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EUROPEAN STANDARD

**Environmental Engineering (EE);
Energy Efficiency measurement methodology and metrics
for Network Function Virtualisation (NFV)**

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Contents

List of figures

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Foreword

This draft European Standard (EN) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

The present document specifies the method and metrics to determine the energy efficiency of operational Network Function Virtualisation (NFV) applications and their associated infrastructure.

Any such implementation of NFV within the access network served is addressed by the general engineering and associated energy management KPIs of the access network itself as described in ETSI EN 305 200-2-2 [i.2], ETSI EN 305 200-2-3 [i.3] and ETSI GR NFV 001 [i.4].

1   Scope

The present document specifies the method and metrics to determine the energy efficiency of operational Network Function Virtualisation (NFV) applications and their associated infrastructure when that infrastructure is implemented outside the boundaries of the access fixed, cable and mobile networks which they serve.

The present document:

- Extends the Objective KPIs of ETSI EN 305 200-2-2 [i.2] (fixed access networks) and ETSI EN 305 200-2-3 [i.3] (mobile access networks) to assess the impact of NFV when applied to those networks as described in ETSI GR NFV 001 [i.4].

- Does not consider any assessment of energy saved by the implementation of NFV as there can be no time-stamped comparison of an operational infrastructure from which functions have been removed to a virtualized environment.

NOTE: In an ICT network (e.g. a fixed access network) comprising many Network Distribution Nodes (NDNs) with different loading levels it is not clear that there will always be an energy consumption benefit - the more relevant benefit being network and operational flexibility (such as reduced maintenance or increased reliability).

The present document:

- Does not address the operational energy efficiency of specific Information Technology Equipment (ITE) such as servers which may provide NFV facilities. Other ETSI EN documents (e.g. ETSI EN 303 470 [i.1]) have been prepared to address such factors.

- Does not specify any assessment of the overall effectiveness of an NFV implementation although it contains information in an informative annex regarding the technical milestones that would be required for this to be addressed in a future revision of the present document.

The KPIs specified are primarily intended for trend analysis - not to enable comparison between individual implementations of NFV unless the conditions of operation are "similar".

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 at https://docbox.etsi.org/Reference/.

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.

[1]   ETSI ES 202 336-12: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (power, cooling and building environment systems used in telecommunication networks); Part 12: ICT equipment power, energy and environmental parameters monitoring information model".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the 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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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 EN 303 470: "Environmental Engineering (EE); Energy Efficiency measurement methodology and metrics for servers".

[i.2]   ETSI EN 305 200-2-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements; Sub-part 2: Fixed broadband access networks".

[i.3]   ETSI EN 305 200-2-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements; Sub-part 3: Mobile broadband access networks".

[i.4]   ETSI GR NFV 001: "Network Functions Virtualisation (NFV); Use Cases".

[i.5]   ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.6]   ETSI GS NFV-TST 008: "Network Functions Virtualisation (NFV) Release 2; Testing; NFVI Compute and Network Metrics Specification".

[i.7]   ISO/IEC 17788: "Information technology -- Cloud computing -- Overview and vocabulary".

[i.8]   Mandate M/462: "Standardisation mandate addressed to CEN, CENELEC and ETSI in the field of ICT to enable efficient energy use in fixed and mobile information and communication networks".

[i.9]   CEN-CENELEC-ETSI (12-2011): "Framework Document for ESO Response to EU Mandate M/462".

NOTE: Available at https://portal.etsi.org/Portals/0/TBpages/ee/Docs/ESO%20response%20to%20M462%20phase%201%20.pdf.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Base Station (BS): radio access network component which serves one or more radio cells and interfaces the user terminal (through air interface) and a wireless network infrastructure

Base Station (BS) site: Network Distribution Node (NDN) which accommodates a Base Station (BS)

Cloud Service Customer (CSC): entity responsible for operation of a network services for cloud service users to consume

NOTE: Source: ISO/IEC 17788 [i.7] modified.

Cloud Service Provider (CSP): entity which makes cloud services available

NOTE: Source: ISO/IEC 17788 [i.7] modified.

cloud service user: end user, or applications operating on their behalf, using cloud services

NOTE: Source: ISO/IEC 17788 [i.7] modified.

core network: functional elements (that is equipment and infrastructure) that enable communication between Operator Sites (OSs) or equivalent ICT sites

Customer Premises (CP): any location which is the sole responsibility of the customer

energy efficiency: relation between the useful output (telecom service, etc.) and energy consumption

Fibre Node (FN): device which performs a media conversion between an optical fibre cable link and a coaxial cable link in a cable access network

Head-End (HE): facility for receiving television signals for processing and distribution over a cable access network

ICT equipment: equipment providing data storage, processing and transport services

NOTE: A combination of Information Technology Equipment and Network Telecommunications Equipment.

ICT site: site containing structures or group of structures dedicated to the accommodation, interconnection and operation of ICT equipment together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

Information Technology Equipment (ITE): equipment providing data storage, processing and transport services for subsequent distribution by Network Telecommunications Equipment (NTE)

Last Operators Connection point (LOC): interface to the fixed access transport networks of one or more operators from which cabling is routed to a customer network

Network Data Centre (NDC): data centre embedded within the core network

NOTE: An NDC of a cable access network may be termed a master head-end.

Network Distribution Node (NDN): grouping of Network Telecommunications Equipment (NTE) within the boundaries of an access network providing distribution of service from an Operator Site (OS)

NOTE: Where all the NTE at a given location is under common governance, any supporting infrastructure for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability is included as part of the NDN.

Network Functions Virtualisation (NFV): principle of separating network functions from the hardware they run on by using virtual hardware abstraction

NOTE: Source: ETSI GS NFV 003 [i.5].

Network Functions Virtualisation Infrastructure (NFVI): totality of all hardware and software components which build up the environment in which VNFs are deployed

NOTE: Source: ETSI GS NFV 003 [i.5] modified.

Network Interface Unit (NIU): principal device within customer premises allowing user access to the services provided by the cable access network

Network Telecommunications Equipment (NTE): equipment between the boundaries of, and dedicated to providing direct connection to, core and/or access networks

Operator Site (OS): premises accommodating Network Telecommunications Equipment (NTE) providing direct connection to the core and access networks and which may also accommodate Information Technology Equipment (ITE)

NOTE 1: An OS that is only connected to the core network is considered as a Network Data Centre (NDC).

NOTE 2: An OS of a cable access network may be termed a local head-end.

Repeater (R): device with two RF ports, both of which are intended to be connected to antennas, which is capable of receiving, amplifying and transmitting simultaneously in one direction a signal in a base station's transmit band and in the other direction a signal in the corresponding base station's receive band

Terminal Equipment (TE): principal device within customer premises allowing user access to the services provided by the fixed access network

User Equipment (UE): device allowing user access to the services provided by the mobile access network

NOTE: Examples of user equipment include a mobile phone, tablet, data modem and connected devices such as meter or actuator.

3.2 Symbols

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

Δt	the maximum time variation between measurement points of the different Objective KPIs within a given Global KPI
k	assessment period index
$data\_volume_{NFVI}$	volume of data transported to and from the NFVI during an assessment period
EC_{NFVI}	energy consumption of NFVI during an assessment period
$KPI_{EE\text{-}transfer}$	KPI of NFVI energy efficiency based on data volume
T_{KPI}	period of time over which $KPI_{EE\text{-}transfer}$ is assessed
T_{REPEAT}	the time between which the KPI are assessed to determine relevant trend information

3.3 Abbreviations

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

|	
BS	Base Station
CP	Customer Premises
CSC	Cloud Service Customer
CSP	Cloud Service Provider
FN	Fibre Node
HE	Head-End
ICT	Information and Communications Technology
ITE	Information Technology Equipment
KPI	Key Performance Indicator
LOC	Last Operator Connection Point
LON	Last Operator Node
NDC	Network Data Centre
NDN	Network Distribution Node
NFV	Network Function Virtualisation
NFVI	Network Function Virtualisation Infrastructure
NIU	Network Interface Unit
NTE	Network Telecommunications Equipment
ODC	Operator Data Centre
OS	Operator Site
R	Repeater
TE	Terminal Equipment
UE	User Equipment

4 Network Function Virtualisation (NFV) configurations

4.1 Access network

Figure 1 shows schematics of the following access networks:

- fixed access network;

- cable access network;

- terrestrial and satellite mobile access networks.

Figure 1 has been updated since the original schematic included in the initial response [i.9] to the Mandate M/462 [i.8]. The original schematic and details of the changes are listed in annex A.
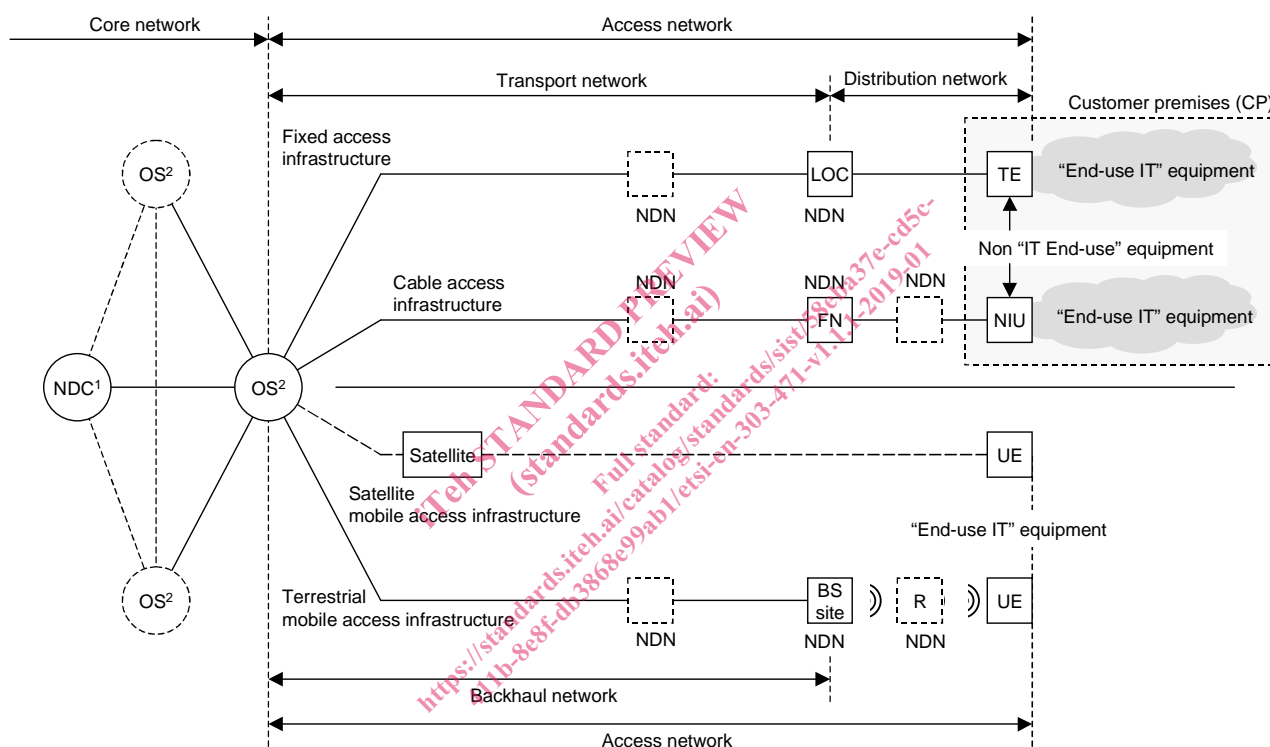
[1] For cable access networks this is termed "Master head-end/OS"
[2] For cable access networks this is termed "Local head-end/OS"

Figure 1: Updated schematic of fixed and mobile access networks

It is necessary to distinguish between the access provider, who is responsible for the design, operation and maintenance of the access network, and the service provider that provides the service carried to the subscriber by the access network. These two entities may be different. A given access network may support multiple service providers.

The Network Function Virtualisation Infrastructure (NFVI) may be accommodated within a Network Data Centre (NDC), Operator Site (OS) or NDN under the common governance with the access network to which the functions apply or in 3rd party ICT sites or Customer Premises (CP).The roles within the NFV ecosystem are further designated as Cloud Service Provider (CSP) and Cloud Service Customer (CSC). In the context of the present document CSP will be concerned with the energy efficiency of the NFVI, while the CSC will be concerned with the energy efficiency of the NFV.

Figure 1 shows certain Network Distribution Nodes (NDNs) within dashed boxes to indicate that they are:

- optional;

- not restricted in number to the configurations shown.