Procurement guidance for energy efficient server room and data centre equipment

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PrimeEnergyIT
EFFICIENT DATA CENTERS

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Content

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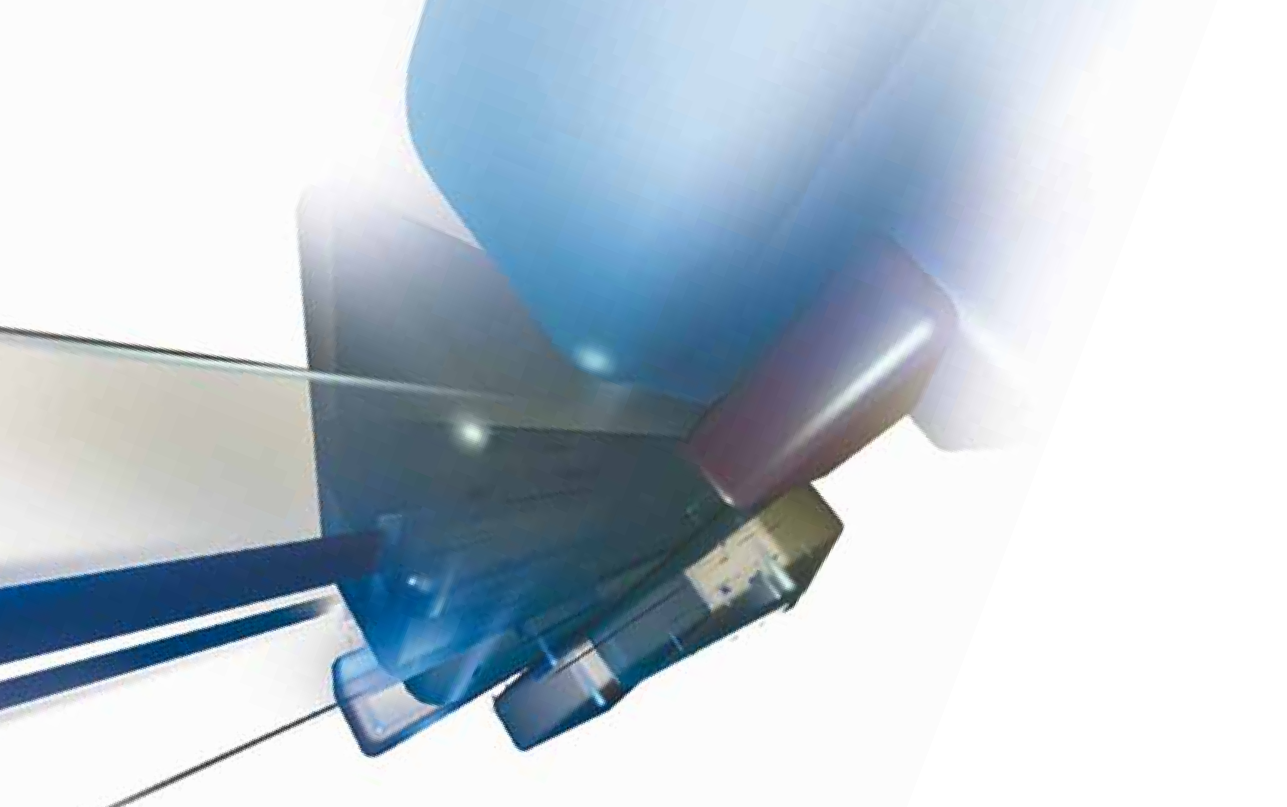


1 Introduction

1.1 Definition and Scope

This document provides purchasing recommendations for public authorities in the European Union for the replacement and renewal of server room/data centre equipment – namely:

- Servers
- Storage devices
- Network equipment (network access equipment, gateways, switches and routers)
- Cooling equipment
- Monitoring equipment

Please note the following points in relation to the scope of the document:

1. The recommendations relate **solely to the purchase of individual devices**. Guidance is not provided on the design, configuration or management of server rooms and data centres. Guidance on these elements is provided in the accompanying Technology Brochure available on the PrimeEnergyIT website at www.efficient-datacenter.eu, and from other sources such as the EU Code of Conduct for Data Centres [1].

2. In line with the scope of the PrimeEnergyIT project, the procurement criteria relate **solely to the energy efficiency aspects** of the devices covered. Other environmental aspects, such as harmful substances, recyclability etc. are not dealt with here.

3. The guidance relates **solely to direct equipment purchases, not the procurement of services**. Increasingly system design, operation and also hosting services are being contracted out to private providers. Guidance may be added on such procurement in future versions of these guidelines.

1.2 Key Environmental Impacts

The most significant environmental impact of the IT services provided by server rooms/data centres is energy consumption. This relates to the energy consumed directly by the IT equipment, by the cooling system required to maintain the appropriate environmental conditions, and other elements belonging to the IT facilities (e.g. lighting etc.).

The relatively short lifespan of data centre equipment also impacts significantly on resource efficiency. The life time of servers is typically 3-5 years, network equipment 5-7 years, and the entire life time of infrastructure equipment is currently set at about 10-15 years. Consumption of materials and generation of electronic waste is therefore also an aspect to consider..

1.3 Integrated system design and managements

TThe optimisation of energy efficiency in server rooms and data centres is strongly related to overall system design. Effective IT- and facility system design is particularly important for mid- to large-size data centres. Significant energy efficiency improvements can be accessed through consolidated IT-hardware arrangements, virtualisation and optimised cooling system design. The selection of efficient hardware for IT and infrastructure, as covered in this guide, is therefore only one measure for improving energy efficiency, and should follow system design-based decisions.

In many public authorities there is considerable fragmentation and decentralisation in terms of computing facilities and management. Even for single server rooms or data centres responsibilities for the IT-hardware and for the infrastructure or facility components are often separated. This may often lead to less than optimal, poorly integrated solutions.

The implementation of a sound, integrated IT and infrastructure management strategy (ideally across the whole authority) provides an essential basis for improvements - allowing optimisation measures to be designed from a complete system perspective, taking into account the requirements and integration of both the IT hardware and the facilities. The most effective form of sustainable, energy-efficient public procurement will therefore be based on such a strategy.

References

[1] http://re.jrc.ec.europa.eu/energyefficiency/html/standby_initiative_data_centers.htm

1.4 Server rooms and data centres in the public sector

The data service and storage arrangements of public authorities vary considerably. In many cases, particularly for smaller or highly decentralised administrations, data services are provided by server rooms contained within administrative buildings. Many larger authorities are starting to centralise at least some of their services in one or more dedicated data centres to take advantage of the significant efficiency gains in terms of space, personnel and finance. Different types of data service may be provided in different ways – some decentralised, some centralised – often depending on privacy and data security issues.

Another trend is towards the provision and hosting of certain aspects of their data services by external service providers, rather than in their own server rooms or data centres. In some cases external providers may be able to provide these services more efficiently in terms of financial cost, space and maintenance requirements. They may also be able to provide levels of data protection and security not available in smaller server rooms.

Most public authorities rely to some extent on contracted IT service providers to manage and maintain their IT software and hardware arrangements. This may also include responsibility for procuring IT hardware. In such cases, energy efficiency criteria can be made a compulsory element of the service contract.

Image: dreamstime.com

2 Preparing your procurement approach

2.1 Functional and performance requirements

Given the speed of technological advances in the IT sector, detailed technical specifications for equipment can quickly become obsolete. To allow the market to provide innovative solutions, you can frame your requirements in terms of the functional, performance and efficiency requirements (e.g. in terms of energy consumption) the equipment should fulfil, rather than prescribing the specific technology. The extent to which this is feasible will depend on compatibility issues and other framework conditions you may have – the more comprehensive the upgrade or renewal, the greater the scope for innovative solutions.

Typical costs in each category include:

Facility(CAPEX)	Facility (OPEX)	IT(CAPEX)	IT(OPEX)
• Facility construction/ renovation/ rental costs • Cooling system • Power supply infrastructure (including UPS and back up) 0 • Security system for failsafe performance	• Energy costs (Power distribution, UPS, lighting) • Operation and management • Maintenance • Network access	• IT hardware purchase and installation (servers, data storage, network and monitoring equipment) • Software licenses and installation	• IT equipment energy costs • IT equipment maintenance • Software operation and maintenance • IT operation

2.2 Total cost of ownership (TCO)

Over the lifetime of a typical server room or data centre, the purchasing price of the IT, cooling and monitoring equipment installed only accounts for part of the costs which will be incurred by the public authority. Total operating costs over the lifetime can be up to four times higher than the capital costs of the equipment itself. [2] [3]

Private data centre operators will typically base investment decisions on the Total Cost of Ownership (TCO) of the facility – many procurers will be more familiar with the terms life cycle costing (LCC) or whole life costing (WLC) which are largely comparable [4]. For a server room or data centre these may be divided into capital expenditure (CAPEX), and operating expenditure (OPEX), and further sub-divided into costs relating to the facility, and those relating to the IT equipment installed:

TCO = Facility(CAPEX) + Facility(OPEX) + IT(CAPEX) + IT(OPEX)

Public authorities would also benefit considerably from using a TCO model in making decisions on how to procure the computing services they require. The TCO approach may also be used at the level of direct equipment purchases, where competing bids are compared based on their TCO rather than the purchase and installation price alone. This would allow for the consideration of energy consumption as well as other aspects such as product lifetime and software costs. When applying this approach it is critical to ensure that suppliers are using the same methodology to determine the TCO.

TCO is being increasingly employed within procurement decision making across the EU, and a number of tools have been developed for calculating TCO. For example:

- VMware ROI TCO tool allows a comparison of TCO savings, required investments and the business benefits of virtualisation solutions: http://roitco.vmware.com/vmwg
- The Microsoft Assessment and Planning (MAP) Toolkit supports planning for migration including TCO and ROI calculation
- The SMART SPP tool for calculating life cycle costs, as well as CO_2 emissions in procurement: www.smart-spp.eu/guidance
- an LCC calculation tool developed by the Swedish Environmental Management Council (SEMCO): www.msr.se/en/green_procurement/LCC

References

[2] http://www-03.ibm.com/services/ca/en/cfo/documents/Data_Centre_Costs_Article_2.pdf
[3] Further information on data centre TCO can be found here: www.apcmedia.com/salestools/CMRP-5T9PQG_R4_EN.pdf
[4] Precise definitions of these terms vary. In the context of these guidelines however TCO, LCC and WLC are all considered to relate to the financial costs borne by the contracting authority in the ownership of a product or facility, or the contracting of a service. In the IT sector TCO is the accepted term; in the EU procurement field LCC is more typically used.

2.3 Engaging the market

The most effective way to determine what energy efficient technology options are available is to engage with the market. Communicating with potential suppliers prior to tendering is perfectly legal within the context of public procurement as long as this is carried out in a transparent and non-discriminatory manner, and does not confer an unfair advantage on the participants.

Different forms of market engagement may be used – from holding an open seminar with interested suppliers, to asking for suppliers to submit potential products/solutions. Undertaking such a process will help you to:

- Discuss the different technical options available for your needs, including the identification of any new technologies and system design concepts;
- Describe your technical requirements in tender documents in a way that is clear for potential suppliers to respond to, and which allows a fair comparison between offers.

Again, the bigger the procurement activity the more value there is in market engagement, and the more interested companies are likely to be. [5]

In the practical guidance below, several aspects are included as award criteria rather than as technical specifications, indicating a preference but not a requirement for a particular characteristic. Often award criteria are used when the procurer is uncertain about the broad availability of products meeting certain standards on the market, and cannot therefore make it a requirement. Engaging with the market prior to tendering can help determine whether to include a requirement as a specification or an award criterion.

2.4 Procuring services

The guidance provided here relates to the direct purchase of server room and data centre equipment. However, increasingly the design, operation and also hosting of data services is being contracted out to private providers.

Whilst such arrangements appear to limit direct control of the direct equipment used, they will often prove beneficial in achieving efficiency savings and improving performance, through accessing private sector technical expertise and making use of highly efficient state-of-the-art private facilities.

If the service provider only provides purchase and supporting services for your data centre you may include the efficiency criteria from Section 3 in the service contract.

The procurement of complete IT services hosted in a private data centre is outside the scope of this document, however approaches to consider in terms of energy efficiency when contracting out hosting arrangements could include reference to participation in the Code of Conduct on Data Centres Energy Efficiency of the European Commission [6] or meeting the criteria of the Blue Angel standard for Energy-Conscious Data Centers RAL-UZ 161. [7]

2.5 Monitoring of energy consumption

Monitoring of energy consumption and related parameters in server rooms and data centres is essential regardless of the system size. Detailed information on energy consumption is invaluable for supporting decisions on effective optimisation measures.

Several companies offer monitoring and control systems (some using wireless information transmission) that allow detailed monitoring of energy use and environmental conditions in data centres.

The section on monitoring equipment in this document (section 3.5), presents guidance on the procurement of the monitoring equipment. The selection of the most appropriate monitoring system design and devices however depends on the specific situation and purpose. More comprehensive information sources on monitoring system design specific sources are included in the Further Reading section below.

References

[5] More detailed guidance on undertaking market engagement can be found in the SMART SPP guide Driving energy efficient procurement through innovation at: www.smart-spp.eu/index.php?id=7633, and in a guide on Early Market Engagement produced by the former UK Office of Government Commerce (OGC): www.eastmidlandsiep.gov.uk/latest-news/1/260/early-market-engagement-principles-and-examples-of-good-practice/

[6] http://re.jrc.ec.europa.eu/energyefficiency/html/standby_initiative_data_centers.htm

[7] www.blauer-engel.de/en/products_brands/search_products/produkttyp.php?id=598

3 Criteria for energy efficient Public Procurement

The recommendations presented in this section are intended to provide guidance for public authorities procuring components for server rooms and data centres. In each section guidance is also provided on actions which may be taken prior to tendering.

The criteria themselves are split into three sections, according to the standard elements of public tenders:

- **Technical specifications** – these define the mandatory requirements for the product to be purchased. If products offered do not meet these minimum standards then the bids will be rejected;
- **Award criteria** – these outline how the different offers provided by suppliers will be compared, i.e. they indicate your preferences. The guidance below presents relative weighting for each of the energy efficiency award criteria. The total weighting given to energy efficiency will however need to be determined by the contracting authority;
- **Contract clauses** – these indicate how a specific contract must be carried out. This is particularly important in the case of service contracts.

With an archival life of 30 years and large storage capacity, tapes are an appealing solution for data centres with large long-term backup and archival requirements. Hence, for an environment with multiple tiers of storage, tape-based systems are still the most power-efficient solutions when considering long-term archival and low retrieval rate of archived files. There are disk library solutions that attempt to minimise the impact of the energy consumption of disk drives by using techniques such as disk spin-down. These technologies are further discussed below.

3.1 Criteria for servers [8]

Introduction

The overall energy efficiency of servers is strongly influenced by the degree of workload consolidation (e.g. through virtualisation), the use of power management options and the efficiency of the individual servers.

Consequently, a first step before procuring new server equipment should be to check if workloads can be consolidated and thus the utilisation of hardware can be increased. Virtualisation allows a significant increase in server utilisation and therefore substantial efficiency gains. Consolidation of workload onto a few larger servers can strongly improve energy efficiency.

Effective power management, which allows low power consumption at times of low load also contributes to reducing overall energy consumption. Finally the energy efficiency of the server hardware itself, in terms of energy used in relation to computing performance, must be considered when tendering.

Energy efficiency comparisons of individual servers should be carried out in reference to the two principle industry standards:

- Energy Star – (see Appendix)
- SPECpower – (see Appendix)

Recommendations prior to tendering:

→ Check options for server consolidation and virtualisation with IT experts, including a check on hardware requirements for virtualised servers (CPU, storage, network etc.). If specific expertise on consolidation issues is not available in house, consider external consultancy services.

→ Determine the average load level of the servers to be purchased, and communicate this in tender documents.

→ Determine the required capacity and performance level of the hardware.

→ Compare virtualisation products based on features, license costs etc.

TECHNICAL SPECIFICATIONS (Mandatory criteria)

1. Power supply

- The efficiency of the power supplies must meet the following efficiency requirements at defined levels of electric load [9]:

Electric load	10%	20%	50%	100%
Efficiency	80%	88%	92%	88%

Verification: The supplier must provide technical documentation that this criterion is met [10].

References

[8] The criteria presented here are intended to be used with standard volume servers and blade servers with up to four processor sockets.
This section provides guidance on the procurement of individual servers, not on server room/data centre design and architecture. Sources of information and recommendations for design are indicated in the Further Reading section.
[9] The 20-100% load efficiency levels correspond to the GOLD-efficiency level of the 80plus standard (www.80plus.org) and the Energy Star requirements expected for summer 2012. The 10% level corresponds to the Energy Star requirements expected for summer 2012.
[10] Once the new Energy Star label comes into force (likely summer 2012) this should be accepted as an alternative means of proof.

2. Temperature requirements

- Servers must operate error-free with dry-bulb air inlet temperatures at the server of up to 27 °C (according to ASHRAE thermal guidelines for data processing environments, 2011). The manufacturer must provide a full warranty for the specified operating conditions.

  Verification: The supplier must provide technical documentation that this criterion is met.

AWARD CRITERIA

(Assumes the use of the most economically advantageous tender (MEAT) method of evaluation) The energy efficiency of the bids will be evaluated according to the following criteria*[11]:

1. Server energy efficiency (30 points out of 100):

   Maximum points will be awarded to servers within a given size or configuration class [12] with the best efficiency rating according to the SPECpower_ssj2008 methodology [13].
   0 points will be awarded to the worst efficiency rating. Points will be awarded on a sliding scale in between.

   Verification: Suppliers must provide SPECPower information clearly indicating the average active power at the requested loads (SPECpower=Σssj_ops / Σpower, see Annex).

2. Ratio of idle power to maximum power at 100% workload (20 points out of 100):

   Maximum points will be awarded to servers which the lowest ratio between power in idle mode and power at full load, using a SPECpower100%/SPECpowerIdle comparison. 0 points will be awarded to the highest ratio. Points will be awarded on a sliding scale in between.

   Verification: Suppliers must provide power consumption figures for SPECpower100% and SPECpowerIdle.

3. Optimised sizing for power supply (10 points out of 100):

   Maximum points will be awarded to servers with the highest ratio of actual maximum power (100% SPECpower load level) to rated power (name plate power according to manufacturer). 0 points will be awarded to the lowest ratio. Points will be awarded on a sliding scale in between.

   Verification: The supplier must provide technical data on rated power and SPECPower100%.

4. (Where redundant power supply is requested) Power supply redundancy (20 points out of 100):

   Maximum points will be awarded for servers supplied with a power management feature that allows the redundant power supply to be permanently switched to standby unless the primary power supply fails. This feature must be enabled when the product is delivered or installed.

   Verification: This feature must be clearly explained in the accompanying technical documentation.

5. Power management features (20 points out of 100) [14]:

   Maximum points will be awarded where power management functionality is provided with the server which allows the following functions:

   - Power monitoring
   - Power management at component level (CPU, disk, power supply, etc.)
   - Power management at server unit level/ system level (standby and reactivation options in racks etc., e.g. for virtual migration)
   - Chassis power management features (for blade servers only)
   - Power capping

   Verification: Suppliers must describe the functionality supplied and provide an online link indicating availability of the power management features. All power management functions must be clearly described in the accompanying documentation.

* The weighting (number of points) given above is for guidance purposes only, and is indicative of the typical importance of each criterion in relation to energy consumption. They may need to be adapted by users according to the specific situation. **These criteria relate solely to the energy efficiency of the equipment**, and will of course need to be integrated into the contracting authority's standard model for assessing value for money. In the overall evaluation of offers energy efficiency should have a weighting of at least 20%.

An alternative model to consider for the award stage is to evaluate all tenders based on total cost of ownership (TCO – also called life cycle costing or whole life cost), rather than a comparison of purchase price and individual energy efficiency characteristics. Further information on TCO is included in Section 2.2.

CONTRACT CLAUSES

1. Suppliers must provide training to users on the power management features available.

References

[11] Application of the criteria requires that the server is well configured (right-sized) for the intended workloads.
[12] Where a contract covers a variety of server classes the procuring authority will need to determine an appropriate methodology for the overall award of points per bid. This will be case-dependent.
[13] When available in 2013, the SPECpower criterion will be replaced by a SPEC SERT criterion. For further information on SPECpower see also Annex I
[14] This criterion may be excluded for small entry level servers

3.2 Criteria for data storage devices and elements

Introduction [15]

The performance requirements for data storage devices are clearly dependent on the usage and workload scenarios for the equipment.

Data storage equipment may include a variety of specific devices and elements. Different technologies offer different advantages depending on usage requirements and system architecture.

Examples of devices and elements include the following:

The international Storage Networking Industry Association (SNIA) recommends considering these features as secondary energy efficiency criteria [16]. Thus such features may be encouraged in procurement through the use of award criteria.

For more information on current technologies and power saving features see the further reading section.

- Small Form Factor (SFF), with 2.5-inch drives should be preferred. They use less power, produce less heat, and use less floor space for the same storage capacity.
- Consider optimisation features (e.g. data de-duplication, compression, thin provisioning, virtualisation and snapshotting) when assessing a storage solution. The savings they can offer are high however vary with the characteristics of the workload. Sound data management policies are also important in identifying the optimisations that may be required.
- Opt for large capacity drives, when choosing a backup-to-disk solution.
- Consider the impact your storage choices will have on temperature requirements for server rooms/data centres. For tape drives a maximum rate of change is 5 °C/hr is recommended, and 20 °C/hr for disk drives (according to ASHRAE Thermal guidelines for data processing environments 2011).

Data Storage Devices	Data Storage Elements	Storage Solutions
Solid state drives (SSDs)	Disk arrays	Direct Attached Storage (DAS)
Hard disk drives (HDDs)	Massive Arrays of Idle Disks (MAIDs)	Network Attached Storage (NAS)
Tape based systems		Storage Area Networks (SANs)

Power management options, depending on the number and type of idle and low-power states provided, may significantly increase energy efficiency.

A number of widely available consolidation and management features (also called capacity optimisation measures or COM) also allow significant energy savings in practice. These include:

- Data deduplication
- Data compression
- Storage tiering
- Thin provisioning
- Delta snapshots
- RAID groups

Recommendations prior to tendering:

- Identify a data storage architecture that is optimised for your usage and application requirements.
- Tapes provide the best energy efficiency for long-term storage and present good data retaining characteristics. Hence, they should be used for storing data that is not frequently accessed, but needs to be maintained over long periods.
- Although more expensive, SSDs have better performance than most HDDs and are more energy efficient unless for long-term storage. They may also be used as a high performance storage layer.

References

[15] This section provides guidance on the procurement of data storage devices and elements not on server room/data centre design and architecture. Sources of information and recommendations on storage system design are indicated in the Further Reading section.

[16] SNIA EmeraldTM Power Efficiency Measurement Specification V1.0 – August 2011 - http://snia.org/sites/default/files/EmeraldMeasurementV1_0.pdf

TECHNICAL SPECIFICATIONS (Mandatory criteria)

1. Power supply:

- The efficiency of the power supply must meet the following efficiency requirements at defined levels of electric load [17]:

Electric load	10%	20%	50%	100%
Efficiency	80%	88%	92%	88%

Verification: The supplier must provide technical documentation that this criterion is met [18].

2. Temperature requirements

- Devices must operate error-free with air inlet temperatures of up to 27 °C (according to ASHRAE thermal guidelines for data processing environments, 2011). The manufacturer must provide a full warranty for the specified operating conditions.

Verification: The supplier must provide technical documentation that this criterion is met.

AWARD CRITERIA

(Assumes the use of the most economically advantageous tender (MEAT) method of evaluation) For online and near-online systems the energy efficiency of the bids will be evaluated according to the following criteria*:

1. Energy efficiency (40 points out of 100):

   Maximum points will be awarded to the most efficient solution measured according to the power efficiency metrics for idle and active states according to the SNIA Emerald Power Efficiency Measurement Specification Version 1.0 [19]. 0 points will be awarded to the least efficient. Points will be awarded on a sliding scale in between.

   Verification: The supplier must provide technical documentation indicating the energy efficiency of the offered solution according to the measurement methodology outlined.

2. Capacity optimisation measures (COM) (20 points out of 100):

   Maximum points will be awarded to solutions offering the following features:

   - Data deduplication
   - Data compression
   - Storage tiering
   - Thin provisioning
   - Delta snapshots
   - RAID groups

   Verification: Compliance shall be declared based on the test procedures proposed by SNIA (User Guide for the SNIA EmeraldTM Power efficiency specification).

3. Low power modes (10 points out of 100) [20]:

   Maximum points will be awarded for HDDs and Massive Array of Idle Disks (MAIDs) which support multiple idle and/or low power states that allow energy savings during idle periods.

4. RAID levels (10 points out of 100):

   Maximum points will be awarded for solutions where RAID levels are optimised for energy efficiency.

5. Redundant storage units (10 points out of 100):

   Maximum points will be awarded to composite storage solutions supplied with a feature that allows the redundant units to be put in low energy saving mode.

6. Redundant power supply units (10 points out of 100):

   Maximum points will be awarded for equipment supplied with a power management feature that allows the redundant power supply to be permanently switched to standby unless the primary power supply fails. This feature must be enabled when the product is delivered or installed.

* The weighting (number of points) given above is for guidance purposes only, and is indicative of the typical importance of each criterion in relation to energy consumption. They may need to be adapted by users according to the specific situation. **These criteria relate solely to the energy efficiency of the equipment**, and will of course need to be integrated into the contracting authority's standard model for assessing value for money. In the overall evaluation of offers energy efficiency should have a weighting of at least 20%.

References

[17] The 20-100% load efficiency levels correspond to the GOLD-efficiency level of the 80plus standard (www.80plus.org) and the Energy Star requirements expected for summer 2012. The 10% level corresponds to the Energy Star requirements expected for summer 2012.
[18] Once the new Energy Star label comes into force (likely summer 2012) this should be accepted as an alternative means of proof.
[19] Available at: www.snia.org/sites/default/files/EmeraldMeasurementV1_0.pdf. See also Annex II.
[20] The procurer should define an appropriate power management configuration/implementation for the specific application

3.3 Criteria for network equipment [21]

Introduction

The power consumption of network equipment varies according to the equipment's performance features, form factor, rack integration and cooling as well as the selected power supply. With respect to the overall energy consumption of the network the implemented network architecture, cabling solution, together with the defined service requirements also plays a significant role. These guidelines address only the equipment itself.

Network equipment covers a variety of products. The given procurement recommendations will focus the following devices:

- Layer 2 access switches
- Layer 3 / layer 2 core switches
- Edge routers / Ethernet service routers
- Multipurpose routers

The main considerations when purchasing network equipment are:

- The energy efficiency of the equipment, including the power supply. Traditionally, network devices consume a constant amount of power regardless of data throughput. In addition the operational load of network equipment differs from load profiles of servers, assuming that network equipment mainly operate below 30% load over the entire life time. Therefore, the power consumption in low power mode and power supply efficiency on 30% and 10% load need special attention.

- Integrated power management approaches:

  - Inactive and unconnected ethernet transceivers consume the same power as active components. Integrated power management approaches to shut down or power down unused ports will increase the device efficiency. Therefore the new Energy Efficient Ethernet standard (IEEE802.3az) should be integrated into network equipment's power management.

  - Fan and fan subsystems to control inner airflow consume significant power. Fan speed control should be integrated into the power management system.

- Monitoring capability. The equipment should provide the option of being metered and integrated into an energy measurement system.

Recommendations prior to tendering:

→ Identify a flat network architecture which fulfils your technical requirements.

→ Check options for the implementation of converged networking technologies to consolidate your LAN and SAN network equipment.

→ Firewall and security functionalities should be shifted to the virtualisation level. This will affect the requirements for the dedicated network security equipment.

→ Consider the technical requirements for equipment to be purchased, including virtualisation needs for server and storage.

→ Consider whether a more capable optical fibre solution may be installed in place of standard copper cabling (especially for the installation of content delivery systems).[22]

→ Consider reducing the power supply redundancy, where service levels and architecture permit. Instead of each device having its own redundant power supply ("1+1"), alternative solutions allow multiple devices to share a redundant power supply ("N+1"). This will be only applicable for single unit equipment like blade switches.

TECHNICAL SPECIFICATIONS (Mandatory criteria)

1. Power supply:

- The efficiency of the power supply must meet the following efficiency requirements at defined levels of electric load [23]:

Electric load	10%	20%	50%	100%
Efficiency	80%	88%	92%	88%

Verification: The supplier must provide technical documentation that this criterion is met.

References

[21] This section provides guidance on the procurement of individual network devices, not on server room/data centre design and architecture. Sources of information and recommendations on design are indicated in the Further Reading section.

[22] One option may be to allow variant bids for modular fibre systems. These could then be evaluated against the standard copper cabling solutions offered using a Total Cost of Ownership (TCO) approach at the award stage. The criteria below are also applicable for optical fibre solutions, except those relating to low power/idle modes, and monitoring.

[23] The 20-100% load efficiency levels correspond to the GOLD-efficiency level of the 80plus standard (www.80plus.org).

2. Temperature requirements

- Equipment must operate error-free with a dry bulb temperature of 27 °C (according to ASHRAE thermal guidelines for data processing environments, 2011). The manufacturer must provide a full warranty for the specified operating conditions.

  Verification: The supplier must provide technical documentation that this criterion is met.

3. Power consumption information (not applicable for optical fibre solutions):

- Suppliers must specify the power consumption of the equipment in idle-mode when all ethernet transceivers have an active connection.

  Verification: Supporting documentation must be provided by the supplier.

AWARD CRITERIA

(Assumes the use of the most economically advantageous tender (MEAT) method of evaluation) The energy efficiency of the bids will be evaluated according to the following criteria*:

1. Energy efficiency (of switches) (40 points out of 100):

   Maximum points will be awarded to the product offered with the highest Telecommunications Energy Efficiency Ratio (TEER) [24], with the product with the lowest TEER receiving 0 points. Other points will be awarded on a sliding scale in between.

   Or Maximum points will be awarded to the product offered with the product offered with the highest Energy Consumption Rating (ECR), with the product with the lowest ECR receiving 0 points. Other points will be awarded on a sliding scale in between.

   Verification: The supplier must provide technical documentation indicating the energy efficiency of the offered solution according to the measurement methodology outlined.

2. (Where redundant power supply is requested) Power supply redundancy (20 points out of 100):

   Maximum points will be awarded for equipment supplied with a power management feature that allows the redundant power supply to be permanently switched to standby unless the primary power supply fails. This feature must be enabled when the product is delivered or installed:

   Verification: This feature must be clearly explained in the accompanying technical documentation.

3. Low Power Idle (LPI) mode (30 points out of 100) (not applicable for optical fibre solutions):

   Maximum points will be awarded to equipment that supports Energy Efficient Ethernet (EEE) in accordance with the IEEE 802.3az standard. Such equipment should allow Ethernet transceivers (PHYs) to power down into Low Power Idle (LPI) mode in periods with low data rates.

   Verification: The supplier must provide technical documentation that this criterion is met.

4. Monitoring (10 points out of 100):

   Maximum points will be awarded to network equipment which is capable of monitoring and reporting real time energy consumption.

   Verification: The supplier must provide technical documentation that this criterion is met.

* The weighting (number of points) given above is for guidance purposes only, and is indicative of the typical importance of each criterion in relation to energy consumption. They may need to be adapted by users according to the specific situation. **These criteria relate solely to the energy efficiency of the equipment**, and will of course need to be integrated into the contracting authority's standard model for assessing value for money. In the overall evaluation of offers energy efficiency should have a weighting of at least 20%.

References

[24] See also Annex III

3.4 Criteria for cooling equipment [25]

Introduction

Cooling can be responsible for up to 50% of the total energy consumption in server rooms and data centres. Appropriate cooling systems and equipment are therefore essential in both small and larger IT facilities.

The efficiency of cooling in medium sized to large data centres strongly depends on the cooling system design including aspects such as effective airflow, temperature etc. (see ASHRAE Thermal Guidelines for Data Processing Environments, 2011 [26]). The exploitation of free cooling significantly reduces energy consumption and opportunities should be explored before new equipment is purchased or new system installed.

Cooling requirements very much depend on the temperature requirements of the installed IT equipment – the higher the acceptable temperature in the server room/data centre, the lower the cooling requirements. Overall efficiency is therefore determined by a combination of the cooling system design, efficiency of cooling components and the specific operating conditions.

Recommendations prior to tendering:

- → Check the level of cooling required by the IT hardware installed, to ensure you are not over-dimensioning the cooling system.
- → Check the minimum required starting cooling capacity and scalability of the cooling system.
- → Consider whether there is scope for adjusting the temperature and humidity requirements of the IT equipment installed, which may alter the need for cooling and humidification. A set point temperature of 27°C in line with ASHRAE recommendations should be considered.
- → Investigate opportunities for using free cooling (water or air side economisers) and reducing (or eliminating) solar gains.
- → Determine whether there are opportunities to reduce cold air transmission and ventilation losses to other rooms/outside space, and optimise air flow which may reduce cooling needs.
- → Consider options to segregate equipment with different airflow/temperature requirements.

Additionally, for medium to large systems:

- → Where expertise on specific aspects of cooling design is not available in house, consider consultancy services for an economical and technical feasibility analysis.
- → Consider heat densities in highly consolidated systems: if the specific load per rack is > 10-20 kW an in-row or in-rack (or liquid) cooling system could be considered.
- → Assess the type of cooling system to install. Typically a water cooled chiller will be more efficient than an air-cooled chiller.
- → Optimise the air flow in the system. Ensure hot/cold aisle containment is implemented.
- → A connection with existing BEMS/control and monitoring systems is desirable.

The two sets of recommended criteria presented below, address the following levels of cooling capacity:

- Small systems: <12kW cooling capacity – typically split/DX systems, using air at the evaporator side
- Medium to large systems: > 12kW cooling capacity - typically comprising a chiller (a compression refrigerator), a distribution system and an internal terminal unit (CRAH/CRAC/air handlers)

TECHNICAL SPECIFICATIONS FOR SMALL SYSTEMS

1. Energy efficiency

- Split systems must meet the following performance standards, according to the methodology described in EC Regulation 626/2011 on the energy labelling of air conditioners [27]:
  - <6kW cooling capacity – a seasonal energy efficiency ratio (SEER) [28] higher than 5.1 (new label, class A) [29]

References

[25] This section provides guidance on the procurement of cooling equipment, not on overall cooling system design. Sources of information and recommendations on design are indicated in the Further Reading section.
[26] http://tc99.ashraetcs.org/documents/ASHRAE%20Whitepaper%20-%202011%20Thermal%20Guidelines%20for%20Data%20Processing%20Environments.pdf
[27] Regulation 626/2011 provides for future performance increases in air conditioning systems. From 2015, public authorities will be able to request products to simply be labelled A+ (rather than making EER and SEER requirements)
[28] The new European regulation on the labelling of air conditioners will come into force on 1 January 2013. Until that date EER should be used instead of SEER. For systems <6kW EER should be higher than 4.5. For systems >6kW it should exceed 4.
[29] For server rooms or data centres with lower cooling requirements (for example those in northern climates with well exploited free cooling), the efficiency of the equipment is less important. In these cases the label class B value of 4.6 SEER may also be used for systems with a cooling capacity of <6kW.

- <6kW cooling capacity – a seasonal energy efficiency ratio (SEER) higher than 4.6 (new label, class B)

  Verification: The energy label accompanying the product will provide verification that the criterion is met.

TECHNICAL SPECIFICATIONS FOR LARGE SYSTEMS

1. All cooling equipment (such as air handling units (AHU), chillers and computer room air-conditioning units) must meet the energy efficiency requirements of Eurovent class A.

   Verification: The supplier must provide technical documentation that this criterion is met. The Eurovent documentation will be accepted as alternative means of proof.

AWARD CRITERIA [30]

(Assumes the use of the most economically advantageous tender (MEAT) method of evaluation) The energy efficiency of the bids will be evaluated according to the following criteria*:

1. Energy efficiency (65 points out of 100):

   Maximum points will be awarded to appliances with a SEER value [31] at least 5 points higher than the minimum performance indicated in the technical specifications. Points will be awarded on a sliding scale in between.

   Verification: The supplier must provide technical documentation indicating the SEER value. For appliances with greater than 12kW coolant power testing documentation from an independent laboratory should be submitted.

2. Free cooling efficiency (35 points out of 100):

   Maximum points will be awarded to appliances with the highest energy efficiency ratio (EER) during free cooling operation. 0 points will be awarded to the offer with the lowest number. Points will be awarded on a sliding scale in between.

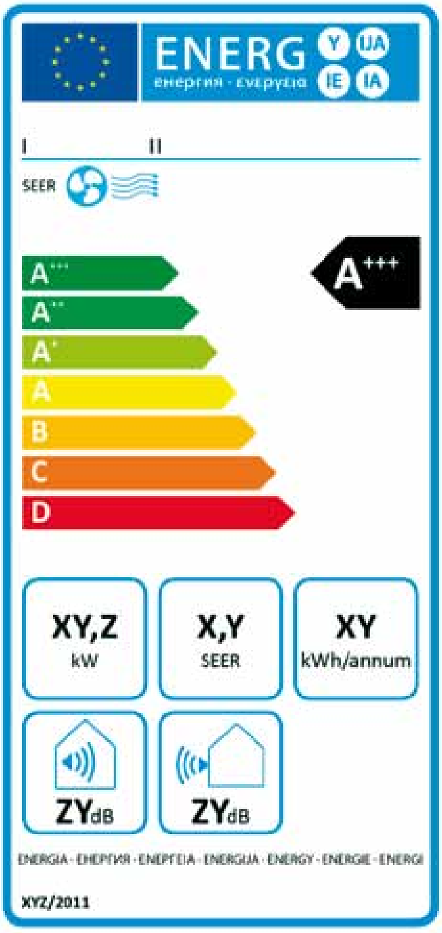
   Verification: The supplier must provide documentation indicating the EER value during free cooling operation.

* The weighting (number of points) given above is for guidance purposes only, and is indicative of the typical importance of each criterion in relation to energy consumption. The contracting authority will need to determine its own weighting according to the individual situation and priorities. The more free cooling is exploited within the server room/ data centre the more important the second criteria on free cooling efficiency becomes. The model above is based on Mediterranean country requirements.

These criteria relate solely to the energy efficiency of the equipment, and will of course need to be integrated into the contracting authority's standard model for assessing value for money. In the overall evaluation of offers energy efficiency should have a weighting of at least 20%.

References

[30] When tendering for overall cooling system design as well as the equipment, the amount of free cooling operating time should also be used as an award criterion.
[31] Until 1 January 2013 EEER should be used rather than SEER



Energy label for cooling only air conditioners
(Source: regulation supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners)

3.5 Criteria for monitoring equipment [32]

Introduction

A monitoring system will typically be comprised of:

- Energy meters,
- Sensors for measuring key variables such as temperature, flow rate, voltage, current, pressure, humidity, etc, and
- Software for collecting and analysing the data to provide a user friendly interface and individual variable monitoring.

Usually the system uses a central node called an "info node", and multiple individual modules called "data nodes" that reside close to the point of measurement.

The guidance below provides purchasing criteria for the following monitoring devices:

- Portable meters,
- Panel meters and power transducers,
- Intelligent power distribution units and server-embedded power metering features,
- Other measurement sensors, and
- Data acquisition and analysis software.

The individual requirements for the monitoring devices will depend to a large extent on the system being installed. The criteria presented here are generic for all purchases.

Recommendations prior to tendering:

→ Identify the most appropriate monitoring approach and number of "info nodes" necessary;

→ Identify the most suitable data acquisition and analysis software, energy meter type and individual sensors required;

→ Consider the instrument range and resolution required from your sensors.

TECHNICAL SPECIFICATIONS (Mandatory criteria)

1. All portable meters must:

- be capable of measuring AC RMS voltages up to 480V (phase-to-neutral) or 960V (phase-to-phase) for two-wire, three-wire or four-wire networks,
- be capable of measuring alternating RMS currents for the specific load range, up to 3000A RMS,
- be equipped with current and voltage probes of Cat III ~600V,
- have an accuracy of 1.5% measured according to ASHRAE Guidelines 22-2008,
- be capable of accurate readings of waveforms with crest factors of up to 5,
- have the internal memory capacity to be able to record the following information for a period of at least one month (preferably with the billing interval of 15 to 15 minutes): Voltage, current, phase unbalance power (active, reactive and apparent), power factor, harmonics until the 15th, THD of voltage and current, and
- be accompanied by software able to perform basic data analysis and monitoring data export.

2. All panel meters and power transducers must:

- be capable of measuring AC RMS voltages up to 480V (phase-to-neutral) or 960V (phase-to-phase) for two-wire, three-wire or four-wire networks,
- be capable of measuring alternating RMS currents for the specific load range,
- have an accuracy of 1.5% measured according to ASHRAE Guidelines 22-2008,
- (If required by the monitoring system) have remote data acquisition capabilities (RS232/RS485 or LAN communication ports) and be compatible with the monitoring data acquisition software already selected.

3. All intelligent power distribution units and server-embedded power metering features must:

- allow remote unit-level and individual outlet-level power monitoring, and
- have an accuracy of 1.5% measured according to ASHRAE Guidelines 22-2008.

References

[32] This section provides guidance on the procurement of monitoring devices, not on overall design and configuration of the monitoring system, or data requirements. Sources of information and recommendations on these aspects are indicated in the Further Reading section.

4. Other measurement sensors must meet the accuracy requirements presented in the table below:

Type of sensor	Sensor	Application	Measuring range	Accuracy
Temperature sensors	Thermocouples	Any (acquire room, liquid, equipment temperature, etc)	Largest	< 5.0%
	Thermistors		Small	< 2.0%
	RTDs		Smaller	< 1.0%
Humidity sensors*	Any technology	Room air humidity	0 - 95%	< ±2%
Pressure	Bourdon tubes	Pressure in pipes	Any	< 1.5%
	Strain gauge		Any	< 1.0%
Flow rate Liquid and Gas	Paddle wheel (Liquid)	Liquid, Flow pipes/ducts	Any	< 5.0%
	Turbine wheel (Liquid)	Liquid, Flow pipes/ducts	Any	< 2.0%
	Ultrasonic (Liquid)	Liquid, Flow pipes, needs solids or bubbles	Any	< 5.0%
	Pilot tube (Gas)	Gas, Any	> 600 fpm	< 4.0%
	Hot wire anemometer (Gas)	Gas, Any	Any	< 5.0%

* Usually humidity sensors are coupled with the temperature sensors, but individually accuracy is given by the manufacturer.

Table source: Real-Time Energy Consumption Measurements in Data Centres, ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2010.
ISBN: 978-1-933742-73-1

5. (where required by the monitoring system applied) Data acquisition and analysis software must*:

- be compatible with ...<type of energy meters and sensors to be specified by the contracting authority>,
- allow continuous data acquisition and database feeding,
- display multiple plot windows and time series analysis,
- be capable of adding new data sources from further sensors added at a later date (new "info nodes),
- have an alarm function: e.g. if room temperature rises above a pre-set threshold,
- allow the time to be set up during data acquisition from the different input channels, and
- allow the export of data.

* The type of data acquisition and analysis software required depends to a large degree on the monitoring system to be installed. The list here includes the requirements of a typical system, but may need to be adapted to suit individual needs.

CONTRACT PERFORMANCE CLAUSE

Suppliers must provide comprehensive training to users on the functions and operation of the data acquisition and analysis software and to all the different energy meters and sensors composing the monitoring system.

4 Further Reading

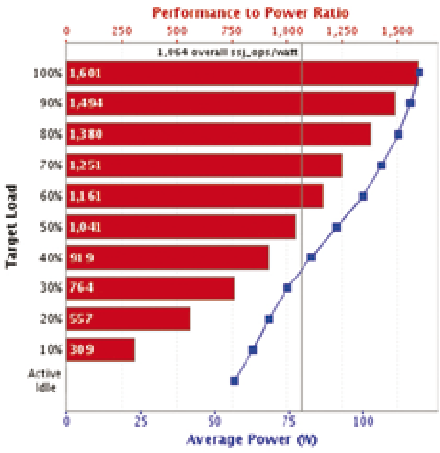
- PrimeEnergyIT (2011): Energy efficient IT and infrastructure for date centres and server rooms (www.efficient-datacenters.eu)
- ASHRAE (2011): Thermal Guidelines for Data Processing Environments (www.ashrae.org)
- SNIA (2011): SNIA Emerald™ Power Efficiency Measurement Specification (www.snia.org)
- SPEC (2011): SPEC Power and Performance. Benchmark Methodology 2.1 (www.spec.org)
- Real-Time Energy Consumption Measurements in Data Centers, ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2010. ISBN: 978-1-933742-73-1
- The Science of Measurement: Improving Data Center Performance with Continuous Monitoring and Measurement of Site Infrastructure, Stanley, Jonh and Koomey, Jonathan October 2009: www.analyticspress.com/scienceofmeasurement.html
- DC Power for Improved Data Center Efficiency, Ton, My, Fortenbery, Brian and Tschudi, William, Ecos Consulting, EPRI, Lawrence Berkeley National Laboratory, March 2008 http://hightech.lbl.gov/documents/DATA_CENTERS/DCDemoFinalReport.pdf
- Green Grid Data Center Power Efficiency Metrics. White Paper 6, The Green Grid, White Paper 6.December 30, 2008 www.thegreengrid.org/Global/Content/white-papers/The-Green-Grid-Data-Center-Power-Efficiency-Metrics-PUE-and-DCiE
- Determining Total Cost of Ownership for Data Center and Network Room Infrastructure, Neil Rasmussen, APC by Schneider Electric, White paper #6 – Revision 4 www.apcmedia.com/salestools/CMRP-5T9PQG_R4_EN.pdf
- Avoiding Costs From Oversizing Data Center and Network Room Infrastructure, Neil Rasmussen, APC by Schneider Electric, 2010. White paper #37 – Revision 6 www.apcmedia.com/salestools/SADE-5TNNEP_R6_EN.pdf
- Schneider Electric e-learning website (Energy University) that provides the latest information and training on Energy Efficiency concepts and best practice, www.myenergyuniversity.com
- Webinar: „The Data Center in Real Time: MonitoringTools Overview & Demon“, www.42u.com/webinars/Real-Time-Measurement-Webinar/playback.htm

ANNEX I – SPECpower Benchmark

SPECpower_ssj2008 is a benchmark developed by the Standard Performance Evaluation Corporation (SPEC), a non-profit group of computer vendors, system integrators, universities, research organisations, publishers, and consultants. The general approach is to compare measured performance with measured power consumption. It includes the power measurement of a system running at different target load levels, to reflect the fact that data centre server systems run at different target loads relative to maximum throughput. SPECpower considers the ambient temperature during the benchmark measurement as relevant to the results, and so temperature measurement is a requirement as part of a full benchmark report.

The target loads are measured in terms of the performance of a fixed chosen workload that runs on the SUT (server under test). The Java application generates and completes a mix of transactions, and the throughput is the number of transactions completed per second over a fixed period. A calibration phase is designed to determine the maximum throughput of the system, by generating transactions at the full rate that they can be completed. After the maximum throughput has been determined, the application calculates the throughput values that correspond to each target load (100%, 90%, … 20%, 10%, 0% of maximum as calibrated). The benchmark then enters the measurement interval during which the workload iterates through ten target loads. The 0% target load is also referred to as "active idle". In this operating mode, the system is ready to accept transactions, but none are being issued.

Fig. 1. shows a typical SPECpower diagram. The SPECpower value is calculated as the sum of the operations for the different load levels divided by the sum of the power consumption for the load levels.



SPECpower=Σssj_ops / Σpower

FFor detailed information on SPECpower_ssj2008 consider the references indicated below [33] [34]. Both reference documents can be downloaded at www.spec.org.

ANNEX II – SNIA EMERALD POWER EFFICIENCY CRITERIA

The SNIA Emerald™ Power Efficiency measurement is designed to provide a reproducible and standardised assessment of the energy efficiency of commercial storage products in both active and idle states.

It is assumed to accurately characterise the power requirements of the tested system. The precise configuration used for a measurement is left to the sponsor of a test.

Storage products are said to be in an "active" state when they are processing externally initiated, application-level requests for data transfer. For

References

[33] SPECpower_ssj2008 V1.11 –User Guide
[34] SPEC Power And Performance. Methodology V2.1, SPEC 2011

the purposes of this specification, idle is defined as "ready idle", in which storage systems and components are configured, powered up, connected to one or more hosts and capable of satisfying externally initiated requests, but where no such IO (input/output) requests are being submitted.

Power Efficiency Metric for Online and Near Online Systems

READY IDLE TEST
For the ready idle test, the power efficiency metric represents the amount of raw capacity supported per watt of power required by the SUT. It is calculated as the ratio of:

- The total raw capacity of the SUT, measured in GB;
- The average power, from the ready idle test, measured in watts.

$$EP_{RI} = \frac{C_R}{PA_{RI}(7200)}$$

Where:
- EP_{RI} is the power efficiency metric for the ready idle test;
- C_R is the raw capacity of the SUT;
- $PA_{RI}(7200)$ is the average over a 2-hour measurement interval for the ready idle test.

ACTIVE TEST
For each test phase of the active test, the power efficiency metric represents the amount of data transfer supported per watt of power required by the SUT. It is calculated, as the ratio of:

- The operations rate, from the active test, during the measurement interval, measured in IO/s or MiB/s;

$$EP_i = \frac{O_i(1800)}{PA_i(1800)}$$

Where:
- EP_i is the power efficiency metric for active test phase i;
- $PA_i(1800)$ is the average power over a 30-minute measurement interval for active test phase i;
- $O_i(1800)$ is the operations rate over a 30-minute measurement interval for active test phase i
- The average power, from the active test, during the measurement interval, measured in watts.

For detailed information on the SNIA Emerald metrics see SNIA Emerald™ Power Efficiency Measurement Specification Version 1.0 (available for download at www.snia.org).

ANNEX III – METRICS FOR NETWORK EQUIPMENT

For the purpose of product comparison, it is necessary to measure the energy efficiency with an appropriate metric. The following section describes two sophisticated load variable efficiency metrics in more detail.

Energy Consumption Rating Variable Load: ECR-VL (ECR Initiative 2010)

The original ECR (Energy Consumption Rating) is a peak metric and intended for a general description of network efficiency.

ECR = E / T

E represents the energy consumption (in watts) and T represents the effective maximum system throughput (in bits per second). ECR is normally expressed in W/Gbps.

The shortcoming of the ECR peak metric is obvious. It only reflects the energy efficiency in correlation to the highest performance capacity of the device. However, the power consumption of current network devices typically adapts according to the actual work load. In order to get a more accurate understanding of the energy efficiency of modern network equipment a load variable testing of the devices is necessary.

The enhanced ECR-VL (Energy Consumption Rating Variable Load) is a variable load metric and intended to differentiate energy efficiency under various workload conditions.

$$ECR\text{-}VL = (\alpha * E_{100} + \beta * E_{50} + \gamma * E_{30} + \delta * E_{10} + \varepsilon * E_i) / = (\alpha * T_f + \beta * T_{50} + \gamma * T_{30} + \delta * T_{10})$$

The ECR-VL is also measured in W/Gbps. The variable load is represented by the measurement of different throughput levels in percent of total (T_{50}, T_{10}).

For further details please refer the ECR 3.0.1 standard. (http://www.ecrinitiative.org)

Telecommunications Energy Efficiency Ratio: TEER (ATIS 2009)

The TEER standard was developed to provide telecommunication equipment manufacturers and service providers with a methodology to calculate the energy efficiency of individual equipment and network configurations. It is a useful tool for benchmarking similar equipment.

The TEER (Telecommunications Energy Efficiency Ratio) is the ratio of useful work (workload) over power (energy consumption). A higher TEER value expresses a higher energy efficiency level.

$$TEER = \frac{UsefulWork}{Power}$$

The TEER standard specifies equipment classes according to the number of ports and throughput parameters. The standard also specifies the UsefulWork and power measurement procedures in supplementary documents. It is interesting to note that UsefulWork can be expressed by a variety of aspects including data rate, throughput, processes per second, etc.

The enhanced TEER considers three different data utilisation states 0%, 50%, and 100% with associated power levels. The metric further differentiates utilisation aspects by additional weighting of power modes according to the different load rates:

$$P_{TEER\_CERT} = \sum_{j=1}^{m} \left(\frac{P_{0j}}{3} + \frac{P_{50j}}{3} + \frac{P_{100j}}{3} \right)$$

For further details please refer to ATIS Standards ATIS-0600015.2009, ATIS-0600015.01.2009, ATIS-0600015.02.2009 on http://www.atis.org

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