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Information Technology — Data centres — Application Platform Energy Effectiveness (APEE)

Technologies de l'information — Centres de traitement de données — Efficacité énergétique des plateformes d'applications (APEE)

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Contents

Page

Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 39, *Sustainability, IT & Data Centres*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The growth of the Internet of Things (IoT) has resulted in the storage of increasingly large amounts of data in data centres and the increased utilization of this data by technologies such as artificial intelligence (AI). As a result, energy consumption of data centres is also increasing. In this recent utilization of large amounts of data by technologies such as AI, various kinds of data are combined and analysed, and processing requests for such combinations and analysis are also increasing. Middleware, such as a database management system (DBMS), is also becoming more important for this data utilization. The energy effectiveness of application platforms can be greatly improved through the selection of middleware.

In addition to improving the energy effectiveness of target IT equipment itself, it is necessary to improve application platform energy effectiveness by choosing an optimally energy-effective combination of target IT equipment, operating systems and middleware.

Although there are several KPIs for the energy effectiveness of target IT equipment itself (for example, ISO/IEC 30134-4, ISO/IEC 21836), there have previously been no KPIs for energy effectiveness to calculate the energy effectiveness of a combination of target IT equipment, operating systems and middleware. This document, therefore, introduces a KPI for the energy effectiveness of an entire application platform. A typical use case of application platform energy effectiveness (APEE) is a criterion for procuring an energy efficient application platform for an IT service.

This KPI provides assistance in selecting an optimal application platform for energy effectiveness. This KPI does not apply to the energy effectiveness of an entire data centre. The colloquial term of "efficiency" is commonly used in regional programmes and "effectiveness" can be referenced as "efficiency" in those programmes.

Information Technology — Data centres — Application Platform Energy Effectiveness (APEE)

1 Scope

This document specifies application platform energy effectiveness (APEE) as a Key Performance Indicator (KPI) which quantifies the energy effectiveness of an application platform for an IT service in data centres. This KPI evaluates the energy consumption of an application platform prior to deployment. The purpose of this KPI is to measure the energy effectiveness of a set of target IT equipment, operating systems and middleware, to enable the selection of an energy effective IT stack.

This document specifies a formula for calculating APEE and definitions of components of the formula.

This document specifies a measurement method for assessing and reporting the energy effectiveness of an application platform.

This document also specifies requirements for benchmarks to be used for APEE and requirements for reporting.

The following topics are outside of the scope of this document:

1) KPIs intended to solely evaluate the energy effectiveness of target IT equipment hardware,

2) energy effectiveness of data centre facilities.

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.

ISO/IEC 21836:2020, *Information technology — Data centres — Server energy effectiveness metric*

ISO/IEC 21878, *Information technology — Security techniques — Security guidelines for design and implementation of virtualized servers*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 21878 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
application platform
platform composed of *target IT equipment* (3.1.4), operating systems, and *middleware* (3.1.3) with the purpose of providing an *IT service* (3.1.5)

Note 1 to entry: An application platform is an environment for executing *software applications* (3.1.2) such as ERP and CRM software. Therefore, a software application itself is not included as part of an application platform.

3.1.2
software application
computer program for implementing an *IT service* (3.1.5)

Note 1 to entry: A software application is usually developed independently for each IT service.

3.1.3
middleware
software layer between an operating system and the *software applications* (3.1.2)

Note 1 to entry: Examples of middleware include DBMS, web server software, application server software, transaction monitor.

Note 2 to entry: An operating system is the software directly managing the hardware, e.g. conventional operating system, hypervisor, etc.

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.2459, modified – Notes 1 and 2 to entry have been added.]

3.1.4
target IT equipment
server, storage and network equipment that are components of an *application platform* (3.1.1)

3.1.5
IT service
service that provides an outcome to its users via information technology

3.1.6
application outcome
information provided by an *IT service* (3.1.5) to its users

Note 1 to entry: An example of an application outcome is a set of reports to support decision-making at retail outlets (such as sales analysis reports, and stock status reports).

3.1.7
measurement period
duration in which the benchmark performs the intended data processing

Note 1 to entry: Typically, the measurement period(s) is/are the only portion of the benchmark execution which is/are used to calculate the benchmark score.

Note 2 to entry: The intended data processing routine is a routine including the benchmark calculation.

Note 3 to entry: In the case of using TPC-H[1)], the measurement target of TPC-H is a performance for executing SQL queries, so a period of executing SQL queries is a measurement period. Other periods, such as a data loading, are not a measurement period.

3.1.8
benchmark identifier
string which identifies a specific benchmark, which consists of the name and the major *version* (3.1.9), when applicable

1) TPC-H, TPC-E, and TPCx-IoT are trademarks of the Transaction Processing Performance Council. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO/IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

3.1.9
version
particular form or variation of a resource that differs from other instantiations of the resource in at least one aspect or item of information

Note 1 to entry: The first digit of a version is called the major version, and any numbers right of that digit is called a minor version.

Note 2 to entry: Example: in the version designated as "v1.2.3," the Major Version identification is "1", and the Minor Version identification is "2.3".

[SOURCE: ISO 24619:2011, 3.1.9, modified — Notes 1 and 2 to entry added.]

3.1.10
internal power supply
independent device that converts commercial AC power to DC power as required inside *target IT equipment* (3.1.4)

3.2 Abbreviated terms

AC	alternating current
AI	artificial intelligence
APEE	application platform energy effectiveness
CRM	customer relationship management
DBMS	database management system
DC	direct current
EAP	energy consumption of application platform during the measurement periods
ERP	enterprise resource planning
FC	fibre channel
IoT	Internet of Things
NoAO	number of application outcomes during an APEE measurement
OS	operating system
RDBMS	relational database management system

4 Relevance of APEE

Many kinds of IT services are provided by using data centres, and it is necessary to conserve the amount of energy used by these IT services. A lot of IT services use various technologies, such as AI, IoT and big data technologies. For each of these technologies, there are several combinations of target IT equipment, OSs and middleware that can be used to provide IT services. These combinations of target IT equipment, OSs and middleware are called an application platform.

Even if the results provided by an IT service are the same, if the application platform used to provide the IT service is different, the energy consumption is also different. For example, when the same query is executed on different DBMSs, because the processing method and processing time are different for each DBMS, energy consumption also differs.

In order to choose the optimum application platform for energy effectiveness, a KPI for measuring the energy effectiveness of an application platform is necessary. There are KPIs for measuring the energy effectiveness of target IT equipment only, and ISO/IEC 21836 is one of KPIs for a server. APEE is a KPI for measuring the energy effectiveness of an application platform. Use cases of APEE are described in Annex A.

NOTE APEE is a KPI for measuring the energy effectiveness of an application platform for a particular IT service, not the energy effectiveness of an entire data centre. Therefore, APEE is not suitable for use in regulations that apply to an entire data centre.

5 Determination of APEE

APEE shall be determined and described by Formula (1):

$$c = a / b \tag{1}$$

where

a is the number of application outcomes during an APEE measurement (NoAO) (see Clause 6);

b is the energy consumption (kWh) of the application platform during the measurement periods (EAP) (see Clause 6);

c is the APEE.

The unit dimension of APEE is (application outcome(s)/kWh). The APEE value should have at least 2 significant digits.

Reporting of data for APEE is described in Clause 7.

An example of APEE calculation is given in Annex B.

6 Determination of application outcome and energy consumption of the application platform for APEE

6.1 Prerequisites for the benchmark and application platform

The following prerequisites shall apply when measuring the APEE of an application platform that provides an IT service:

a) The measurer determines one benchmark to be used for the calculation of APEE. Benchmarks shall meet the following requirements. Examples of benchmarks that can be used for APEE measurement are given in Annex D.

   1) The benchmark is representative of the target IT service.

   2) The start and the end of the execution of the benchmark are clear.

   3) All iterations of the benchmark run produce comparable results.

   4) An application outcome defined by the benchmark is identical regardless of how many times it is executed on any application platform.

      NOTE 1 In the case of TPC-H as an example of an application outcome, it defines a set of results of business-oriented ad-hoc queries as an application outcome of the execution. A performance metric such as throughput and processing time is not an application outcome.

EXAMPLE 1 A benchmark that executes transactions while increasing the multiplicity until the system cannot keep the specified response time in order to obtain maximum multiplicity is not applicable because the processes of measurement target for these benchmarks have the potential to change from run to run.

5) Start date and time, and end date and time of all the measurement period(s) are clear.

NOTE 2 Some benchmarks have multiple measurement periods in one benchmark execution.

EXAMPLE 2 (Example of clarification) A benchmark has warmup and cooldown phases which do not effort a benchmark performance score. It records start date and time and end date and time of these phases in a log file, so these phases are distinguishable from measurement period(s).

6) Measurement period start and stop time are measured in seconds or higher precision.

7) To ensure that the result is verifiable, the benchmark is made publicly available.

b) The measurer determines the target IT equipment, OSs and middleware that are to serve as the elements of the application platform. The application platform shall meet the following requirements:

1) The application platform contains all of the target IT equipment necessary to execute the benchmark.

2) Every target IT equipment component can be measured for energy consumption.

6.2 Determination of application outcome

For the determination of application outcome, the following terms are introduced:

— One application outcome is defined as one valid execution of the benchmark.

The following requirements for measurement shall be met:

a) The benchmark is executed at least one time. If the benchmark is executed multiple times, the number of benchmark executions is a positive integer.

NOTE The tester can interact with the server between benchmark iterations, typically to calculate the total measured time for benchmarks which include unmeasured periods.

b) If the total time of the whole measurement period is less than one hour, the benchmark is repeatedly executed until the total time of the whole measurement period exceeds one hour.

c) If the benchmark has a setting for official or valid or reportable results for publication or use in comparisons, this mode shall be used for APEE comparisons.

6.3 Determination of energy consumption of the application platform

6.3.1 Requirements for obtaining energy consumption of the application platform

Energy consumption of the application platform shall be obtained by the sum of energy consumption (kWh) of all the target IT equipment in the application platform during all benchmark measurement period(s) of the APEE measurement. Non-benchmark software should be minimal during the measurement period(s). Execution of non-benchmark software on the application platform shall not invalidate energy results. Energy measurements during benchmark execution shall not be adjusted to remove the effects of non-benchmark software.

NOTE The application platform is usually used solely by the benchmark during the measuring period for accuracy.

The energy consumption of each item of target IT equipment in the application platform is obtained by the measurement method. Details of this method are given in 6.3.2.