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Information technology — Data centres — Best practices for resource-efficient data centres

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Foreword

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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*.

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

Data centres are essential to the provision of information technology (IT) services and can play an important role in the conservation of resources. However, they can also consume a considerable amount of resources if mis-managed and thus, it is critical to utilize these resources efficiently.

Resource efficiency in the data centre begins with the location (taking advantage of the external environment) and the building design to minimize energy consumption. The facilities can then implement modular extension or easily extensible space, cooling, and power according to the IT services provided and co-location situation.

Once data centres are constructed and equipped with all the necessary facilities, it is important to collect and monitor operational data. Based on the information obtained, it is possible to determine which elements utilize resources least efficiently and assess how to improve that performance.

The performance of existing facilities can be periodically measured to determine if the original design objectives for resource efficiency are being achieved and allowing performance to be improved by replacement of equipment with better resource-efficiency characteristics.

This document provides information on available options for improving resource efficiency in data centres, with particular emphasis on operational procedures.

Information technology — Data centres — Best practices for resource-efficient data centres

1 Scope

This document describes generally applicable best practices for improving the resource efficiency of data centres, independent of their application.

This document focuses on continuous improvement processes, designs and guidelines that prioritize resource efficiency. In general, the processes and best practices are technology-neutral and independent of location.

The best practices for data centre resource efficiency improvement deal with various establishment and operation aspects such as data centre planning, management, cooling, power feeding, information and communications technology (ICT) and cost aspects that are not restricted by the scope of this document.

The following items are not included in the scope of this document:

— development of key performance indicators (KPIs);

— comparability between data centre performance results;

— definition of maturity models for data centre;

— social sustainability issues.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviations

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

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
availability
ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

[SOURCE: ISO/IEC 22237-1:2021, 3.1.1]

3.2
computer room space
area within the data centre that accommodates the data processing, data storage and telecommunication equipment that provides the primary function of the data centre

[SOURCE: ISO/IEC 22237-1:2021, 3.1.6]

3.3
computer room air conditioning/computer room air handling
CRAC/CRAH
equipment that provides cooling airflow volumes into a computer room as a means of environmental control

Note 1 to entry: Other abbreviations such as CCU, DFU, RACU, UFU are sometimes used.

3.4
data centre
structure, or group of structures, dedicated to the centralized accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing and transport services together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

Note 1 to entry: A structure can consist of multiple buildings and/or spaces with specific functions to support the primary function.

Note 2 to entry: The boundaries of the structure or space considered the data centre which includes the information and communication technology equipment and supporting environmental controls can be defined within a larger structure or building.

[SOURCE: ISO/IEC 30134-1:2016, 3.1.4]

3.5
direct liquid-cooled ICT equipment
ICT equipment that is cooled by a direct flow of liquid into an equipment cabinet or directly to the ICT equipment chassis to provide cooling, rather than the use of moving air

3.6
energy efficiency
measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed

3.7
hot aisle/cold aisle
<system> construction of cabinets and containment intended to prevent the mixing of ICT equipment intake and exhaust air within computer room space(s)

3.8
information and communication technology equipment
ICT equipment
information technology (IT) and network telecommunications (NT) equipment providing data storage, processing and transport services

Note 1 to entry: This represents the “critical load” of the data centre.

3.9
rack
open construction, typically self-supporting and floor-mounted, for housing closures and other information technology equipment

3.10
resilience
capacity to withstand failure in one or more of the ICT equipment or data centre infrastructures

3.11
set-point
desired or target value (maximum or minimum) for a physical quantity used for control

3.12
virtualization
creation of a virtual version of physical ICT equipment or resource to offer a more efficient use of ICT hardware

3.1 Abbreviated terms

For the purposes of this document the following abbreviated terms apply.

ASHRAE	(formerly) American Society of Heating, Refrigeration and Air conditioning Engineers
BREEAM	Building Research Establishment Environmental Assessment Methodology
CMDB	configuration anagement database
CPU	core processing unit
CRAC	computer room air conditioning
CRAH	computer room air handling
DCIM	data centre infrastructure management
F-R-F-R	front-rear-front-rear
ICT	information and communications technology
I/O	input/output
IT	information technology
LAN	local area network
LEED	leadership in energy and environmental design
MAID	massive array of inactive disks
MLPS	multiprotocol label switching
OVP	open virtual platform
PDU	power distribution unit
PUE	power usage effectiveness
RAID	redundant array of independent disks
SLA	service level agreement
UPS	uninterruptible power supply
VLAN	virtual local area network
VPN	virtual private network
VXLAN	virtual extensible local area network
WUE	water usage effectiveness

4 Principles

4.1 General

To operate and manage a data centre with effective usage of resources, there are many things to be considered in each phase, from design to operation. Resource efficiency in the data centre can be achieved mostly in the design and building phase. In the design and building phase of a data centre, the location selection can take advantage of the external environment, by taking into consideration building that minimizes consumption, modular extension or easily extensible space, cooling, and power, according to the IT services provided and co-location situation. As there can be a variety of forms and structures depending on the purpose of the data centre, resource efficiency technology can be suitably applied in accordance with the relevant application. In addition, it is advantageous to utilize state-of-the-art IT equipment which achieves the best practice in energy efficiency as well as performance.

Once the data centre is introduced, it is quite difficult to rebuild or reengineer it. One of the effective ways to improve the resource efficiency of existing data centres is to collect and monitor operational data in facilities in order to find inefficient equipment. In addition to infrastructure facilities such as cooling and power generation and distribution, IT equipment can also be monitored. Measured data can be analysed and processed to provide statistics and insights such as predictions of the energy consumed, and key performance indicators as introduced in the ISO/IEC 30134 series (PUE, WUE, etc). The data centre operators can find out how much the efficiency of equipment is degraded. If aging facilities are failing to achieve the initially-designed efficiency and performance, they can be properly replaced.

For a data centre to achieve resource efficiency, the aspects described in 4.2 to 4.8 need to be considered.

In the design stage, it is necessary to prevent over-investments or budget shortages due to miscalculation of IT equipment capacity growth. In addition, the design can take optimal usage of resources into account during operation after the construction of a data centre. This sub-clause describes considerations for data centre design and construction in terms of building, power, cooling, and data centre information management (DCIM) for improving resource efficiency.

For data centres that are designed and constructed with resource-efficient components, continuous maintenance activities are necessary for maintaining their efficiency. During its operations, a data centre's efficiency can be degraded due to various reasons, such as equipment aging or IT trend changes. It is thus necessary to perform maintenance and enhancement activities. The following subclauses provide best practices in effective operation for the infrastructure and IT equipment of a standalone medium/large data centre in order to maintain and enhance resource efficiency through data centre operation and management. Though other data centre types can utilize different elements of the following subclauses, some data centres will not have access or control of the infrastructure described therein. Therefore, some aspects of the following subclauses will not be applicable to other types of data centres, especially those with shared facility resources.

4.2 Data centre utilization, management and planning

It is important to develop a holistic strategy and management approach to the data centre to ensure the required availability and effective delivery of economic and environmental benefits. The following aspects can be considered.

a) General policies.

   Policies can be established that apply to all aspects of the data centre and its operation. See ISO/IEC TS 22237-7.

b) Resilience level and provisioning.

   Two of the most significant sources of inefficiency in data centres are the over provisioning of space, power or cooling, or the facilities being run at less than full capacity. Monolithic, as opposed to modular design of facilities also represents a significant and frequently unnecessary capital

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expenditure. Furthermore, as the level of resilience of the data centre increases, inefficiencies due to fixed overheads increase and this is compounded by poor utilization.

c) Involvement of organizational groups.

Ineffective communication between the disciplines working in the data centre is a major driver of inefficiency and can create issues of capacity management and reliability.

4.3 Data centre ICT equipment and services

The ICT equipment creates most of the demand for power and cooling in the data centre. Any reductions in power and cooling used by, or provisioned for, the ICT equipment will have magnified effects at the utility energy supply.

The purpose of the equipment environmental specifications in this subclause is to ensure that new equipment can operate under the wider ranges of temperature and humidity, thus allowing greater flexibility in operating temperature and humidity to the operator.

The following aspects can be considered.

a) Selection and deployment of new ICT equipment.

Once ICT equipment is purchased and installed in the data centre it typically spends several years in the data centre consuming power and creating heat. The appropriate selection of hardware and deployment methods can provide significant long-term savings.

b) Deployment of new ICT services.

The service architecture, software and deployment of ICT services have an impact at least as great as that of the ICT equipment.

c) Management of existing ICT equipment and services.

It is common to focus on new services and equipment being installed into the data centre but there are also substantial opportunities to achieve energy and cost reductions from within the existing service and physical estate, for example, by decommissioning hardware no longer in use or implementing energy saving policies.

d) Data management and storage.

Storage is a major growth area in both cost and energy consumption within the data centre. It is generally recognized that a significant proportion of the data stored is unnecessary, duplicated or does not require high performance access.

Some sectors have a particular issue due to very broad and non-specific data retention directives from governments or regulating bodies which can cause large volumes of data to be unnecessarily heavily protected and archived.

See Clause 5 for further information.

4.4 Data centre cooling equipment

A major part of the facility infrastructure is the cooling system.

Cooling of the data centre is frequently the largest energy loss in the facility and as such represents a significant opportunity to reduce energy consumption.