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Network Functions Virtualisation (NFV);
Ecosystem;
Report on NFVI Node Physical Architecture Guidelines
for Multi-Vendor Environment

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Reference

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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

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1 Scope

The present document provides guidelines for NFVI Node physical architecture. It is limited to the hardware resources - compute, storage, and network - needed to construct and support the functions of an NFVI Node. This includes physical components needed to house and interconnect nodes.

The present document also provides some examples on "building" specific NVFI Node configurations and addresses related issues such as reliability and energy efficiency.

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.

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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 not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GS NFV-INF 001 (V1.1.1): "Network Functions Virtualisation (NFV); Infrastructure Overview".

[i.2] IEEE 802.3ae™ Standard for Information technology: "Telecommunications and information exchange between systems - Local and metropolitan area networks, - Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications, Amendment 1: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation".

[i.3] Introducing data centre fabric, the next-generation Facebook™ data center network.

NOTE: Available at https://code.facebook.com/posts/360346274145943/introducing-data-center-fabric-the-next-generation-facebook-data-center-network/.

[i.4] ETSI EN 300 019-1-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations".

[i.5] ETSI EN 300 753: "Environmental Engineering (EE); Acoustic noise emitted by telecommunications equipment".

[i.6] NEBS GR-63: "NEBS Requirements: Physical Protection".

[i.7] ASHRAE: "Thermal Guidelines for Data Processing Environment", 3rd edition, 2012.

[i.8] ETSI GS NFV 002 (V1.2.1): "Network Functions Virtualisation (NFV); Architectural Framework".

[i.9] ETSI GS NFV-INF 003 (V1.1.1): "Network Functions Virtualisation (NFV); Infrastructure; Compute Domain".

[i.10] ETSI GS NFV-MAN 001 (V1.1.1): "Network Functions Virtualisation (NFV); Management and Orchestration".

[i.11] EIA/ECA-310, Revision E, December 1, 2015: "Electronic Components Industry Association (ECIA)".

[i.12] ETSI ETS 300 119-4: "Equipment Engineering (EE); European telecommunication standard for equipment practice; Part 4: Engineering requirements for subracks in miscellaneous racks and cabinets".

[i.13] ETSI GS NFV-REL 003 (V0.3.0) (08-2015): "Network Functions Virtualisation (NFV); Reliability; Report on Models and Features for E2E Reliability".

NOTE: Available at https://docbox.etsi.org/ISG/NFV/Open/Drafts/REL003_E2E_reliability_models/NFV-REL003v030.zip.

[i.14] Final Report: "Virtualised Mobile Network with Integrated DPI, ETSI ISG NFV, October 31st 2014".

[i.15] "Refactoring Telco Functions, the Opportunity for OCP in telco SDN and NFV Architecture", Tom Anschutz, March 9, 2015.

[i.16] IETF RFC 7075: "Diameter Base Protocol".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI GS NFV-INF 003 [i.9], ETSI GS NFV-INF 001 [i.1] apply.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
AES	Advanced Encryption Standard
AES-NI	Advanced Encryption Standard New Instructions
API	Application Program Interface
ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers
CPE	Customer Premise Equipment
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
DC	Direct Current
DC-DC	Direct Current-Direct Current
DMA	Direct Memory Access
DSC	Diameter Signaling Controller
E2E	End to End
ECC	Error Correcting Code
EMI	Electromagnetic Interference
EPC	Evolved Packet Core
ER	Extended Reach
FRU	Field Replaceable Unit
FW	FirmWare

GPON	Gigabit Passive Optical Network
GR	Generic Requirements
HDD	Hard Disk Drive
ISG	Industry Specification Group
IT	Information Technology
JBOD	Just a Bunch Of Disks
KVM	Kernel-based Virtualisation Machine
LAN	Local Area Network
LR	Long Reach
LW	Long Wavelength
MANO	Management and Orchestration
MME	Mobility Management Entity
NAS	Network Attached Storage
NEBS	Network Equipment Building System
NFV	Network Functions Virtualisation
NFVI	NFV Infrastructure
NFVI-PoP	NFV Infrastructure Point of Presence
NUMA	Non-Uniform Memory Access
OCP	Open Compute Project
OLT	Optical Line Terminator
OS	Operating System
PCI	Peripheral Component Interconnect
PGW	Packet Data Network Gateway
SDDC	Single Device Data Correction
SGW	Serving Gateway
SONET	Synchronous Optical Networking
SR	Special Report
SR-IOV	Single Root Input/Output Virtualisation
SW	Short Wavelength
ToR	Top of Rack
UMA	Uniform Memory Access
UPS	Uninterruptible Power Supply
VDC	Volts of Direct Current
VLAN	Virtual Local Area Network
VM	Virtual Machine
VNF	Virtualised Network Function
WAN	Wide Area Network

4 Principles for development of physical components

4.1 Introduction

Virtualised Network Functions (VNFs) have to reside and operate on physical hardware. The telecommunications industry is moving away from specialized, sophisticated, and possibly proprietary hardware; instead the goal is to move towards commercially available off-the-shelf products in terms of processors, disks, racks, and other physical elements.

The goal of the present document is to provide guidance for an ecosystem of generic and commonly available sets of physical products and components for the industry.

The guidelines will be beneficial to telecommunication equipment providers and other vendors as well as service providers in the development and acquisition of desired components for building NFVI Nodes.

The focus of the present document is limited to the description of the physical hardware - compute, storage, and network domains shown in figure 1.

The present document draws upon available hardware principles (e.g. Open Compute Project) as necessary. Other topics covered include the following:

- Node functions (compute, storage, network);
- Physical components (racks, frames, processors, etc.);

- Power and cooling issues - guidelines on potential relationships between power delivery, heat build-up and heat dissipation will be provided as appropriate;
- Interconnection methods.

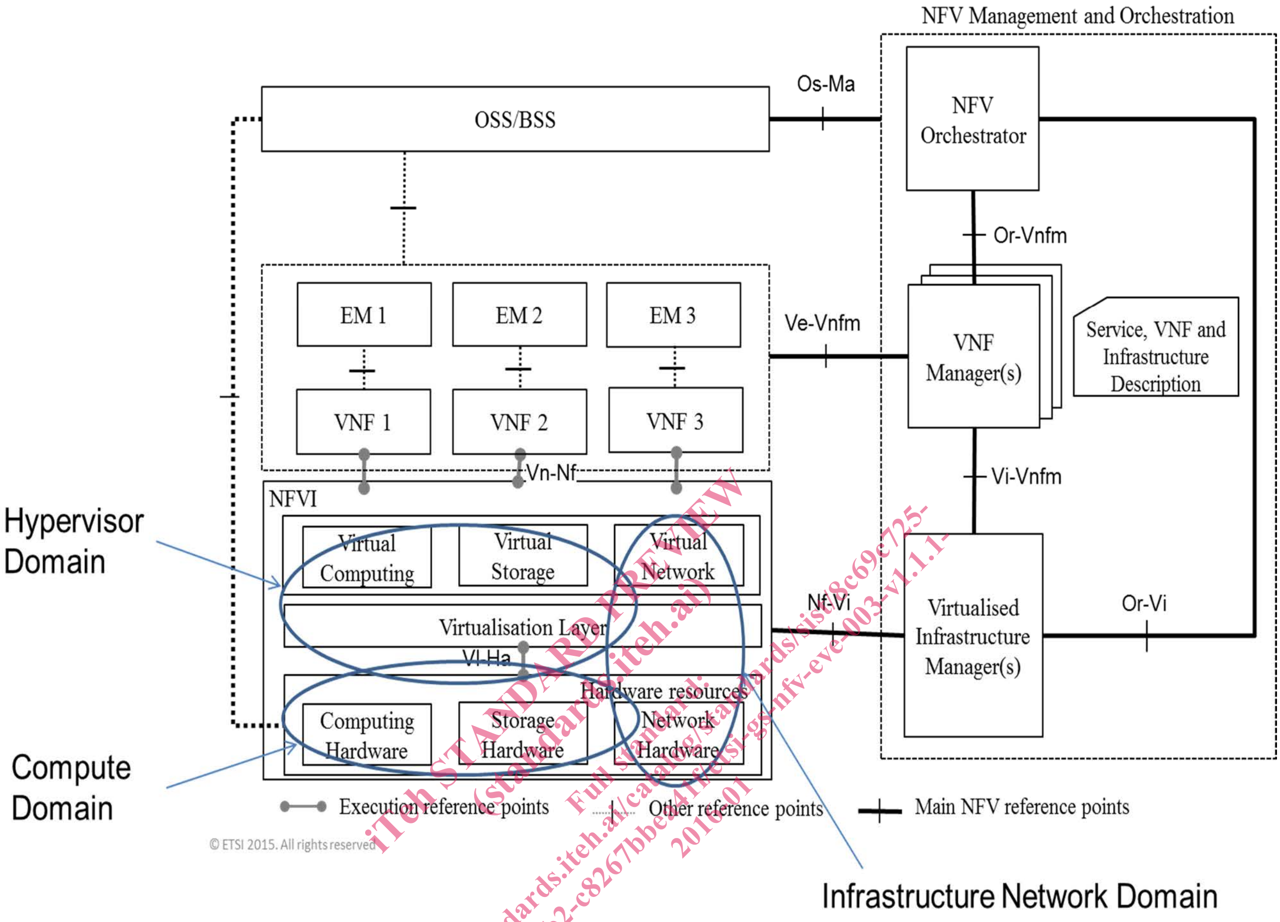

Figure 1: NFV architectural framework and identification of NFVI domains

Clause 4.2 provides general principles and goals for the NFVI Node physical architecture. Clause 4.3 provides key criteria for NFVI Nodes. Additional clauses outline common architectural practices with evaluation of their applicability to the NFVI Node physical architecture.

4.2 General principles

4.2.1 Observations

These general observations are included as guidance when considering architectural implementations for NFVI Nodes. Unlike software elements of NFV, NFVI has unique characteristics due to its physical nature. General observations include:

- The end goals for the platform dictate the architectural choices. Without alignment around goals, it is difficult to determine a cohesive architecture;
- Infrastructure, by nature, is physical. Infrastructure has size and weight. It consumes power and generates heat and noise. These are all interrelated and need to be balanced to meet equipment needs. Ambient temperature, power delivery and acoustic limits are derived from building and equipment practices;
- Infrastructure nodes live within the equipment practices in which they are deployed. They interface with other mechanical, electrical and software elements. These interfaces and behaviours need to be taken into account.

4.2.2 High level goals for NFVI Nodes

The following high level goals are desired for whatever NFVI Nodes are developed. These goals are consistent with a vision to enable a robust software ecosystem on commercially available hardware infrastructure.

High level goals for NFVI Nodes are:

- Multi-vendor, multi-customer, commercially available off-the-shelf ecosystem. Specific products do not need to be developed for each customer. Suppliers are free to innovate within the ecosystem;
- Economical scalability, addressing a wide range of application sizes and capacities;
- Appropriate features: solutions take into account concerns regarding space, power, cooling, and maintenance;
- Able to address multiple layers of the network: including transport, switching/routing and applications.

4.2.3 Other solution values

The following additional solution values are desired:

- Manageable. Application as well as field replaceable units may be managed. Management method integrates with NFV management interfaces;
- Resilient. Failure of components within the solution is detectable in order to support failover to another resource. Fail-over is handled in such a way to reduce the possibility of outages. Resiliency objectives (e.g. 5 nines) may be specified by service providers;
- Efficient (power, space, etc.);
- Interoperable. Equipment from one vendor interoperates with equipment from other vendors;
- Backward compatible. New equipment works with older equipment;
- Future proofed. Current-generation equipment works with future-generation equipment.

4.3 Key criteria

4.3.1 Space

Space criteria relate to the physical height, width, depth and volume that the equipment occupies. Space-related criteria are important to comprehend because NVFI Nodes will be deployed within facilities where space-related constraints exist. The following are key space-related criteria:

- Rack footprint and height compatible with data center and central office;
- Efficient use of the available volume;
- Flexible module widths, heights, etc.;
- Approximately 1 rack unit module height, or multiples thereof (allows use of commercially available off-the-shelf components).

4.3.2 Power

Power criteria are related to the type and amount of power that is supplied to the NFVI Nodes as well as limitations on how much power the equipment draws. Key criteria are:

- High power density within the constraints of climate and cooling scheme;
- Flexibility to interface to various direct current (including high voltage direct current) and alternating current configurations and topologies;
- Capability to support installations in both data centers and central offices, depending on configuration;

- Rack level uninterruptable power supply option with appropriate backup time;
- Maximum rack power consistent with facilities infrastructure practices;
- Maximum node power depends on node density. Full rack of nodes consume no more than the maximum rack power;
- Support power control at NFVI Node as well as individual compute/storage/network node levels;
- Avoidance of single Points of Failures at power system;
- Support power redundancy including N+M (M<N) and N+N.

4.3.3 Cooling

Cooling criteria are related to the capability to remove heat from the NFVI Node. Since dissipation of power by the NFVI Node generates heat, power consumption and cooling capabilities need to be matched. Key criteria are:

- Cooling matches the power needs in the central office and data center environments;
- Air filter option is desirable;
- Roadmap to support for liquid cooling;
- Front-to-back airflow is desirable;
- Placing temperature sensitive parts (e.g. optical module, HDD) at air intake position is desirable;
- Maintenance at cold aisle is desirable.

4.3.4 Physical interconnect

System interconnect criteria provide guidance on how elements of the NFV Node infrastructure are connected together. Key criteria are:

- Common interconnection methods (e.g. Ethernet) for all nodes;
- Capacity scalable to order of Terabits/s per rack unit;
- Modular capacity can grow as installation needs demand;
- Support high bandwidth and low latency switching to meet the resource pooling requirements;
- Support isolation of north-south data flow and east-west data flow;
- Support isolation of service data flow and management data flow.

4.3.5 Management

Infrastructure management applies to how each module or physical subcomponent (power supplies, fans, nodes) is managed. NFVI management fits within the overall framework of NFV management.

4.3.6 Climatic

Since NFVI equipment may be deployed in both central office and datacenter environment, compliance with the climatic standards of central office and datacenter environment (e.g. ETSI EN 300-019-1-3 [i.4], NEBS GR-63 [i.6], ASHRAE Thermal Guidelines for Data Processing Environment [i.7], etc.) is desirable.

4.3.7 Acoustic

For the hearing protection of employees working in high noise emission environment, compliance with noise emission standards (e.g. ETSI EN 300 753 [i.5], NEBS GR-63 [i.6]) is desired. For central office and datacenter deployment, the NFVI equipment adherent to acoustic emission limits is strongly desired and likely will be mandated by operators.