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Information Technology — Data Centres — Server Energy Effectiveness Metric

Technologies de l'information — Centres de données — Grandeurs de mesure de l'efficacité énergétique des serveurs

ICS: 35.020

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138 Foreword

139 ISO (the International Organization for Standardization) is a worldwide federation of
140 national standards bodies (ISO member bodies). The work of preparing International
141 Standards is normally carried out through ISO technical committees. Each member body
142 interested in a subject for which a technical committee has been established has the right to
143 be represented on that committee. International organizations, governmental and non-
144 governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with
145 the International Electrotechnical Commission (IEC) on all matters of electrotechnical
146 standardization.

147 The procedures used to develop this document and those intended for its further
148 maintenance are described in the ISO/IEC Directives, Part 1. In particular the different
149 approval criteria needed for the different types of ISO documents should be noted. This
150 document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part
151 2 (see www.iso.org/directives).

152 Attention is drawn to the possibility that some of the elements of this document may be the
153 subject of patent rights. ISO shall not be held responsible for identifying any or all such
154 patent rights. Details of any patent rights identified during the development of the
155 document will be in the Introduction and/or on the ISO list of patent declarations received
156 (see <https://www.iso.org/iso-standards-and-patents.html>).

157 Any trade name used in this document is information given for the convenience of users and
158 does not constitute an endorsement.

159 For an explanation on the meaning of ISO specific terms and expressions related to
160 conformity assessment, as well as information about ISO's adherence to the WTO principles
161 in the Technical Barriers to Trade (TBT) see, [https://www.iso.org/foreword-](https://www.iso.org/foreword-supplementary-information.html)
162 [supplementary-information.html](https://www.iso.org/foreword-supplementary-information.html).

163 The committee responsible for this document is ISO/IEC JTC 1, Information technology, SC
164 39, Sustainability for and by Information Technology.

165

Introduction

The global economy is now totally reliant on information and communication technologies (ICT) and the associated generation, transmission, dissemination, computation, and storage of digital data. While the Internet backbone carries the traffic, it is data centres which find themselves at the nodes and hubs of a wide variety of both private enterprise and shared/collocation facilities. With the large and continually increasing data capacity demands placed on data centres worldwide, efficient use of data centre energy is an extremely important strategy to manage environmental, cost, electrical grid capacity and other impacts.

The ISO/IEC 30134 series of International Standards specify data centre energy effectiveness KPIs to help data centre operators measure and improve specific aspects of data centre energy effectiveness. ISO/IEC 30134-4, in particular, defines a method to measure the peak capacity and utilization of servers operating in a data centre using operator selected benchmarks. It, however, does not provide a method of comparing individual server energy effectiveness across data centres and as stated in ISO/IEC 30134-4, “should not be used to set regulation for a data centre or individual server”. There is stakeholder demand for an international standard to measure the energy effectiveness of servers before procurement and installation, particularly for use in worldwide server energy effectiveness regulations and programs.

This standard provides a server energy effectiveness metric (SEEM) to measure and report the energy effectiveness of specific server designs and configurations. This document will be useful to stakeholders, including vendors, users and governments, from the design verification testing phase all the way through compliance verification, procurement and operation. Organizations that wish to establish compliance or reporting programs will find that the test methods and scoring specified in ISO/IEC 21836 will save them significant time and effort in implementing such programs. Standardization across such programs will allow vendors to comply to stakeholder requirements more quickly and efficiently.

For applicable servers, ISO/IEC 21836 builds upon the widely-adopted Server Efficiency Rating Tool™ (SERT), developed by the Standard Performance Evaluation Corporation (SPEC®), as the energy effectiveness metric and test method. For servers where SERT is not applicable, this standard provides requirements for the creation of alternate server energy effectiveness metrics, referred to as “implementer-specified” metrics.

Information technology – Data centres – Server Energy Effectiveness Metric

1 Scope

This document specifies a measurement method to assess and report the energy effectiveness of a computer server. This standard does not set any pass/fail criteria for servers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

SPEC Server Efficiency Rating Tool (SERT) version 2.x.x

SPEC PTDaemon™ version 1.8.1 and later

SPEC SERT Run and Reporting Rules version 2.0.1 (20170929)

SPEC Client Configuration XML (https://www.spec.org/sert2/SERT-JVM_Options-2.0.html)

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: <http://www.electropedia.org/>
- ISO Online browsing platform: <http://www.iso.org/obp>

3.1.1

64-bit server

server which includes a CPU which has data path widths, memory addressing, registers, and other architectural features which are 64-bits wide

3.1.2

active state

operational state in which the server is carrying out data processing in response to external requests

Note 1 to entry: Example: active processing, data seeking/retrieval from memory, cache, internal/external storage while awaiting further input over the network

232 **3.1.3**

233 **active state power**

234 average server power, in watts, when server is performing data processing

235 **3.1.4**

236 **auxiliary processing accelerator**

237 additional compute device installed in the computer server that handles parallelized workloads
238 in conjunction with the CPU

239 **3.1.5**

240 **blade chassis**

241 enclosure that contains shared resources for the operation of blade servers, blade storage, and
242 other blade form-factor devices

243 Note 1 to entry: Shared resources provided by a chassis may include power supplies, data storage and
244 hardware for DC power distribution, thermal management, system management, and network services

245 **3.1.6**

246 **blade server**

247 server that is designed for use in a blade chassis

248 Note 1 to entry: A blade server is a high-density device that functions as an independent server and includes
249 at least one processor and system memory, but is dependent upon shared blade chassis resources (e.g.
250 power supplies, cooling) for operation

251 **3.1.7**

252 **blade storage**

253 storage device that is designed for use in a blade chassis that is dependent upon shared blade
254 chassis resources, like power supplies or cooling, for operation.

255 **3.1.8**

256 **buffered memory**

257 circuitry between the server's memory and memory controller to either increase memory
258 capacity, increase bandwidth, and/or reduce the electrical load on the memory controller

259 **3.1.9**

260 **coefficient of determination**

261 statistic used to determine the strength of a fit between a mathematical model and a set of
262 observed data values

263 [SOURCE: ISO 15551-1:2015, 3.26, Note 1 has been removed]

264 **3.1.10**

265 **coefficient of variation**

266 standard deviation divided by the mean

267 [SOURCE: ISO 3534-1:2006]

3.1.11**configuration**

interrelated functional and physical characteristics of a product specified in product configuration information

Note 1 to entry: This standard employs the following configurations: low-end, high-end and typical

Note 2 to entry: For server products, a configuration is one of many possible combinations of components including CPU, storage devices, memory size and capacity and input/output devices for a single server product within a larger product family. There are a large number of possible configurations within a product family.

[SOURCE: ISO 17599:2015, 3.15 – modified, Note 1 and Note 2 have been added]

3.1.12**core**

component of a processor which can independently receive instructions and takes actions or performs calculations in response

3.1.13**CPU**

a central processing element with functions for interpreting and executing instructions.

Note 1 to entry: In this standard, cache memory is included with the CPU

Note 2 to entry: This standard uses the terms CPU and processor interchangeably

[SOURCE: ISO 14576:1999, 2.1.9 – modified, Definition is shortened, Note 1 and Note 2 have been added]

3.1.14**CPU architecture**

CPU design with significant similarities to other CPU architectures within the same CPU architecture class

Note 1 to entry: CPU architectures are used to create CPU models which are often released in a similar timeframe

Note 2 to entry: Examples of CPU architectures in the same CPU architecture class are Intel® Haswell, Intel Broadwell, and Intel Skylake, or separately, AMD® Bulldozer, AMD Piledriver, and AMD Steamroller

3.1.15**CPU architecture class**

group of one or more CPU architectures which share the same instruction set architecture and in which newer architectures designs are derived from previous architecture designs

Note 1 to entry: Within a CPU architecture class, the initial CPU architecture is, for the most part, a new design, and subsequent CPU architectures are derived from preceding CPU architectures

Note 2 to entry: Examples of different CPU architecture classes are ARMv8-A® and AMD EPYC®

Note 3 to entry: In certain cases, software programs need to be recompiled for use with different CPU architecture classes

3.1.16**CPU model**

specific CPU that is sold in the marketplace

308 Note 1 to entry: All CPUs of the same model share the same technical characteristics, such as core
309 frequencies and core counts, and can be used interchangeably

310 Note 2 to entry: Examples of different CPU models are AMD EYPC 7601, AMD EYPC 7251 and Intel Xeon
311 Platinum 8180

312 **3.1.17**

313 **CPU nominal frequency**

314 the CPU core clock frequency which is the main frequency used in naming, marketing, and selling
315 the CPU

316 **3.1.18**

317 **data averaging internal**

318 for a power analyser, the time period over which all samples captured by the high-speed sampling
319 electronics of the analyser are averaged to provide a set of measured data

320 **3.1.19**

321 **double data rate**

322 transfers data on the rising and falling edges of the memory clock signal, resulting in twice the
323 memory bandwidth capacity at a specific clock frequency

324 **3.1.20**

325 **end user**

326 person or persons who will ultimately be using the system for its intended purpose

327 Note 1 to entry: for the purposes of this standard, the end user is the entity applying for certification of a
328 server model to a SEEM compliant regulation or program. For example, if server manufacturer A was
329 submitting a server model to ENERGY STAR for certification, server manufacturer A would be the end user.

330 [SOURCE: ISO/IEC/IEEE 24765:2010, 3.990, Note 1 has been added]

331 **3.1.21**

332 **energy effectiveness**

333 measure of the amount of data processing performed for a given amount of energy consumed

334 Note 1 to entry: for the purposes of this standard energy effectiveness is equivalent to the term energy
335 efficiency as used in server compliance regulations and programs such as ENERGY STAR®.

336 **3.1.22**

337 **expansion auxiliary processing accelerator**

338 auxiliary processing accelerator that is an add-in card installed in a general-purpose add-in
339 expansion slot.

340 Note 1 to entry: An expansion APA add-in card may include one or more APAs and/or separate, dedicated
341 removable switches

342 Note 2 to entry: example is a GPGPU installed in a PCI-e slot

343 **3.1.23**

344 **fair use**

345 uses of content that are considered valid defences to copyright infringement, such as for criticism
346 or educational purposes

347 Note 1 to entry: For the purposes of this standard, fair use refers to the guidelines the developer of a metric
348 has specified related to how results can be used

349 [SOURCE: ISO 19153:2014, 4.14 – modified, original Note 1 remove, Note 1 added]

350 **3.1.24**

351 **fully fault tolerant server**

352 computer server that is designed with complete hardware redundancy, in which every computing
353 component is replicated between two nodes running identical and concurrent workloads

354 Note 1 to entry: A fully fault tolerant server uses two systems to simultaneously and repetitively run a
355 single workload for continuous availability in a mission critical application

356 Note 2 to entry: An example of a fault tolerant server; if one node fails or needs repair, the second node
357 can run the workload alone to avoid downtime

358 **3.1.25**

359 **hardware threads**

360 in a CPU core, the number of fully independent instruction streams which can be executed through
361 SMT

362 **3.1.26**

363 **high performance computing (HPC) system**

364 computing system which is designed, marketed, sold, and optimized to execute highly parallel
365 applications for high performance, deep learning, or artificial intelligence applications

366 Note 1 to entry: HPC systems consist of multiple clustered servers, primarily for increased computational
367 capability, high speed inter-processing interconnects, large and high bandwidth memory capability and
368 often accelerators such as GPGPUs or FPGAs

369 Note 2 to entry: HPC systems may be purposely built or assembled from more commonly available computer
370 servers

371 **3.1.27**

372 **high-end configuration**

373 server equipped with a specific selection of high performance components, which is required to
374 be tested as part of measuring a server product family

375 **3.1.28**

376 **idle state**

377 operational mode in which the OS and other software have completed loading, the server is
378 capable of completing workload transactions, but no active workload transactions are requested
379 or pending by the system

380 Note 1 to entry: In the idle state, the server is operational, but not performing any useful data
381 processing

382 Note 2 to entry: For systems where Advanced Configuration and Power Interface (ACPI) has
383 been implemented, idle state is the ACPI G0 global state and S0 sleep state.

384 **3.1.29**

385 **idle state power**

386 average server power, in watts, when in idle state

387 Note 1 to entry: SERT provides a standard way to measure the idle power of a server, which is included
388 with the result output, and is in addition to power measurement while the server is actively performing data
389 processing

390 **3.1.30**

391 **implementer**

392 entity that transforms specified designs into their physical realization

393 Note 1 to entry: For the purposes of this standard, implementer is the entity which creates a selection or
394 procurement program based on SEEM.

395 [SOURCE: IEC 62279:2015, 3.1.15, Note 1 added]

396 **3.1.31**

397 **integrated auxiliary processing accelerator**

398 auxiliary processing accelerator that is integrated into the motherboard or CPU package

399 **3.1.32**

400 **large network equipment**

401 network product which contains more than 11 network ports with a total line rate throughput of
402 12 Gb/s or more

403 **3.1.33**

404 **large server**

405 resilient/scalable server which ships as a pre-integrated/pre-tested system housed in one or
406 more full frames or racks and that includes a high connectivity I/O subsystem with a minimum of
407 32 dedicated I/O slots

408 **3.1.34**

409 **load level**

410 percentage of data processing relative to the maximum a server can execute

411 Note 1 to entry: Load levels are typically used by benchmark designers to simulate situations where a
412 system is receiving fewer data processing requests than it can execute

413 Note 2 to entry: Load level is not necessarily the same as CPU utilization

414 **3.1.35**

415 **low-end configuration**

416 server configuration which includes a specific selection of entry level components, which is
417 required to be tested as part of measuring a server product family

418 **3.1.36**

419 **memory channel**

420 independent interface in a computer which facilitates the communication of data between a core's
421 memory controller and installed memory DIMMs

422 Note 1 to entry: Modern computer servers usually have a number of memory channels connected to
423 different CPUs or cores