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Environmental Engineering (EE); Energy Efficiency measurement methodology and metrics for heterogeneous servers

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI Membership Approval Procedure (MAP).

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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Introduction

Computer server and data centers have experienced a rapid increase, playing the central role in digital services. With the development of Artificial Intelligence (AI), heterogeneous servers equipped with more than one type of processors (CPU, GPU, FPGA, ASIC, etc., the abbreviations defined in clauses 3.1 and 3.3) play an increasingly important role and take a growing market share in computing industry. Heterogeneous servers gain extra performance by adding the dissimilar coprocessors, usually incorporating specialized processing capabilities to handle particular tasks [i.4]. Categories of heterogeneous servers include CPU+GPU server, CPU+FPGA server, CPU+ASIC server. The most popular heterogeneous server type is the CPU+GPU server, which is commonly used to accelerate the training process of deep learning by parallel computing.

For heterogeneous servers, the better performance the higher the energy consumption. There is a tradeoff between the performance and energy consumption for the high performance heterogeneous servers. Energy Efficiency (EE) that scales the server performance and energy consumption is one of the critical factors of the server operation and maintenance. ETSI EN 303 470 [i.5] specifies the metric and method for EE assessment of general servers. However, there is currently no standard for EE assessment of heterogeneous servers.

The present document specifies a metric for the assessment of EE of heterogeneous servers using reliable, accurate and reproducible measurement methods, which take into account the recognized state-of-the-art. The present document formalizes the tools, conditions and calculations used to generate a single figure of merit of a single heterogeneous server representing its relative EE and power consumption. The single figure EE metric is targeted for use as a tool in the selection process of heterogeneous servers to be provisioned.

For comparisons, evaluations should be conducted across similar heterogeneous server types or categories. The EE metric is targeted for identify energy saving servers by differentiating the ability of heterogeneous servers to be provisioned for mainstream market. The present document does not prescribe the levels or values for acceptance but prescribes a method of evaluation which EE programs could use to establish such criteria.

As there are many operational deployments of heterogeneous servers resulting in a range of specialized equipment and configurations for a single heterogeneous server product, an EE metric that evaluates provisioning impacts to general purpose operations may not be applicable. ICT equipment, and servers in particular, are generally customized and commissioned on site for deployment. As with most ICT equipment, new technologies are regularly introduced, which may require product level customization or an industry wide tool upgrade to more appropriately represent the EE of the heterogeneous servers.

The present document categorizes heterogeneous servers to address applicability, configuration groupings to represent a diversity of heterogeneous servers to address the broad range of custom configurations, as wells as a tool revision control to ensure comparability and consistency of the resulting metric value.

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5 and published by ITU and ETSI as Recommendation ITU-T L.EE_sgpu [i.6] and ETSI ES 204 083 (V1.1.1) (the present document), which are technically equivalent.

1 Scope

The present document is based upon benchmark for server Energy Efficiency (EE) tool for general and heterogeneous servers [i.6].

The present document specifies:

1) test conditions and product configuration for the assessment of EE of heterogeneous servers using reliable, accurate and reproducible measurement methods;
2) an EE metric to support procurement requirements;
3) requirements for equipment to perform the measurements and analysis;
4) requirements for the measurement process;
5) requirements for the management of the EE metric calculation;
6) operation or run rules to configure, execute, and monitor the testing;
7) documentation and reporting requirements.

The metrics and methods apply to heterogeneous servers with various configurations, including type and count of APAs, CPU, memory, storage and any other add-on hardware expected to be present when deployed.

NOTE: Products whose feature set and intended operation are not addressed by active mode testing parameters are excluded from this evaluation method.

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.

[1] IEEE 802.3az™: "The road to energy efficient ethernet".

[2] EN 62623:2013: "Desktop and notebook computers. Measurement of energy consumption", (produced by CEN).

[3] IEEE 802.3™: "IEEE Standard for Ethernet".

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

[i.1] Commission Regulation (EU) 2019/424 of 15 March 2019 laying down ecodesign requirements for servers and data storage products pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 617/2013.

[i.2] EN 60297 series: "Mechanical structures for electrical and electronic equipment. Dimensions of mechanical structures of the 482,6 mm (19 in) series", (produced by CEN).

[i.3] ETSI EN 300 119 series: "Equipment Engineering (EE); European telecommunication standard for equipment practice".

[i.4] Shan, Amar (2006): "Heterogeneous Processing: a Strategy for Augmenting Moore's Law". Linux® Journal.

NOTE: Linux® is the registered trademark of Linus Torvalds in the U.S. and other countries.

[i.5] ETSI EN 303 470 (V1.1.1) (2019): "Environmental Engineering (EE); Energy Efficiency Measurement methodology and metrics for servers".

[i.6] Recommendation ITU-T L.EE_sgpu on Energy Efficiency measurement methodology and metrics for heterogeneous servers.

NOTE: Recommendation ITU-T L.EE_sgpu is at the time of publication only the draft working title. Recommendation ITU-T L.1311 should be the official number to be decided in May/June 2025.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

active state: operational state of a computer server (as opposed to the idle state) in which the computer server is carrying out work in response to prior or concurrent external requests (e.g. instruction over the network)

NOTE 1: The work in the present document includes, but is not restricted to, active processing and data seeking/retrieval from memory, cache, or internal/external storage while awaiting further input over the network.

NOTE 2: See ETSI EN 303 470 [i.5].

Application-Specific Integrated Circuit (ASIC): integrated circuit designed and manufactured according to specific user requirements and specific electronic system requirements

NOTE 1: Processor units belong to ASIC include, but are not limited to:

a) Tensor Processing Unit (TPU): an AI accelerator ASIC that is developed specifically for neural network machine learning by Google;

b) Vision Processing Unit (VPU): a specific type of AI accelerator, designed to accelerate machine vision tasks;

c) Neural Processing Unit (NPU): a specialized processing unit that is designed to accelerate artificial intelligence and machine learning applications, including artificial neural networks and machine vision;

d) Deep Learning Processing Unit (DPU): a processor designed for deep learning that has the ability to handle large-scale neural networks.

NOTE 2: DSP is used in Embedded and Real-time Systems.

Auxiliary Processing Accelerator (APA): additional compute device installed in the computer server that handles parallelized workloads

NOTE 1: This includes, but is not limited to, Graphical Processing Units (GPUs), Field Programmable Gate Array (FPGA) or Application-Specific Integrated Circuit (ASIC) chips which can be installed in a server either on Graphics or Extension add-in cards installed in general-purpose add-in expansion slots (e.g. GPGPUs, CPU accelerators, etc. installed in a PCI/PCIe slot) or directly attached to a server component such as the motherboard.

NOTE 2: There are two specific types of APAs used in servers:

a) Expansion APA: an APA that is on an add-in card installed in an add-in expansion slot (e.g. GPGPUs, CPU accelerators, etc. installed in a PCI/PCIe slot). An expansion APA add-in card may include one or more APAs.

b) Integrated APA: an APA that is integrated into the motherboard or CPU package or an expansion APA that has part of its subsystem, such as switches, included in the non-APA server configuration that would be used to run the energy efficiency test.

NOTE 3: See ETSI EN 303 470 [i.5].

blade chassis: enclosure that contains shared resources for the operation of blade servers and other blade form-factor devices

NOTE 1: Shared resources provided by a chassis include, but are not restricted to, power supplies, data storage, and hardware for d.c. power distribution, thermal management, system management, and network services.

NOTE 2: See Commission Regulation (EU) 2019/424 [i.1].

blade server: computer server, designed for use in a blade chassis, that is a high-density device and functions as an independent computer server and includes at least one processor and system memory, which is dependent upon shared blade chassis resources (e.g. power supplies, cooling) for operation

NOTE 1: A processor or memory module that is intended to scale up a standalone server is not considered a blade server.

NOTE 2: See ETSI EN 303 470 [i.5].

blade system: blade chassis and one or more removable blade servers and/or other units which provide a scalable means for combining multiple blade server or storage units in a single enclosure

NOTE 1: A blade system is designed to allow service technicians to easily add or replace (hot-swap) blades in the field.

NOTE 2: See ETSI EN 303 470 [i.5].

controller system: computer or computer server that manages a benchmark evaluation process

deployed power: average power level of the utilization applicable to the total number of servers provisioned to meet an aggregate peak load

hypervisor: supervisory system level software that establishes and manages a virtualized environment which enables multiple operating systems to run on a single physical system at the same time

pedestal server: self-contained computer server that is designed with power supply units, cooling, input/output devices, and other resources necessary for stand-alone operation within a frame similar to that of a tower client computer

NOTE: See ETSI EN 303 470 [i.5].

processor: digital circuit which performs operations on some external data source, usually memory or some other data stream

NOTE: This includes, but is not limited to, Central Processing Unit (CPU), Graphics Processing Unit (GPU), Neural Processing Unit (NPU), Tensor Processing Unit (TPU), Deep Learning Processing Unit (DPU), Vision Processing Unit (VPU), etc.