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GROUP SPECIFICATION

Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Specification of non-functional requirements of reliability

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Network Functions Virtualisation (NFV).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document specifies the non-functional reliability requirements for parts of NFVI and NFV-MANO, which are listed below:

- Non-functional reliability requirements for physical resources and virtualised resources.
- Non-functional reliability requirements for Virtualised Infrastructure Manager (VIM).
- Non-functional reliability requirements for Container Infrastructure Service Management (CISM).
- Non-functional reliability requirements for Virtualised Network Function Manager (VNFM).
- Non-functional reliability requirements for NFV Orchestrator (NFVO).

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found in the ETSI docbox.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

[i.1] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.2] ETSI GS NFV-REL 001: "Network Functions Virtualisation (NFV); Resiliency Requirements".

[i.3] ETSI GS NFV-REL 003: "Network Functions Virtualisation (NFV); Reliability; Report on Models and Features for end-to-end Reliability".

[i.4] ETSI GS NFV-IFA 031: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Requirements and interfaces specification for management of NFV-MANO".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GR NFV 003 [i.1] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.1] apply.

4 Overview

4.1 Introduction

Reliability plays a crucial role for operators in maintaining the stability of service provision. The specification of reliability requirements is one of the approaches to improve the reliability of networks based on NFV. For example, ETSI GS NFV-REL 001 [i.2] provides analysis, requirements, engineering and deployment guidelines for maintaining reliability and availability in a virtualised environment, including network function migration, failure detection, state management, etc. Additionally, ETSI GS NFV-REL 003 [i.3] studies the reliability estimation model and develops NFV software upgrade mechanisms based on NFV reliability and availability methods. However, it lacks the coordination from the infrastructure layer, potentially leading to risks such as long failure recovery times and significant impact on providing services.

4.2 General principles

The non-functional reliability requirements in the present document focus on parts of NFVI and NFV-MANO to reinforce coordination from the reliability perspective. This includes reliability requirements for physical resources, virtualised resources, and resource management requirements for Virtualised Infrastructure Manager (VIM), Virtualised Network Function Manager (VNFM) and NFV Orchestrator (NFVO).

5 Non-functional Requirements of Reliability

5.1 Introduction

Generally, high reliability can be achieved by enabling fault recovery processes in case the fault or disaster cause severe damage. In such cases, a redundant mechanism can be an effective and important technology to be applied in the reliability architecture, allowing redundant data or resources to take over and continue providing services (see note). An example to improve reliability based on NFV architecture is introduced in Annex A, illustrating where redundancy technologies can be applied. Consequently, the requirements for arranging redundancy and recovering process are further specified based on NFV architecture.

This clause introduces the specification of non-functional reliability requirements for parts of NFVI and NFV-MANO, emphasizing coordination and the capability to accelerate fault recovery processes. It includes reliability requirements for physical resources, virtualised resources, and resource management requirements for VIM, CISM, VNFM and NFVO, which are further specified in clauses 5.2 to 5.7 respectively.

NOTE: Possible redundant mechanisms can be active-standby, active-active for physical resources, replication for data, load balancing, network multi-homing (i.e. connecting a network node like a computer, server, or even a network itself to more than one network), etc.

5.2 Specific reliability requirements for physical resources

Table 5.2-1: Non-functional reliability requirements for NFVI physical resources

Numbering	Non-functional requirements description
Nfvi.prr.001	An implementation of NFVI should support redundancy for physical resources within each resource zone (see note 1 and note 3).
Nfvi.prr.002	In the event of a fault or disaster, an NFVI implementation should support fault recovery by switching to redundant physical resources within the affected resource zone (see note 2).
Nfvi.prr.003	An NFVI implementation should support more than one resource zone.
Nfvi.prr.004	An NFVI implementation should support physical resources redundancy within each NFVI-POP.
Nfvi.prr.005	An NFVI implementation should support physical resources redundancy across multiple resource zones.
Nfvi.prr.006	In the event of a fault or disaster, an NFVI implementation should support fault recovery by switching to redundant physical resources within each NFVI-POP.
Nfvi.prr.007	In the event of a fault or disaster, an NFVI implementation should support fault recovery by switching to redundant physical resources in other NFVI-POPs.
NOTE 1: Examples of physical resources are physical compute nodes, power supply system and heat dissipation systems. NOTE 2: Example of fault recovery is switching to the redundant power supply system and heat dissipation system. NOTE 3: The definition of Resource zones can be referred to ETSI GR NFV 003 [i.1].	

5.3 Specific reliability requirements for virtual resources

NOTE: In the context of the present document, and in the requirements specified in the present clause, "virtual resources" refer to "virtualised resources" such as virtual machines managed by VIM and OS containerized workloads managed by CISM.

Table 5.3-1: Non-functional reliability requirements for NFVI virtual resources

Numbering	Non-functional requirements description
Nfvi.vrr.001	In the event of a fault or disaster, an NFVI implementation should support migrating to virtual resources in other resource zones.
Nfvi.vrr.002	An NFVI implementation should support mechanisms such as restart, recreation, scaling, online migration, evacuation and backup of virtual resources within each resource zone to achieve fault recovery (see note).
Nfvi.vrr.003	An NFVI implementation should support mechanisms such as restart, recreation, scaling, online migration, evacuation and backup of virtual resources across multiple resource zones to achieve fault recovery (see note).
Nfvi.vrr.004	An NFVI implementation should support mechanisms such as restart, recreation, scaling, online migration, evacuation and backup of virtual resources within each NFVI-POP to achieve fault recovery (see note).
Nfvi.vrr.005	An NFVI implementation should support mechanisms such as restart, recreation, scaling, online migration, evacuation and backup of virtual resources across multiple NFVI-POPs to achieve fault recovery (see note).
NOTE: Backup of virtual resources refers to the process of creating copies of virtual assets (like virtual machines, virtual disks and configurations) and storing them in a separate location. Evacuation of virtual resources typically refers to the process of moving running Virtual Machines (VMs) and their associated data from one compute node to another compute node.	

5.4 Specific reliability requirements for VIM

Table 5.4-1: Non-functional reliability requirements for VIM

Numbering	Non-functional requirements description
Vim.vimr.001	A VIM implementation should support high reliability of VIM components (see note).
NOTE: Refer to clause 4.3 of ETSI GS NFV-IFA 031 [i.4] for the concept of "component" related to NFV-MANO functional entities.	

5.5 Specific reliability requirements for CISM

Table 5.5-1: Non-functional reliability requirements for CISM

Numbering	Non-functional requirements description
Cism.cismr.001	A CISM implementation should support high reliability of CISM components (see note).
NOTE: Refer to clause 4.3 of ETSI GS NFV-IFA 031 [i.4] for the concept of "component" related to NFV-MANO functional entities.	

5.6 Specific reliability requirements for VNFM

Table 5.6-1: Non-functional reliability requirements for VNFM

Numbering	Non-functional requirements description
Vnfm.vnfmr.001	A VNFM implementation should support high reliability for VNFM components (see note).
NOTE: Refer to clause 4.3 of ETSI GS NFV-IFA 031 [i.4] for the concept of "component" related to NFV-MANO functional entities.	

5.7 Specific reliability requirements for NFVO

Table 5.7-1: Non-functional reliability requirements for NFVO

Numbering	Non-functional requirements description
Nfvo.nfvor.001	An NFVO implementation should support high reliability of NFVO components (see note).
NOTE: Refer to clause 4.3 of ETSI GS NFV-IFA 031 [i.4] for the concept of "component" related to NFV-MANO functional entities.	

Annex A (informative): An example of reliability architecture

A.1 Introduction

This clause introduces an example to improve reliability based on the NFV architecture. The structure and components of multiple NFVI-POPs and multiple resource zones as the foundation of the reliability architecture are depicted in clauses A.2 and A.3 respectively. In this example, it is assumed that VNF instances are using resources residing in a single resource zone. This example does not preclude other deployment scenarios whereby VNF instances could also be deployed using resources from multiple resource zones.

A.2 Multiple NFVI-POPs

A.2.1 General principles

The architecture is composed of multiple NFVI-POPs, each containing multiple resource zones. Coordination among different NFVI-POPs ensures redundancy, thereby maintaining the reliability of the overall system. The NFVI-POPs can provide redundant data to each other, or there could be a centralized NFVI POP to provide redundant data to other NFVI-POPs. In this way, when the whole NFVI-POP is affected or destroyed, data can be recovered from backup in other NFVI-POPs and the service can be provided by other NFVI-POPs as soon as possible.

A.2.2 Structure of multiple NFVI-POPs architecture for redundancy

This clause introduces the structure for multiple NFVI-POPs architecture for redundancy. Figure A.2.2-1 shows an example as three NFVI-POPs. There are multiple resource zones in each NFVI-POPs. The components of multiple resource zones are further introduced in clause A.3. The resource zones within different NFVI-POPs are physically isolated.

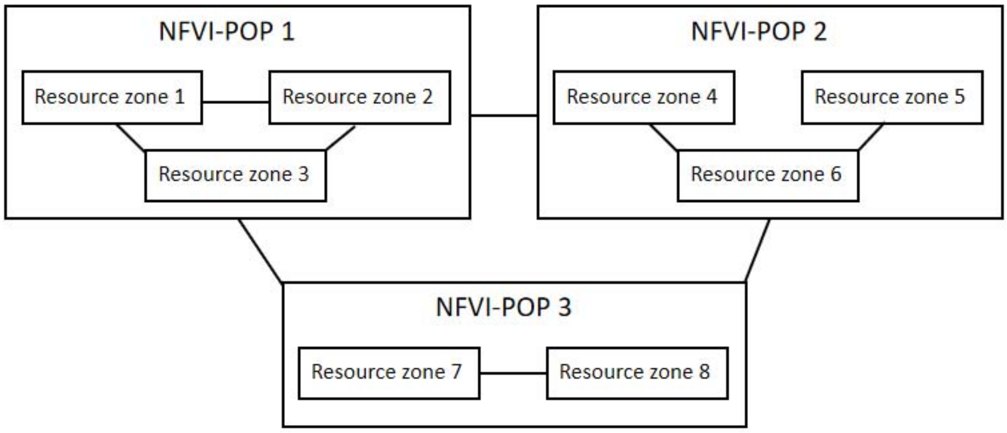

Figure A.2.2-1: An example for multiple NFVI-POPs architecture for redundancy

A.3 Multiple resource zones

A.3.1 General principles

The architecture is composed of layers (e.g. the Resource layer and the Network element layer) and multiple resources zones, where the components in each layer are deployed in the resource zones. Resource zones provide physical isolation to avoid the effect of faults, failures or disaster from one resource zone affecting the other resource zones.

A.3.2 Structure of multiple resource zones architecture

This clause introduces the structure of multiple resource zones architecture. In figure A.3.2-1, it shows an example as three resource zones. The components of the architecture are explained in detail as follows:

- NFVI-POP: It consists of multiple resource zones:
  - Resource zone: The definition can be found in ETSI GR NFV 003 [i.1]. It consists of computing, storage and network devices, providing cloud resources and services. The number of resource zones in an NFVI-PoP depends on the operator's deployment policy, which can be based also on the kind of application/services to deploy.
  - Resource layer: It includes NFVI, VIM and CISM. NFVI can provide the physical resource instances and virtual resource instances for the network element layer. VIM and CISM are responsible for managing virtualised resources and containerized workloads respectively.
  - Network element layer: It consists of VNF instances and VNFM. The VNF instances are deployed in each resource zone, where the coordination mode among different VNF instances could be load balanced or primary/secondary mode. VNFM is responsible to provide management for the corresponding VNF instances.

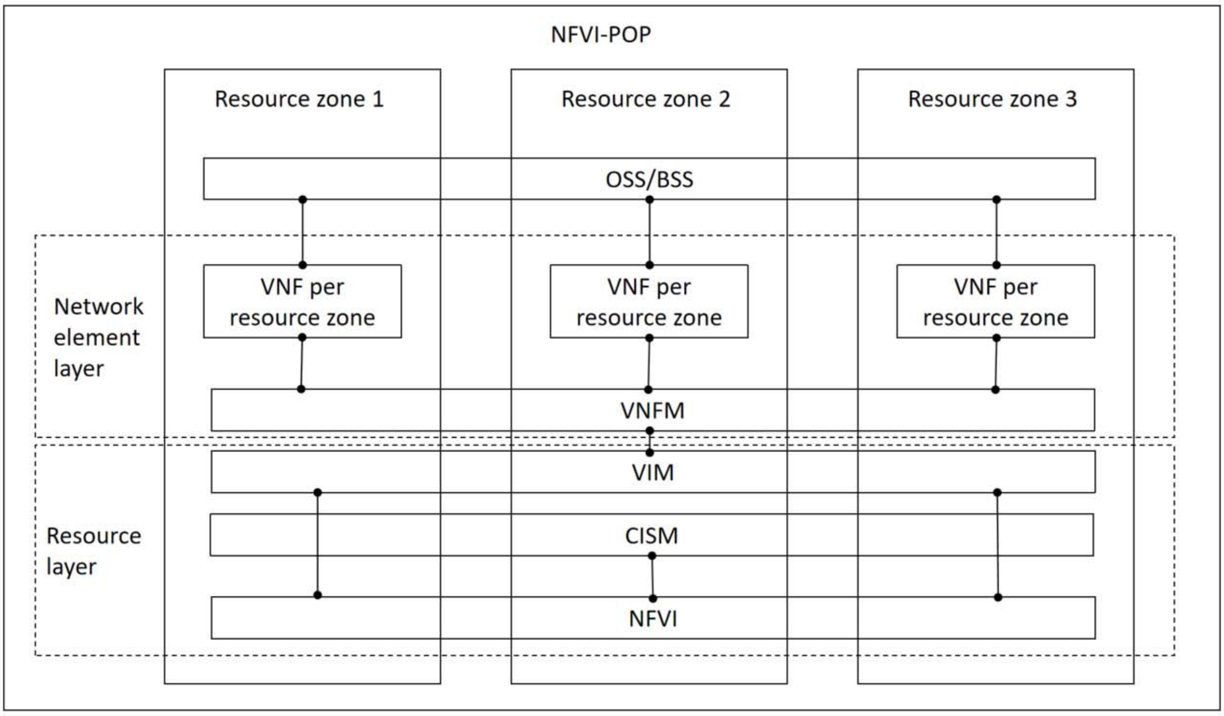

Figure A.3.2-1: An example for multiple resource zones architecture

The coordination through layers accelerates the recovery from faults, failures or disaster happening in one resource zone with the help from the other resource zones. To facilitate recovery, redundancy data, synchronization mechanisms, etc., could be applied.

NOTE: The present document does not describe how coordination between layers can be achieved.

A.3.3 Use cases for multiple resource zones architecture

This clause introduces several use cases considering the multiple resource zones architecture for redundancy to explain how to improve the reliability through advanced fault recovery processes. Generally, fault recovery can be based on the resources within the resource zone or using resources from other resource zones.

Different cases can be categorized according to the layer where the fault occurs and the fault recovery process in effect. When the fault is detected in the Network element layer, VNFM asks NFVO to grant resources and NFVO decides to grant within the same resource zone or with other resource zones When the fault is detected in the Resource layer, VIM or CISM asks NFVO to grant resources and NFVO decides to grant resources within the same resource zone or in other resource zones. Four use cases are described in detail as examples for supporting fault recovery process considering the multiple resource zones architecture. Cases 1 and 2 describe the fault detected in the Network element layer, while cases 3 and 4 describing the case the fault is detected in the Resource layer:

- Case 1: VNF#1 in resource zone#1 encounters a fault. NFVO decides to recover it within the same resource zone and asks VNFM to initiate and execute the fault recovery process. Therefore, VNF#2 is created by using the resource within the resource zone#1, replacing VNF#1 for providing the intended functionality. Case 1 is depicted in figure A.3.3-1.

- Case 2: VNF#3 in resource zone#1 encounters a fault. NFVO decides to recover it in other resource zones and asks VNFM initiate and execute fault recovery process. Therefore, with the appropriate management which considers multiple resource zones, VNF#4 is created by using the resource in resource zone#2 , replacing VNF#1 for providing the intended functionality. Case 2 is depicted in figure A.3.3-2. Additionally, VNF#4 can be created in resource zone 3; this depends on the decision taken by the management layer.

- Case 3: VM#1 in resource zone#3 fails. NFVO decides to recover it within the same resource zone and asks VIM to initiate and execute the fault recovery process. There could be two possible options for recovery. One option is to reboot VM#1 and the other option is to create a new VM as VM#2, taking place of VM#1 to provide service. Case 3 is depicted in figure A.3.3-3.

- Case 4: VM#3 in resource zone#1 fails. NFVO decides to recover it in other resource zones and asks VIM initiate and execute fault recovery process. With the appropriate management among resource zones, VM#4 is created in resource zone#2, replacing VM#3 for providing the intended functionality. Case 3 is depicted in figure A.3.3-4. Additionally, VM#4 can be created in resource zone#3; this depends on the decision from management layer.

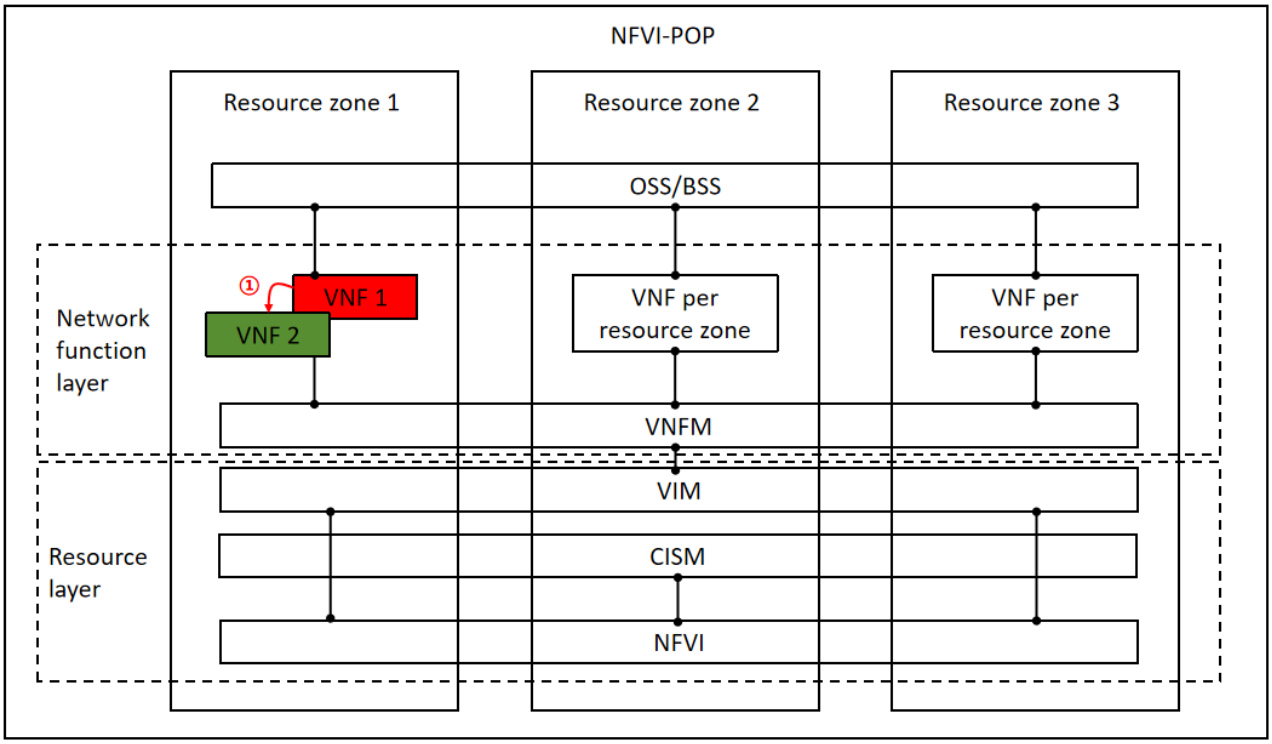

Figure A.3.3-1: Use case 1 for multiple resource zones architecture for redundancy

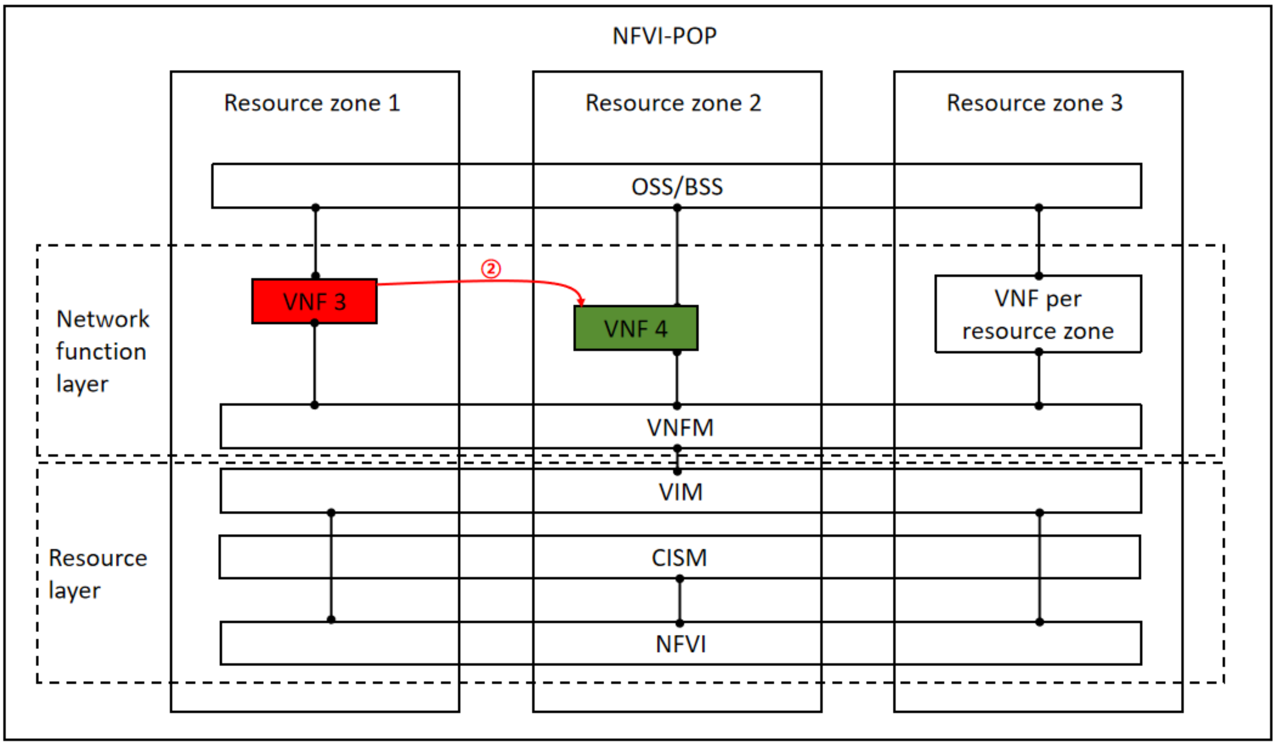

Figure A.3.3-2: Use case 2 for multiple resource zones architecture

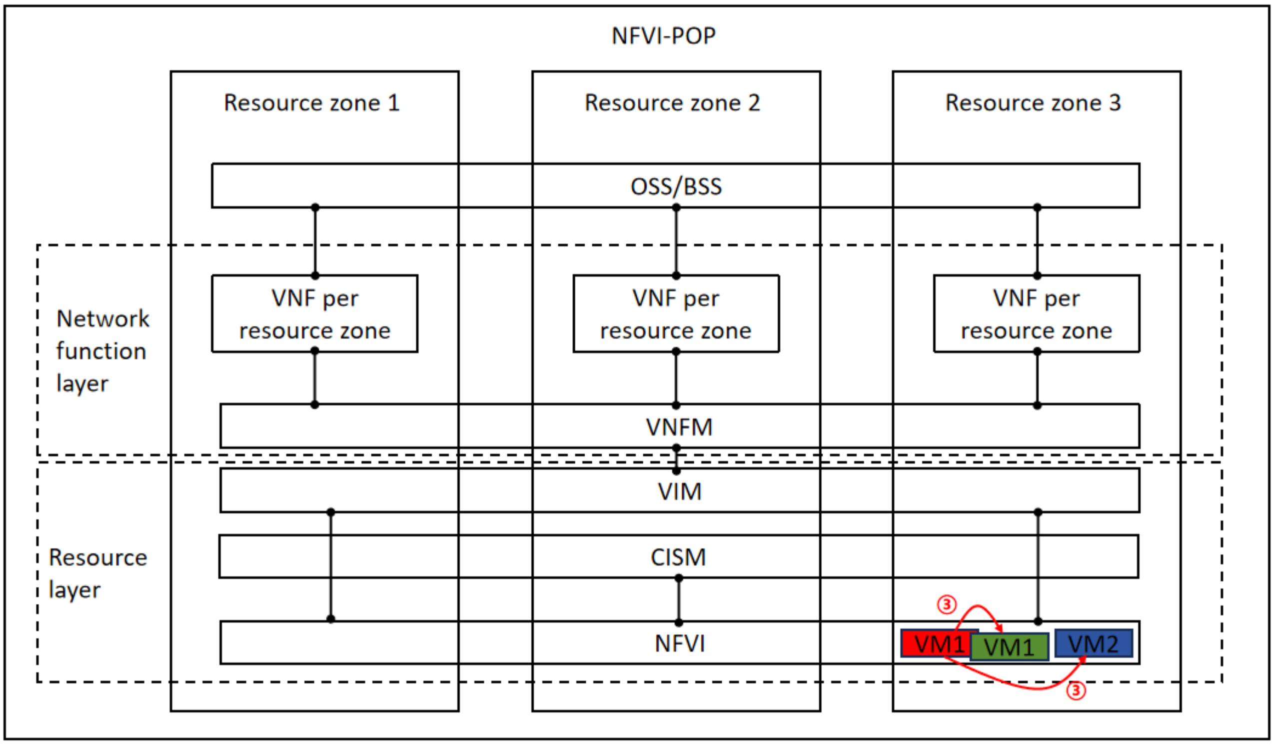

Figure A.3.3-3: Use case 3 for multiple resource zones architecture for redundancy

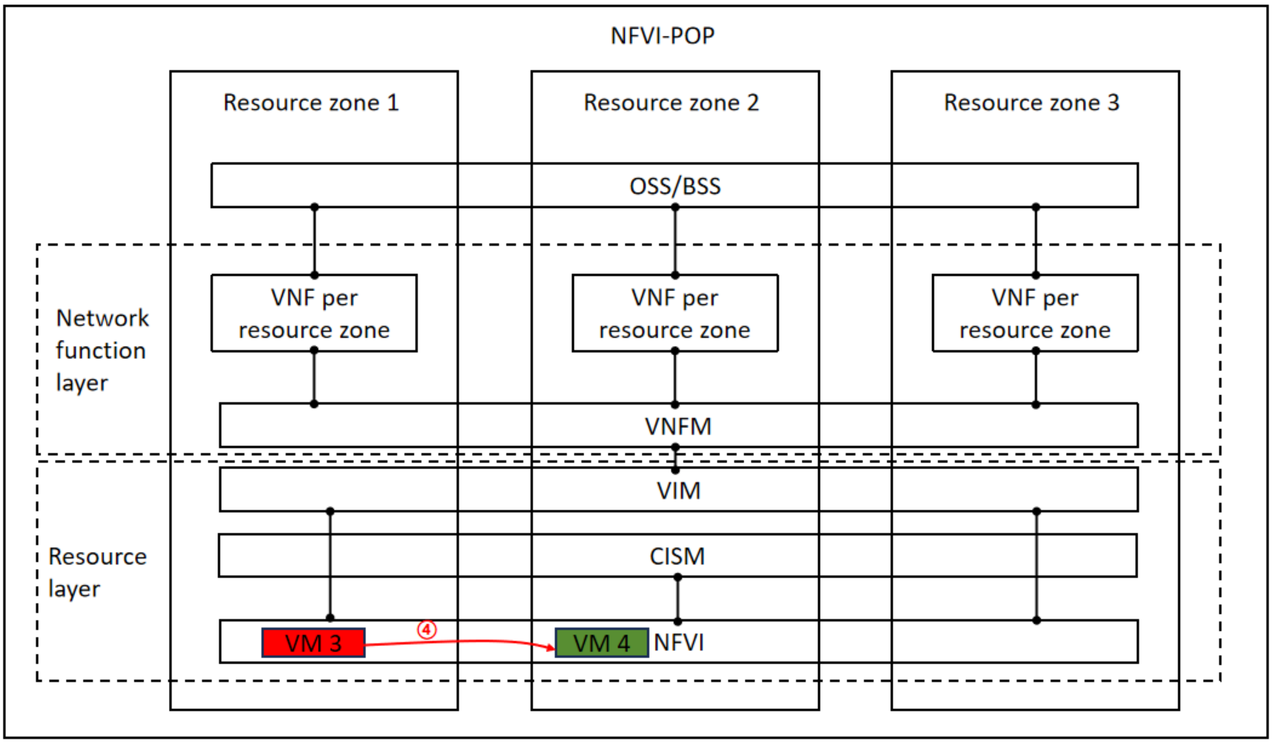

Figure A.3.3-4: Use case 4 for multiple resource zones architecture for redundancy

Annex B (informative): Change history

Date	Version	Information about changes
July 2024	0.0.1	First draft, introducing the document skeleton and scope.
April 2025	0.1.0	Stable draft, incorporates approved contributions: • NFVIFA(25)000023r2_4_Overview • NFVIFA(25)000045r3_Annex_A_for_IFA055 • NFVIFA(25)000055r1_IFA055_1_Scope_and_3_Definitions_and_abbreviations • NFVIFA(25)000077_IFA055_1_Scope • NFVIFA(25)000054r6_IFA055_5_x_Specific_requirements_for_reliability
June 2025	0.2.0	• NFVIFA(25)000151r1_IFA055 stable draft review comments

History

Document history		
V5.3.1	August 2025	Publication