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EUROPEAN STANDARD

Measurement Process for Energy Efficiency KPI for Servers

SKELETON DRAFT

Reference

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Contents

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document is

National transposition dates	
Date of adoption of this EN:	1 October 2014
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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 takes into account:

- Final Report - Ecodesign Technical Assistance Study on Standards for Lot 9 Enterprise Servers and Enterprise Data Storage
- ETSI GS OEU 003: Operational energy Efficiency for Users (OEU); Energy Consumption Measurement of Operational Information Technology Servers
- ISO/IEC 30134-4: Information technology – Data Centres – Key Performance Indicators - Part 4: IT Equipment Energy Efficiency for Servers ($ITEE_{SV}$)
- TGG Deployed power (need the proper appropriation)
- SPEC SERT (need proper appropriation)

1 Scope

The present document defines the current standpoint of ISG OEU members in relation to the operational measurement of energy performance and selection of ICT physical servers. It defines an energy performance operational KPI and its related measurement points, measurement protocols, data aggregation and calibration. The measured KPI unequivocally links the measured ICT physical server and its relative deployed power impact in a data centre. The specification defines a technical KPIs allowing to predict energy consumption and task efficiency for general use in a multitask data centre. The technical KPI defines a test suite, test conditions, data aggregation method, and confirmation method that assesses the relative energy consumption of a physical server as deployed in a data centre environment. The energy consumption comprehends the noble parts (e.g. CPU, memory, disk) of ICT physical server and its overall consumption including cooling and power supplies.

An ICT physical server is a general-purpose ICT equipment with its own dedicated power supplies. The aforementioned KPIs applies to general purpose 1 and 2 socket servers provisioned for data centres, whose data processing requirements exceed the use of a single server. The KPI applies to a family of configurations, including type and count of CPU, memory, storage, power supplies, cooling (e.g. fans) and any other add-on hardware expected to be present when deployed in a production data centre.

The specification formalizes a KPI representing a single figure of merit of a single server representing the relative efficiency and power impact at a data centre level of deployment. The KPI is targeted for use as a tool in the selection process of servers to be provisioned for a data centre.

The present document defines:

- an energy efficiency KPI for selection of servers to provision in a data centre;
- equipment requirements to perform the analysis;
- a relevant process to perform measurement and manage the KPI calculation;
- documentation and reporting requirements;
- operation or run rules to configure, execute, and monitor the testing;
- validation process for the metric to data centre level impact.

2 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 http://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.

{how much can we reference from SPEC?}

2.1 Normative references

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

EXAMPLE:

[1] SPEC « runrules {placeholder for real title}

2.2 Informative references

The following referenced documents arenot necessary for the application of the present document but they assist the user with regard to a particular subject area.

EXAMPLE:

[i.1] TGG Deployed power {placeholder for real title}

TGG/SPEC creating a single value metric {placeholder for real title}

SPEC SERT design guide

Chauffeur

3 Definitions, symbols and abbreviations

Definitions and abbreviations extracted from ETSI deliverables can be useful when drafting documents and can be consulted via the ***Terms and Definitions Interactive Database (TEDDI) (http://webapp.etsi.org/Teddi/).***

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following apply:

deployed power: xxxxx

efficiency: xxxxx

geometric mean (geomean): xxxxx

normalized performance: xxxxx

maximum power: xxxxx

product family: xxxxx

weighted geometric mean: xxxxx

worklets: xxxxx

EDITORS NOTE: during the development of the document see xxxxxx

3.2 Symbols

For the purposes of the present document, the [following] symbols [given in ... and the following]apply:

XXXX

3.3 Abbreviations

For the purposes of the present document, the [following] abbreviations [given in ... and the following] apply:

Geomean geometric mean of n items

$$Geomean(x) = \left(\prod_{i=1}^{n} x_i \right)^{1/n} = \sqrt[n]{x_1 \times ...... \times x_n}$$

SERT Server Efficiency Weighting Tool

EDITORS NOTE: during the development of the document see xxxxxx

4 Mathematical definition of Eff_{server}

$$Eff_{server} = Perf_{server} / Pwr_{server}$$ Equation 1

where

$$Eff_{server} = \exp\left[W_{CPU} \times \ln\left(Eff_{CPU}\right) + W_{Memory} \times \ln\left(Eff_{Memory}\right) + W_{Storage} \times \ln\left(Eff_{Storage}\right)\right]$$

Equation 2

$$Perf_{server} = \exp\left[W_{CPU} \times \ln\left(Perf_{CPU}\right) + W_{Memory} \times \ln\left(Perf_{Memory}\right) + W_{Storage} \times \ln\left(Perf_{Storage}\right)\right]$$

Equation 3

$$Pwr_{server} = \exp\left[W_{CPU} \times \ln\left(Pwr_{CPU}\right) + W_{Memory} \times \ln\left(Pwr_{Memory}\right) + W_{Storage} \times \ln\left(Pwr_{Storage}\right)\right]$$

Equation 4

where

W_{CPU} is the weighting assigned to the CPU worklets

W_{Memory} is the weighting assigned to the Memory worklets

$W_{Storage}$ is the weighting assigned to the Storage worklets

Editors NOTE: Where do we reference the default weightings? (Annex B)

Alternatively {choice pending on assessment}

With reference to Annex A for Efficiency:

$$Eff_{CPU} = \left(\prod_{i=1}^{7} Eff_i\right)^{1/7}$$ Equation 5

where i the CPU efficiency worklet and is 1 for worklet$_{Compress}$, 2 for worklet$_{LU}$, 3 for worklet$_{SOR}$, 4 for worklet$_{Crypto}$, 5 for worklet$_{Sort}$, 6 for worklet$_{SHA256}$ and 7 for worklet$_{Hybrid\ SSJ}$

$$Eff_{Memory} = \left(\prod_{i=1}^{2} Eff_i\right)^{1/2}$$ Equation 6

where i the memory efficiency worklet and is 1 for worklet$_{Flood3}$ and 2 for worklet$_{Capacity3}$

$$Eff_{Storage} = \left(\prod_{i=1}^{2} Eff_i\right)^{1/2}$$ Equation 7

where i the storage efficiency worklet and is 1 for worklet$_{Sequential}$ and 2 for worklet$_{Random}$

$Eff_{worklet}$ is the Efficiency value for the worklet in question. This value is calculated by taking the geomean of calculated worklet interval efficiencies or by taking the ratio of the geomean of the normalized interval performance to geomean of the interval power.

$$Eff_{worklet} = \left(\prod_{i=1}^{n} Eff_i \right)^{1/n} = Perf_{worklet} / Pwr_{worklet}$$ Equation 8

$$Perf_{worklet} = \left(\prod_{i=1}^{n} Perf_i \right)^{1/n}$$ Equation 9

$$Pwr_{worklet} = \left(\prod_{i=1}^{n} Pwr_i \right)^{1/n}$$ Equation 10

where

n = the number of worklet interval values for the worklet being evaluated

Eff_i = Efficiency value of the worklet interval i

$Perf_i$ = Performance value of worklet interval i

Pwr_i = Power value of the worklet interval i

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5 Measurement Method and Managing Calculations

{to be added … ref. SPEC SERT}

6 Documentation and reporting

{see green grid and Energy Star}

7 Run rules and monitoring data acquisition

Validation

{see Green Grid and what can be referenced from Appendix B}

Annex A: Creating a single Metric

A.1 A Single Efficiency Metric from SERT™ Worklet Results

The SERT™ tool reports performance and power data for:

- 6 CPU worklets: Compress, LU, CryptoAES, SOR, Sort, and SHA 256.
- 2 memory worklets: Flood3 and Capacity3;
- 2 storage worklets: Sequential and Random.

For each worklet, data is reported for a set of proportional performance intervals and associated, measured power values along with other test measurements. For each interval the SERT tool calculates an interval efficiency value by dividing the normalized performance value by the interval power value. The set of individually measure Performance and Power values with their associated efficiency value will be referred to as interval data.

In order to create a single energy efficiency metric for a server it is necessary to combine the worklet interval performance and power values for all the different worklets in some manner.

The method developed by the Green Grid SERT Analysis Working Group (WG) and the SPECpower Committee to create a single efficiency metric follows the following general procedure:

1) combine individual worklet normalized performance and power interval data to obtain an overall Efficiency, Performance and Power value for the worklet;
2) combine worklet Efficiency, Performance and Power values by workload type (CPU, Memory, Storage) to obtain a workload type value;
3) combine worklet types using a weighted geomean to obtain a single, total server Efficiency, Performance or Power value.

The method used to combine interval Efficiency, Performance and Power data is a geomean of the interval data as described below in Equations 8 to 10 in clause 4.

Similar values are calculated for Performance and Power by substituting performance (*Perf*) or power (*Pwr*) for *Eff* in

Error! Reference source not found.5 to

$$Eff_{Storage} = \left(\prod_{i=1}^{2} Eff_i \right)^{1/2}$$

Equation 7

where i the storage efficiency worklet and is 1 for $worklet_{Sequential}$ and 2 for $worklet_{Random}$

$Eff_{worklet}$ is the Efficiency value for the worklet in question. This value is calculated by taking the geomean of calculated worklet interval efficiencies or by taking the ratio of the geomean of the normalized interval performance to geomean of the interval power.

7 in clause 4.

Then we combine the three geomean values workload efficiency, performance and power values to get an overall server Efficiency, Performance and Power values using a weighted geomean of the workload values as shown in **Error! Reference source not found.**to Equation 4 of clause 4.

A weighted geomean is achieved by applying a weighting factor to the log function of each worklet type, summing the resulting weighted worklet type values and then taking the exponent function of the weighted sum to generate a single efficiency score . The server level performance and power values are calculated by replacing efficiency (*Eff*) with performance (*Perf)* or power (*Pwr*).

A.2 ???

A.2.1 ??????

Annex B: Deployed Power Assessment

B.1 Overview of the Deployed Power Analysis Methodology for validation of a proposed server efficiency metric

In order to evaluate potential metrics, a series of assessments to the relative power impact of selecting the server offers a definitive confirmation of a metric's ability to predict efficiency of the server as deployed in the data centre. The assessment comprises a graphical correlation and rank comparison between the power impact of a number of servers deployed to execute a defined workload versus the aggregated efficiency metric for the server. The selection of servers mimics the provisioning method used by IT professionals when determining the data processing needs of that data centre.

The Deployed Power assessment is based on determining the ability of provisioning a set of servers for a targeted workload that results in a minimum expenditure of energy at the data centre, across the various utilization levels. The metric validation is to ensure that a better efficiency score will result in a lower deployed server power demand to execute that work in a data centre. The use of a deployed power calculation enables differentiation between the effectiveness of a low performance, low power server and a high performance, high power server, as it enables an assessment of the number of servers and their associated energy use required to deliver a given workload in a data centre or office environment.

To calculate the number of servers needed to perform a workload and their associated deployed power, it is necessary to select a workload level to use to calculate the number of deployed servers.

1) Target workload should represent the maximum composite of the work targeted for the data centre. Based on actual workloads deployed in data centres, the weights used are 65% CPU, 30% Memory and 5%Storage.

2) A value of 100 * the maximum performance value of the group of tested servers defines the target workload performance level for the evaluation. This value is large enough avoid quantization effects.

3) As servers execute a diverse range of workloads, three assessment workloads were selected: a CPU intensive workload, a memory intensive workload and a weighted workload which mimics the workload weighting of the combined metric being assessed.

4) Additionally, the following power/utilization/workload types to be used in our comparison analysis. The intent is to assess a combination of workload types and power consumption levels that a set of servers will experience in an operating environment:
   a) idle power as measured by the SERT tool;
   b) geomean of the power for all workloads at the 25% utilization (light workload);
   c) geomean of the power for all workloads at the 50% utilization (medium workload);
   d) geomean of the power for all workloads at the 100% utilization (heavy workload);
   e) weighted deployed power using the metric weighting;
   f) weighted deployed power using the CPU intensive workload weightings (85% CPU, 15% memory);
   g) weighted deployed power using the Memory intensive workload weightings (40% CPU, 60% memory).

   Multiple workloads and power use scenarios were assessed to validate that the combined metric is balanced and representative of efficiency across the range of workloads that servers are expected to perform and to avoid the assertion that use of a single power/workload/utilization might be biased to a particular outcome.

B.2 Determining the number of deployed servers

B.2.1 General

Any attempt at a single efficiency metric based upon the SERT tool must use some method to combine the individual worklet values to create a single value. The aggregation used to determine a single value is with the geomean combinatory method and the designated component (CPU, memory and storage) weightings to calculate the number of servers required.

In order to determine the number of servers required for any given server model one must determine both a performance target for the dataset and a performance capability for each individual server. The individual worklet performance values reported in the SERT tool are combined to determine the number of servers required to meet the performance target.

B.2.1 Establishing target performance

In order to minimize quantization issues, since deployed power is based on an integral number of servers, a 100 times the maximum performance of the highest performance server in the data set for the performance target,

The number of servers required to meet a desired performance level is calculated according to Equation B.1.

$$Deployed_{QTY_n} = Roundup\left(\frac{100 \times Max\left(Perf_{AllServers}\right)}{Perf_n}\right) \qquad \text{Equation B.1}$$

where:

$Perfmax_{AllServers}$ = the performance values for all servers in the data set
$Perfmax_n$= the maximum performance of server n.

B.2.1 Weighting factors

A weighted geomean (CPU 60 %: Memory 35 %: Storage 5 %) of performance, designated as the weighted performance maximum, is used.

Error! Reference source not found.2 aggregates the geomean of the normalized maximum performance values to obtain a single maximum performance number for each individual server. The weighted maximum performance number represents the maximum capability of the server and what would be used to provision a data centre.

$$Perfmax_{weighted} = \exp\left[0,6 \times \ln\left(Perfmax_{CPU}\right) + 0,35 \times \ln\left(Perfmax_{Memory}\right) + 0,05 \times \ln\left(Perfmax_{Storage}\right)\right]$$

Equation B.2

$$Perfmax_{CPU} = \left(\prod_{i=1}^{7} Perfmax_i\right)^{1/7} \qquad \text{Equation B.3}$$

where i the CPU efficiency worklet and is for $worklet_{Compress}$, 2 for $worklet_{LU}$, 3 for $worklet_{SOR}$, 4 for $worklet_{Crypto}$, 5 for $worklet_{Sort}$, 6 for $worklet_{SHA256}$ and 7 for $worklet_{Hybrid\ SSJ}$

$$Perfmax_{Memory} = \left(\prod_{i=1}^{2} Perfmax_i\right)^{1/2} \qquad \text{Equation B.4}$$

where i the memory efficiency worklet and is 1 for $worklet_{Flood3}$ and 2 for $worklet_{Capacity3}$

$$Perfmax_{Storage} = \left(\prod_{i=1}^{2} Perfmax_i\right)^{1/2} \qquad \text{Equation B.5}$$

where i the storage efficiency worklet and is 1 for $worklet_{Sequential}$ and 2 for $worklet_{Random}$

$Perfmax_{worklet}$ represents the maximum performance score from the SERT data base.

$Perfmax_{Wght}$ represents the newly calculated weighted maximum performance

Other annexes (as required)

History

Document history		
<Version>	<Date>	<Milestone>
V0.0.1	04/10/2016	First draft
V0.0.2	08/11/2016	Skeleton draft