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Information technology — Data centre facilities and infrastructures —

Part 31: Key performance indicators for resilience

Technologie de l'information — Installation et infrastructures de centres de traitement de données —

Partie 31: Indicateurs clés de performance pour la résilience

Reference number
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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 39, *Sustainability, IT and data centres*.

This second edition cancels and replaces the first edition (ISO/IEC TS 22237-31:2023), which has been technically revised.

The main changes are as follows:

— Annex B was added to provide dependability data for items of data centre infrastructures;

— all subsequent annexes were reviewed and reordered;

— terms and definitions were clarified.

A list of all parts in the ISO/IEC 22237 series can be found on the ISO and IEC websites.

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.

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Introduction

The various parts of the ISO/IEC 22237 series reference four qualitative Availability Classes as well as structural definitions to categorize different designs. The documents also refer to resilience criteria in order to improve structural requirements for a qualitative approach.

In order to meet the requirements for evaluating or comparing different designs or for validating service level agreements (SLAs) for data centres, this document introduces quantitative metrics as key performance indicators (KPIs). The proposed KPIs cover resilience attributes, including dependability and fault tolerance metrics. The characteristics of aging of infrastructures are covered by reliability criteria.

Through the use of KPIs, the comparison of designs, functional elements and components of infrastructure designs becomes possible. In addition, it is possible to optimize data centre infrastructures (DCIs) with holistic targets. It is recommended to use the KPIs of this document in combination with the efficiency and sustainability KPIs of the ISO/IEC 30134 series.

ISO/IEC 22237-1:2021, Annex A, demonstrates that a single KPI, such as Availability, is not sufficient to describe the complexity of a DCI. In recognition, this document has been developed in order to compare and value different designs with different Availability Classes of DCIs based on a set of selected KPIs.

Furthermore, this document has been created to establish KPIs for resilience of DCIs with defined resilience levels. The resilience objectives can vary depending on the outcome of the ISO/IEC 22237-1 risk analysis, the process criticality of the end user's information technology equipment (ITE), and the data centre type of business.

Using the different stages of a data centre design process, this document describes in which phases the application of KPIs for resilience is appropriate. With its assistance, data centre designers, planners and operators will be supported in defining resilience levels, performing theoretical assessments and designing and operating DCIs which are able to meet SLAs.

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Information technology — Data centre facilities and infrastructures —

Part 31: Key performance indicators for resilience

1 Scope

This document:

a) defines metrics as key performance indicators (KPIs) for resilience, dependability, fault tolerance and availability tolerance for data centres;

b) covers the data centre infrastructure (DCI) of power distribution and supply, and environmental control;

c) can be referred to for covering further infrastructures, e.g. telecommunications cabling;

d) defines the measurement and calculation of the KPIs and resilience levels (RLs);

e) targets maintainability, recoverability and vulnerability;

f) provides examples for calculating these KPIs for the purpose of analytical comparison of different DCIs.

This document does not apply to IT equipment, cloud services, software or business applications.

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 22237-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*

ISO/IEC 22237-3, *Information technology — Data centre facilities and infrastructures — Part 3: Power distribution*

ISO/IEC 22237-4, *Information technology — Data centre facilities and infrastructures — Part 4: Environmental control*

ISO/IEC 30134-1, *Information technology — Data centres — Key performance indicators — Part 1: Overview and general requirements*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 22237-1, ISO/IEC 22237-3, ISO/IEC 22237-4 and the following apply.

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

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

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

3.1.1
availability
ability to be in a state to perform as required

[SOURCE: IEC 60050-192:2015, 192-01-23, modified — Notes 1 and 2 to entry have been deleted.]

3.1.2
availability tolerance
ability to be in a state to perform as required with certain *failures* (3.1.8) present

3.1.3
dependability
ability to perform as and when required

Note 1 to entry: In this document, the term is used for the determination of data centre *reliability* (3.1.28), *availability* (3.1.1) and *failure rate* (3.1.9).

[SOURCE: IEC 60050-192:2015, 192-01-22, modified — Notes 1 and 2 to entry have been replaced by a new Note 1 to entry.]

3.1.4
double point of failure
DPoF
combination of two functional elements whose simultaneous *failures* (3.1.8) cause overall system *fault* (3.1.10)

[SOURCE: IET, Journal of Engineering, Vol. 2019 Iss. 12, 99. 8419-8427][1]

3.1.5
double point of reduced availability
DPoRA
combination of two functional elements whose simultaneous *failures* (3.1.8) result in the violation of the *service level agreement (SLA)* (3.1.30)

[SOURCE: IET, Journal of Engineering, Vol. 2019 Iss. 12, 99. 8419-8427][1]

3.1.6
down state
state of being unable to perform as required, due to *failures* (3.1.8) or *faults* (3.1.10)

Note 1 to entry: The state can be related to failures of items or faults at a specified *operation point (OP)* (3.1.21).

[SOURCE: IEC 60050-192:2015, 192-02-20]

3.1.7
event
something that happens and leads to one or more *failures* (3.1.8) or *faults* (3.1.10)

3.1.8
failure
<of an item> loss of ability to perform as required

Note 1 to entry: In this context it is irrelevant if the cause was planned or unplanned.

[SOURCE: IEC 60050-192:2015, 192-03-01, modified — Notes 1 to 3 to entry have been replaced by Note 1 to entry.]

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3.1.9
failure rate
limit of the ratio of the conditional probability that the instant of time, *T*, of a *failure* (3.1.8) of a product falls within a given *time interval* (3.1.34) (t, $t + \Delta t$) and the duration of this interval, Δt, when Δt tends towards zero, given that the item is in an *up state* (3.1.35) at the start of the time interval

[SOURCE: IEC 60050-192:2015, 821-12-21]

3.1.10
fault
inability to perform as required, due to an internal state

Note 1 to entry: Opposite of success. In the context of the expected *resilience level (RL)* (3.1.26), at a specified *operation point (OP)* (3.1.21).

[SOURCE: IEC 60050-192:2015, 192-04-01]

3.1.11
fault tolerance
ability to continue functioning with certain *faults* (3.1.10) present

[SOURCE: IEC 60050-192:2015, 192-10-09]

3.1.12
information technology equipment
ITE
equipment providing data storage, processing and transport services together with equipment dedicated to providing direct connection to either core or access networks or both

3.1.13
infrastructure
technical systems providing the functional capability of the data centre

Note 1 to entry: Examples are power distribution, environmental control, telecommunications cabling and physical security.

[SOURCE: ISO/IEC 22237-1:2021, 3.1.21, modified — The term "telecommunications cabling" has been added to the list in Note 1 to entry.]

3.1.14
inherent availability
availability (3.1.1) provided by the design under ideal conditions of operation and maintenance

[SOURCE: IEC 60050-192:2015, 192-08-02]

3.1.15
mean down time
MDT
average downtime caused by scheduled and unscheduled maintenance, including any logistics time (expectations including detection time, diagnostic time, spare part delivery time, repair time)

[SOURCE: IEEE Std. 493-2007]

3.1.16
mean operating time between failures
MTBF
expectation of the duration of the operating time between *failures* (3.1.8)

Note 1 to entry: Mean operating time between failures should only be applied to repairable items. For non-repairable items, see *mean operating time to failure* (3.1.17).

Note 2 to entry: The term “mean time between failures” (MTBF) is used synonymously in this document.

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[SOURCE: IEC 60050-192:2015, 192-05-13]

3.1.17
mean time to failure
MTTF
expectation of the operating time to *failure* (3.1.8)

Note 1 to entry: In the case of non-repairable items with an exponential distribution of operating times to failure, i.e. a constant *failure rate* (3.1.9), the mean operating time to failure is numerically equal to the reciprocal of the failure rate. This is also true for repairable items if after restoration they can be considered to be "as-good-as-new".

[SOURCE: IEC 60050-192:2015, 192-05-11, modified — The term "operating" has been removed from the preferred term and "MTTF" has been added as a preferred term.]

3.1.18
mean time between maintenance
MTBM
average time between all maintenance *events* (3.1.7), scheduled and unscheduled, and also includes any associated logistics time

[SOURCE: IEEE Std. 493-2007]

3.1.19
mean time to restoration
mean time to replace or repair a failed component

Note 1 to entry: Logistics time associated with the repair, such as parts acquisitions or crew mobilization, are not included.

[SOURCE: IEEE Std. 493-2007]

3.1.20
normal resilience level
NRL
resilience level (3.1.26) mandatory during nominal operation

3.1.21
operation point
OP
point of reference for which calculation of *resilience level* (3.1.26) is performed

Note 1 to entry: This can be an individual socket taking into account the entire data centre infrastructure or certain defined parts of the *infrastructure* (3.1.13), described by at least one *system success path* (3.1.33). The documentation of the referenced operation point is required for any key performance indicator.

3.1.22
operational availability
availability (3.1.1) experienced under actual conditions of operation and maintenance

[SOURCE: IEC 60050-192:2015, 192-08-03, modified — Note 1 to entry has been deleted.]

3.1.23
past availability
availability (3.1.1) measured during a period of 1 year

Note 1 to entry: For the purposes of this document, 1 year equals 8 760 h.

3.1.24
reduced resilience level
RRL
resilience level (3.1.26) mandatory during reduced operation in case of one or more *failures* (3.1.8)

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3.1.25
resilience
ability to withstand and reduce the magnitude and/or duration of disruptive *events* (3.1.7), including the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event

[SOURCE: IEEE Task Force on Definition and Quantification of Resilience, PES-TR65:2018-04][2]

3.1.26
resilience level
enumeration of attributes for the determination of *resilience* (3.1.25) aspects of a defined service at a defined *operation point (OP)* (3.1.21)

3.1.27
redundancy
<in a system> provision of more than one means for performing a function

Note 1 to entry: In a data centre, redundancy can be achieved by duplication of devices, functional elements, and/or supply paths.

[SOURCE: IEC 60050-192:2015, 192-10-02, modified — Original Note 1 to entry has been replaced by a new Note 1 to entry.]

3.1.28
reliability
ability to perform as required, without *failure* (3.1.8), for a given *time interval* (3.1.34), under given conditions

[SOURCE: IEC 60050-192:2015, 192-01-24, modified — Notes 1 to 3 to entry have been deleted.]

3.1.29
resilience model
representation *x* of the data centre infrastructure that shows all required subsystems, components and items as well as their systemic interdependencies

3.1.30
service level agreement
SLA
agreement defining the content and quality of the service to be delivered and the timescale in which it is to be delivered

[SOURCE: ISO/IEC TS 22237-7:2018, 3.1.20, modified — The term "SLA" has been added as a preferred term.]

3.1.31
single point of failure
SPoF
functional element whose *failure* (3.1.8) causes overall system *fault* (3.1.10)

[SOURCE: IET, Journal of Engineering, Vol. 2019 Iss. 12, 99. 8419-8427][1]

3.1.32
single point of reduced availability
SPoRA
functional element whose *failure* (3.1.8) results in the violation of the *service level agreement (SLA)* (3.1.30)

[SOURCE: IET, Journal of Engineering, Vol. 2019 Iss. 12, 99. 8419-8427][1]

3.1.33
system success path
infrastructural path, consisting of a minimum of functional elements, to express the success of the *infrastructure* (3.1.13) system at the *operation point (OP)* (3.1.21) to be in the *up state* (3.1.35)

Note 1 to entry: Each functional element can consist of one or more devices.

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$S(\boldsymbol{x}_{\mathrm{E}})$ environmental control success function

$S(\boldsymbol{x}_{\mathrm{OP}})$ overall success function

$S(\boldsymbol{x}_{\mathrm{P}})$ power and distribution success function

t_{MDT} mean down time

t_{MTBF} mean time between failures

t_{MTBM} mean time between maintenance

t_{MTTR} mean time to restoration

t_x time interval of x

T instant of time

U_{N} nominal voltage

$\boldsymbol{x}_m$ vector of elements of $x_{m(i)}$ of the mth data centre infrastructure

$x_{m(i)}$ functional element x of the mth data centre infrastructure with the index i

X_m set of all functional elements x of the mth data centre infrastructure

α confidence rate

Δt duration of time interval

λ_{i} inherent failure rate

λ_{mean} mean failure rate

λ_{o} operational failure rate

λ_{p} past failure rate

χ^2 chi-square distribution function law with two degrees of freedom

3.2.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO/IEC 22237-1, ISO/IEC 30134-1 and the following apply.

DCI data centre infrastructure (infrastructure residing within a data centre)

DPoF double point of failure

DPoRA double point of reduced availability

FMECA failure mode effects and criticality analysis

ITE information technology equipment

KPI key performance indicator

MDT mean down time

MTBF mean operating time between failures

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MTBM	mean time between maintenance
MTTF	mean time to failure
MTTR	mean time to restoration
NRL	normal resilience level
OP	operation point
PDF	probability density function
PREP	power reliability enhancement program
RBD	reliability block diagram
RL	resilience level
RRL	reduced resilience level
SLA	service level agreement
SPoF	single point of failure
SPoRA	single point of reduced availability
SSP	system success path
UPS	uninterrupted power system

4 Area of application

4.1 General

The KPIs for resilience, including the dependability, fault tolerance and availability tolerance KPIs, as specified in this document are associated with the following DCIs of the ISO/IEC 22237 series:

a) ISO/IEC 22237-3: Power supply and distribution;

b) ISO/IEC 22237-4: Environmental control.

The application can be extended to additional infrastructures, e.g. ISO/IEC TS 22237-5 (telecommunications cabling infrastructure).

4.2 DCI service definition

To determine system success at the operation point (OP), it is required to define the relevant DCI. In general, the overall success function $S(\boldsymbol{x}_{\mathrm{OP}})$ is represented by a certain number, *N*, of successes of infrastructures inside the DCI as shown in Formula (1):

$$S(\boldsymbol{x}_{\mathrm{OP}}) = \cap_{m=1}^{N} S(\boldsymbol{x}_m) \tag{1}$$

The success $S(\boldsymbol{x}_m)$ of the enumerated infrastructures $\boldsymbol{x}_m$ is connected by the $\cap$ operator. In general, these infrastructures are not mutually exclusive, because the functions depend on each other. Functional dependencies shall be taken into account in the calculations.

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