# General Resources Energy Investigation Committee, Energy Savings Standards Section, Computer and Hard Disk Drive Judging Standards Subcommittee Final Report

The Computer and Hard Disk Drive Judging Standards Subcommittee (General Resources Energy Investigation Committee, Energy Savings Standards Section) discussed evaluation standards for manufacturers and importers (hereinafter referred to as “Manufacturers, etc.”) and released the following final report regarding computers and HDDs, for which the target fiscal year was FY2007.

## I. Interim evaluation of current standards

2007 was the target fiscal year for computers and HDDs. The energy efficiency results have been identified and were found to greatly exceed the target standard values.

Specifically, power consumption by computers is decreasing for reasons such as higher efficiency of power devices, and at the same time contributions to improving energy efficiency in the PC field have resulted from higher CPU performance, typified by multi-core technologies such as the use of quad-core CPUs.

For HDDs, significant improvements in smaller disk sizes and technologies for higher-density storage media have resulted in improving energy efficiency.

As shown here, the existing standards using the top runner method are functioning effectively and contributing to saving energy in computers and HDDs.

| | FY2001 results | FY2007 forecast | FY2007 results |
|---|---|---|---|
| [Computers] | | | |
| Energy efficiency (W/MTOPS) | 0.012 | 0.0037(69%) | 0.0023(81%) |
| [HDDs] | | | |
| Energy efficiency (W/GB) | 0.14 | 0.040(71%) | 0.020(86%) |

Note 1. Figures in parentheses are the improvement ratios from fiscal year 2001 results.
2. “Energy efficiency” is the efficiency per device calculated from the average energy efficiency of that device type, weighted by the number of units shipped.

Source: Investigation by the Ministry of Economy, Trade and Industry

## II. Basic approach to review of the standards

The current review of the standards for computers and HDDs has been conducted with consideration for the relevant conditions listed below.

- With the increasing performance and advancing functionality of computers, and the approximately corresponding decrease in power consumption, the measurement methods and performance indexes that are currently used are becoming insufficiently versatile to keep up with further advances in energy savings. It is necessary to consider measurement methods and indexes for computer energy efficiency that include the conditions of actual calculated loads. (Because new measurement methods were not established at this review, it is believed that the current measurement methods and performance

indexes are the most suitable for measuring improvements in energy efficiency.)

- In relation to the above, as part of the International Energy Star Program[1], Japan is studying new measurement methods for computers, and it will be necessary to pay close attention to these trends.
- There are technologies such as SSD (Solid State Drive) which cannot be incorporated in the current standards because they are not products in general use, however which are highly likely to replace HDDs and will make large contributions to improving energy efficiency. For this reason, a review of the evaluation standards will be necessary when these products have begun entering the market to some degree.

In this way, because of the presence of transitory elements, the current review addressed the evaluation standards while retaining the top runner standard concept and also giving consideration to the elements described above.

## III. Major points of change

From the perspective of further strengthening energy-saving measures, the standard values were reviewed, and the following changes were made, including a change to the scope of designated equipment.

### III-1. Computers

(1) Expansion of scope

Computers with the composite theoretical performance of 50,000 mega calculations to less than 200,000 mega calculations per second (formerly considered a part of the super computer class) were added as subject products.

(2) Setting of target standard values based on the top runner standard concept

Based on the results from FY2007, target standard values (standard energy efficiency) were set based on the concept of top runner standards.

(3) Review of categories to match the actual conditions of use in the market

- For the definition of server computers and client computers, due to advancing technologies it was decided that they should be defined based on the intended form (conditions) of use at the time of design rather than on vague

[1] The International Energy Star Program is an international energy-saving system for office equipment that is being carried out in seven countries and regions worldwide. Japan has agreed to mutual recognition under this program, and approves the marking of a particular logo on equipment that meets the standard for superior energy-saving performance.

categorization using main memory capacity and other factors.

- For server computers, advances in technology have resulted in problems such as the mainframe server and open-frame server classes becoming mixed. As a result, it was decided to change the basis for categorization from factors such as the main memory capacity to the CPU type.
- For client computers, the categories compact desktop and netbook were added to the existing notebook and desktop categories.

III-2. HDDs

(1) Change of scope

The scope was broadened to include the following devices with maximum data transfer speeds between 70 gigabytes and 270 gigabytes.

(2) Review of categories based on the top runner standard concept and the setting of target standard values

Based on the results from FY2007, target standard values (standard energy efficiency) were set based on the concept of top runner standards. Based on the technical improvement elements in each class, some classes were further broken down so that standards could be set for each.

## IV. Evaluation standards

### IV-1. Computers

#### 1. Designated equipment [Refer to Attachment 1.]

As currently prescribed, these standards apply to the digital central processing units (5211) and personal computers (5212) as determined in the Japan standard product classifications.

However, the following items are excluded: (1) products with a composite theoretical performance of 200,000 mega calculations or more per second, (2) products capable of performing calculations using an arithmetic processing unit composed of more than 256 processors, (3) products with 512 or more I/O signal transmission lines (only lines with maximum data transmission speeds of 100 megabits or more per second), (4) products with a composite theoretical performance of less than 100 mega calculations per second, (5) products that are powered exclusively by an internal battery during use and never operate based on a power supply from a power line, and that do not contain an HDD, (6) products

that comprise redundant arithmetic processing units, main memory devices, I/O control units or power devices (fault tolerant products).

2. Necessary items for judging standards of manufacturers, etc.

(1) Target fiscal year [Refer to Attachment 2.]

FY2011

(2) Classes and target standard values for target achievement [Refer to Attachments 3 and 4.]

For computers that are shipped domestically by manufacturers, etc. in the target fiscal year, the average energy efficiency measured by the method prescribed in (3) and weighted by the number of units shipped for each class in the table below, must not be higher than the target value (standard energy efficiency) listed in the right column of the same table.

Target standard values for server computers

| Classification | | | | Target standard value (W/GTOPS) |
|---|---|---|---|---|
| CPU type | No. of I/O slots | No. of CPU sockets | Provisional classification | |
| Dedicated CISC | Less than 32 | – | A | **1,950** |
| | 32 or more | – | B | **2,620** |
| RISC | Less than 8 | – | C | **13.0** |
| | 8 to less than 40 | – | D | **31.0** |
| | 40 or more | – | E | **140.0** |
| IA64 | Less than 10 | – | F | **6.2** |
| | 10 or more | – | G | **22.0** |
| IA32 | 0 | – | H | **1.3** |
| | 1 to less than 7 | Less than 2 | I | **1.2** |
| | | 2 to less than 4 | J | **1.9** |
| | | 4 or more | K | **6.7** |
| | 7 or more | – | L | **7.4** |

Note 1. “Server computer” refers to a computer that is designed to operate 24 hours a day and provide services on a network, and which can be accessed only via the network.

2. Dedicated CISC (Complex Instruction Set Computer): Used in high-functionality processors with a diverse instruction set. It is primarily used in mainframe servers and similar products.

3. RISC (Reduced Instruction Set Computer): This type of processor uses a simplified instruction set in order to prioritize high speed, and is primarily used in UNIX servers and similar devices.

4. IA64, IA32: These are typical architectures for general-purpose CICS microprocessors that are universally used in products from personal computers to high-functionality servers. IA32 is a 32-bit microprocessor architecture, and is primarily used in products such as IA servers. IA64 is a 64-bit microprocessor architecture, and is primarily used in products such as high-functionality servers.

Target standard values for client computers

| Classification | | | | Provisional classification | Target standard value (W/GTOPS) |
|---|---|---|---|---|---|
| Type of client computer | Main memory capacity | Discreate GPU | LCD size | | |
| Battery-powered, with 2 or more memory channels | 16 GB or more | – | – | a | **2.25** |
| | More than 4 GB to less than 16 GB | – | – | b | **0.34** |
| | 4 GB or less | – | 17 or more | c | **0.31** |
| | | Installed | Less than 17 | d | **0.21** |
| | | Not installed | 12 to less than 17 | e | **0.15** |
| | | | Less than 12 | f | **0.21** |
| Not battery-powered, with 2 or more memory channels, and uses an AC adapter as the power device | – | – | – | g | **0.29** |
| Not battery-powered, with 2 or more memory channels other than the above | 16 GB or more | – | – | h | **2.25** |
| | More than 4 GB to less than 16 GB | Installed | – | i | **0.51** |
| | | Not installed | – | j | **0.64** |
| | 4 GB or less | – | – | k | **0.53** |
| Less than 2 memory channels | – | – | – | l | **0.51** |

Note 1. “Client computers” refers to computers that are not “server computers”.
2. The LCD size values indicate the dimension in centimeters between opposite corners of the display screen, divided by 2.54 and rounded to the second decimal place.

[Reference] Current target standard values (target standard values for FY2007)

| Classification | | | | Standard energy efficiency (W/MTOPS) |
|---|---|---|---|---|
| Type of computer | No. of I/O signal lines | Main memory capacity | Classification | |
| Server computers | 64 or more | | a | 3.1 |
| | 8 to less than 64 | | b | 0.079 |
| | 4 to less than 8 | 16 gigabytes or more | c | 0.071 |
| | | Less than 16 gigabytes | d | 0.068 |
| | Less than 4 | 16 gigabytes or more | e | 0.053 |
| | | 4 gigabytes to less than 16 gigabytes | f | 0.039 |
| | | 2 gigabytes to less than 4 gigabytes | g | 0.024 |
| | | Less than 2 gigabytes | h | 0.016 |
| Client computers that are not battery powered | 2 to less than 4 | Less than 6 gigabytes | i | 0.027 |
| | Less than 2 | 2 gigabytes to less than 6 gigabytes | j | 0.0048 |
| | | Less than 2 gigabytes | k | 0.0038 |
| Client computers that are battery powered | | 1 gigabytes to less than 6 gigabytes | l | 0.0026 |
| | | Less than 1 gigabytes | m | 0.0022 |

Note 1. “Server computers” refers to computers which are not “client computers”.
2. “No. of I/O signal lines” refers to the number of lines which directly split from a signal line that connects an arithmetic processor and main storage device (also including other signal lines which have a transmission capacity equal to that signal line), or which directly split from a signal line splitter that is connected to such a signal line. It refers to the number of lines which are connected to an external location via only a graphics display port or keyboard port and which have a maximum data transfer speed of 100 megabits per second or more.
3. “Battery powered” refers to products which operate exclusively from an internal battery and never operate based on a power supply from a power line.
4. “Client computers” refers to products which have a graphics display port and keyboard port (including products which have an internal graphics display in place of a graphics display port and an internal keyboard in place of a keyboard port) and which have a main memory capacity of less than 6 gigabytes and fewer than 4 I/O signal lines.

(3) Energy efficiency and the method of measurement

Computer energy efficiency is the power consumption in units of Watts divided by the performance index in giga calculations, and is calculated by the following formula.

$$E = [(W_1 + W_2) / 2] / Q$$

In this formula, E, $W_1$, $W_2$, and Q indicate the following values.

E: Energy efficiency (units: Watts/giga calculations)
$(W_1 + W_2) / 2$: Power consumption (units: Watts)
$W_1$: Power consumption in idle state (units: Watts)
$W_2$: Power consumption in low-power mode (units: Watts)
Q: Composite theoretical performance (CTP) (units: giga calculations)

$W_1$: Power consumption in idle state

"Power consumption in idle state" indicates the power consumption when the main power is energized, in a state when operation is possible without resetting the initial program, and in a state before transitioning to a low-power mode such as the standby mode or suspend mode described in ACPI standards[2] (hereafter this state is referred to as "idle state"). It is expressed in units of Watts and is the value measured by the method described below.

(1) Ambient temperature shall be 16ºC - 32ºC.
(2) The power voltage shall be within ±10% of the rated input voltage. However for products with a rated input voltage of 100 volts, the range shall be 100 volts ±10%.
(3) The power frequency shall be the rated power frequency.
(4) Measure in the maximum configuration range which excludes I/O control devices, communication control devices and HDDs that can be disconnected from the computer without impairing its basic functions. For products where the number of processors can be expanded, measure the configuration with the smallest number of processors. For client computers that are not battery powered, measurement may be performed with the graphics display unit power turned off.

$W_2$: Power consumption in low-power mode

Power consumption in the low-power mode refers to a low-power mode defined in ACPI standards as a standby mode, suspended mode, or similar mode. (However this is limited to modes in which the programs and data are retained in the main memory device.) It is expressed in units of Watts and is the value measured by the method described below. It is expressed in units of Watts and is the value measured by the method described below. It is expressed in units of Watts and is the value measured by the method described below.

For server computers and client computers which do not have a low-power mode, use the same value as $W_1$ for $W_2$.

(1) Ambient temperature shall be 16ºC - 32ºC.
(2) The power voltage shall be within ±10% of the rated input voltage. However for products with a rated input voltage of 100 volts, the range shall be 100

[2] This is the standard for power management that is being promoted by the US Microsoft Corporation. ACPI stands for "Advanced Configuration and Power Interface".

volts ±10%.

(3) The power frequency shall be the rated power frequency.

(4) Measure in the maximum configuration range which excludes I/O control devices, communication control devices and HDDs that can be disconnected from the computer without impairing its basic functions. For products where the number of processors can be expanded, measure the configuration with the smallest number of processors.

(4) Labeling related matters

1) Items for labeling

The manufacturers, etc. shall indicate the following items related to computer energy efficiency on a label.

a) Part name and type name

b) Classification

c) Energy efficiency

d) Name or title of manufacturer, etc.

e) The fact that energy efficiency is the power consumption measured by methods determined in the Energy Conservation Law (the Law Concerning the Rational Use of Energy) divided by the composite theoretical performance as determined in the Energy Conservation Law

2) Compliance items

a) Energy efficiency indicates the values listed in the lower row in Appendix Table 3 of the Enforcement Regulations of the Energy Conservation Law, to 2 significant digits.

b) In catalogs which include descriptions of performance and in materials provided by the manufacturers, etc. for selecting devices, the labeling items listed in 1) shall be listed in an easily visible location, by means which are not easily erased.

## IV-2. HDDs

### 1. Designated equipment [Refer to Attachment 1.]

As currently prescribed, these standards apply to HDDs (52131) as determined in the Japan standard product classifications.
However the following items are excluded: (1) products with a disk diameter of 40 mm or less, (2) products with a maximum data transfer speed of more than 270 gigabytes per second.

### 2. Necessary items for judging standards of manufacturers, etc.

(1) Target fiscal year [Refer to Attachment 2.]

FY2011

(2) Classes and target standard values for target achievement [Refer to Attachments 3 and 4.]

For HDDs that are shipped domestically by manufacturers, etc. in the target fiscal year, the average energy efficiency measured by the method prescribed in (3) and weighted by the number of units shipped for each class in the table below or by a similar party, must not be higher than the target value listed in the right column of the same table. (The calculation formula for standard energy efficiency is the value calculated using the calculation formula in the table for the corresponding class, with N as the rotating speed of the device (units: rpm).)

Target values for individual HDDs

| Disk size | No. of disks | Rpm | Provisional classifications | Target value formula |
|---|---|---|---|---|
| More than 75 mm | 1 disk | – | A | E=exp(2.98*ln(N)-30.8) |
| | 2 or 3 disks | – | B | E=exp(2.98*ln(N)-31.2) |
| | 4 or more disks | – | C | E=exp(2.11*ln(N)-23.5) |
| More than 50 mm to 75 mm or less | 1 disk | 5000 rpm or less | D | E=exp(2.98*ln(N)-29.8) |
| | | More than 5000 rpm to 6000 rpm or less | E | E=exp(2.98*ln(N)-31.2) |
| | | More than 6000 rpm | F | E=exp(4.30*ln(N)-43.5) |
| | 2 or 3 disks | 5000 rpm or less | G | E=exp(2.98*ln(N)-31.5) |

| | | | | |
|---|---|---|---|---|
| | | More than 5000 rpm to 6000 rpm or less | H | E=exp(2.98*ln(N)-32.2) |
| | | More than 6000 rpm | I | E=exp(4.58*ln(N)-46.8) |
| | 4 or more disks | – | J | E=exp(2.98*ln(N)-31.9) |
| More than 40 mm to 50 mm or less | 1 disk | – | K | E=exp(2.98*ln(N)-30.2) |
| | 2 or more disks | – | L | E=exp(2.98*ln(N)-30.9) |

Note 1. “Individual disk” refers to a single disk drive.
2. E and N indicate the following values.
E: Energy efficiency
N: Rotating speed (rpm)
3. “ln” indicates the log of base e.

Sub-system target standard values

| Application | Provisional classification | Target value formula |
|---|---|---|
| Mainframe server | a | E=exp(1.85*ln(N)-18.8) |
| Other | b | E=exp(1.56*ln(N)-17.7) |

Note 1. “Sub-system” refers to a product with multiple disk drives. For individual disks, cases that bear a type name shall be considered 1 unit. For sub-systems, the magnetic disk control unit and HDD shall together be considered 1 unit. (For products that only use a magnetic disk controller that is built into a computer, cases that bear a type name shall be considered 1 unit.).
2. E and N indicate the following values.
E: Energy efficiency
N: Rotating speed (rpm)
3. “ln” indicates the log of base e.

[Reference] Current target standard values (target standard values for FY2005)

| Classification | | | Formula for calculating energy efficiency |
|---|---|---|---|
| Type of HDD | HDD form and performance | Classification | |
| Individual disk | Disk size more than 75 mm with 1 disk | a | E=exp(2.98×ln(N)-28.6) |
| | Disk size more than 75 mm with 2 or 3 disks | b | E=exp(2.98×ln(N)-29.3) |
| | Disk size more than 75 mm with 4 or more disks | c | E=exp(2.98×ln(N)-29.5) |
| | Disk size more than 50 mm to 75 mm or less with 1 disk | d | E=exp(2.98×ln(N)-28.6) |
| | Disk size more than 50 mm to 75 mm or less with 2 or 3 disks | e | E=exp(2.98×ln(N)-29.4) |
| | Disk size more than 50 mm to 75 mm or less with 4 or more disks | f | E=exp(2.98×ln(N)-29.8) |
| | Disk size more than 40 mm to 50 mm or less with 1 disk | g | E=exp(2.98×ln(N)-27.2) |
| | Disk size more than 40 mm to 50 mm or less with 2 or more disks | h | E=exp(2.98×ln(N)-28.8) |
| Sub-system | - | i | E=exp(2.00×ln(N)-19.7) |

Note 1. “Individual disk” refers to a single disk drive. “Sub-system” refers to a product with multiple disk drives. For individual disks, cases that bear a type name shall be considered 1 unit. For sub-systems, the magnetic disk control unit and HDD shall together be considered 1 unit. (For products that only use a magnetic disk controller that is built into a computer, cases that bear a type name shall be considered 1 unit.)

2. E and N indicate the following values.
   E: Energy efficiency
   N: Rotating speed (rpm)
3. “ln” indicates the log of base e.

(3) Measurement method for energy efficiency

The energy efficiency shall be the power consumption in units of Watts calculated by the following method and divided by the storage capacity in units of gigabytes. However when actual measurement is difficult, calculation by a formula shall be permitted.

(1) Ambient temperature shall be 16ºC - 32ºC.

(2) The power voltage shall be within ±10% of the rated input voltage. However for products with a rated input voltage of 100 volts, the range shall be 100 volts ±10%.

(3) The power frequency shall be the rated power frequency.

(4) For individual disks, measure in the range that covers the internal control device, buffer cache memory, and disk drive.

(5) For sub-systems, measure in the range of the power necessary to operate the control device, buffer cache memory and HDD, with the maximum number of disk drives and maximum number of I/O signal lines that can be connected to the control unit.

(6) Input the power and measure with the power on, the disk in the individual disk device rotating, and in a state when data reading and writing can be immediately performed.

(4) Labeling related matters

1) Items for labeling

The manufacturers, etc. shall indicate the following items related to magnetic disk drive energy efficiency on a label.

a) Part name and type name

b) Classification

c) Energy efficiency

d) Name or title of manufacturer, etc.

e) The fact that energy efficiency is the power consumption measured by methods determined in the Energy Conservation Law divided by the storage capacity as determined in the same law.

2) Compliance items

a) Energy efficiency indicates the values listed in the lower row in Appendix Table 3 of the Enforcement Regulations of the Energy Conservation Law, to a minimum of 2 significant digits, with fractional digits rounded up to 1.

b) In catalogs which include descriptions of performance and in materials provided by the manufacturers, etc. for selecting devices, the labeling items listed in 1) shall be listed in an easily visible location, by means which are not easily erased.

## V. Recommendations on energy saving

### V-1. Computers

(1) Efforts by users

1) Recommend that users select an energy-efficient computer, and work to save energy by using the computer in an appropriate and efficient manner.
2) Recommend that users set and use the low-power mode when using a computer that is equipped with a low-power mode.

(2) Efforts by manufacturers, etc.

1) Promote technical development for energy savings in computers, and recommend the development of energy-efficient computers.
2) For devices which include low-power mode functions, recommend shipping the devices with this function already activated whenever possible. Manufacturers should take steps to increase user understanding in order to promote the use of low-power modes by users.
3) From the perspective of expanding the use of energy-efficient computers, manufacturers should take steps for the early introduction of an “energy-saving label” and should provide suitable information which will contributed to user selection of energy-efficient computers. When creating the energy-saving label, consideration must be given to its contents so as to make it easy for the user to understand and prevent misunderstandings.
4) Manufacturers should collect information concerning international standards and measurement methods, and should review them to determine their suitability.

(3) Efforts by the government

1) In order to expand the use of energy-efficient computers, the government should provide policy support, conduct promotional campaigns, and take other

necessary steps to promote the efforts by users and manufacturers, etc.

2) The government should work to regularly and continuously determine the status of labeling by the manufacturers, etc., and enact appropriate laws so that correct and easily-understood information concerning energy efficiency is provided to users.

3) Focus on international trends and respond in a flexible manner with regards to the adoption of measurement methods and other elements that are closer to the conditions of actual use.

## V-2. HDDs

(1) Efforts by users

Recommend that users select an energy-efficient HDD, and work to save energy by using the HDD in an appropriate and efficient manner.

(2) Efforts by manufacturers, etc.

1) Promote technical development for energy savings in HDDs, and recommend the development of energy-efficient HDDs.

2) From the perspective of expanding the use of energy-efficient HDDs, manufacturers should take steps for the early introduction of an "energy-saving label" and should provide suitable information which will contribute to user selection of energy-efficient HDDs. When creating the energy-saving label, consideration must be given to its contents so as to make it easy for the user to understand and prevent misunderstandings.

3) Manufacturers should collect information concerning international standards and measurement methods, and should review them to determine their suitability.

(3) Efforts by the government

1) In order to expand the use of energy-efficient HDDs, the government should provide policy support, conduct promotional campaigns, and take other necessary steps to promote the efforts by users and manufacturers, etc.

2) The government should work to regularly and continuously determine the status of labeling by the manufacturers, etc., and enact appropriate laws so that correct and easily-understood information concerning energy efficiency is provided to users.

3) Focus on international trends and respond in a flexible manner with regards to the adoption of measurement methods and other elements that are closer to the conditions of actual use.

Attachment 1

# Scope of designated computers and HDDs

## I. Scope of designated computers

1. Designated computers

These standards apply to digital central processing units (5211) and personal computers (5212) as determined in the Japan standard product classifications.

2. Excluded products

(1) Computers with advanced processing capabilities

Computers with advanced processing capabilities that are used in limited special applications are excluded.

1) Super computers

Under the existing provisions, computers with a composite theoretical performance of 50,000 mega calculations (MTOPS) per second or more are classified as supercomputers that are primarily used in science and engineering research. However, in the current evaluation standards, this classification range has been further restricted, and now only computers with a composite theoretical performance of 200,000 MTOPS or more are classified as supercomputers. (No. of units shipped in FY2007 (3 types): 143)

2) Massively parallel processors

Under the existing provisions, computers that are capable of performing calculations using an arithmetic processing unit composed of 256 or more processors (when multiple cores are present on a single chip (multi-core), each chip is counted as 1 processor) are classified as massively parallel processors equivalent to supercomputers. At this review of the evaluation standards, the excluded items will remain as currently described.

(No. of units shipped in FY2007: 5)

3) Computers that perform special I/O control (computers with large numbers of I/O signal lines for control)

At this review of the evaluation standards, computers for core systems with reinforced I/O control functions designed for purposes such as network management and data management will continue to be excluded as currently prescribed. Specifically, computers composed of 512 or more I/O signal lines (only lines with a maximum data transfer speed of 100 megabits or more per second) are excluded. (No. of units shipped in FY2007: 57)

4) Fault-tolerant computers

At this review of the evaluation standards, fault-tolerant computers that give particular priority to safety and reliability will continue to be excluded as systems which are responsible for core economic and social systems, as currently prescribed. Specifically, computers with a structure that includes a redundant arithmetic processing unit, main memory device, I/O control device or power device are excluded.

(No. of units shipped in FY2007: Approx. 1,500)

(2) Office computers and other specialized for office functions

At the current review of the evaluation standards, computers that are specialized for wage calculations, office information management and similar tasks, and which are primarily used at small and mid-sized companies, will continue to be excluded as computers with extremely low processing capability, as currently prescribed. Specifically, computers with a composite theoretical performance of less than 100 MTOPS per second are excluded.

(No. of units shipped in FY2007: 64)

(3) Mobile computers

At the current review of the evaluation standards, mobile computers will continue to be excluded as currently prescribed for reasons including their low power consumption (on the order of several Watts), and the uncertainty of future technology and market trends. Specifically, computers that operate exclusively from an internal battery and never operate based on a power supply from a power line, and that do not contain an HDD.

(No. of units shipped in FY2007: Approx. 10,000)

Because of the significant technical progress and changes in market trends for computers that have occurred previously, it is necessary to consider products where energy-saving designs have not been fully incorporated for reasons

related to design and development. Therefore at this review of the evaluation standards, it was decided that these standards will not apply to models that, in the target fiscal year, are shipped in a quantity that is 10% or less of the quantity shipped in the previous fiscal year when the peak number of units was shipped, in order to exclude products that have already passed their sales peak. These excluded items will remain as currently prescribed.

## II. Scope of designated HDDs

### 1. Designated HDDs

These standards apply to HDDs (52131) as determined in the Japan standard product classifications.

### 2. Excluded products

(1) Small-size HDDs for special applications

At this review of the evaluation standards, small-size HDDs that are used for special applications will continue to be excluded as currently described. Specifically, HDDs with a disk diameter of 40 mm or less are excluded.
(No. of units shipped in FY2007: Approx. 159,000. Proportion of all units shipped: Approx. 0.5%)

(2) Sub-systems with special data transfer speeds

In the existing provisions, special sub-systems with a maximum data transfer speed exceeding 70 GB per second are excluded. However at this review of the evaluation standards, the range of excluded items has been further reduced, and it was decided to now only exclude devices with a maximum data transfer speed exceeding 270 GB per second.

(No. of units shipped in FY2007: 0)

(Reference) Total No. of units shipped in FY2007: 31,200,000

Because of the significant technical progress and changes in market trends for HDDs that have occurred previously, it is necessary to consider products where energy-saving designs have not been fully incorporated for reasons related to design and development. Therefore at this review of the evaluation standards, it was decided that these standards will not apply to models that in the target fiscal year are shipped in a quantity that is 10% or less of the quantity shipped in the previous fiscal year when the peak number of units was shipped, in order to exclude products that have already passed their sales peak. These excluded items will remain as currently prescribed.

Attachment 2

# Target fiscal year for computers and HDDs

## I. Target fiscal year for computers

1. The average computer product cycle is approximately 4 years for personal computers, and approximately 5 years for mid-range computers and general-purpose computers. Therefore it is suitable to set FY2011, 4 years after the standards were established, as the target fiscal year.

2. The improvement ratio for energy efficiency for the target fiscal year is expected to be approximately 78%, assuming that there are no changes in the existing numbers of units shipped and the configuration of each class (FY2007 results).

<General description of calculation>

○ Server computers
Current energy efficiency (FY2007 results) (average): 15.9 W/GTOPS
Target year (FY2011) energy efficiency (average of target standard values for each class): 6.1 W/GTOPS
(15.9 – 6.1) / 15.9 x 100 = Approx. 62%

○ Client computers
Current energy efficiency (FY2007 results) (average): 1.37 W/GTOPS
Target year (FY2011) energy efficiency (average of target standard values for each class): 0.21 W/GTOPS
(1.37 – 0.21) / 1.37 x 100 = Approx. 84%

## II. Target fiscal year for HDDs

1. The product cycle for HDDs that are incorporated in a computer or are used by connecting them to a computer, is thought to be equivalent to the computer average product cycle. Therefore in the same way as for computers, it is suitable to set FY2011 as the target fiscal year for HDDs.

2. The improvement ratio for energy efficiency for the target fiscal year is expected

to be approximately 76%, assuming that there are no changes in the existing numbers of units shipped and the configuration of each class (FY2007 results).

<General description of calculation>

- Individual disks
  Current energy efficiency (FY2007 results) (average): 0.019 W/GB
  Target year (FY2011) energy efficiency (average of target standard values for each class): 0.0045 W/GB
  (0.019 – 0.0045) / 0.019 x 100 = Approx. 76%

- Sub-systems
  Current energy efficiency (FY2007 results) (average): 0.094 W/GB
  Target year (FY2011) energy efficiency (average of target standard values for each class): 0.044 W/GB
  (0.094 – 0.044) / 0.094 x 100 = Approx. 53%

Attachment 3

# Classification used to set targets for computers and HDDs

## I. Basic concept

For computers and HDDs, the measurement methods and energy efficiency used are based on the standards for evaluation by the manufacturers, etc. related to performance improvements in computers and HDDs (= standards with target fiscal year of 2007, hereafter “existing standards”).
The basic concept for the classifications used to set targets is based on the classes in the existing standards, and a review was conducted of classes where factors such as improved performance of computers and HDDs have resulted in a difference between the class from the previous review and the actual conditions.
For household devices, the expansion of broadband communications has resulted in new product forms based on a diverse range of computer needs.
At this review, classes were set with consideration for this type of product diversity, and it was decided to require further improvements in computer and HDD energy efficiency.

## II. Classes used to set targets

### II-1. Computers

#### 1. Classes based on product characteristics

Based on the form of use and required performance, computers can be universally divided into the following types.

- ○ Server computers (general-purpose computers, mid-range computers, others)
- ○ Client computers

As a result of to the diverse needs of users, client computers can be classified into notebooks, desktops, compact desktops, and netbooks (including nettops, same below). Features and uses for each product class are listed in Table 1.
It is appropriate to classify these separately because the basic product specifications, including processing performance and power, are different as a

result of the different uses of the computers.

Table 1: Features and uses of each product class

| Product class | Feature (primary) | Application |
|---|---|---|
| Server computers | ○ Used in a broad range of fields from ordinary applications to special applications.<br>○ Diverse performance range such as high reliability required for system management, high speed required for data communications, and parallel processing characteristics for multiple applications. | ○ Large-scale system management<br>○ Financial and other accounting applications<br>○ Business and other core system applications<br>○ Network connections<br>○ Academic calculations, others |
| Client computers | ○ Computers primarily used as terminal devices<br>○ Includes workstations | ○ Offices<br>○ Homes<br>○ Schools, others |
| Battery-powered 2 or more memory channels [Notebook] | ○ Some give priority to performance, while others give priority to portability.<br>○ Integrated LCD display and keyboard<br>○ Contains an internal battery for mobile use. | |
| Not battery-powered, 2 or more memory channels, and uses an AC adapter as the power device [Compact desktop] | ○ Desktop that can be easily carried and relocated<br>○ Product with low expandability in terms of peripherals and other devices<br>○ Used for relatively low-load applications | |
| Not battery-powered, with 2 or more memory channels other than the above [Desktop] | ○ Computer used for personal applications and similar purposes<br>○ Operated by means of direct input/output (such as a display).<br>○ Product with high expandability in terms of peripherals and other devices | |
| Less than 2 memory channels [Netbook, Nettop] | ○ Computer designed primarily for using the internet<br>○ Priority is given to portability, and performance is limited to the minimum necessary. | |

* Refer to Reference Document 1 for a specific product image.

(1) Classification of server computers and client computers

For server computers and client computers, the classes were defined at the previous review as follows.

Client computers are defined as computers that have a graphics display port and keyboard port (including products that have an internal graphics display in place of a graphics display port and an internal keyboard in place of a keyboard port).
Because there are server computers that include a keyboard port and graphics display port primarily for maintenance purposes, computers are classified as server computers and client computers with consideration for the actual performance indexes. Specifically, in addition to the above definition, client computers are computers with a main memory capacity of less than 6 gigabytes (GB) and fewer than 4 I/O signal lines. Under the existing provisions, the main memory capacity in the performance index definition was determined to be "less than 4 GB", however due to the growing memory capacities of the main memory of client computers, it was decided to increase this capacity by one level, to "less than 6 GB".

However performance in terms of storage capacity and the number of I/O signal lines does not intrinsically differentiate a server computer and client computer. Because the classifications are made based on the performance at the time when the standards are formulated, advances in technology mean that there are already client computers with 6 GB or more of memory, and it is likely that the classifications will become even more imprecise in the future.

On the other hand, the server computer and client computer classifications in the market are generally accepted and are a closer reflection of the actual circumstances. Therefore, the classifications shall be organized as shown below.

- ○ "Server computer" refers to a computer that is designed to operate 24 hours and provide services on a network, and which can only be accessed via the network.
- ○ "Client computers" refers to computers that are not "server computers".

(2) Classifications of client computers (desktop, compact desktop, notebook, netbook)

High diversity is a particular requirement of client computers, and in addition to the "notebook" and "desktop" classes in the existing standards, there are also compact desktops – a product intermediate between a notebook and desktop, and netbooks – used primarily for connecting to the internet: two types of devices which have shown particular growth in recent years. In the same way as the existing standards, notebook and desktops are defined as battery-driven and non battery-driven types. Of the desktop types, those which use an AC adapter as the power source are defined to be "compact desktops", and those with less than 2 memory channels[3] are defined to be "netbooks".

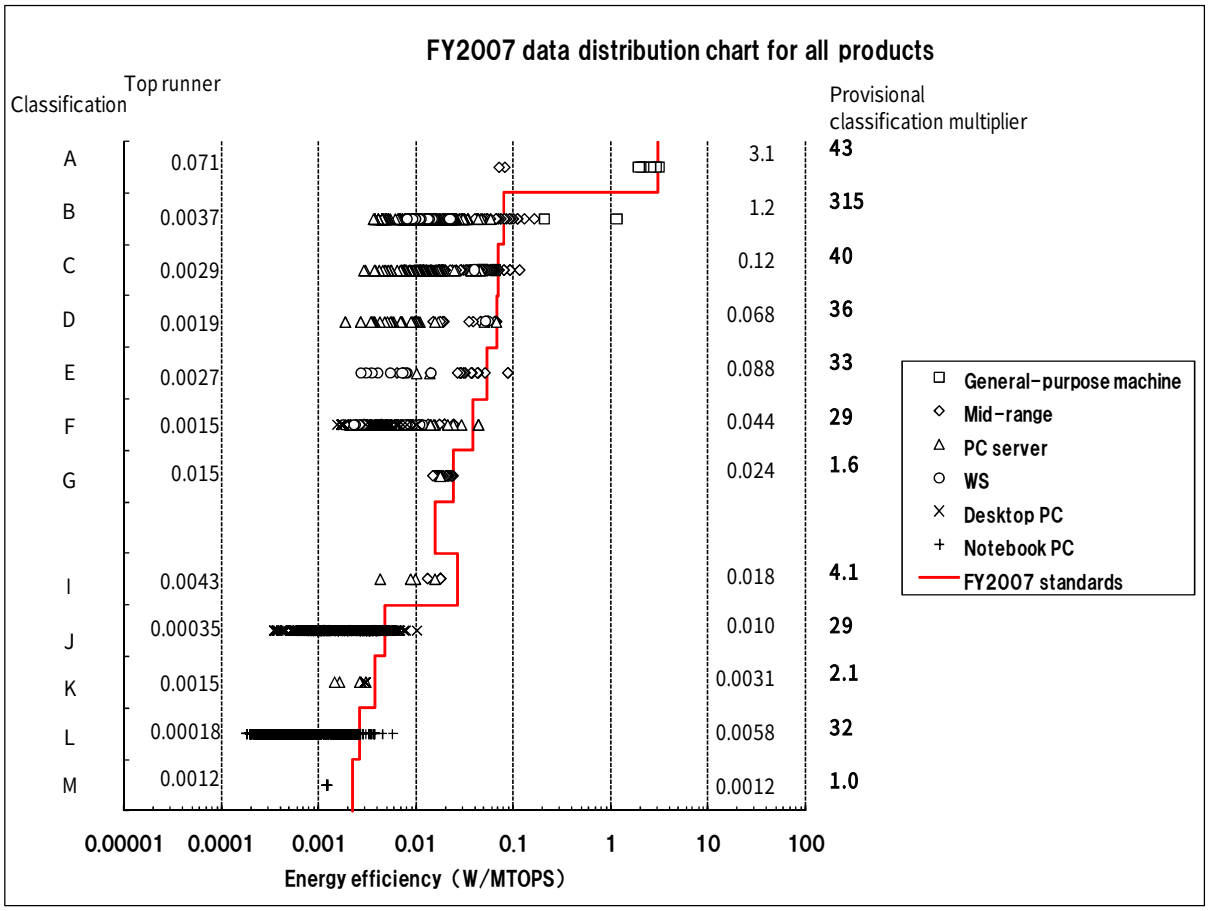
2. Classes based on performance characteristics

Classification in the existing standards establishes classes of computers based on the number of I/O signal wires and main memory capacity, factors which are

[3] No. of memory channels: The number of main controller and main memory bus interfaces.

correlated with energy efficiency (W/MTOPS). However as shown in Figure 1, the performance differences for products in each class (class multipliers) have become extremely large and it has become necessary to review the product classes.
Server computers, used primarily for business applications, give priority to commercial calculating performance (decimal calculations) and use dedicated CISC in the CPU. For this reason, the performance cannot be fully indicated by the composite theoretical performance (binary calculations) (hereafter, “CTP”). In addition, because there are also security functions and other elements besides the CPU which affect the power consumption in a server, the class multipliers are growing larger.
On the other hand, new client computer product forms such as the netbook have been introduced to meet user needs, and it has become difficult to classify client computers using only the existing “notebook” and “desktop” classes.
For this reason, it was decided to set new classes for server computers and client computers which are based on a correlation with energy efficiency.

Figure 1: Distribution of energy efficiency and class multipliers in existing classes (FY2007 products)




○ Server computers

In the existing standards as well, server computer classes which reflect these issues were established in order to allow the supply of products that satisfy the needed processing performance according to the application.
However with increases in computer performance, the classes originally created have become unable to keep pace with the actual conditions. For this reason, a review of the necessary categories has been conducted, and as a result the following categories shall be used.

Table 2: Categories based on product characteristics and performance characteristics (proposed)

| CPU type | No. of I/O slots | No. of CPU sockets |
|---|---|---|
| **Dedicated CISC** | **Less than 32** | **–** |
| | **32 or more** | **–** |
| **RISC** | **Less than 8** | **–** |
| | **8 to less than 40** | **–** |
| | **40 or more** | **–** |
| **IA64** | **Less than 10** | **–** |
| | **10 or more** | **–** |
| **IA32** | **0** | **–** |
| | **Less than 7** | **Less than 2** |
| | | **2 to less than 4** |
| | | **4 or more** |
| | **7 or more** | **–** |

*1 Dedicated CISC (Complex Instruction Set Computer): Used in high-functionality processors with a diverse instruction set. It is primarily used in mainframe servers and similar products.
*2 RISC (Reduced Instruction Set Computer): This type of processor uses a simplified instruction set in order to focus on high speed, and is primarily used in UNIX servers and similar devices.
*3 IA64, IA32: These are typical architectures for general-purpose CICS microprocessors that are broadly used in products from personal computers to high-functionality servers. IA32 is a 32-bit microprocessor architecture, and is primarily used in products such as IA servers. IA64 is a 64-bit microprocessor architecture, and is primarily used in products such as high-functionality servers.

Table 3: [Reference] Existing server computer classes

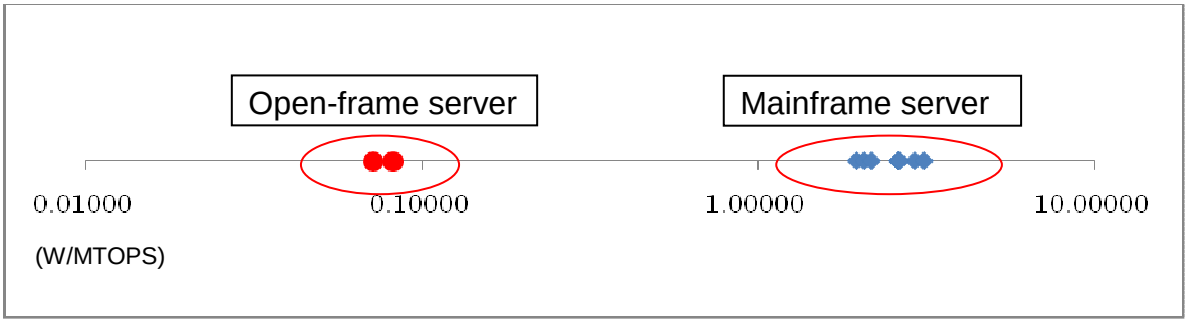
| No. of I/O signal lines | Main memory capacity | Classification |
|---|---|---|
| 64 or more | – | a |
| 16 to less than 64 | – | b |
| 8 to less than 16 | 16 GB or more | c |
| | 4 GB to less than 16 GB | d |
| | Less than 4 GB | e |
| 4 to less than 8 | 16 GB or more | f |
| | 4 GB to less than 16 GB | g |
| | Less than 4 GB | h |
| Less than 4 | 16 GB or more | i |

| | | |
|---|---|---|
| | 4 GB to less than 16 GB | j |
| | 2 GB to less than 4 GB | k |
| | Less than 2 GB | l |

(1) CPU type

In the existing classes, server computers were classified as either mainframe servers or open-frame servers according to the main memory capacity and number of I/O signal lines. However technical innovations in recent years have resulted in unavoidable mixing of the mainframe server and open-frame server classes and discrepancies in energy efficiency (as shown by the example in Figure 2) when classification is based on the main memory capacity and number of I/O signal lines. For this reason, it was decided to establish new classes based on the CPU type.

Figure 2: Mixing of devices in class A of the existing standards

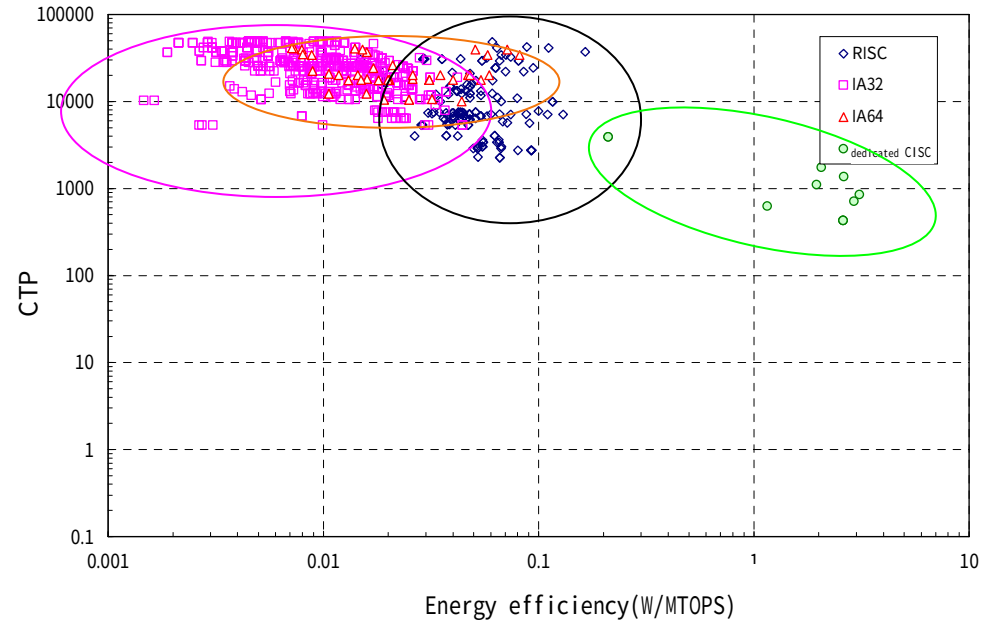



The CPU that are mounted in server computers are classified into 4 types: dedicated CISC, RISC, IA64, and IA32.

IA64 and IA32 are general-purpose CPU with high energy efficiency. In particular, IA32 accounts for the majority of the devices shipped and has the highest energy efficiency.

On the other hand, the energy efficiency of dedicated CISC and RISC is relatively low. In particular, dedicated CISC has the lowest energy efficiency because the CTP underestimates the actual performance as described earlier.

Figure 3: Distribution of energy efficiency by CPU type




(2) No. of I/O slots

The number of I/O slots is the number of I/O expansion slots, such as PCI slots, in a single case. It is different from the I/O number in the existing standards (No. of I/O signal lines), which indicates the number of I/O signal lines splitting from signal lines between the arithmetic unit and main memory device.

The use of CPU type servers make it no longer necessary to classify servers by the I/O number (No. of I/O signal lines). However because the case and power capacity become larger depending on the I/O slot expandability described above, it was decided to classify servers based on the number of I/O slots, a factor which correlates with energy efficiency, as shown in Figure 4 – 7.

Figure 4: Number of I/O slots and energy efficiency (dedicated CISC)

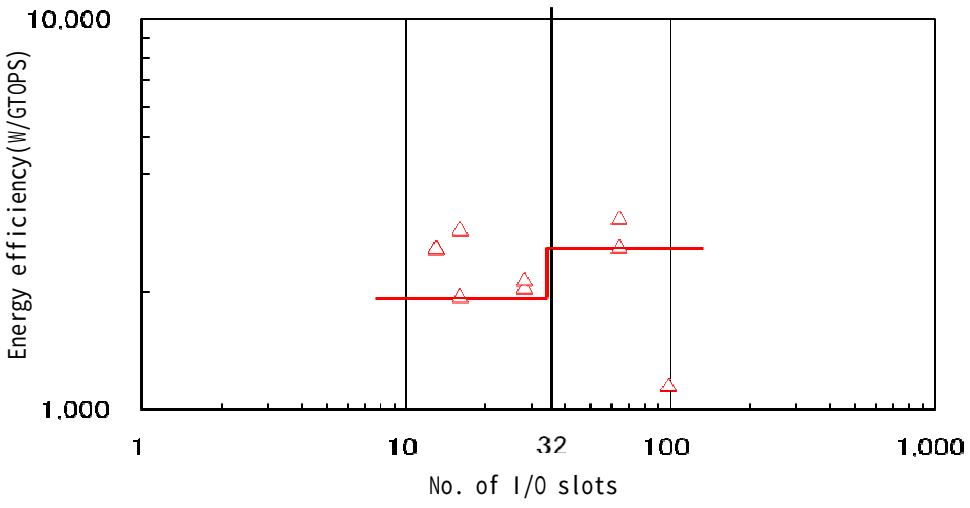


Figure 5: Number of I/O slots and energy efficiency (RISC)

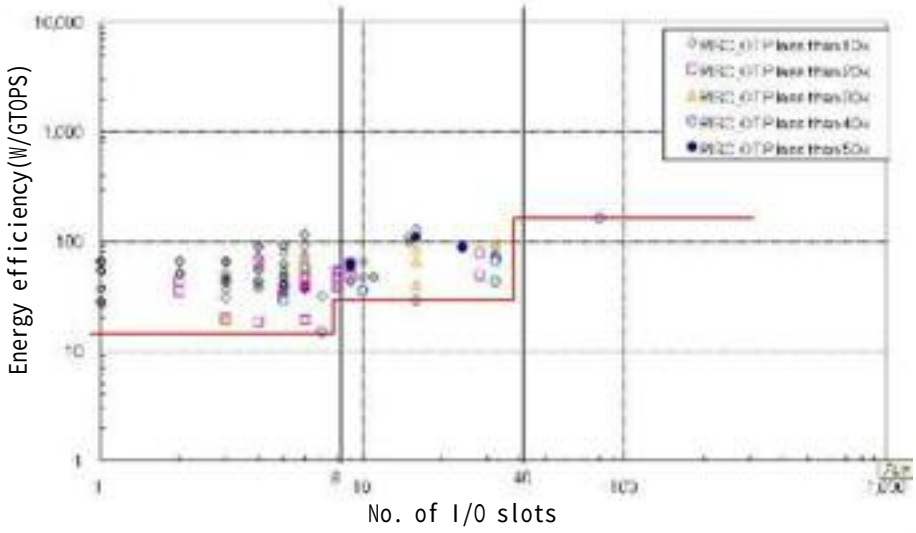



Figure 6: Number of I/O slots and energy efficiency (IA64)

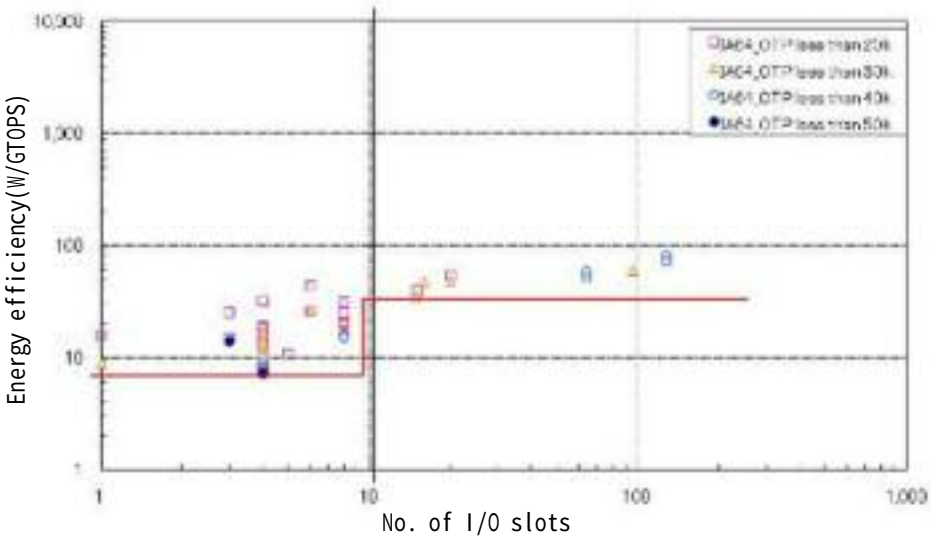
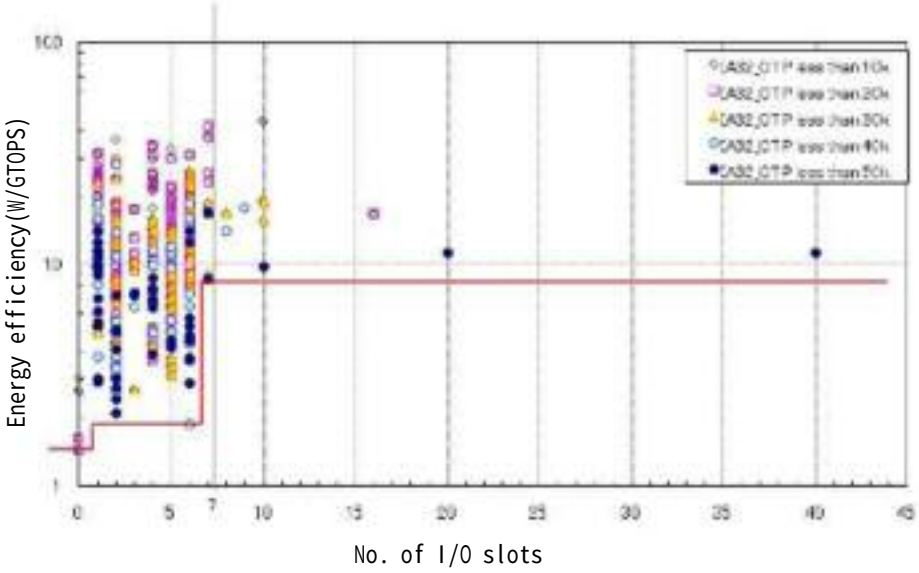


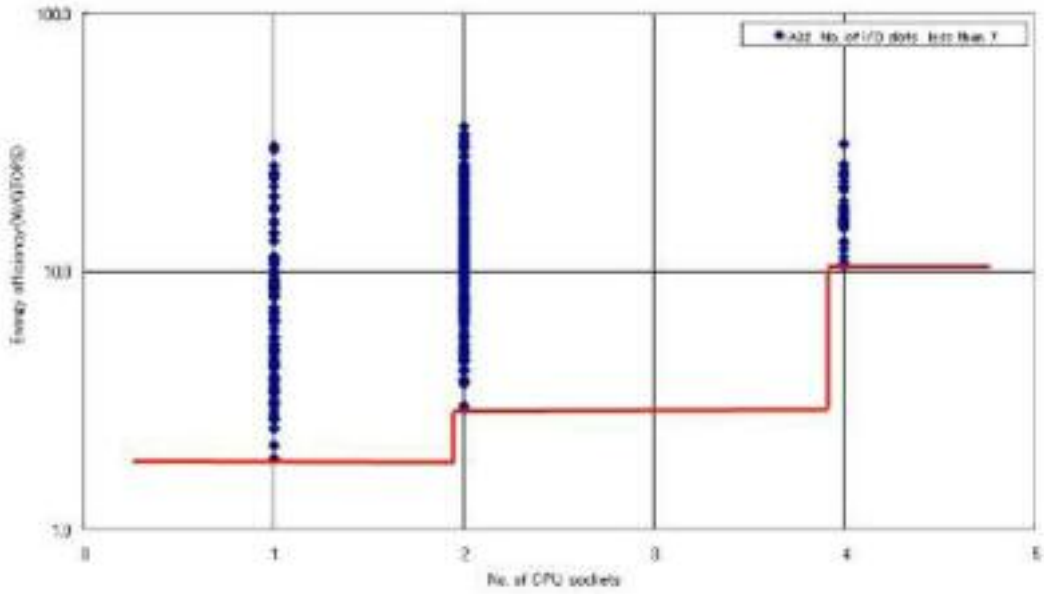
Figure 7: Number of I/O slots and energy efficiency (IA32)




(3) Number of CPU sockets

Servers using IA32 with less than 7 I/O slots account for approximately 85% of all servers shipped. This is the class that contains the greatest number of product types. In particular, because products are designed with the intention of increasing the number of CPU installed, power consumption tends to increase according to the number of CPU sockets as shown in Figure 8. For this reason, it was decided to add classes based on the number of CPU sockets only for servers using IA32 and with less than 7 I/O slots.

Figure 8: Number of CPU sockets and energy efficiency (IA32)



○ Client computers

Diversification of client computer products is continuing, and product lineups are expanding along two particular trends: increasingly high-performance devices and devices with limited performance that prioritize portability. For both types of product, this is the result of increasing user needs. Because these needs are expected to continue increasing, it was decided to review the classes as shown below.

Table 4: Categories based on product characteristics and performance characteristics (proposed)

| Type of client computer | Main memory capacity | Discreate GPU | LCD size | Primary product |
|---|---|---|---|---|
| Battery-powered, with 2 or more memory channels | 16 GB or more | – | – | Workstations |
| | More than 4 GB to less than 16 GB | – | – | High-performance notebooks |
| | 4 GB or less | | 17 or more | Large-size notebooks |
| | | Installed | Less than 17 | Standard-size notebooks |
| | | Not installed | 12 or more Less than 17 | |
| | | | Less than 12 | Mobile notebooks |
| Not battery-powered, with 2 or more memory channels, and uses an AC adapter as the power device | | | | Compact desktops |
| Not battery-powered, with 2 or more memory channels other than the above | 16 GB or more | – | – | Workstations |
| | More than 4 GB to less than 16 GB | Installed | – | High-performance desktops |
| | | Not installed | – | |
| | 4 GB or less | | | Standard-size desktops |
| Less than 2 memory channels | – | – | – | Nettops Netbooks |

* The LCD size values indicate the dimension in centimeters between opposite corners of the display screen, divided by 2.54 and rounded to the second decimal place.

Table 5: [Reference] Existing client computer classes

| Classification | | |
|---|---|---|
| Type of computer | No. of I/O signal lines | Main memory capacity |
| Client computers that are not battery powered | 2 to less than 4 | Less than 6 gigabytes |
| | Less than 2 | 2 gigabytes to less than 6 gigabytes |
| | | Less than 2 gigabytes |
| Client computers which are battery powered | | 1 gigabytes to less than 6 gigabytes |
| | | Less than 1 gigabytes |

(1) Main memory capacity

Main memory capacity is the capacity excluding the cache memory and is handled in units of gigabytes (GB). The existing standards also contain classes based on main memory capacity. Specifically, because the majority of products sold at present have main storage capacities of 4 GB, 8 GB or 16 GB, 3 classes have been created: main memory capacity 4 GB or less, more than 4 GB to less than 16 GB, and 16 GB or more.

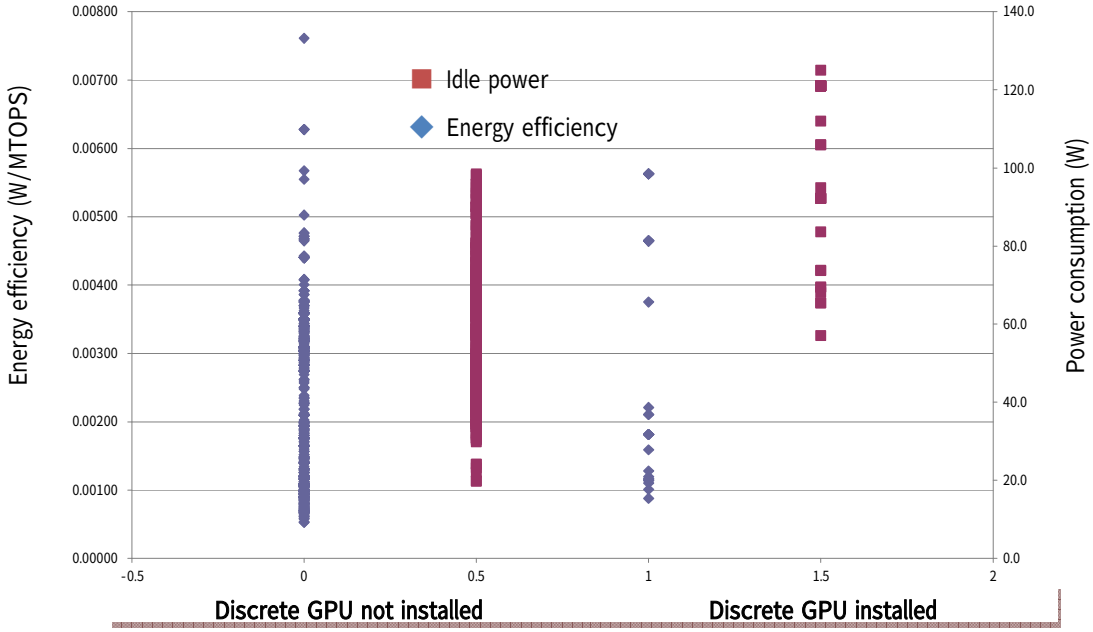
For devices with expandable main storage capacities, based on the measurement methods the maximum mountable main memory capacity for that device is used.

(2) Discreate GPU (graphics processing unit)

A discreate GPU is a processor which includes dedicated local memory and is used for processing graphics data. With increasing amounts of information being displayed graphically in recent years, the number of products with a discreate GPU is increasing.

Because a discreate GPU adds a high-speed memory interface and dedicated local memory for graphics processing, the power consumption increases as shown in Figure 9. For this reason, it was decided to add a class.

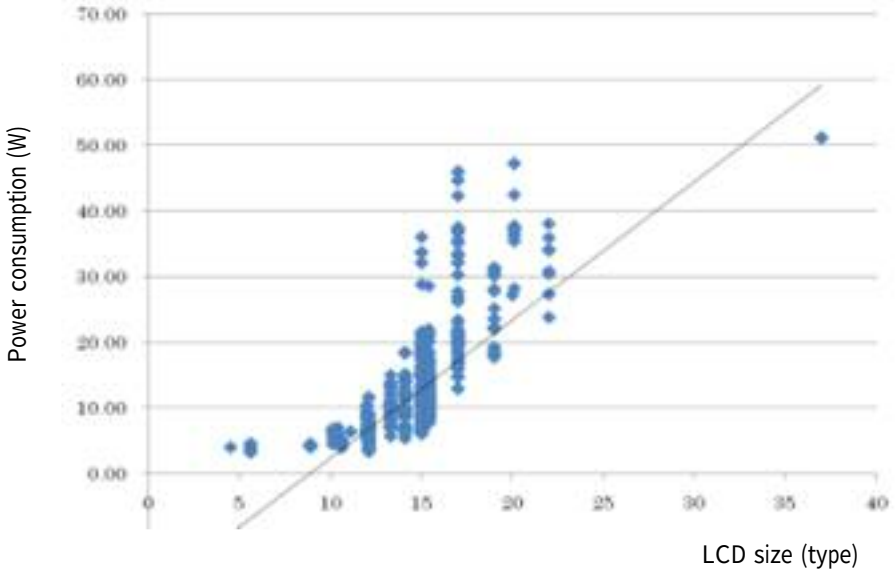
Figure 9: Effects of a discreate GPU on energy efficiency and energy consumption




(3) LCD size

For notebook PCs, the sizes of the installed LCD are growing and the power consumption of the LCD is increasing as shown in Figure 10. Conversely, almost no power is consumed by LCD of size 12 or smaller. It was decided to classify LCD sizes into large-size notebooks sizes 17 and larger, standard-size notebooks sizes 12 to less than 17, and mobile notebooks sizes less than 12.

Figure 10: Effects of LCD size on energy efficiency and energy consumption



## II-2. HDDs

### 1. Classes based on product characteristics

HDDs are classified as either individual disks which are installed in computers or other devices, or as sub-systems which are used as large external memory devices for computers. At this review of the evaluation standards, HDDs are classified as “individual disks” with a single disk drive, or "sub-systems" with multiple disk drives, as prescribed in the existing standards.

### 2. Classes based on performance characteristics

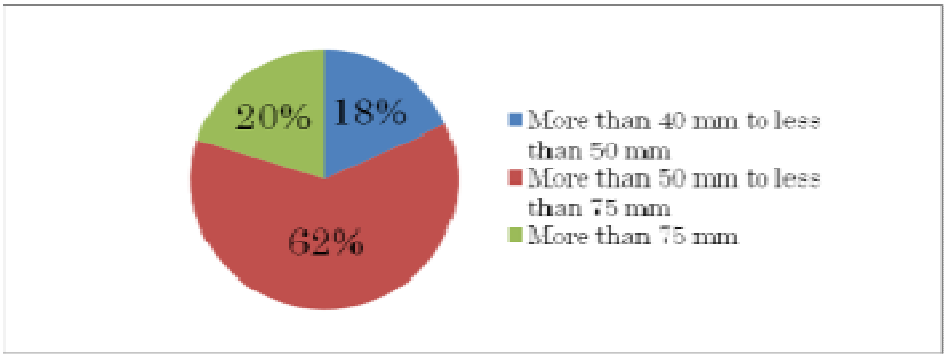
(1) Individual disks

1) Disk size (diameter)

There is a positive correlation between the power consumption required to turn the disk drive and the disk diameter. The most common disk sizes are 3.5 inches (95 mm), 2.5 inches (65 mm), and 1.8 inches (48 mm). HDDs with a disk size of 3.5 inches (95 mm) are widely used in desktop computers, mid- and large-size computers, and as sub-system internal disk drives. HDDs with a disk size of 2.5 inches are used in mid-and large-size computers and as sub-system internal disk drives, and are especially widely used in notebook computers where small size is a priority.

Therefore based on market trends, it was decided to divide products into 50 mm and 75 mm classes in the same way as the existing classes.

Figure 11: Share of total devices shipped by disk size (mm) (FY2007)




2) Number of disks

Increasing the number of disks increases the power consumption, however there are types of energy consumption such as the energy required to turn the shaft which must be constant regardless of the number of disks. Therefore, the energy

consumption is not increasing in proportion to the increase in storage capacity, and energy efficiency is improving.
Based on the above, it was decided to set classes according to the number of disks, in the same way as the existing standards. With reference to product trends, the specific classes are 1 disk, 2 – 3 disks, and 4 or more disks.

3) Disk rotating speed (rpm)

The power consumption required to rotate the disk drive is positively correlated with the disk rotating speed. Because of increasing reading and writing speeds, and the high demand for faster speeds, a standard has been created based on a function formula for the rotating speed.
However in a portion of the current classes, there is an inverse correlation with energy efficiency for devices with low speeds. This is because the increasing efficiency of motors and other parts combined with low rotating speeds means that small-size magnetic disks operate using 1 W or less of power, and the power consumption of the circuit increases relative to the power consumption of the mechanism.
Therefore it was decided to express target values using a function expression relating rpm and energy efficiency as in the existing standards. It was also decided to add new classes of “More than 5000 rpm or less than 6000 rpm” and “5000 rpm or less” to the “Disk size more than 50 mm to 70 mm or less with 1 disk” and “Disk size more than 50 mm to 70 mm or less with 2 or 3 disks” classes where the correlation is inverted.

Figure 12: Correlation with energy efficiency in the existing class D

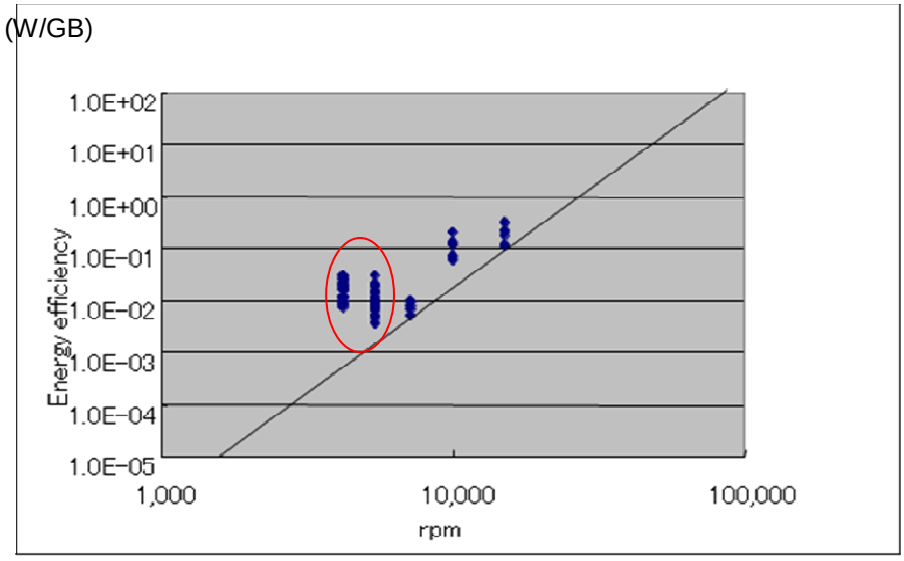



Table 6: Categories based on product characteristics and performance characteristics (individual disks)

| Type of HDD | HDD form and performance | | Rpm |
|---|---|---|---|
| | Disk size | No. of disks | |
| Individual disk | More than 75 mm | 1 disk | – |
| | | 2 or 3 disks | – |
| | | 4 or more disks | – |
| | More than 50 mm to 75 mm or less | 1 disk | 5000 or less |
| | | | More than 5000 to 6000 or less |
| | | | More than 6000 |
| | | 2 or 3 disks | 5000 or less |
| | | | More than 5000 to 6000 or less |
| | | | More than 6000 |
| | | 4 or more disks | – |
| | More than 40 mm to 50 mm or less | 1 disk | – |
| | | 2 or more disks | – |

* “Individual disk” refers to a single disk drive.

Table 7: Categories based on product characteristics and performance characteristics (sub-systems)

| Type of HDD | Application |
|---|---|
| Sub-system | Mainframe servers |
| | Other |

* The mainframe server application refers to sub-systems used in servers which mount dedicated CISC.
* “Sub-system” refers to a product with multiple disk drives. For individual disks, cases that bear a type name shall be considered 1 unit. For sub-systems, the magnetic disk control unit and HDD shall be together considered 1 unit (for a product that uses only a magnetic disk controller that is built into a computer, cases that bear a type name shall be considered 1 unit).

Table 8: [Reference] Existing magnetic disk classification

| Classification | | |
|---|---|---|
| Type of HDD | HDD form and performance | Classification |
| Individual disk | Disk size more than 75 mm with 1 disk | a |
| | Disk size more than 75 mm with 2 or 3 disks | b |
| | Disk size more than 75 mm with 4 or more disks | c |
| | Disk size more than 50 mm to 75 mm or less with 1 disk | d |
| | Disk size more than 50 mm to 75 mm or less with 2 or 3 disks | e |
| | Disk size more than 50 mm to 75 mm or less with 4 or more disks | f |
| | Disk size more than 40 mm to 50 mm or less with 1 disk | g |
| | Disk size more than 40 mm to 50 mm or less with 2 or more disks | h |
| Sub-system | - | i |

(2) Sub-systems

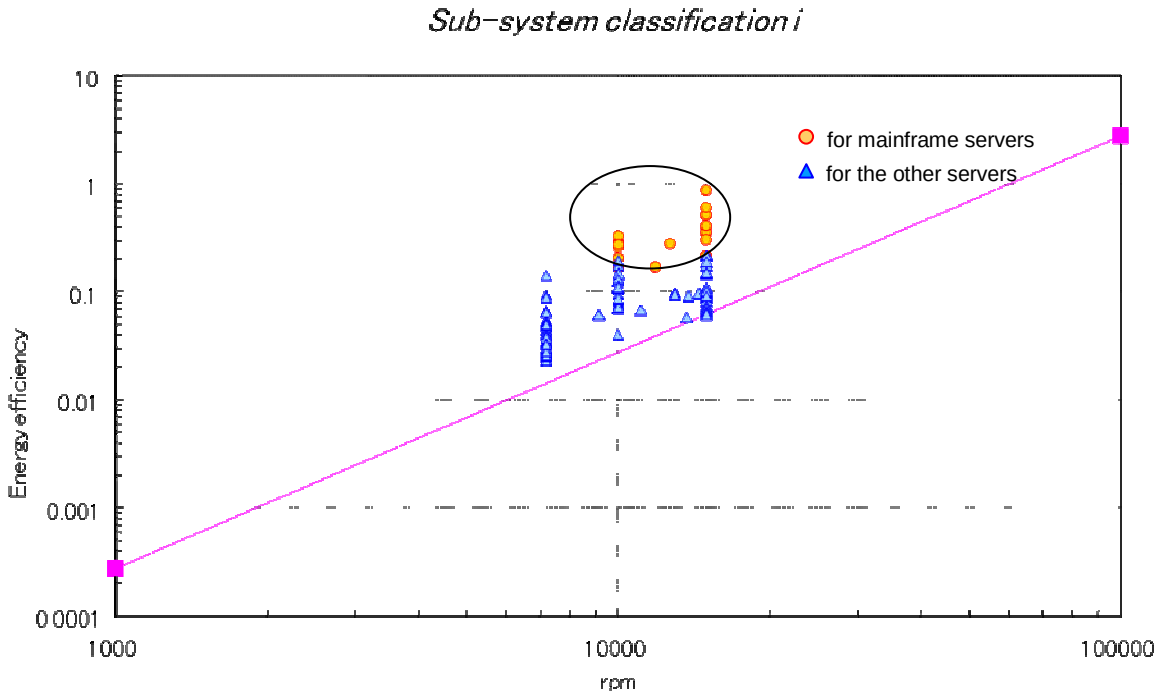
1) Disk rotating speed (rpm)

In the same way as for individual disks, there is a positive correlation between disk rpm and power consumption as shown in Figure 13. Therefore, target standards based on a relational formula for rpm are set in the same way as the existing standards.

2) Application

In devices for sub-systems for mainframe servers, because of the OS requirements, when a small logical disk capacity is packed into a large hard disk, there is a large drop in performance. Therefore, the trend is to maintain performance by keeping the unit capacity as small as possible and using high-rpm hard disks. For this reason, there has been a relative increase in the energy efficiency of sub-systems for mainframe servers. As a result, it was decided to create a separate class for mainframe server sub-systems.

Figure 13: Sub-system energy efficiency and rpm



Attachment 4

# Target standard values and target fiscal years for computers and HDDs

## I. Basic concept of setting target standards

### 1. Basic concept

Target standard values are set based on the concept of the top runner method. The specific concept is as shown below.

1) Target standard values are set for each of the appropriately determined classes.
2) For classes where improvement in efficiency is expected as a result of future advances in technology, those improvements are incorporated into the target standard value to the extent possible.
3) There shall be no contradictions in the target standard values in different classes.

### 2. Basic approach to setting target standard values for computers and HDDs

When setting target standard values for computers and HDDs, for both types of device the value used is the value for energy efficiency divided by a performance index (composite theoretical performance (CTP), storage capacity (GB)). Naturally as a result, it is necessary to consider performance index trends in order to predict energy efficiency improvements when setting the target standard values.

In addition when reviewing the classes, although the class balance is adjusted in the theoretical performance, because there remains a large bias in the number of units shipped between the classes, discrepancies occur in the introduction timing of new products and an inverse correlation is likely to occur in the actual values between classes.

For this reason, and based on “1. Basic concept” above, it is important to correct contradictions which occur between classes while promoting the maximum amount of energy savings.

## II. Target fiscal year

### II-1. Computers

- The average product cycle for computers is approximately 4 – 5 years, and in the existing standards as well the target year was set approximately 5 years following the year the standards were enacted.
- However for computers, international studies concerning new measurement methods are being carried out and it will also be necessary to give consideration to conformance with future international standards.
- When the above factors are considered, it is appropriate to set the target fiscal year as fiscal year 2011, 4 years after the year the standards were enacted (FY2007).

### II-2. HDDs

- The product cycle for HDDs that are incorporated in a computer or are used by connecting them to a computer, is thought to be the same as the computer average product cycle. Therefore in the same way as for computers, setting FY2011 as the target fiscal year is suitable for HDDs.

## III. Specific target standard values

### III-1. Computers

For each computer class, the top runner value was found from the actual measured energy efficiency (FY2007), and then an energy efficiency value which gives consideration to improvements that will occur between the present time and the target fiscal year was set as the target standard value. The specific values are shown in Table 1 and Table 2.

○ Server computers

For mainframe servers which use dedicated CISC, because the development period is long and improvements in power consumption and CTP before the target fiscal year cannot be predicted, the top runner value is used as the target standard value.
For provisional class G, because the number of devices investigated was small and the CTP of top runner devices was smaller than provisional class F, which

also uses the same IA64, the CTP value was corrected to approximately the same value, resulting in a stricter target standard value and a higher improvement ratio.

In provisional classes I and J, IA32 accounts for approximately 85% of the total devices shipped, and the greatest technical improvements in 2011 are also expected in these classes. Therefore, a higher improvement ratio than the other classes is expected.

Table 1: Target standard values for server computers

| CPU type | No. of I/O slots | No. of CPU sockets | Provisional classification | Top runner value (W/GTOPS) | Target standard value (W/GTOPS) | Top value improvement ratio | No. of devices shipped (units) |
|---|---|---|---|---|---|---|---|
| Dedicated CISC | Less than 32 | – | A | 1,954.1 | 1,950 | 0.0% | 332 |
| | 32 or more | – | B | 2,620.3 | 2,620 | 0.0% | 62 |
| RISC | Less than 8 | – | C | 14.9 | 13.0 | 12.7% | 20,614 |
| | 8 or more Less than 40 | – | D | 35.6 | 31.0 | 12.9% | 4,821 |
| | 40 or more | – | E | 164.5 | 140.0 | 14.9% | 13 |
| IA64 | Less than 10 | – | F | 7.1 | 6.2 | 13.6% | 1,361 |
| | 10 or more | – | G | 35.0 | 22.0 | 37.1% | 308 |
| IA32 | 0 | – | H | 1.5 | 1.3 | 13.6% | 6,745 |
| | Less than 7 | Less than 2 | I | 1.9 | 1.2 | 36.7% | 116,629 |
| | | 2 to less than 4 | J | 2.9 | 1.9 | 36.7% | 108,511 |
| | | 4 or more | K | 10.5 | 6.7 | 36.7% | 606 |
| | 7 or more | – | L | 8.6 | 7.4 | 13.6% | 3,507 |

○ Client computers

For client computers, the target standard values vary largely depending on the degree of CTP improvement that is expected by FY2011. As the change to multiple cores[4] continues, CPU performance in recent years has seen a dramatic increase in CTP, however it is unlikely that the pace of improvements to this point will continue until FY2011. However because improving the efficiency of power devices is among the technologies which can be improved by the efforts of client computer manufacturers, energy efficiency improvements of 15% - 20% are expected.

At present, provisional class k is the primary class for desktop computers. However with increasing use of multi-core processors and increasing main memory capacity due to OS changes occurring by FY2011, it is forecast that the primary market will change to provisional class i or j. On the other hand, a special product mounting a quad-core processor in the declining provision classification k is currently the top runner value. Because the development of technologies which exceed this efficiency on a weighted average will not occur in this class, a dual-core top runner value was adopted as the target standard value.

Provisional class e is also a class with an extremely large number of units shipped. However the power consumption is approaching the minimum required for operation, including the LCD. At present, the power consumption in the idle state for top runner devices in this class has declined to approximately 6W. For this reason, the standard was set at maintaining the current level of power consumption even with increasing CTP.

Provisional classes a and b contain no products at the present time. Therefore, the standard was set using estimates based on other classes.

[4] Multi-core refers to a single processor that mounts multiple processor cores.

Table 2: Target standard values for client computers

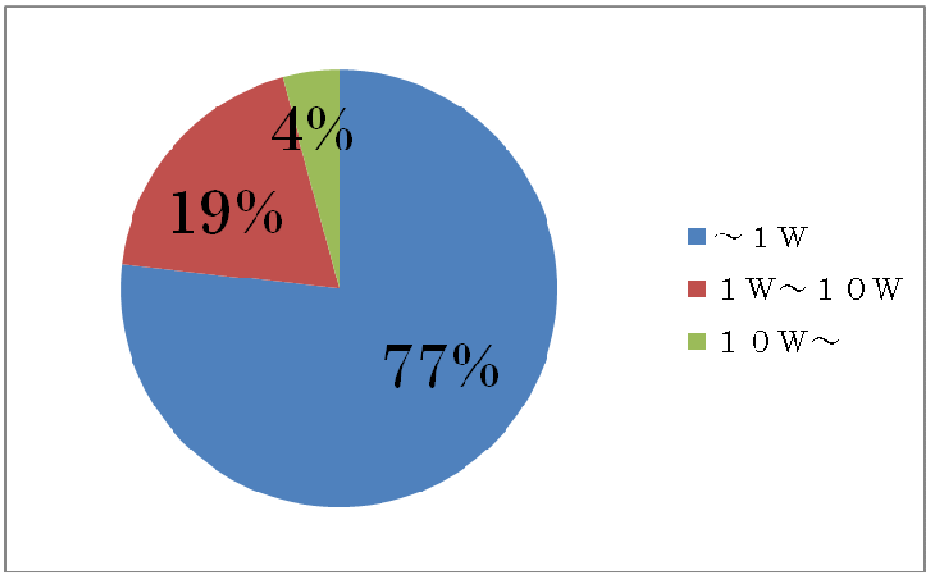
| Type of client computer | Main memory capacity | Discreate GPU | LCD size | Provisional classification | Weighted average in class | Top value | Target standard value | Weighted average improvement ratio | Improvement ratio from top value | No. of devices shipped (units) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Battery-powered, with 2 or more memory channels | 16 GB or more | – | – | a | – | – | **2.25** | – | – | 0 | 0.0% |
| | More than 4 GB to less than 16 GB | – | – | b | – | – | **0.34** | – | – | 0 | 0.0% |
| | 4 GB or less | – | 17 or more | c | 1.56 | 0.37 | **0.31** | 80.4% | 17.3% | 25,972 | 0.4% |
| | | Installed | Less than 17 | d | 0.56 | 0.25 | **0.21** | 63.5% | 17.8% | 163,778 | 2.2% |
| | | Not installed | 12 to less than 17 | e | 1.03 | 0.18 | **0.15** | 85.6% | 17.4% | 4,644,569 | 63.1% |
| | | | Less than 12 | f | 0.68 | 0.24 | **0.21** | 68.6% | 10.8% | 111,070 | 1.5% |
| Not battery-powered, with 2 or more memory channels, and uses an AC adapter as the power device | – | – | – | g | 1.87 | 0.35 | **0.29** | 84.7% | 18.5% | 234,282 | 3.2% |
| Not battery-powered, with 2 or more memory channels other than the above | 16 GB or more | – | – | h | 11.28 | 2.7 | **2.25** | 80.0% | 16.6% | 4,327 | 0.1% |
| | More than 4 GB to less than 16 GB | Installed | – | i | 5.48 | 0.62 | **0.51** | 90.7% | 18.2% | 28,278 | 0.4% |
| | | Not installed | – | j | 7.01 | 0.8 | **0.64** | 90.9% | 20.0% | 23,309 | 0.3% |
| | 4 GB or less | – | – | k | 2.01 | 0.53 | **0.53** | 73.8% | 0.6% | 2,128,782 | 28.9% |
| Less than 2 memory channels | – | – | – | l | 0.89 | 0.67 | **0.51** | 43.4% | 24.6% | 0 | 0.0% |

Note 1. Because no products with less than 2 memory channels were shipped during FY2007, the performance value for products shipped in FY2008 has been applied.
2. The top runner value for classification k is a dual-core value. The quad-core top runner value is 0.47.

III-2. HDDs

For individual disks, the significantly smaller sizes and higher efficiencies in recent years have greatly reduced the power consumption. As shown in Figure 1, 77% of all shipped products have a power consumption of 1W or less, and products with the lowest power consumption consumes less than 0.5W. For this reason, if the reduction in power consumption were found based on the current top runner device, there would be the risk of adversely affecting reliability. Therefore, the standard was set so that the power consumption remains at the level of the current top runner even if storage capacity increases.

Figure 1: Ratio of individual disks shipped by power consumption




As shown in Table 3, the standard value was found from the top runner method using the standard formula. Although this proposed standard contains differences in the improvement ratios by class, an improvement of approximately 60 – 90% is expected. Even if the storage capacity increases by approximately 4 times, the power consumption will maintain the current level.

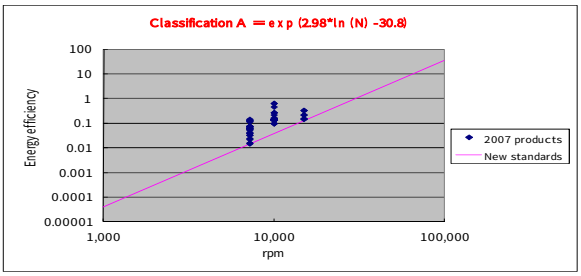
Table 3: Target standard values for HDDs

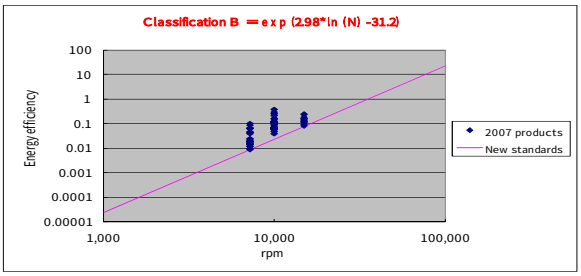
| Type of HDD | HDD form and performance | | Rpm | Provisional classifications | Target value formula | No. of devices shipped | Weighted average improvement ratio |
|---|---|---|---|---|---|---|---|
| | Disk size | No. of disks | | | | | |
| Individual disk | More than 75 mm | 1 disk | – | A | E=exp(2.98*ln(N)-30.8) | 3,001,846 | 74.0% |
| | | 2 or 3 disks | – | B | E=exp(2.98*ln(N)-31.2) | 2,880,862 | 63.7% |
| | | 4 or more disks | – | C | E=exp(2.11*ln(N)-23.5) | 279,154 | 43.8% |
| | More than 50 mm to 75 mm or less | 1 disk | 5000 rpm or less | D | E=exp(2.98*ln(N)-29.8) | 3,422,716 | 81.7% |
| | | | More than 5000 rpm to 6000 rpm or less | E | E=exp(2.98*ln(N)-31.2) | 6,878,557 | 83.2% |
| | | | More than 6000 rpm | F | E=exp(4.30*ln(N)-43.5) | 26,519 | 63.1% |
| | | 2 or 3 disks | 5000 rpm or less | G | E=exp(2.98*ln(N)-31.5) | 555,927 | 84.8% |
| | | | More than 5000 rpm to 6000 rpm or less | H | E=exp(2.98*ln(N)-32.2) | 7,257,285 | 76.6% |
| | | | More than 6000 rpm | I | E=exp(4.58*ln(N)-46.8) | 493,287 | 69.5% |
| | | 4 or more disks | – | J | E=exp(2.98*ln(N)-31.9) | 529,648 | 51.0% |
| | More than 40 mm to 50 mm or less | 1 disk | – | K | E=exp(2.98*ln(N)-30.2) | 4,311,650 | 52.1% |
| | | 2 or more disks | – | L | E=exp(2.98*ln(N)-30.9) | 1,136,084 | 38.2% |

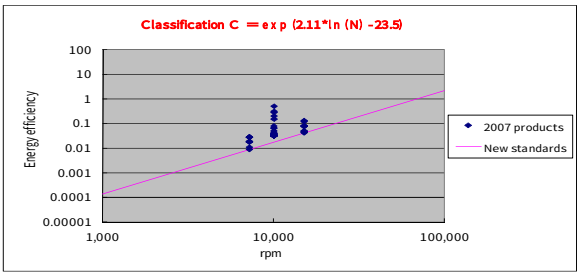
| Type of HDD | Application | | Target value formula | No. of devices shipped | Weighted average improvement ratio |
|---|---|---|---|---|---|
| Sub-system | Mainframe server | M | E=exp(1.85*ln(N)-18.8) | 790 | 29.3% |
| | Other | N | E=exp(1.56*ln(N)-17.7) | 14,381 | 58.4% |

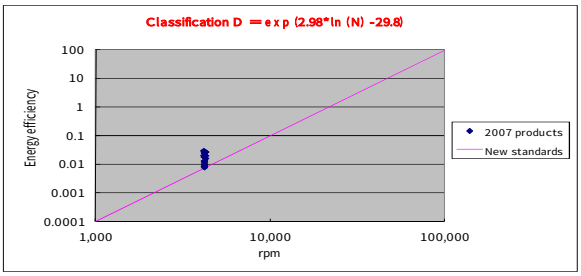
Distribution and standard top runner formula for each class

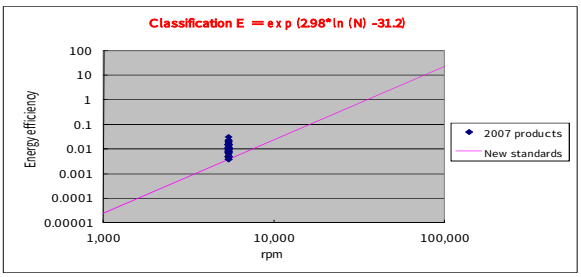
<Individual disk>

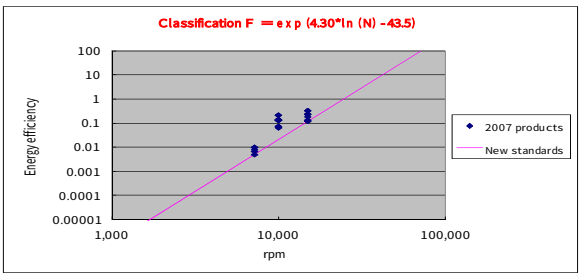


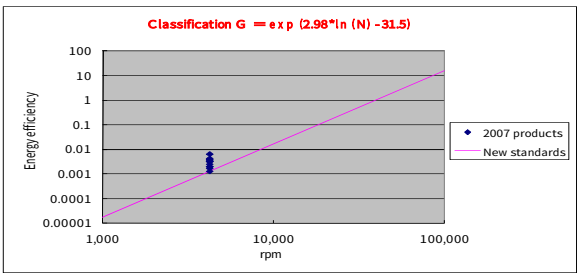



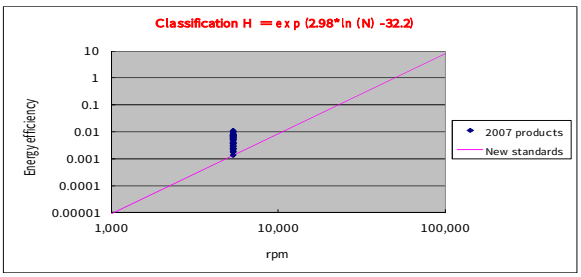



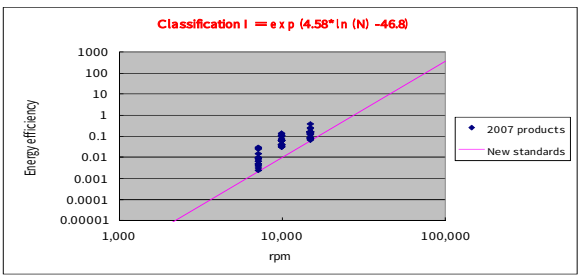



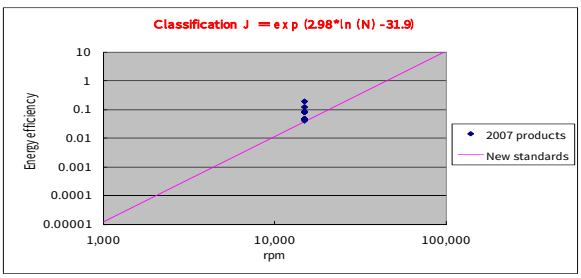



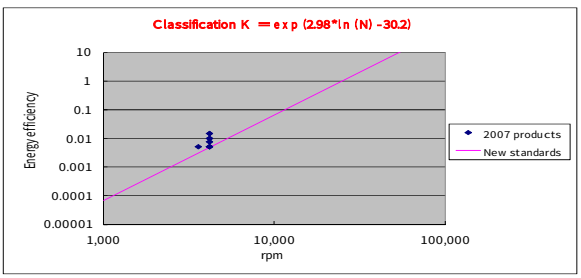



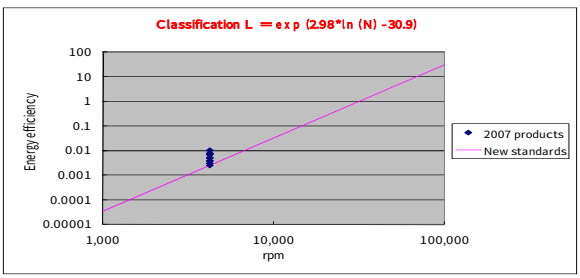



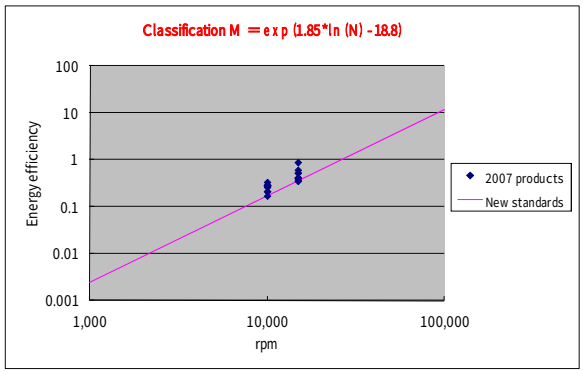



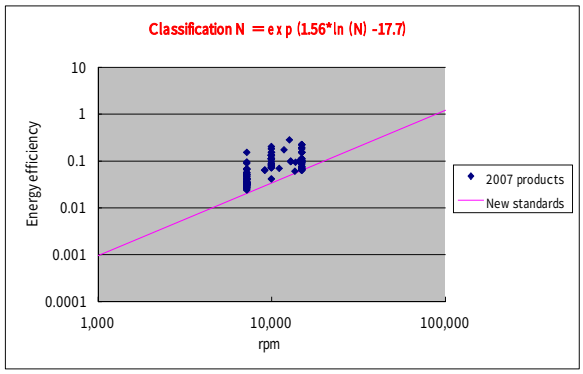



<Sub-system>


Classification M ＝ e x p (1.85*ln (N) - 18.8)
Energy efficiency
100
10
1
0.1
0.01
0.001
1,000
10,000
100,000
rpm
2007 products
New standards


Classification N ＝ e x p (1.56*ln (N) -17.7)
Energy efficiency
10
1
0.1
0.01
0.001
0.0001
1,000
10,000
100,000
rpm
2007 products
New standards

Attachment 5

General Resources Energy Investigation Committee, Energy Savings Standard Section,
Computer and Hard Disk Drive Judging Standards Subcommittee
Meeting History

1st subcommittee meeting (February 17, 2009)

- Making subcommittee meetings open to the public
- Current status of computers and HDDs
- Scope of designated devices

2nd subcommittee meeting (October 8, 2009)

- Target standard values and classifications
- Review of evaluation standards

3rd subcommittee meeting (December 9, 2009)

- Interim report

Attachment 6

General Resources Energy Investigation Committee, Energy Savings Standard Section,
Computer and Hard Disk Drive Judging Standards Subcommittee
List of committee members

| | | |
|---|---|---|
| Chairman: | Yutaka Matsushita | Former chairman of the Home IT Promotion Committee<br>Former professor at Keio University |
| Member: | Hideharu Amano | Professor at Faculty of Science and Technology, Keio University |
| | Kenichi Ito | Director of the Education Planning Division, Japan Consumers' Association |
| | Minako Oishi | Deputy chair of the Environment Committee, Nippon Association of Consumer Specialists |
| | Kazuhito Omaki | Professor at the Faculty of Information Science and Arts, Toyo University |
| | Seiichi Shin | Professor at the Department of Electronic Engineering, The University of Electro-Engineering |
| | Tadayoshi Tanaka | Director of Energy Conservation Center, Japan, Technology Division |
| | Yukio Nakano | Senior researcher at the System Engineering Research Laboratory, Central Research Institute of Electric Power Industry |
| | Takeshi Muranoi | Mitsubishi Electric Information Technology Corporation<br>Director, Business Group II |

Reference Document 1

# Types of computers

## ◆ Examples of server using dedicated CISC

| |  |  |
|---|---|---|
| CPU | Dedicated CISC | Dedicated CISC |
| Form | Dedicated rack | Dedicated rack |
| I/O slot | 28 | 84 |
| Width (mm) | 770 | 1568 |
| Depth (mm) | 1806 | 1803 |
| Height (mm) | 2015 | 2015 |
| Weight (Kg) | 4.35 | 2318 |
| Power capacity (KVA) (Max.) | 6.253kVA | 27.5kVA |

## ◆ Examples of server using RISC

| |  |  |  |  |  |  |  (Photo of 4 units) |  |
|---|---|---|---|---|---|---|---|---|
| CPU | RISC | RISC | RISC | RISC | RISC | RISC | RISC | RISC |
| Form | Blade | Blade | Tower | Rack | Tower | Rack | Rack | Dedicated rack |
| I/O slot | 2 | 2 | 5 | | 5 | | 6 | 20 |
| | | | | 4U | | 4U | 4U | |
| Width (mm) | 27 | 29 | 182.3 | 440 | 182.5 | 440 | 483 | 775 |
| Depth (mm) | 445 | 445 | 628 | 538 | 778 | 730 | 824 | 1806 |
| Height (mm) | 245 | 245 | 540 | 173 | 540 | 173 | 174 | 2014 |
| Weight (Kg) | 4.35 | 4.35 | 40.8 | 31.75 | 53.7 | | 63.6 | 1552 |
| Power consumption (W) Max. power capacity (KVA) | 350W | 400W | 0.876KVA | | 1.443KVA | | 1.428KVA | 27.7KVA |

## ◆ Examples of server using IA32

| |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| CPU | IA32 | IA32 | IA32 | IA32 | IA32 | IA32 | IA32 | IA32 |
| Form | Blade | Tower | Tower | Tower | Rack | Rack | Rack | Rack |
| I/O slot | 0 | 4 | 6 | 6 | 2 | 4 | 6 | 7 |
| | | | | | 1U | 2U | 4U | 4U |
| Width (mm) | 333 | 216 | 218 | 218 | 440 | 443.6 | 483 | 443.6 |
| Depth (mm) | 603 | 540 | 747 | 747 | 559 | 705 | 711 | 720.2 |
| Height (mm) | 156 | 438 | 440 | 440 | 43 | 85.4 | 178 | 172.8 |
| Weight (Kg) | 4.14 | 25.2 | 38 | 40.8 | 12.7 | 29.3 | 43.2 | 43.2 |
| Power capacity (KVA) | | 0.55kVA | 0.68KVA | 0.78KVA | 0.55KVA | 0.93KVA | 1.820KVA | 1.62KVA |

Netbooks





Nettops

Compact desktops



Mobile notebooks



Large-size/standard-size notebook





Desktop

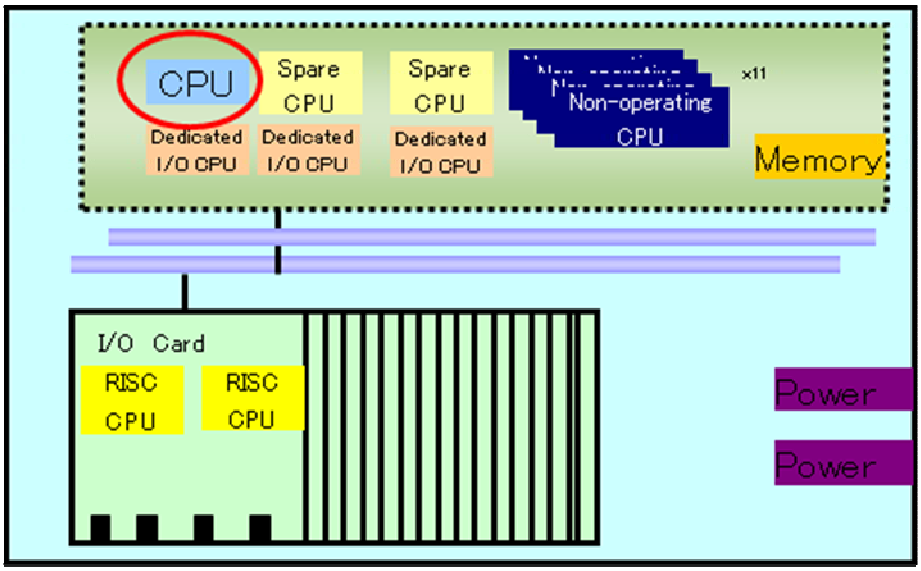
Workstations

Reference Document 2

Handling of mainframe servers

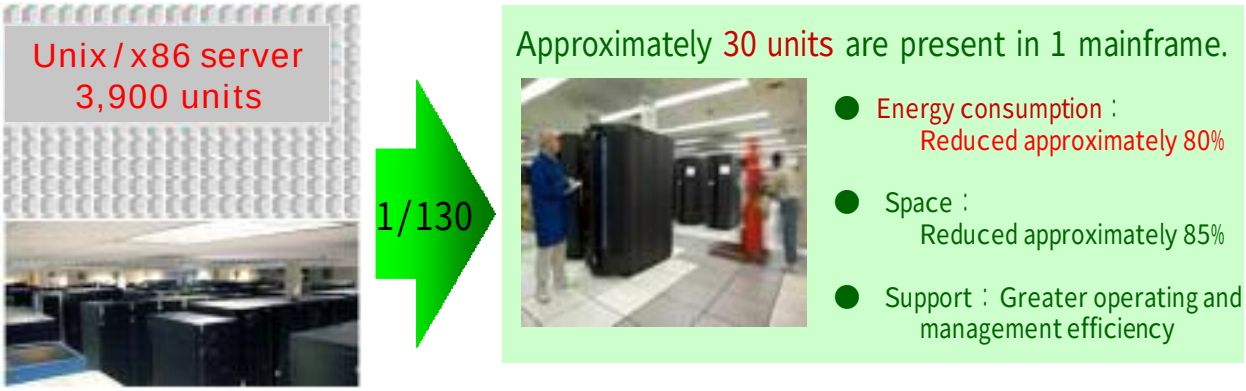
Because the energy efficiency of mainframe servers was low, committee members pointed out the need for improvements of such servers at this review of the standards. However, it cannot be said that all mainframe servers are in fact inferior in energy-saving performance compared with other devices.
As mentioned at the beginning, the largest problem in particular is that the use of the compound theoretical performance in an index of energy efficiency is nearing its limit. When the processing capacity of a mainframe server is divided such as in a dedicated I/O CPU, then from a security perspective an additional non-operating CPU is mounted in order to ensure redundancy.
Because the performance of this CPU is not reflected in the CTP value, the performance of the mainframe server appears to be low, classifying it as a product with poor energy efficiency.

**Concept diagram of a large-size mainframe**



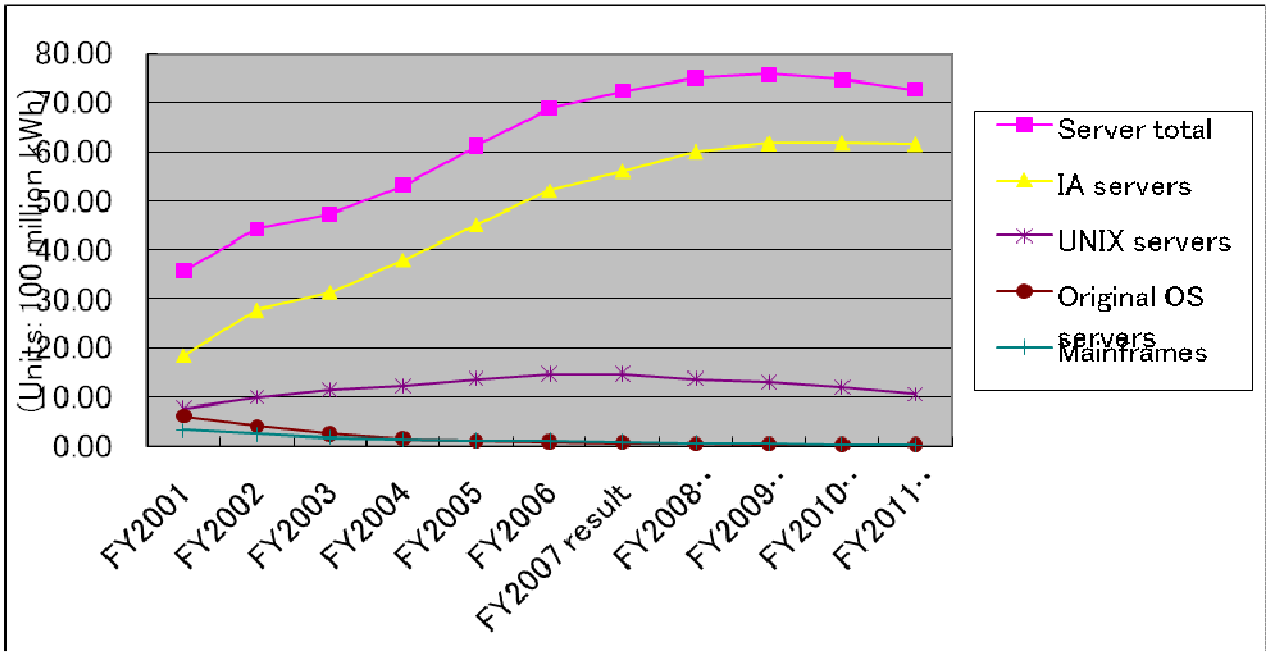

In fact when this kind of mainframe server is replaced with different equipment, the energy efficiency value increases. However if it is assumed that redundancy and other performance is to be ensured in the same way, there is a strong possibility that the energy consumption of the mainframe server, which collects all of these functions in one device, may be lower. And in fact there are many examples of such cases.

Example of energy savings by a mainframe server




In addition, the energy consumption of mainframe servers in use in the market is considerably smaller than other devices.

Estimates of server energy consumption




(Source: JEITA)

For this reason, mainframe servers remain as a class in the current evaluation standards, and steps will be taken to improve energy efficiency within that class.
On the other hand, because of the need to review problems with measurement methods and other issues at an early date, the target fiscal year was set at 2011 in the same way as for other computers.

# Current Status of Computers and Magnetic Disk Devices

## Contents

# Ⅰ. Computers

# 1. Trends in the Computer Market

## 1-1. Trends in the Server Computer Market

■The number of servers shipped in Japan has continued to grow steadily year after year.
The number declined in 2007 in part due to changes in the number of companies participating in the statistics. With the further development of the Internet, there is growing demand for servers that are compatible with a diverse range of information services.

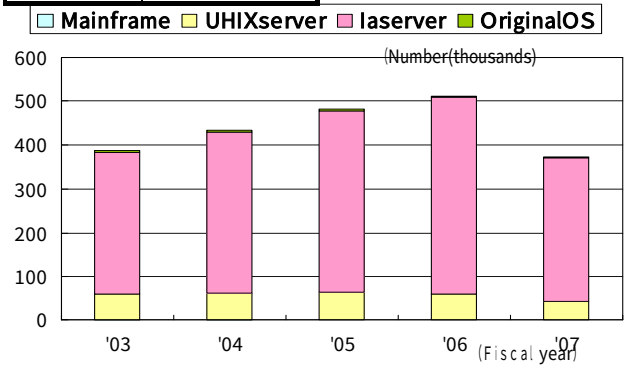
Demand is expected to center primarily on IA servers.

(1) Changes in the number shipped in Japan

| Fiscal year | Number (thousands) |
|---|---|
| 2003 | 456 |
| 2004 | 534 |
| 2005 | 633 |
| 2006 | 660 |
| 2007 | 478 |

(2) Changes in the number shipped in Japan by type

| Fiscal year | Number (thousands) | | | |
|---|---|---|---|---|
| | Mainframe | UNIXserver | IA server | Original OS |
| 2003 | 1.2 | 59 | 323 | 4.4 |
| 2004 | 1.2 | 60 | 369 | 4.1 |
| 2005 | 0.9 | 63 | 414 | 3.5 |
| 2006 | 0.9 | 59 | 450 | 3.2 |
| 2007 | 0.7 | 43 | 327 | 2.8 |




JEITA statistics: the following companies are participating.
Apple Computer, Oki Electric Industry, Casio Computer, Sun Microsystems, Seiko Epson, Toshiba Solutions, IBM Japan, NEC, Nihon Unisys, Hitachi, PFU, Fujitsu, Mitsubishi Electric
Other manufacturers and retailers:
Dell, Japan HP

【From JEITA shipping statistics data】

# 1. Trends in the Computer Market

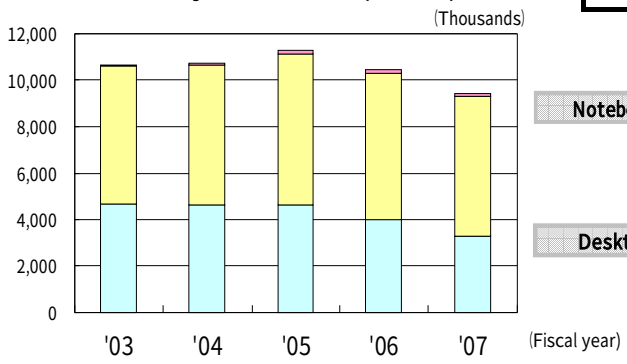
## 1-2. Trends in the Client Computer Market

- The number of PCs shipped in Japan has remained above 10 million units for the past few years.
- Beginning from 2005, the proportion of notebook PCs has increased, and exceeded 60% in 2007.

(1) Trends in the PC market

| Fiscal year | Japanese market Number (Thousands) |
|---|---|
| 2003 | 10,578 |
| 2004 | 10,654 |
| 2005 | 11,122 |
| 2006 | 10,276 |
| 2007 | 9,301 |

Note: The number of companies participating in the statistics changed from 15 to 13 companies in April 2007..




(2) Numbers shipped by type
(figures for companies participating in JEITA statistics)

| Fiscal year | Number (Thousands) | | |
|---|---|---|---|
| | Notebook | | Workstation |
| | Desktop | Notebook (notebook share) | |
| 2003 | 4,694 | 5,884 (55.6%) | 68 |
| 2004 | 4,655 | 5,999 (56.3%) | 100 |
| 2005 | 4,636 | 6,486 (58.3%) | 151 |
| 2006 | 4,007 | 6,269 (61.0%) | 147 |
| 2007 | 3,266 | 6,035 (64.9%) | 105 |

(3) Manufacturers and retailers

JEITA statistics: the following companies are participating.
Apple Computer, NEC, Onkyo, Sharp, Seiko Epson, Sony, Toshiba, Panasonic, Hitachi, Fujitsu, Mitsubishi Electric Information Technology, Unitcom, Lenovo Japan

Other manufacturers and retailers
Dell, Japan HP, Mouse Computer, Gateway, ASUS, Acer Japan, Kohjinsha

From JEITA shipping statistics data

# 2. Previous Energy-Saving Efforts

## 2-1. Changes Related to the Energy Conservation Law

**Energy Conservation Law (average-based method)**

Sept. 1994 Computers are listed as designated devices under the "Energy Conservation Law" (the Law Concerning the Rational Use of Energy). (Government ordinance No. 286)

Dec. 1994 Evaluation standards are announced. (Ministry of International Trade and Industry notice No. 687)
Fiscal year achieved: 2000
Subject products: Computers
Energy efficiency: Power consumption

**Energy Conservation Law (top runner method)**

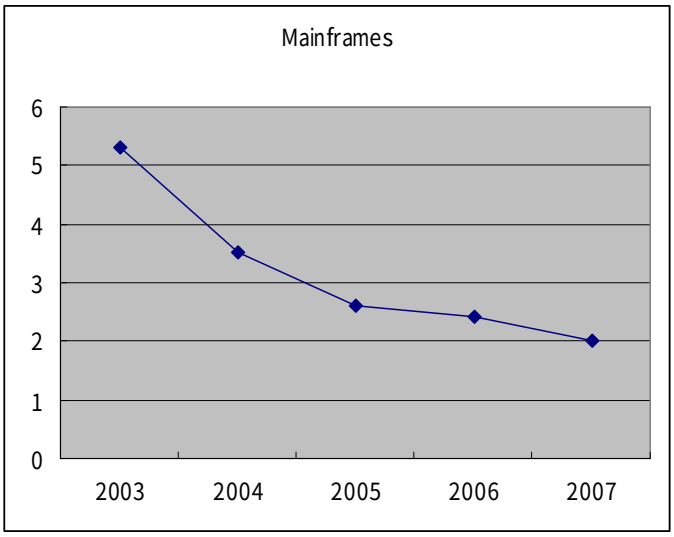
Mar. 1999 The "Revised Energy Conservation Law" was announced. (Ministry of International Trade and Industry notice No. 194) Range of subject products, categories, and indexes of energy efficiency were reviewed and revised.
Fiscal year achieved: 2005
Subject products: Computers
Characteristic: Utilizes the top runner method.
Energy efficiency: Power consumption in ready mode / Composite theoretical performance value

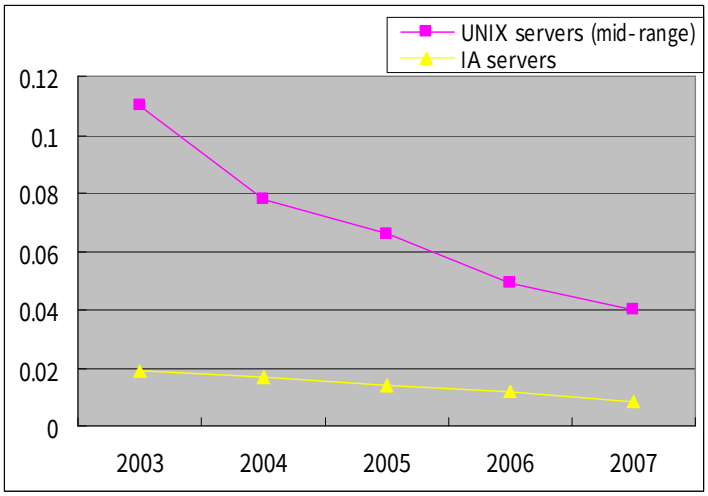
Mar. 2006 The "Revised Energy Conservation Law" was announced. (Ministry of Economy, Trade and Industry notice No. 50) Range of subject products, categories, and indexes of energy efficiency were reviewed and revised.
Fiscal year achieved: 2007
Fiscal year achieved: 2007
Subject products: Computers
Energy efficiency: [(Power in low-power mode + Power when idling) / 2] / Composite theoretical performance value

# 2. Previous Energy-Saving Efforts

## 2-2. Changes in the Energy Efficiency of Server Computers

[From JEITA sampling investigation]



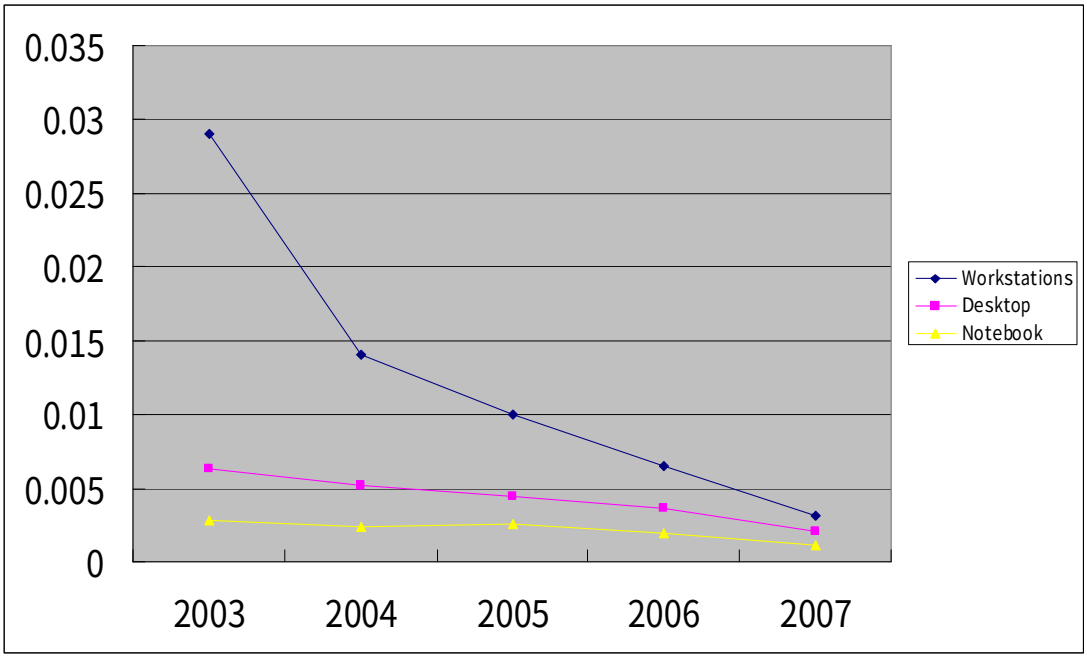




■Changes in the energy efficiency of server computers
From 2003 to 2007, efficiency was improved by approximately 20 – 30% each year for both UNIX servers (mid range) and IA servers.
For mainframes, efficiency improved by approximately 60% from 2003 to 2007.

# 2. Previous Energy-Saving Efforts

## 2-3. Changes in the Energy Efficiency of Client Computers

[From JEITA sampling investigation] Units: W/MTOPS




■Changes in the energy efficiency of client computers
From 2003 to 2006, the efficiency of desktops improved by 43%, while the power consumption of notebooks was reduced despite continuing increases in performance and functionality.
From 2006 to 2007, as a result of large changes in power-saving technologies, large improvements in energy efficiency of approximately 50% were achieved for both desktops and notebooks

## 2-4. Changes in Energy-Saving Technologies

### ■Server computers

**Server computers operate almost uninterrupted 24 hours a day, 365 days a year, and they are accessed via a network by multiple users and applications. For these reasons, rather than changing to a low-power mode such as the PC sleep mode, the main method of improving energy efficiency in server computers has been the development of technologies for reducing the power consumption of the hardware itself and reducing the power required for operation of the server system as a whole.**

(1) Reducing hardware power consumption

- CPU Change to multi-cores, partial power-off for non-operating parts
- DIMM Reduction of power voltage
- Power mprovements to circuit topology (resonant converter circuits or synchronous rectification circuits)
  Development of power switching elements composed of new materials such as silicon carbide or potassium nitride
- Fan Multi-stage speed control according to the temperature
- Disk Use of 2.5-inch disks, use of SSD or other Flash memory

(2) Reducing the power required for operation

- Server integration by virtualization
- Reduction in total power consumption at the data center by using A/C control that is linked with the data center facilities

2. Previous Energy-Saving Efforts

### ■Client computers

**(1) Improving energy efficiency in the hardware**

**Energy efficiency has been improved through improvements to semiconductor technologies and a range of other energy-saving technologies.**

- Energy savings through greater integration and lower voltages accomplished by miniaturization (CPU, memory, other LSI)
- Energy savings through improvements to power management technologies
- Improved power efficiency and energy savings through improvements to power devices and VRM technologies
- Improved energy efficiency through higher speeds, multiple cores, and other improvements in performance

**(2) System energy savings**

**Energy savings are achieved by developing both software and hardware functions that control device power in order to reduce power consumption when the device is used.**

①Energy-saving management when the device is not used
Optimize the power consumption status for all devices according to the conditions of use by the user.
- Automatic transition to standby or sleep state

②Power-saving management of device internal components
Allowing selective use of device functions by the user reduces the power at peripheral functions that are not used.
- User interface that facilitates device energy-saving functions and power management

# 3. Future Directions for Saving Energy

## 3-1. Future Product Trends

■Mainframes
- Mainframes utilizing Itanium (IA-64) first appeared in 2004, however some manufacturers announced models containing higher-speed versions of the same CISC processors with company-specific specifications that were used previously.
- Some models have appeared which are able to operate Linux, Windows Server OS, or other OS in parallel with the mainframe OS. It is expected that both single-OS and multi-OS models will continue to be sold in the future.

■UNIX servers
- Device sizes are continuing to become smaller with higher-density mounting of multiple processors and memory. This has increased the number of devices that can be installed per rack, reducing the amounts of space required. As applications in mission-critical fields are increasing, further improvements in device reliability, availability, expandability, and other characteristics are being demanded. As a result, it is expected that system multiplexing functions, redundancy functions, and similar functions will be expanded.

■IA servers
- The switch to multiple cores in order to reduce processor power consumption is progressing, and quad cores are now used even in small-size servers. The adoption of increasing numbers of cores and processors which consume less power will continue in the future.
- 64-bit compatible OS with virtualization functions will be installed as standard. In the future, synergy with the increasing number of processor cores is expected to advance server consolidation, with the maximum memory capacity per server and other resources expected to increase.

■PC
- Further advances in functionality and performance are expected in order to meet demands for high-speed processing. The need for space-saving types is also high, and demand is further increasing for low power-consumption as well as for low-price products with limited performance and function, reflecting the realities of an internet-based society.
- Under these conditions, the energy-saving functions that are commonly seen in notebook PCs will be adopted and improved for desktop PCs. For this purpose, further energy savings and improvements in energy efficiency will be necessary.
- As the market for notebook PCs grows due to their space-saving advantages, in order to achieve further advances in mobile computing, there is growing need for improved wireless technologies, as well as greater power savings for maintaining and improving battery operating times.

# 3. Future Directions for Saving Energy

## 3-2. Efforts for Future Improvements in Energy Efficiency and Related Issues

■Mainframes
- In addition to accelerating the CPUs of devices which contain conventional CISC processors, it will also be necessary to improve the processing capacity of the entire system by the use of other dedicated processors or other means. Because there are processes which are not represented in the CTP value, it will be difficult to continue using the current energy-saving performance standards which use only CTP and power consumption to evaluate data processing capacity.
- It will be necessary to improve I/O processing for devices which contain Itanium (IA-64) as well. However when the large increase in CTP resulting from faster CPU and more mounted processors is considered, energy-saving performance is expected to gradually increase.

■UNIX servers
- Higher performance and greater energy savings in the processor, memory, and other primary components, as well as higher efficiency of power devices, is expected to continue improving energy efficiency per unit of performance in the future.
- In mid- to large-size system configurations, trials are being carried out to improve the operating rate of the system as a whole, and to raise the energy efficiency through virtualization and dynamic control of device operating status according to the required processing capacity.

■IA servers
- For server units, continued future improvements in energy efficiency are expected to result from higher performance and greater energy savings in multi-core processors, memory, magnetic disk devices, and other primary components, as well as from increased efficiency of power devices and efficient control of cooling fans.
- In mid- to large-size system configurations, trials are being carried out to improve the energy efficiency of the system as a whole by means such as monitoring the load status of each server, combining the processing of specific servers as necessary, and temporarily shutting down the power of other servers.

■PC

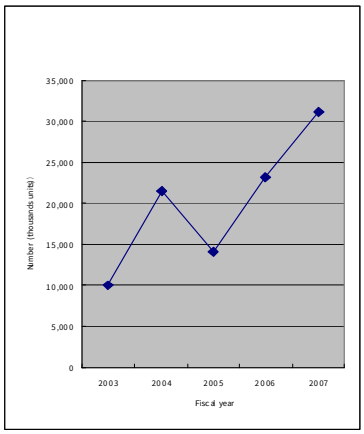
A variety of technical improvements will be made in order to further increase hardware energy savings.
- Advances in quad-core and other multi-core CPU technologies and power management technologies will lead to improved performance and lower power consumption.
- Expanded use of LED backlights and other energy-saving technologies in displays
- Incorporation of cache technologies and SSD technologies that are compatible with the increasingly high-speed performance of memory devices
- Improvements to power source efficiency

# Ⅱ. Magnetic Disk Devices

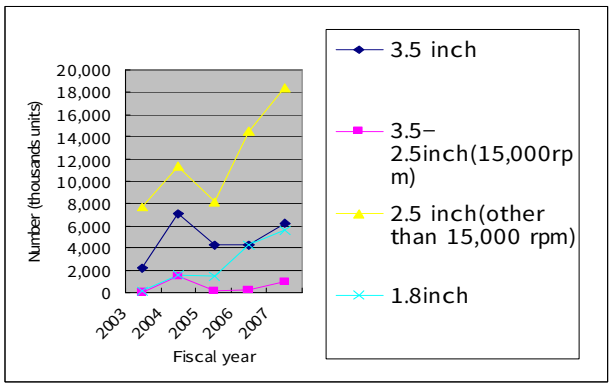
# 1. Trends in the Magnetic Disk Device Market

## 1-1. Market Trends

(1) Changes in the number shipped in Japan
(Individual disk devices only)




(2) Changes in the number shipped in Japan by type



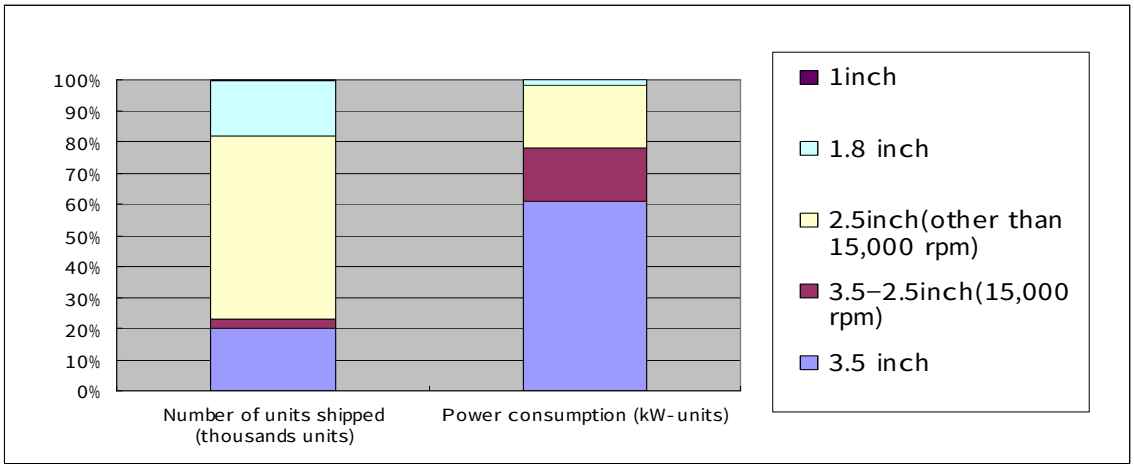

With the increasing volume of information in the market, the number of individual disk devices shipped is increasing. However due to improvements in high-density recording technology, the number is not increasing in proportion to the increase in information. In addition, the improvements in recording density are increasing the number of small 2.5 inch disks that are shipped. The discontinuity in the above data is the result of changes in the number of companies providing information each fiscal year.

*1: Shipping results for fiscal year 2007 as provided by the JEITA Magnetic Disk Energy-Saving Subcommittee
*2: Calculated by multiplying the number of units shipped by the idling time
JEITA statistics: the following companies are participating.
Toshiba, Toshiba Solutions, IBM Japan, NEC, Hitachi, HGST, Fujitsu

[From JEITA shipping statistics data produced by sampling investigation]

# 1. Trends in the Magnetic Disk Device Market

## 1-2. Number of Individual Disk Devices Shipped (*1) and Power Consumption (*2)

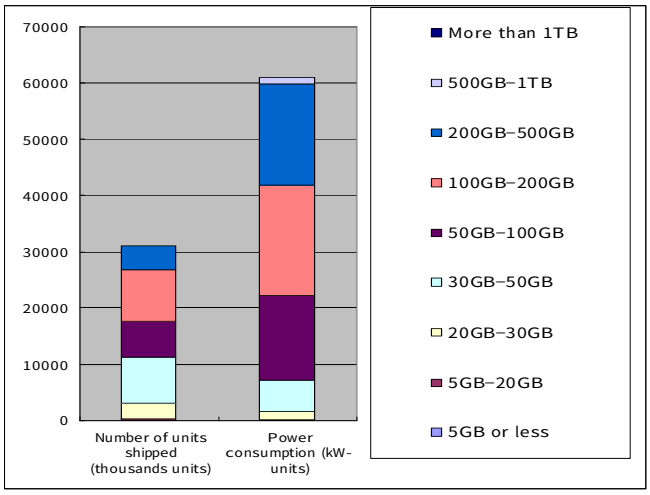


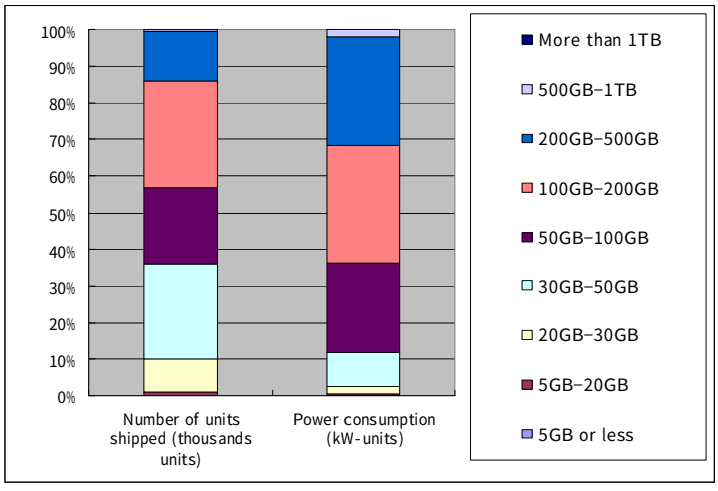

**2.5 inch disk devices account for more than half of all devices shipped, and the smaller disk sizes are also reducing the amount of power consumed.**

*1: Shipping results for fiscal year 2007 as provided by the JEITA Magnetic Disk Energy-Saving Subcommittee
*2: Calculated by multiplying the number of units shipped by the idling time
JEITA statistics: the following companies are participating.
Toshiba, Toshiba Solutions, IBM Japan, NEC, Hitachi, HGST, Fujitsu
[From JEITA shipping statistics data produced by sampling investigation]

# 1. Trends in the Magnetic Disk Device Market

## 1-3. Number of Individual Disk Devices Shipped (*1) and Power Consumption (*2) by Storage Capacity



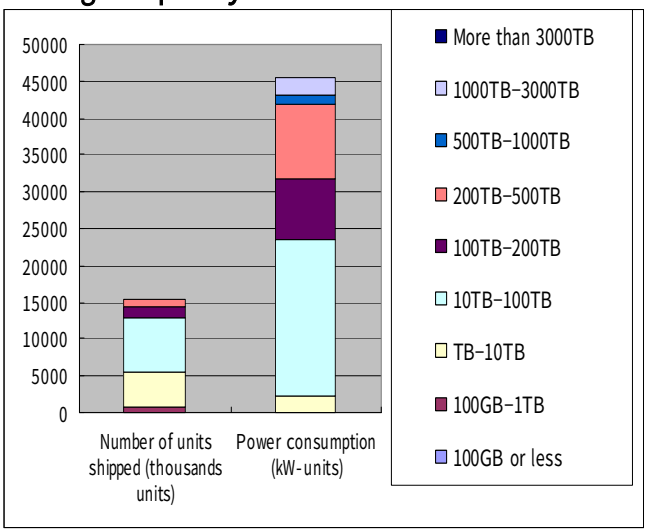



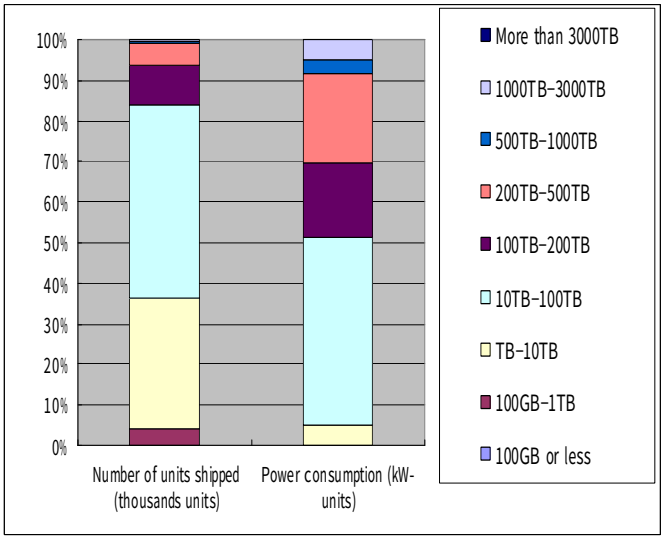

**In fiscal year 2007, no individual disk devices with storage capacities of 5 GB or less were sold. 20 GB and smaller devices accounted for approximately 1% and their power consumption accounted for approximately 0.2**

*1: Shipping results for fiscal year 2007 as provided by the JEITA Magnetic Disk Energy-Saving Subcommittee
*2: Calculated by multiplying the number of units shipped by the idling time
JEITA statistics: the following companies are participating.
Toshiba, Toshiba Solutions, IBM Japan, NEC, Hitachi, HGST, Fujitsu
[From JEITA shipping statistics data produced by sampling investigation]

# 1. Trends in the Magnetic Disk Device Market

## 1-4. Number of Magnetic Disk Sub-Systems Shipped (*1) and Power Consumption (*2) by Storage Capacity




**The most common storage capacity range for magnetic disk sub-systems is from 1 TB to 100 TB.**

*1: Shipping results for fiscal year 2007 as provided by the JEITA Magnetic Disk Energy-Saving Subcommittee *2: Calculated by multiplying the number of units shipped by the idling time
JEITA statistics: the following companies are participating.
Toshiba, Toshiba Solutions, IBM Japan, NEC, Hitachi, HGST, Fujitsu

[From JEITA shipping statistics data produced by sampling investigation]

# 2. Previous Energy-Saving Efforts

**Energy Conservation Law (average-based method)**

Sept. 1994 Magnetic disk devices are listed as designated devices under the "Energy Conservation L (the Law Concerning the Rational Use of Energy). (Government ordinance No. 286)

Dec. 1994 Evaluation standards are announced.
(Ministry of International Trade and Industry notice No. 688)
Fiscal year achieved: 2000
Subject products: Magnetic disk devices
Energy efficiency: Power consumption

**Energy Conservation Law (top runner method)**

Mar. 1999 The "Revised Energy Conservation Law" was announced. (Ministry of International Trade and Industry notice No. 195 Range of subject products, categories, and indexes of energy efficiency were reviewed and revised.
Fiscal year achieved: 2005
Subject products: Magnetic disk devices
Characteristic: Utilizes the top runner method.
Energy efficiency: Idle mode power consumption / Storage capacity

Mar. 2006 The "Revised Energy Conservation Law" was announced. (Ministry of Economy, Trade and Industry notice No. 51) Range of subject products, categories, and indexes of energy efficiency were reviewed and revised.
Fiscal year achieved: 2007
Subject products: Magnetic disk devices
Energy efficiency: Idle mode power consumption / Storage capacity

## 3-1. Improving the Energy Efficiency of Individual Disk Devices

The size of individual disk devices (unit components) are becoming significantly smaller, and power consumption is being reduced. For the same memory capacity, the technical development for reducing power consumption by making units smaller has reached its limit, and it will be difficult to reduce total power consumption in disk devices by making circuits smaller or by reducing energy consumption in the mechanical parts. On the other hand, the development of higher-density recording technologies for disk storage media is continuing unabated. With increasing memory capacities in the future, the energy efficiency per unit of memory is expected to improve.

## 3-2. Improving the Energy Efficiency of Magnetic Disk Sub-Systems

The magnetic disk sub-systems which are shipped at present are proceeding in the direction of mounting smaller individual disk sizes. In the future, there will be a significant trend toward greater LSI of controller circuits. The use of smaller disk sizes and large-capacity individual disk devices, and the development of systems that make effective use of cache memory, are expected to continue. Further improvements in energy management technologies for individual disk devices is also expected to continue.

# Glossary

| Terms | Meaning |
|---|---|
| Processor | Integrated circuits that compose the arithmetic processor of a computer. In this report, one multi-core processor is considered a single processor regardless of the number of cores. |
| CPU (Central Processing Unit) | The CPU is the heart of a computer and performs a variety of numerical calculations, information processing, device control, and other tasks depending on the program. |
| Standalone GPU (Graphics Processing Unit) | A standalone GPU is a processor for processing graphics data that has a dedicated local memory. |
| I/O signal line | This is a line which directly splits from a signal line that connects an arithmetic processor and main storage device (also including other signal lines that have a transmission capacity equal to that signal line), or which directly splits from a signal line splitter that is connected to such a signal line. However it does not include lines that are connected to an external location via only a graphics display port or keyboard port. |
| Composite theoretical performance | Composite theoretical performance is an index of computer calculating performance. For computers listed in the upper section of Appendix Table 2 in the Enforcement Regulations of the Energy Conservation Law (Ministry of International Trade and Industry Ordinance No. 74, 1979), the composite theoretical performance value is the number indicated in units of giga calculations listed in the lower section of the same table. |
| Mainframe server | A mainframe server is a large-size computer that is used for purposes such as core operations in a company. It is a general term that applies to these computers, their series, and their architecture. The characteristics of a mainframe server include the following items.<br>* Large data processing capacity (more than just CPU performance, in particular including I/O performance)<br>* Workload management that processes multiple application processes in a single server<br>* High reliability and availability achieved through complete redundancy<br>* Strict operating management functions and security functions that are required by large-size organizations |

| | |
|---|---|
| | * A long-term manufacturer planning and maintenance system |
| Open-frame server | An open-frame server is a more recent technology than mainframe servers. This is a general term for computer servers that are produced based on open standards. The use of a UNIX-based (Linux) or similar OS and hardware which uses X86 and RISC chips in the CPU gives these products a standardized programming interface similar to UNIX. Compared with the original-specification computers that typified the mainframes that were previously the mainstream, these products have higher interoperability and the ability to use various third-party hardware and software, and can also be configured for a relatively low cost. |