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METHODS OF RATIONALIZATION OF ENERGY RESOURCES DURING WORK WITH OPERATING SYSTEM

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Abstract. In our time, computer systems have become an integral part of any highly skilled workflow. They spend kilowatt of electricity on millions of mathematical operations, which, in turn, determine the software functionality and are responsible for the result of any work. The article considers the numerical efficiency and expediency of using the economical operating mode of the "Windows 7 Unlimited" operating system of 64-bit type. Numerical data, on the basis of which the coefficients given in the work were calculated, were obtained with the help of the energy efficiency monitoring software Joulemeter 1.2 (licensed product of the Microsoft software laboratory). The main task of the work is to bring exact percentages of savings on the example of a particular computer and the work package of office software programs Microsoft Office 2010, which includes programs: Microsoft Word, Microsoft Excel and Microsoft PowerPoint – and browsers Google Chrome and Internet Explorer with different performance.

Based on the results of the experiment, the energy efficiency of the system, when using the economic mode was higher by 0.7% than when using a balanced one. And the maximum energy efficiency of 3.7% was achieved by using the energy-saving Internet Explorer browser instead of Google Chrome.

Key words: energy efficiency, rationalization, Windows 7, Microsoft Office 2010, Google Chrome, Internet Explorer.

Introduction

In our time, computer systems have become an integral part of any highly skilled workflow. They spend kilowatt of electricity on millions of mathematical operations, which, in turn, determine the software functionality and are responsible for the result of any work. The article considers the numerical efficiency and expediency of using the economical operating mode of the "Windows 7 Unlimited" operating system of 64-bit type. Numerical data, on the basis of which the coefficients given in the work were calculated, were obtained with the help of the energy efficiency monitoring software Joulemeter 1.2 (licensed product of the Microsoft software laboratory).

Formulation of Problem

The main task of the work is to bring exact percentages of savings on the example of a particular computer and the work package of office software programs Microsoft Office 2010, which includes programs: Microsoft Word, Microsoft Excel and Microsoft PowerPoint – and browsers Google Chrome and Internet Explorer with different performance.

Analysis of Recent Research Results

Many researchers analyzed the energy efficiency of computer systems: Khankin K.M. searched the energy efficiency of systems depending on the main characteristics of the processor [1], Tsvetkov V.M. - efficiency of energy utilization by the Android operating system [2], and Tokar I.P. noted an increase in the energy efficiency of the system using a genetic algorithm [3]. But none of them has investigated the actual energy consumption of the existing system in operating mode. And also, the economic rent is the profitability of using the Economy mode of the Windows 7 operating system.

Purpose of Research

Detailed energy consumption when using each mode, when working with different types of office software and browsers. Determine the degree of efficiency of using the Economical operating mode of the operating system "Windows 7 Unlimited".

Results of Research

The statistical-comparative method of data processing based on the Windows 7 Unlimited (64-bit) operating system using the Microsoft Office 2010 software package, Google Chrome browser and Internet Explorer software and software for monitoring power consumption Joulemeter 1.2 (licensed product of the Microsoft Company)

The main function of the Joulemeter 1.2 program mainly reflects the energy consumption of the main

elements involved in the exchange of information: the CPU and the hard disk (Disk) on which the functionality of the program used is located.

Other static power consumption items: RAM, graphic adapter, network card, coolers, motherboard (its non-CPU units) and power supply elements are shown in the tables as the "Basic" criterion.

The monitor has its own power supply, but the constant power of transmission is 50 W/h.

Therefore, the main criterion for assessing energy conservation is the load of the central processor and disk. The hardware composition of the computer unit is shown in Table 1.

The need for a central processor in electric power, when operating in Balanced Mode, was 1 W/h (Table 2), while in economic terms it was reduced by 77% to 0.23 W/h. The cost of the disk processes in the Balanced Mode

was 0.03 W/h, while in the Economy mode it was reduced by 33%, to 0.01 W/h.

With the use of Microsoft Word's text editor, while working in Balanced Mode, the CPU's power requirement was 1.26 W/h (Table 3), while in the Economy mode it was reduced by 43% to 0.72 W/h.

The cost of the disk processes in the Balanced Mode was 0.27 W/h, while in the Economical 0.02 W/h, which reduced the power consumption of the computer by 93%.

The need for a central processor in electricity, when used with Microsoft Excel spreadsheet editor, in Balanced Mode, was 1.82 W/h (Table 4), while in the Economy it dropped to 0.81 W/h.

Energy expenditure on disk operation in the Balanced mode was 0.17 W/h, while in the Economy mode it decreased by 47% to 0.09 W/h.

Table 1. The hardware of the computer block.

Composition of elements of a computer block		
Element	Characteristics	Number
Motherboard	Asus P8Z68 Deluxe	1
CPU	Intel Core i7-3770k	1
Power supply	Cooler Master GX 750W	1
Video card	NVIDIA GeForce GTX 1080	1
RAM	Kingston DDR3-1600 4096MB PC3-12800 HyperX	4
ROM	Samsung 850 Pro series 256GB 2.5" SATAIII 3D	1
Network card	Atheros AR922X Wireless	1
Cooling systems	Aerocool P7- F12 RGB 120 mm	4

Table 2. Power consumption of computer in "Balanced" and "Economical" without the participation of additional software.

Type	Energy consumption, W/h							
	Balanced mode				Economical mode			
	1	2	3	Average	1,00	2,00	3,00	Average
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	0,46	1,93	0,62	1,00	0,31	0,00	0,39	0,23
ROM	0,00	0,07	0,03	0,03	0,00	0,00	0,03	0,01
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	115,46	117,00	115,65	116,04	115,31	115,00	115,42	115,24

Table 3. Power consumption of computer when running Microsoft Word.

Type	Energy consumption, W/h							
	Balanced mode				Economical mode			
	1	2	3	Average	1,00	2,00	3,00	Average
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	0,77	1,46	1,54	1,26	1,93	0,23	0,00	0,72
ROM	0,11	0,39	0,30	0,27	0,00	0,00	0,06	0,02
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	115,88	116,85	116,84	116,52	116,93	115,23	115,06	115,74

Table 4. Power consumption of computer when running Microsoft Excel.

Type	Energy consumption, W/h							
	Balanced mode				Economical mode			
	1	2	3	Average	1,00	2,00	3,00	Average
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	1,93	2,00	1,54	1,82	0,77	0,66	1,00	0,81
ROM	0,23	0,18	0,11	0,17	0,09	0,11	0,07	0,09
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	117,16	117,18	116,65	117,00	115,86	115,77	116,07	115,90

Table 5. Power consumption of computer when running Microsoft PowerPoint.

Type	Energy consumption, W/h							
	Balanced mode				Economical mode			
	1	2	3	Average	1,00	2,00	3,00	Average
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	2,62	1,30	3,46	2,46	0,69	2,62	1,54	1,62
ROM	0,31	0,40	0,22	0,31	0,05	0,05	0,11	0,07
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	117,93	116,70	118,68	117,77	115,74	117,67	116,65	116,69

Table 6. Power consumption of computer when use Google Chrome.

Type	Energy consumption, W/h							
	Balanced mode				Economical mode			
	1	2	3	Average	1,00	2,00	3,00	Average
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	7,69	26,70	21,51	18,63	8,77	27,18	17,61	17,85
ROM	0,06	0,53	0,06	0,22	0,22	0,09	0,01	0,11
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	122,75	142,23	136,57	133,85	123,99	142,27	132,62	132,96

Table 7. Power consumption of computer when use Internet Explorer.

Type	Energy consumption, W/h							
	Balanced mode				Economical mode			
	1	2	3	Average	1,00	2,00	3,00	Average
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	2,00	4,69	2,85	3,18	2,31	3,00	2,16	2,49
ROM	0,15	0,06	0,31	0,17	0,09	0,33	0,07	0,16
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	117,15	119,75	118,16	118,35	117,40	118,33	117,23	117,65

The economy mode, with the use of the Microsoft PowerPoint presentation editor, reduced energy consumption by 34% to 1.62 W/h (Table 5), while the CPU demand in Balanced Mode was 2.46 W/h. The cost of the disk processes in the Balanced Mode was 0.31 W/h, while in the Economical 0.07 W/h, which is 77% less than normal.

Google Chrome's energy costs when operating in Balanced Mode amounted to 18.63 W/h (Table 6), while in Economics they dropped by 4% to 17.85 W/h. The work of disk processes in the Economy mode has decreased by 50%.

Internet Explorer, while working in Balanced Mode, spends 3.18 W/h (Table 7) and in Economics 2.49 W/h, which reduces costs by 22%. The work of disk processes, when using this browser, was 0.17 W/h, while in the Economy mode it was reduced to 0.16 W/h, reduces costs by 6%.

The central CPU and disk power consumption for Microsoft Word, Microsoft, Microsoft Excel, and PowerPoint in Balanced and Economical modes is quite different and depends mainly on the type of metering processes and the intensity of file sharing (Table 9).

Table 8. Power consumption of computer when run Microsoft Office 2010 programs.

Type	Energy consumption, W/h							
	Control		Microsoft Word		Microsoft Excel		PowerPoint	
	Bal.	Econ.	Bal.	Econ.	Bal.	Econ.	Bal.	Econ.
Basic	65,00	65,00	65,00	65,00	65,00	65,00	65,00	65,00
CPU	1,00	0,23	1,26	0,72	1,82	0,81	2,46	1,62
ROM	0,03	0,01	0,27	0,02	0,17	0,09	0,31	0,07
Monitor	50,00	50,00	50,00	50,00	50,00	50,00	50,00	50,00
General	116,04	115,24	116,52	115,74	117,00	115,90	117,77	116,69

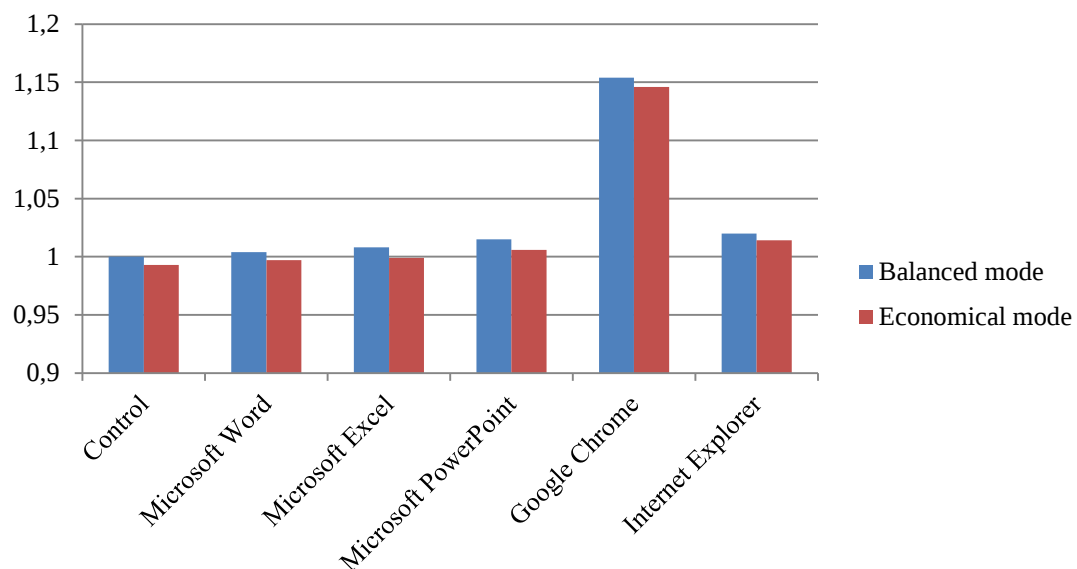
Table 9. Power consumption of computer when browsers work.

Type	Energy consumption, W/h			
	Google Chrome		Internet Explorer	
	Bal.	Econ.	Bal.	Econ.
Basic	65,00	65,00	65,00	65,00
CPU	18,63	17,85	18,63	17,85
ROM	0,22	0,11	0,17	0,16
Monitor	50,00	50,00	50,00	50,00
General	133,85	132,96	118,35	117,65

Table 10. The ratio of the energy efficiency of the system.

Type	The ratio of energy consumption ratios (K _B)		Energy saving, %
	Balanced mode	Economical mode	
Control	1,000	0,993	0,700
Microsoft Word	1,004	0,997	0,697
Microsoft Excel	1,008	0,999	0,893
Microsoft PowerPoint	1,015	1,006	0,887
Google Chrome	1,154	1,146	0,693
Internet Explorer	1,020	1,014	0,588

The ratio of energy efficiency of the system in the Balanced and Economical modes

**Fig. 1.** Ratio of energy efficiency of the system in the Balanced and Economical modes.

Browsers, due to the large amount of data exchange, are largely loaded by the CPU, increasing its power consumption. Energy consumption, for use of two different speeds of browsers, can vary quite a lot (Table 9).

On the basis of these data, ratios were obtained for control in Balanced mode (Table 10).

In graphical form, this ratio is shown in Fig. 1.

On average, the energy efficiency of the system, when using the Economy mode, increased by 0.7%. With the equivalent use of Microsoft Office 2010 (Table 8) and the Google Chrome browser (Table 9), the average computer power consumption is 119.878 W/h. In terms of 247 business days, including 8 hours a day, the average power consumption of the computer will be 236.88 kW/year. Using the Economy mode reduces this number by 1.66 kW/year.

Using Savings Internet Explorer, instead of Google Chrome, reduces power consumption by 3%, that is - still at 6.92 kW/year.

Thus, according to our estimates, the total electricity savings will be 8.58 kW/year. Considering that the number of permanent computers in large IT companies can reach tens or even hundreds of machines, the use of the Economy Mode and the cost-effective Internet Explorer browser can be of significant economic benefit.

Conclusions

1. It's economically feasible to use the economical operating mode of the Windows 7 Unlimited system as the system's energy efficiency increases by 0.7%.

2. Also, using Internet Explorer will reduce system power consumption by 3% compared to using Google Chrome.

3. Therefore, in the future, by studying the energy costs of different software, you can determine the optimal software for the higher degree of energy efficiency of the system.

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МЕТОДИ РАЦІОНАЛІЗАЦІЇ ЕНЕРГЕТИЧНИХ РЕСУРСІВ ПІД ЧАС РОБОТИ З ОПЕРАЦІЙНОЮ СИСТЕМОЮ

С. М. Голопура, Б. В. Синенко

Анотація. В наш час комп'ютерні системи стають невід'ємною частиною будь-якого висококваліфікованого робочого процесу. Вони витрачають кіловат електроенергії на мільйони математичних операцій, які, у свою чергу, визначають функціональність програмного забезпечення і несуть відповідальність за результат будь-якої роботи. У статті розглядається чисельна ефективність і доцільність використання економічного режиму роботи Windows 7 в необмеженій операційній системі 64-бітного типу. Числові дані, на основі яких коефіцієнти, що наводяться в роботі були розраховані, були отримані за допомогою програмного забезпечення моніторингу енергоефективності Joulemeter 1.2 (ліцензійний продукт Лабораторії програмного забезпечення Microsoft). Головне завдання роботи – приносити точні відсотки економії на прикладі конкретного комп'ютера і роботі пакету офісних програм Microsoft Office 2010, який включає в себе програми: Microsoft Word, Microsoft Excel, Microsoft PowerPoint і браузері Google Chrome та Internet Explorer з різною продуктивністю.

Ґрунтуючись на результатах експерименту, енергоефективність системи, при використанні

економічного режиму була вище на 0,7%, ніж при використанні збалансованого. І максимальна енергоефективність 3,7% було досягнуто за рахунок використання енергозберігаючого браузера Internet Explorer замість Google Chrome.

Ключові слова: енергетична ефективність, раціоналізація, Windows 7, Microsoft Office 2010, Google Chrome, Internet Explorer.

МЕТОДЫ РАЦИОНАЛИЗАЦИИ ЭНЕРГЕТИЧЕСКИХ РЕСУРСОВ ВО ВРЕМЯ РАБОТЫ С ОПЕРАЦИОННОЙ СИСТЕМОЙ

С. М. Голопура, Б. В. Сinenko

Аннотация. В наше время компьютерные системы становятся неотъемлемой частью любого высококвалифицированного рабочего процесса. Они тратят киловатт электроэнергии на миллионы математических операций, которые, в свою очередь, определяют функциональность программного обеспечения и несут ответственность за результат любой работы. В статье рассматривается численная эффективность и целесообразность использования экономичного режима работы Windows 7 в неограниченной операционной системе 64-битного типа. Числовые данные, на основе которых коэффициенты, приводимые в работе были рассчитаны, были получены с помощью программного обеспечения мониторинга энергоэффективности Joulemeter 1.2 (лицензионный продукт Лаборатории программного обеспечения Microsoft). Главная задача работы – приносить точные проценты экономии на примере конкретного компьютера и пакета офисных программ Microsoft Office 2010, который включает в себя программы: Microsoft Word, Microsoft Excel, Microsoft PowerPoint и браузеры Google Chrome и Internet Explorer с разной производительностью.

Основываясь на результатах эксперимента, энергоэффективность системы, при использовании экономичного режима была выше на 0,7%, чем при использовании сбалансированного. И максимальная энергоэффективность 3,7% было достигнуто за счет использования энергосберегающего Internet Explorer вместо Google Chrome.

Ключевые слова: энергетическая эффективность, рационализация, Windows 7, Microsoft Office 2010, Google Chrome, Internet Explorer.