certification: A re-test following a significant revision made by the vendor to the VNF.
- Cisco re-certification: A re-test at Cisco's discretion following a significant revision to the underlying SUT

Test Case Objective	Instantiation of a single newly-defined vDUT hosted by CSP2100 and ENCS platforms
Test applicability	$\square$ Initial certification $\square$ Vendor re-certification $\square$ Cisco re-certification.
Priority	Mandatory
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>VNF specs: vCPU, Memory, Storage, Bridge type (Linux, OVS, SR-IOV) and Networks</li> <li>vDUT vendor should specify which interfaces it should be utilized (i.e., for OOB management, data, etc.)</li> <li>vDUT image format tar.gz, qcow2, img, and iso</li> <li>vDUT license</li> <li>vDUT vendor should provide file path of day0 file on the mounted configuration driver upon deployment</li> <li>Uploading Day0 configuration options (CDROM, or virtual mounted disk)</li> <li>Uploading day1/2 vDUT configuration (Optional)</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Upload vDUT image into CSP2100 and ENCS/NFVIS inventory</li> <li>Check the syntax of the day0 configuration in order to be consumed properly by the vDUT</li> <li>Instantiate the vDUT instance using CSP2100 and ENCS/NFVIS CLI, WebUI utilities, or REST APIs</li> </ol>
Test Validation	<ol> <li>Validate that vDUT got deployed successfully and it complies with vDUT specifications and requirements</li> <li>Access VNF over console or SSH</li> <li>Verify vDUT license installation</li> <li>Check whether vDUT consumes day0 configuration</li> </ol>
Pass/Failure Criteria	vDUT should be up and accessible over console or SSH
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP _2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

## 2.3.8.1 Single vDUT Instantiation

Table 3: VDUT Instantiation

### 2.3.8.2 Multi vDUTs Creation

Test Case Objective	Instantiation of multiple instances of newly-defined vDUTs hosted by CSP2100 and ENCS platforms
Test applicability	$\boxtimes$ Initial certification $\boxtimes$ Vendor re-certification $\boxtimes$ Cisco re-certification.
Priority	Highly Recommended
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>VNF specs: vCPU, Memory, Storage, Bridge type (Linux, OVS, SR-IOV) and Networks</li> <li>vDUT vendor should specify which interfaces it should be utilized (i.e., for OOB management, data, etc.)</li> <li>vDUT image format tar.gz, qcow2, img, and iso</li> <li>vDUT license</li> <li>vDUT vendor should provide file path of day0 file on the mounted configuration driver upon deployment</li> <li>Uploading Day0 configuration options (CDROM, or virtual mounted disk)</li> <li>Uploading day1/2 vDUT configuration (Optional)</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Upload vDUT image into CSP2100 and ENCS/NFVIS inventory</li> <li>Check the syntax of the day0 configuration in order to be consumed properly by the vDUTs</li> <li>Instantiate multiple (2 or more) vDUT instances using CSP2100 and ENCS REST APIs</li> </ol>
Test Validation	<ol> <li>Validate that all vDUTs got deployed successfully and they comply with vDUT specifications and requirements</li> <li>Access VNF over console or SSH</li> <li>Verify vDUT license installation</li> <li>Check whether vDUT consumes day0 configuration</li> </ol>
Pass/Failure Criteria	vDUT should be up and accessible over console or SSH
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cis co_CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_C SP_2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

Table 4: Multi vDUT creation

Test Case Objective	Termination of a single newly-defined vDUT hosted by CSP2100 and ENCS platforms
Test applicability	$\square$ Initial certification $\square$ Vendor re-certification $\square$ Cisco re-certification.
Priority	Mandatory
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over mgmt IP address with admin privileges</li> <li>Single vDUT instance should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Delete the vDUT instance using CSP2100 and ENCS/NFVIS CLI, WebUI utilities, or REST APIs</li> </ol>
Test Validation	<ol> <li>Validate that vDUT was deleted successfully and all reserved compute resources have been released.</li> <li>Verify vDUT license has been revoked and returned to free licenses pool</li> </ol>
Pass/Failure Criteria	vDUT should be removed from CSP2100 and ENCS/NFVI, compute resources, and license has been released
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco_CSP_21 00_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_2100_RE ST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.3 Single vDUT Termination

Table 5: Single vDUT Termination

Test Case Objective	Termination of Multiple vDUTs hosted by CSP2100 and ENCS platforms
Test applicability	Initial certification 🗌 Vendor re-certification 🗌 Cisco re-certification.
Priority	Highly Recommended
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>Multiple vDUT instances should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Delete all vDUT instances using CSP2100 and ENCS/NFVIS REST APIs</li> </ol>
Test Validation	<ol> <li>Validate that vDUTs got deleted successfully and all reserved compute resources have been released.</li> <li>Verify vDUT license has been revoked and returned to free licenses pool</li> </ol>
Pass/Failure Criteria	vDUT should be removed from CSP2100 and ENCS/NFVI, compute resources, and license has been released
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco         CSP_2100_Command_Ref.html         http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_2100_REST_API_Guide.pdf         http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.4 Multiple vDUT Termination

Table 6: Multi vDUT Termination

Test Case Objective	Patching software to an active vDUT hosted by CSP2100 and ENCS platforms
Test applicability	Initial certification Vendor re-certification Cisco re-certification.
Priority	Mandatory in case where upgrade is via a patch, else not applicable.
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>Single vDUT instance should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Upload vDUT patch software into CSP2100 and ENCS/NFVIS inventory</li> <li>Patch additive software into vDUT instance using CSP2100 and ENCS/NFVIS CLI, WebUI utilities, or REST APIs</li> </ol>
Test Validation	<ol> <li>Validate that vDUT patch got deployed successfully</li> <li>Access VNF over console or SSH</li> <li>Validate that software update process has no functional impact on vDUT</li> </ol>
Pass/Failure Criteria	vDUT should maintain functionality while patching software update
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco         CSP_2100_Command_Ref.html         http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_2100_REST_API_Guide.pdf         http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.5 vDUT Configuration and Package Management

Table 7: vDUT Configuration and Package Management

Test Case Objective	Validate Operational state changes on operational vDUT
Test applicability	$\boxtimes$ Initial certification $\boxtimes$ Vendor re-certification $\boxtimes$ Cisco re-certification.
Priority	Mandatory
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>Single vDUT instance should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Validate vDUT functionality after x86 SUT (CSP2100 and ENCS5400) force to reboot over CLI or WebUI</li> <li>Validate the following the following operational states on an active vDUT:         <ul> <li>a. Power-on and power-off</li> <li>b. Reset   Restart (soft reset)</li> </ul> </li> </ol>
Test Validation	<ol> <li>Validate that vDUT recover from operational state change</li> <li>Access VNF over console or SSH</li> </ol>
Pass/Failure Criteria	vDUT should recover from operational state change
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco_ CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_ 2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

## 2.3.8.6 vDUT Operational State Changes

Table 8: vDUT State Changes

Test Case Objective	Validate vDUT Operation while CSP2100 and ENCS platform upgrade
Test applicability	$\Box$ Initial certification $\Box$ Vendor re-certification $\boxtimes$ Cisco re-certification.
Priority	Mandatory
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>Single vDUT instance should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Mount CSP2100 and ENCS NFVIS OS file into CIMC virtual terminal disk</li> <li>Could reboot from CIMC</li> <li>While CSP2100 and ENCS booting up; Press F6 to access "BIOS boot up sequence" menu</li> <li>Select CIMC DVD mounted image option, then continue booting</li> <li>Validate vDUT functionality after x86 SUT (CSP2100 and ENCS5400) force to reboot over CLI or WebUI</li> </ol>
Test Validation	<ol> <li>Validate that vDUT recovered after CSP2100 and ENCS finish OS upgrading</li> <li>Access VNF over console or SSH</li> </ol>
Pass/Failure Criteria	vDUT should recover from infrastructure/platform OS upgrade
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp 2100/command ref/Cisco CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp 2100/rest api/Cisco CSP _2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

## 2.3.8.7 SUT Infrastructure Upgrade

Table 9: SUT Infrastructure Upgrade

Test Case Objective	Validate vDUT functionality and service continuity after boosting pre-allocated compute resources
Test applicability	$\boxtimes$ Initial certification $\boxtimes$ Vendor re-certification $\boxtimes$ Cisco re-certification.
Priority	Mandatory
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>Single vDUT instance should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Stop vDUT</li> <li>Increase pre-allocated vDUT resources. The change should be bounded within SUT available resources         <ul> <li>a. vCPU</li> <li>b. Memory</li> <li>c. Storage</li> <li>d. vNICs</li> </ul> </li> <li>Start vDUT</li> </ol>
Test Validation	<ol> <li>Validate vDUT functionality after resources boost.</li> <li>Access VNF over console or SSH</li> </ol>
Pass/Failure Criteria	1. Check resource availability after scaling-up/down hence to ensure that resources have been properly allocated or released
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP _2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

## 2.3.8.8 vDUT Scaling-Up and Scaling-Down (Vertical Scalability)

Table 10: vDUT Scale up / Scale down

Test Case Objective	Validate scaling out and scaling vDUT instances hosted by CSP2100 and ENCS platforms
Test applicability	$\square$ Initial certification $\square$ Vendor re-certification $\square$ Cisco re-certification.
Priority	Optional
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>VNF specs: vCPU, Memory, Storage, Bridge type (Linux, OVS, SR-IOV) and Networks</li> <li>vDUT vendor should specify which interfaces it should be utilized (i.e., for OOB management, data, etc.)</li> <li>vDUT image format tar.gz, qcow2, img, and iso</li> <li>vDUT license</li> <li>vDUT vendor should provide file path of day0 file on the mounted configuration driver upon deployment</li> <li>Uploading Day0 configuration options (CDROM, or virtual mounted disk)</li> <li>Uploading day1/2 vDUT configuration (Optional)</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Upload vDUT image into CSP2100 and ENCS/NFVIS inventory</li> <li>Check the syntax of the day0 configuration in order to be consumed properly by the vDUTs</li> <li>Instantiate multiple vDUT instances using CSP2100 and ENCS REST APIs</li> <li>Starts terminating vDUT instances while validating CSP2100 and ENCS resource quota</li> </ol>
Test Validation	<ol> <li>Validate CSP2100 and ENCS resources utilization. Scaling vDUT instances should not exceed platform available resources</li> <li>Validate CSP2100 and ENCS resources availability. vDUT instances termination should release allocated resources</li> </ol>
Pass/Failure Criteria	CSP2100 and ENCS should accommodate vDUT instances up to available resources. vDUT termination should recover allocated resources.
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp 2100/command ref/Cisco CSP 2100 Command Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp 2100/rest api/Cisco CSP 2100 REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

## 2.3.8.9 vDUT Scaling-In and Scaling-Out (Horizontal Scalability)

Table 11: vDUT Scale In / Scale Out

Test Case Objective	Validate vDUT secure communicate paths outside and within CSP2100 and ENCS/NVIS OS components
Test applicability	$\square$ Initial certification $\square$ Vendor re-certification $\square$ Cisco re-certification.
Priority	Mandatory
Prerequisites	<ol> <li>CSP2100 and ENCS are accessible over management IP address with admin account privileges</li> <li>Single vDUT instance should be active and accessible over console port</li> </ol>
Test Procedure	<ol> <li>From vendor's documentation, determine management interfaces expected on vDUT (for example, ssh, SNMP, HTTPS)</li> <li>From vendor's documentation, determine nature of any API present on a management interface(s) (for example, REST, RESTCONF, Netconf etc.)</li> </ol>
Test Validation	<ol> <li>Validate connectivity to expected ports/services in (1) above</li> <li>Validate API(s) identified in (2) above are active</li> <li>Check for unexpected or malicious traffic generated by vDUT</li> </ol>
Pass/Failure Criteria	vDUT should allow management connections to expected management interfaces
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco_CSP_2100_Command_Ref.html         http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_2100_REST_API_Guide.pdf         http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.10 vDUT Management Connectivity

Table 12: vDUT Management Connectivity

Test Case Objective	Validate vDUT to integrate with external services
Test applicability	$\square$ Initial certification $\square$ Vendor re-certification $\square$ Cisco re-certification.
Priority	Highly Recommended
Prerequisites	<ol> <li>vDUT is up</li> <li>vDUT has at least admin user account which permits wide privileged access</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Upload vDUT image into CSP2100 and ENCS/NFVIS inventory</li> <li>Edit day0 configuration thus incorporate the following services configuration:         <ul> <li>a. DNS server(s)</li> <li>b. NTP server(s)</li> <li>c. DHCP Client</li> <li>d. Zero-touch (Plug-n-Play Open client)</li> </ul> </li> <li>Check the syntax of the day0 configuration in order to be consumed properly by the vDUTs</li> <li>Instantiate single vDUT instances using CSP2100 and ENCS REST APIs</li> <li>Connect to vDUT, and</li> </ol>
Test Validation	Validate vDUT accepts external services configuration
Pass/Failure Criteria	vDUT should configure and document external services supportability
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco         CSP_2100_Command_Ref.html         http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP         2100_REST_API_Guide.pdf         http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.11 vDUT Integration with External Services

Table 13: vDUT Integration with External Services

## 2.3.8.12 Data Path Integrity

Test Case Objective	Validate vDUT north-south data path using IPv4 and IPv6 Pings
Test applicability	$\boxtimes$ Initial certification $\boxtimes$ Vendor re-certification $\boxtimes$ Cisco re-certification.
Priority	Optional
Prerequisites	<ol> <li>vDUT is up</li> <li>vDUT has at least admin user account which permits wide privileged access</li> <li>vDUT has day0 configuration. All required bridging, pNICs, and vNICs should be up and active</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS Web UI or SSH CLI</li> <li>Connect to vDUT as admin user via console or management interface</li> <li>Configure day1/2 vDUT interfaces configuration</li> <li>Starts continuous IPv4 and IPv6 Ping process from vDUT to an outside IP address</li> </ol>
Test Validation	Check vDUT, CSP2100, and ENCS interface counters. They all should reporting that IP Ping packets got forwarded properly
Pass/Failure Criteria	vDUT, CSP2100, and ENCS should not report any ping loss
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco_ CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP _2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

Table 14: vDUT Data Path Integrity

Test Case Objective	Validate vDUT high availability support
Test applicability	$\square$ Initial certification $\square$ Vendor re-certification $\square$ Cisco re-certification.
Priority	Optional – applies only if vDUT has H.A. capability
Prerequisites	<ol> <li>vDUT must support HA functionality, or test is not applicable.</li> <li>Two vDUT instances are up on different CSP2100 or ENCS platforms</li> <li>vDUTs have at least admin user account which permits wide privileged access</li> <li>vDUT has day0 configuration. All required bridging, pNICs, and vNICs should be up and active</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Connect to vDUTs as admin user</li> <li>Configure day1/2 vDUT high-availability configuration. vDUT peer (virtual cluster) should operate one of the following:         <ul> <li>a. Active/active; or, b. Active/standby</li> </ul> </li> <li>Start a continuous ping from a device external to the SUT to the vDUT</li> <li>Force reload active vDUT</li> </ol>
Test Validation	Check vDUT, CSP2100, and ENCS interface counters. They all should reporting that IP Ping packets got forwarded properly. Record number of pings lost, and time duration of switchover.
Pass/Failure Criteria	<ol> <li>HA partner vDUT should assume processing of traffic</li> <li>Any packet loss should be inline with vendor guidance</li> </ol>
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco         CSP_2100_Command_Ref.html         http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_2100_REST_API_Guide.pdf         http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.13 vDUT High Availability

Table 15: vDUT High Availability

Test Case Objective	Validate vDUT backup and restore support
Test applicability	$\boxtimes$ Initial certification $\boxtimes$ Vendor re-certification $\boxtimes$ Cisco re-certification.
Priority	Optional
Prerequisites	<ol> <li>Test applicable to CSP-2100 only</li> <li>Single vDUT instance should be up</li> <li>vDUTs have at least admin user account which permits wide privileged access</li> <li>vDUT has day0 configuration. All required bridging, pNICs, and vNICs should be up and active</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 WebUI or SSH CLI</li> <li>Backup/snapshot vDUT instance</li> <li>Terminate active vDUT instance</li> <li>Load backup vDUT instance file from CSP2100 and ENCS file inventory</li> <li>Spin a new vDUT instance following 0test procedure</li> </ol>
Test Validation	<ol> <li>Check vDUT backup file store on CSP2100 file inventory</li> <li>vDUT restored with day0 configuration</li> </ol>
Pass/Failure Criteria	vDUT should support backup and restore
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco_CSP_2100_Command_Ref.html         http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_2100_REST_API_Guide.pdf         http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure-software/index.html

## 2.3.8.14 vDUT Backup and Recovery

Table 16: vDUT Backup & Recovery

Test Case Objective	vDUT reaction to synthetic error injection
Test applicability	Initial certification Vendor re-certification Cisco re-certification.
Priority	Highly Recommended
Prerequisites	<ol> <li>SUT with multiple vDUT instances should be up leaving enough compute resources for additional vDUT instance</li> <li>vDUT image loaded into SUT resource storage</li> </ol>
Test Procedure	<ol> <li>Login into CSP2100 and ENCS/NFVIS WebUI or SSH CLI</li> <li>Spin a new vDUT instance by requesting proper compute resources from SUT</li> <li>Once vDUT is running, inject synthetic error:         <ul> <li>a. storage space exhaustion. Document how the vDUT reacts during operation while allocated storage is near full and exhausted.</li> <li>b. External network connectivity failure. Document how the vDUT reacts while one of the data links is failed.</li> <li>c. Internal platform SUT connectivity failure (vSwitch issue). Document how the VNF reacts while VIM vSwitch is failed.</li> </ul> </li> <li>For each, document vDUT behavior and any error generation.</li> </ol>
Test Validation	vDUT should generate error when platform resources are unavailable, and should recover from the error condition once the cause resolved. vDUT vendor should share error logs/traps/notifications and troubleshooting operational guide.
Pass/Failure Criteria	vDUT should recover from error condition once the cause resolved
References	http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/command_ref/Cisco_ CSP_2100_Command_Ref.html http://www.cisco.com/c/en/us/td/docs/switches/datacenter/csp_2100/rest_api/Cisco_CSP_ 2100_REST_API_Guide.pdf http://www.cisco.com/c/en/us/products/routers/enterprise-nfv-infrastructure- software/index.html

## 2.3.8.15 vDUT Error Handling

Table 17: Test Plan Template

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