

SYSmark[®] 2002

An Overview of SYSmark 2002

Business Applications Performance Corporation



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Table of Contents

1.0	Introduction	4
2.0	Development Methodology	4
2.1	Identifying Usage Categories	4
2.2	User Output	5
2.3	Characteristics of Output	5
2.4	Input Documents and User Interaction	8
2.5	Constructing the Workload	8
2.5.1	General Usage characteristics	8
2.5.2	SYSmark 2002 Workload Description	9
2.6	Automation and Workload Integration	11
2.6.1	Measurement Methodology	11
2.6.2	Performance Rating Methodology	12
3.0	Features & Characteristics	12
3.1	Usability Features & Execution Improvements	13
3.2	Comparative Workload Characterization of SYSmark 2001 and SYSmark 2002	13
4.0	Conclusion	20
	APPENDIX A: Application Program versions	22

Table of Figures

Figure 1:	BAPCo's output-driven benchmark development methodology	4
Figure 2 -	Main page for Kayaks for the Extreme sports online stores	5
Figure 3 -	Detailed view of the selected Kayak	6
Figure 4 -	Final steps of benchmark development	8
Figure 5-	SYSmark 2002 Internet Content Creation Main Memory Bandwidth Profile (MB/s)	17
Figure 6 -	SYSmark 2001 Internet Content Creation Main Memory Bandwidth Profile (MB/s)	17
Figure 7 -	SYSmark 2002 Office Productivity Main Memory Bandwidth Profile (MB/s)	18
Figure 8 -	SYSmark 2001 Office Productivity Main Memory Bandwidth Profile (MB/s)	18
Figure 9 -	SYSmark 2002 Internet Content Creation I/O Bandwidth Profile (MB/s)	19
Figure 10 -	SYSmark 2001 Internet Content Creation I/O Bandwidth Profile (MB/s)	19
Figure 11 -	SYSmark 2002 Office Productivity I/O Bandwidth Profile (MB/s)	19
Figure 12 -	SYSmark 2001 Office Productivity I/O Bandwidth Profile (MB/s)	20

1.0 Introduction

SYSmark[®] 2002 is the latest performance benchmark suite from Business Application Performance Corporation (BAPCo). SYSmark 2002 is designed as a tool for evaluation of Personal Computer performance in business environments. This document describes the methodologies deployed in the development of SYSmark 2002 and examines the qualitative and quantitative differences between SYSmark 2001 and SYSmark 2002. For detailed instructions on how to install and run SYSmark 2002 please refer to the documentation provided on the product CD-ROM and the BAPCo web site (www.bapco.com)

2.0 Development Methodology

BAPCo follows a yearly development cycle in which it applies its standard development methodologies to a set of parameters driven by usage categories, usage models within the categories, software market segment indicators and technical feasibility. These parameters, along with the application of a judged model of logical and physical workload characteristics, determine the composition of workloads in SYSmark.

The benchmark development process begins with identification of business usage categories of Personal Computers and is followed by determination of the types and characteristics of the output created by users in those categories. By determining the output characteristics, BAPCo can reconstruct the user interactions required to create such outputs. These interactions are converted into instructions (or “scripts”) and integrated into BAPCo’s automated benchmarking environment resulting in candidate workloads for final placement in the benchmark suite. Candidate workloads are then judged based on their logical and physical workload characteristics and minor adjustments are made in order to arrive at a balanced workload.

A graphical representation of BAPCo’s output-driven benchmark development methodology for creating workload candidates is shown in Figure 1.

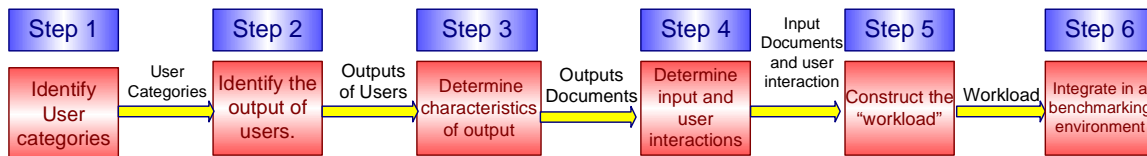


Figure 1: BAPCo’s output-driven benchmark development methodology

The following sections will expand on these steps.

Step 1

2.1 Identifying Usage Categories

For SYSmark 2002, BAPCo identified two distinct business usage categories:

- Internet Content Creation: Tasks for creation of content for a website with an enhanced user experience: web pages with text, images, video and animations.
- Office Productivity: Tasks common to business users: reading email, preparing documents and presentations, etc.

Step 2

2.2 User Output

The next step in BAPCo's benchmark development process identifies typical output generated in each of the usage categories. This information is used to create a usage model for each category. For SYSmark 2002, the following types of output were identified:

Internet Content Creation: Web pages containing text, Digital Images, digital video and 2D animation

Office Productivity: Formatted documents, spreadsheets, presentations, electronic Mail

Step 3

2.3 Characteristics of Output

Format and characteristics of user output for the types of output identified in step 2 (section 2.2) are determined using a survey of actual user creations on and off the Internet. For example, characteristics of Internet Content are determined from a survey of various websites. This information determines the type and identity of data files and applications to be used in the benchmark. It also suggests specific operations that need to be performed in the applications to generate the final material.

Once the characteristics of the typical user output are known, BAPCo uses professional creators to create documents, spreadsheets, websites and other types of user output per specifications developed from surveys mentioned above. For example, for the Internet Content Creation category, BAPCo commissioned a web designer to create an actual web site with characteristics similar to those obtained from surveys. Figure 2 and Figure 3 show the designs created by the BAPCo web designer. For the Office Productivity category, BAPCo collected a suite of documents that were created for a fictitious automobile company – AutoConcepts. The documents included an assembly manual, Excel charts (showing company forecasts) and presentations (on financials).



Figure 2 - Main page for Kayaking for the Extreme sports online stores



Figure 3 - Detailed view of the selected Kayak

In selecting the applications that would create the output in the benchmark, BAPCo uses a variety of different sources to obtain market segment share data for applications used by business users in creating their output. Table 1 lists the output/documents identified by BAPCo, the application selected by BAPCo to be used to generate that output and the source of information that was used to select the given application.

Internet Content Creation		
Document	Application Program	Market Source
Web Page	Macromedia Dreamweaver v4.0	1. IDC Bulletin, "Macromedia Sets Good Example for 21 st Century Business Transformation, Strategies, and Directions," Document# 23125, September 2001, Rikki Kirzner. 2. US Retail/Etail Sales Out 2001 - NPD INTELECT
Digital Image	Adobe Photoshop 6.0.1	1. Forrester Report, "Creation Tool Strategies", June 1999 2. US Retail/Etail Sales Out 2001 - NPD INTELECT
Digital Video	Adobe Premiere 6.0	1. "Market Spotlight on Digital Video Software", 1999, Wanda Meloni 2. US Retail/Etail Sales Out 2001 - NPD INTELECT
Animation	Macromedia Flash v5	1. December 2001 NPD Online Research Browser Survey 2. Media Metrix, Inc
Encoded Media	Microsoft Windows Media Encoder 7.1	Idea Byte, "Microsoft's Growing Streaming Strength, Giga Information Group, April 2000, Jadd Cheng
Office Productivity		
Document	Application Program	Market Source
Text Document	Microsoft Word 2002	1. US Retail/Etail Sales Out Jan 2001-Dec 2001: NPD INTELECT.
Spreadsheet	Microsoft Excel 2002	
Presentation	Microsoft PowerPoint 2002	2. Planning Assumption, "Microsoft Office - Update or Migrate?" Giga Information Group, November 2, 2001
Email	Microsoft Outlook 2002	
Database	Microsoft Access 2002	Jupiter Concept Report, "Beyond the Browser War", April 19, 2000
Browsing Web pages	Netscape Communicator 6.0	US Retail/Etail Sales Out 2001 - NPD INTELECT
Speech converted to text	NaturallySpeaking v.5	1."Worldwide Antivirus Software: A Profile of the Leading Vendors in 2000", Document #25069, July 2001 2. US Retail/Etail Sales Out 2001 - NPD INTELECT
Virus free documents	McAfee VirusScan 5.13	US Retail/Etail Sales Out 2001 - NPD INTELECT
Compressed Documents	WinZip 8.0	US Retail/Etail Sales Out 2001 - NPD INTELECT

Table 1 - SYSmark 2002 Applications

Further details on the specific versions of the applications can be found in Appendix A.

2.4 Input Documents and User Interaction

The remaining steps for the benchmark development are shown in Figure 4.

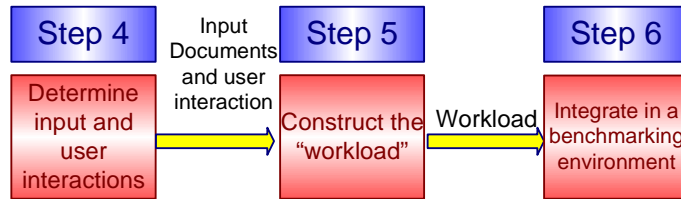


Figure 4 - Final steps of benchmark development

With the aid of professional content creators BAPCo retraced the steps required to create the output developed in step 3. All steps in creation of the material were documented, validated and fed into the workload construction process (Step 5).

2.5 Constructing the Workload

The output of Step 5 is the “workload”. The workload, in terms of BAPCo benchmarks, is defined as a series of input data and user interactions that occur to create the final output documents. The set of workloads corresponding to each user output (9 in Office Productivity and 5 in Internet Content Creation) in each category encapsulates the benchmark for that category.

2.5.1 General Usage characteristics

BAPCo found general behavioral trends that were common to both usage categories. When constructing the workloads, these characteristics were included to make the workloads more realistic.

Switching between applications: Business computer users frequently have a number of applications open on their desktop. For example, office productivity users had many components of Office* XP (Word, Excel and PowerPoint) open at the same time and switched back and forth between the Office XP components. In the Internet Content Creation scenario, users alternated between Photoshop, Dreamweaver, Flash and Premiere. Thus, the workloads defined by BAPCo include opening and leaving applications open while work is being done in another application.

Concurrent Execution: In addition to switching between applications, it was observed that often a user would be actively working with one application while another application was performing work in the background. For example, office productivity users could have file compression, virus scanning and/or a speech to text transcription occurring in the background while Office XP documents were being created in the foreground. In the Internet Content Creation scenario, video encoding would be run concurrently with other web page content creation activities.

User Think Times: It was observed that business users do not send their user inputs (to applications) in super-fast bursts. Input is provided at a finite typing rate with pauses between some of the operations (i.e. – the user would review the results of his request before proceeding with the next operation). This time where the user is assessing what to do next is called “think time”. To reflect this real world occurrence, BAPCo’s workloads include think times between user interactions.

2.5.2 SYSmrk 2002 Workload Description

BAPCo developed the following workloads:

Office Productivity Workloads: The workloads in this category model an office worker at an automobile company. The office worker creates documents using Microsoft Word, Excel and PowerPoint, accesses email and queries a database. An Internet browser is used to view presentations. The user also invokes speech to text translation, file compression and virus detection in the background.

Microsoft* Word* 2002: The user starts Microsoft Word and opens an eight-page assembly manual document for a new transmission system. The user sets paragraph formatting, font configuration and adds text to the document. The user inserts an image, a table of contents and a table of figures. Twenty additional images, ranging in size from 3 to 15 kilobytes are inserted throughout the document. The user then adds a watermark to the document and performs a global find and replace. The document is printed and the user inserts a hyperlink into the document and adds more text. The user inserts a training video, changes the theme and saves the document in web page format.

Microsoft Excel* 2002: The user starts Microsoft Excel and opens a large spreadsheet (a 12 megabyte file with approximately 3000 rows and 248 columns of data). A group of formulae are selected and used to perform data analysis. The user selects the data and performs a sort, using three key fields. This data is then used to create a chart, which is exported to a web page. The user then opens a different spreadsheet (an 8.5 megabyte file with approximately 2100 rows and 248 columns of data), and performs similar operations, resulting in another web page.

Microsoft PowerPoint* 2002: The user starts Microsoft PowerPoint and opens a 24 slide presentation of the previous quarter's news and sales. The user moves through the presentation inserting and positioning several images (47 to 57 kilobytes in size). Upon completing this, the presentation is checked for spelling errors. The user then applies different themes/backgrounds to the presentation and selects one. Finally, the user reviews the material in slide show mode and saves the finished presentation to a web page.

Microsoft* Access 2002: The user starts Microsoft Access and opens a database file containing sales and maintenance data for the last operative month of the automobile assembling company. After opening and reading the data tables, 10 preset complex queries are run to provide analysis. Finally, four reports are generated and reviewed.

Microsoft Outlook 2002: The user starts Microsoft Outlook and opens the inbox, changing the view mode to show the first lines of each message. The email editor, Word, is launched, and a document is opened, printed, and sent to an email recipient. The user then opens one of the documents in the inbox, adds a picture as an attachment, and emails it. Moving to the Draft folder, the user opens three email messages: the first has its spelling checked and is sent, the second is sent and the third is checked for spelling, printed, summarized and sent. Three more messages are created and sent with attached images. Finally, the user compresses the Outlook offline folder.

Netscape* Communicator* 6.0: The user opens the Netscape browser and loads an html version of a word document. The source HTML code is then viewed. The user also views two charts exported to HTML from an Excel file. Finally, the user browses through a 15-page PowerPoint slide show that was saved in HTML format.

Dragon* NaturallySpeaking* Preferred v.5: The user opens NaturallySpeaking and transcribes a pre-recorded audio file (1 minute and 33 seconds long) from speech to text. Once the transcription begins, the user moves this application to the background to do other work.

WinZip* Computing WinZip* 8.0: The user creates a compressed data file from a set of bitmap files (70 megabytes total size) in a specific folder. The resulting zip file is 55% of the size of the original group of files. Once started, the user moves this to the background and works with other applications.

McAfee* VirusScan 5.13: The user scans program files (3,016 files and 420MB) for the presence of viruses. This is run in the background as the user works (as is does on most business user's systems).

Internet Content Creation Workloads: The workloads in this category model the work a web designer would perform in creating web pages. In this case, the workload follows the evolution of material created for selling kayaking products from a company called "Extreme Sports." Web pages are created using Macromedia Dreamweaver with images developed in Adobe Photoshop and web animations created in Macromedia Flash. A web page link is then set up to point to a promotional video assembled in Adobe Premiere and encoded for a web format using Windows Media Encoder.

Adobe* Photoshop* 6.0.1: The user starts Adobe Photoshop and sets the workplace. A 7.12MB high-definition source file is opened, and sized to fit in the window. Copying the source image into an alternate layer to preserve the original, the user experiments with several combinations of filters and parameters, including Charcoal, Underpainting, Gaussian Blur, High Pass, Smart Blur, Lens Flare, Wave, with effects such as rotation, color fading, or overlays. After applying the filters and effects, the user re-sizes the image, and adjusts the image color levels before saving the image in a web-friendly 20-kilobyte jpeg file format.

Adobe* Premiere* 6.0: The user starts Adobe Premiere and assembles a promotional video from stock footage. The user selects the project configuration setting and opens a project file, containing a preconfigured timeline for a total completed video time of 13 seconds. This project uses three uncompressed 640 x 480 resolution AVI video clips of three to four seconds duration each. Digital effects, such as "Alpha Glow", and transition effects, such a "Spin Away", "Tumble Away" and "Doors" are applied. The project also includes an 8 bit monaural audio clip. The user exports the completed movie, rendering the video into a 640 x 480 resolution movie, compressed using the Ligos Indeo Video 5.11 video codec.

Macromedia* Dreamweaver* 4: The user creates two web pages for the online "Extreme Sports" company. The first page gives an overview of four kayaking products. The second page gives details on a specific product. The user starts Macromedia Dreamweaver and opens two partially completed web pages and then builds on these web pages, adding text, images, and links. Links are made to the Flash animation and Premiere encoded video. Images, ranging in size from 1 to 41 kilobytes, are also inserted. The user creates and edits style sheets to apply formatting to both web pages.

Macromedia Flash 5: The user creates a Flash animation that promotes kayaks and kayaking, using text, graphics and still images, for use in the "Extreme Sports" web pages created in Dreamweaver. The user works in an existing Flash animation, adding, then manipulating and positioning a new image to appear appropriately within the final animation. To do this, the user starts Macromedia Flash and opens a preconfigured project (FLA) file,

containing 23 different layers. The user moves down to one of the layers in the project file, deletes the key frame and imports a new image of a person in a kayak (a 24-bit color, 72 dpi, 300 x 211 resolution PNG format image with transparency). This image is then manipulated (rotated, flipped) and positioned appropriately within the frame and is then grouped into an instance. Finally, the user exports the animation to a web ready SWF file using 100 percent jpeg compression.

Microsoft* Windows* Media Encoder 7.1: The program is started and the user uses the session wizard to compress a 44 second promotional video (AVI format, 50 MB, 640x480, including sound) into a Windows Media Video (WMV) file. The compression is done for streaming media to the web with a bandwidth target of 1.5 Mbps. The session wizard selects Windows Media Video V8 with 320x240 resolution using the default variable compression buffer size (3) and Windows Media Audio V8 using 10 Kbps and 11 KHz mono. Image quality is set to 75 out of 100. The result is an 8.5 MB file in WMV format created at 30 fps with a 3 second interval between key frames.

Step 6

2.6 Automation and Workload Integration

The final step in creating SYSmark 2002 is translating the workload into an automated benchmark. BAPCo uses Visual Test and Visual Basic to emulate a human using a keyboard to send commands to the computer. The keyboard commands are converted into scripts that will be used by the benchmark to control each of the individual applications included in SYSmark 2002. In order to make sure the benchmark is deterministic, BAPCo uses something called a “harness” to install applications, run the scripts, record and display the performance results.

2.6.1 Measurement Methodology

The fundamental performance unit in SYSmark 2002 is “Response Time”. Response time, in the context of SYSmark 2002, is defined as the time it takes the computer to complete a task that has been initiated by the automated script. The task can be initiated by a mouse click or a keystroke from the keyboard. For example, the response time for a *Replace All* command in Word 2002 is the time between clicking the *Replace All* button in the *Edit/Replace* window and the time that Word 2002 brings up the completion window. In SYSmark 2002, only the response time of individual operations is included in the performance metric. SYSmark 2002 ignores the time to send keystrokes and mouse clicks to the application. In the real world, these tasks are initiated and controlled by a human and therefore do not measure computer performance. Since these tasks don’t measure computer performance they are not timed. This allows think time to be included in the workloads to more accurately reflect how humans interact with the PC

SYSmark 2002 is designed to emulate human interaction with the computer by sending keystrokes at a rate that approximates how fast a human will type (15 to 50 words per minute). SYSmark 2002 departs from the common practice of using an automation tool (harness) that sends keystrokes as fast as the computer can generate them because today’s computers are able to generate keystrokes much, much faster than a human can type. In SYSmark 2002, Think Time up to one second is added between operations to emulate human input to the computer but Think Time is not included in the performance measurement.

Operating system and application behavior is more realistic in SYSmark 2002 because Think Time enables the operating system and applications to perform normal housekeeping activities. For example, applications can properly schedule spell checking and grammar checking, the operating system can

execute idle time optimizations. Think Time avoids unnatural compression of page use information which can make memory management algorithms in the operating system less effective. The addition of Think Time also enhances cross-platform stability.

The overall response time for a category (Office Productivity or Internet Content Creation) is the average of all the operation response times in all of the applications that make up that category. The average response time for each of the two scenarios is then converted to a performance “rating” (explained in the next section – Performance Rating Methodology). The overall SYSmark 2002 rating is derived from the geometric mean of the two category ratings.

2.6.2 Performance Rating Methodology

Each time SYSmark 2002 is run on a PC, it calculates a performance rating for each category (Office Productivity and Internet Content Creation), and an overall system rating. The user category ratings are based on the average response times for the system being tested compared to a fixed *calibration platform*. For example, a rating of 100 indicates the test system has a SYSmark 2002 performance equal to that of the calibration platform using SYSmark 2002. A rating of 200 indicates the test system has twice the SYSmark 2002 performance of the calibration platform. The SYSmark 2002 calibration platform has the following configuration:

Motherboard:	Intel* Desktop Board D815EEA2U
CPU:	Pentium* 3 processor
Core Frequency:	1.0 GHz with 133 MHz bus speed
Memory:	256 MB, Non-ECC, PC133, CL2 SDRAM
Video Card:	Leadtek WinFast* GeForce3* TD
Video Resolution:	1024x768 resolution with 32 bpp color, 75 Hz monitor refresh rate.
Video Memory:	64MB DDR DRAM onboard
Video Driver:	Nvidia* Detonator* 4 reference driver (version 21.81 for Windows* XP)
File System:	FAT32
Disk:	30GB IBM DTLA-307030 ATA-100 hard disk
Disk Adapter:	Integrated IDE ATA-100 disk controller
Network Card:	Intel Pro/100+ Management PCI LAN card
Operating System:	Microsoft* Windows* XP Professional (Build 2600)

3.0 Features & Characteristics

SYSmark 2002 differs from its predecessor, SYSmark 2001, in several ways:

- New usability features have been added to streamline and improve the process of installation and execution resulting in higher test throughput
- Error handling has improved resulting in quicker resolution of failures
- Full support for Windows XP has been added
- Applications and workloads have been updated

Section 3.1 below briefly describes the new usability features, improved error handling and the support for Windows XP. For details on the operation of these new enhancements please refer to the documentation provided on the product CD-ROM.

Section 3.2 compares the characteristics of SYSmark 2001 and SYSmark 2002 as measured on a sample platform.

3.1 Usability Features & Execution Improvements

Full Support for Windows XP: SYSmark 2002 has been tested on English versions Windows XP (Home and Professional) and seven non-English operating systems (Italian, Spanish, Dutch, French, German, Japanese, Chinese).

New Applications: BAPCo has added Word 2002, Excel 2002, PowerPoint 2002, Outlook 2002, Access 2002, PhotoShop 6.0.1 and Windows Media Encoder 7.1 to SYSmark 2002. These new applications reflect the current workflow in today's desktop scenarios.

Command Line Operation: It is possible to run SYSmark 2002 without using the graphical user interface. See the CD ROM support documentation for details.

Improved installation: One-click installation is provided on Windows XP. Installation of SYSmark 2002 is also simpler than previous versions of SYSmark on other operating systems.

Trial run: The trial run can be used to test the benchmark on a system before scores are generated. On Windows XP, the ProcessIdleTask API is called after the trial run in order to optimize Windows XP performance. It is recommended to run the Trial run before generating an official score on Windows XP.

Automated Error Reporting: It is now possible to report errors using a one-click error-reporting feature. All information pertaining to the error is captured to help BAPCo provide timely technical support.

3.2 Comparative Workload Characterization of SYSmark 2001 and SYSmark 2002

In completing the workload development process, as described in section 2.0, the candidate workloads are judged through a rigorous workload characterization exercise. This section provides some of the pertinent data used in this process for both SYSmark 2001 and SYSmark 2002. This data provides an understanding of the logical and physical implications of the updates made to the applications and workloads. The reader can use this understanding to explain performance differences observed on test platforms.

The approximate quantitative contribution of the applications to the category performance scores in SYSmark 2001 and SYSmark 2002 are shown in Table 2 and Table 3.

Internet Content Creation				
Application	System A¹ SYSmark 2002	System B² SYSmark 2002	System C³ SYSmark 2002	System C³ SYSmark 2001
Adobe Photoshop	25%	32%	31%	13%
Adobe Premiere	51%	32%	32%	29%
Macromedia Dreamweaver	1%	1%	1%	5%
Macromedia Flash	14%	25%	24%	22%
Microsoft Windows Media Encoder	9%	10%	12%	31%

Table 2 - Application Contribution to Internet Content Creation Scores

¹ System A: Intel* Desktop Board D815EEA2U, 1.0 GHz Pentium* 3, 256MB Crucial Tech CT16M64S4D7E.16T SDRAM PC133 CL2, Leadtek* WinFast* GeForce3* with 64MB RAM, Nvidia* Detonator* 4 reference driver (version 21.81 for Windows* XP), 1024x768 screen resolution, 32 bpp color, 75 Hz monitor refresh rate, IBM* DPTA-373420 30GB hard disk, Intel* Application Accelerator Driver v1.10, Windows* XP Professional (Build 2600)

² System B: EPoX EP-8KHA+ Board, 1.60 GHz Athlon* XP, 256MB Crucial PC2100 CL2 DDR SDRAM, Leadtek* WinFast* GeForce3* with 64MB RAM, Nvidia* Detonator* 4 reference driver (version 21.81 for Windows* XP), 1024x768 screen resolution, 32 bpp color, 75 Hz monitor refresh rate, IBM* DPTA-373420 30GB hard disk, VIA 4in1 driver v4.33, Windows* XP Professional (Build 2600)

³ System C: Intel* Desktop Board D850MD, 2.0 GHz Pentium* 4, 256 MB PC800 Samsung KMMR16R88AC1-RKB 800-45 RDRAM memory, Leadtek* WinFast* GeForce* 3 with 64MB RAM, 1024x768 screen resolution, 32 bpp color, 75 Hz monitor refresh rate, IBM* DPTA-373420 30GB hard disk, Windows* XP Professional (Build 2600)

Office Productivity

Application	System A¹ SYSmark 2002	System B² SYSmark 2002	System C³ SYSmark 2002	System C³ SYSmark 2001
Microsoft Word	11%	10%	10%	2%
Microsoft Excel	19%	17%	15%	1%
Microsoft PowerPoint	3%	3%	4%	3%
Microsoft Outlook	25%	22%	23%	8%
Microsoft Access	5%	5%	6%	26%
Dragon NaturallySpeaking	22%	24%	24%	34%
McAfee VirusScan	8%	10%	10%	5%
Netscape Communicator	3%	4%	4%	1%
WinZip Computing WinZip	4%	5%	4%	20%

Table 3 - Application Contribution to Office Productivity Scores

The standard deviation of the contribution of individual applications to the overall SYSmark 2002 score is approximately 17% lower than SYSmark 2001 indicating a more balanced workload.

Some of the important physical characteristics of SYSmark 2001 and SYSmark 2002 workloads are shown in Table 4 and Table 5 (all data is approximate).

Internet Content Creation³

System Characteristic	SYSmark 2001	SYSmark 2002
Main Memory operations/1000 Instructions	3.61	5.22
Average Memory Bandwidth (MB/sec)	303	618
Average I/O Bandwidth (MB/sec)	3.1	8.6

Table 4 - Physical Characteristics of Internet Content Creation

* Other product names used in this publication may be trademarks of their respective companies.

Office Productivity³		
System Characteristic	SYSmark 2001	SYSmark 2002
Main Memory operations/1000 Instructions	6.77	6.88
Average Memory Bandwidth (MB/sec)	567	589
Average I/O Bandwidth (MB/sec)	3.7	8.1

Table 5 – Physical Characteristics of Office Productivity

Data in Table 4 and Table 5 indicate that the workloads in SYSmark 2002 spend substantially more time performing system level (i.e. disk and memory) operations (as projected on the reference configuration³) and therefore are more sensitive to platform configuration.

The instantaneous profile of the key physical characteristics of SYSmark 2001 and SYSmark 2002 are shown in the various plots below⁴. They can be used to understand the temporal variation of the physical resource usage of the workloads in the two benchmarks.

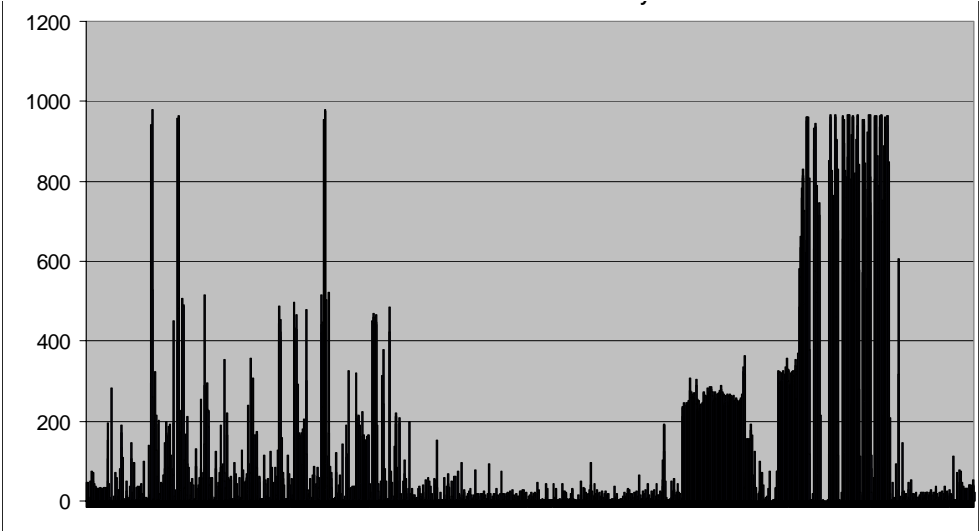


Figure 5- SYSmark 2002 Internet Content Creation Main Memory Bandwidth Profile (MB/s)

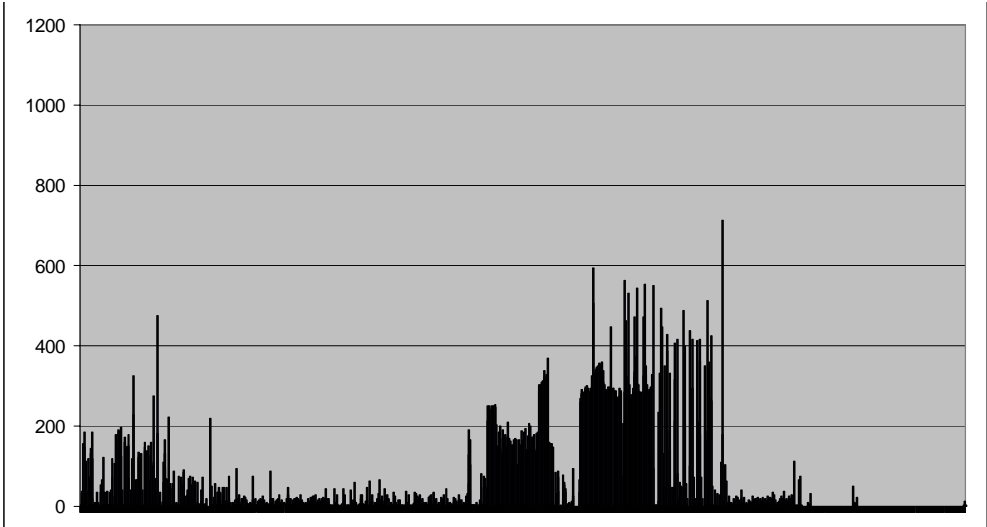


Figure 6 - SYSmark 2001 Internet Content Creation Main Memory Bandwidth Profile (MB/s)

Figure 5 and Figure 6 show that the SYSmark 2002 Internet Content Creation workload generates a higher amount of memory traffic than the SYSmark 2001 Internet Content Creation workload. Moreover, the memory traffic in SYSmark 2002

⁴ Intel* Desktop Board D845HV, 1.7 GHz Pentium* 4, 256MB Crucial Tech CT16M64S4D7E.16T SDRAM PC133 CL2, GeForce2* MX 400, Nvidia* Detonator* 4 reference driver (version 21.81 for Windows* XP), 1024x768 screen resolution, 32 bpp color, 75 Hz monitor refresh rate, IBM* DPTA-373420 30GB hard disk, Intel* Application Accelerator Driver v1.10, Windows* XP Professional (Build 2600)

Internet Content Creation is more evenly distributed across the various tasks performed during the execution of the benchmark.

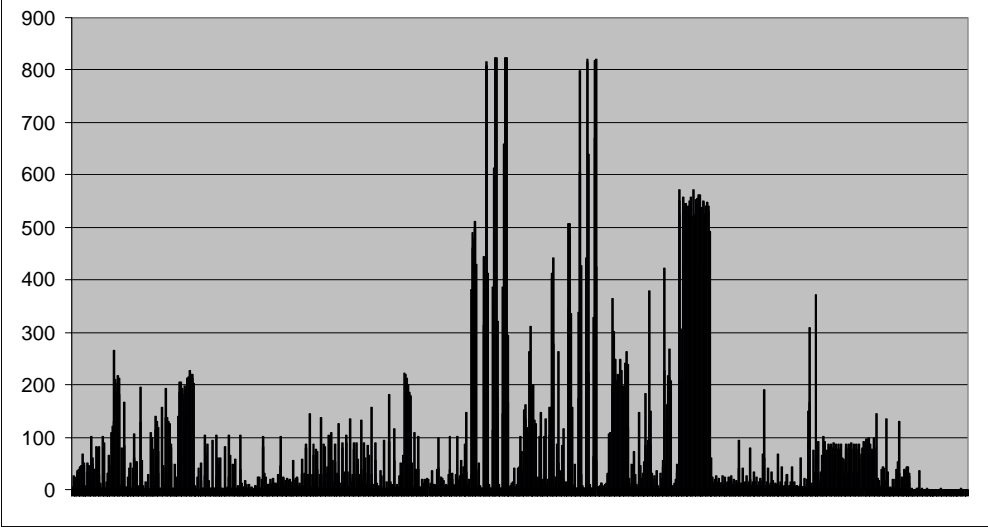


Figure 7 - SYSmark 2002 Office Productivity Main Memory Bandwidth Profile (MB/s)

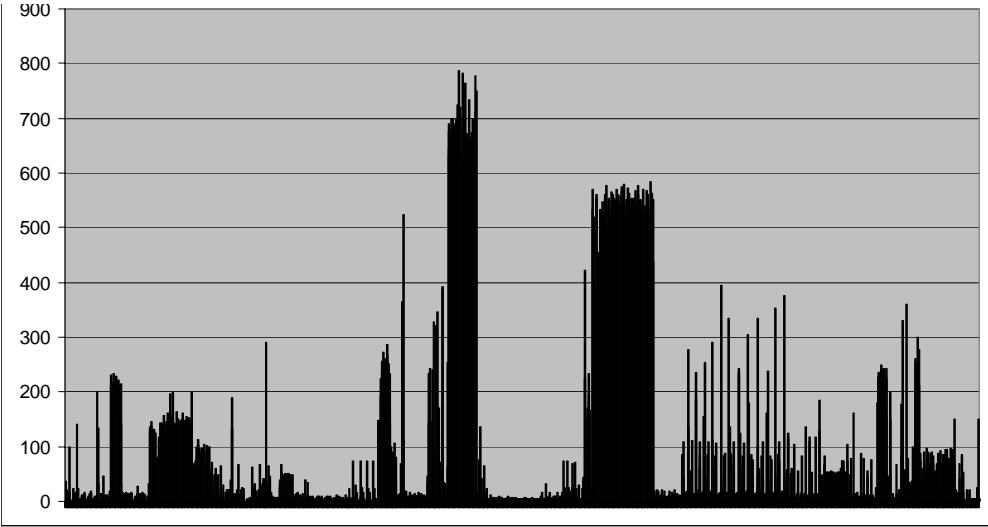


Figure 8 - SYSmark 2001 Office Productivity Main Memory Bandwidth Profile (MB/s)

Figure 7 and Figure 8 depict the temporal profile of main memory bandwidth of SYSmark 2002 and SYSmark 2001 Office Productivity workloads.

* Other product names used in this publication may be trademarks of their respective companies.

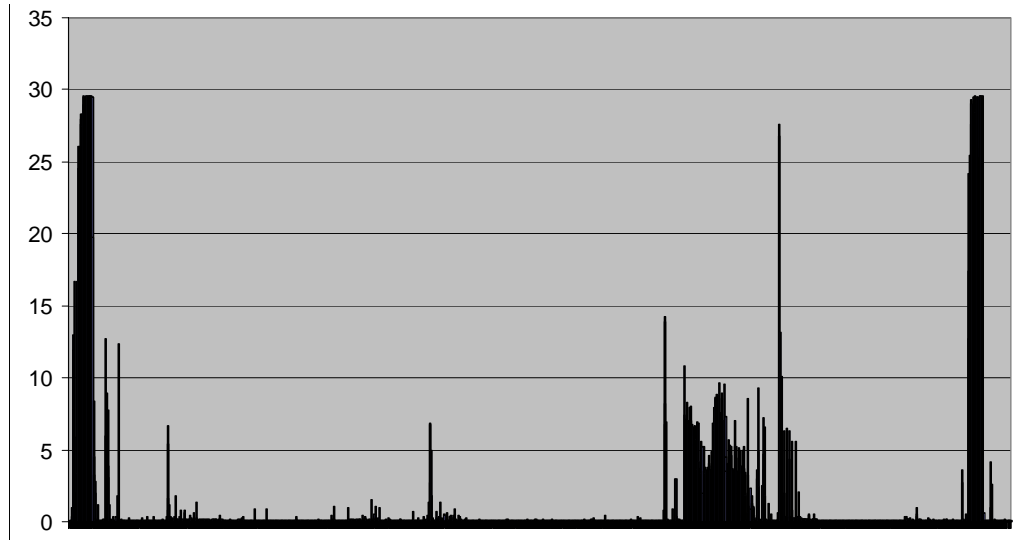


Figure 9 - SYSmark 2002 Internet Content Creation I/O Bandwidth Profile (MB/s)

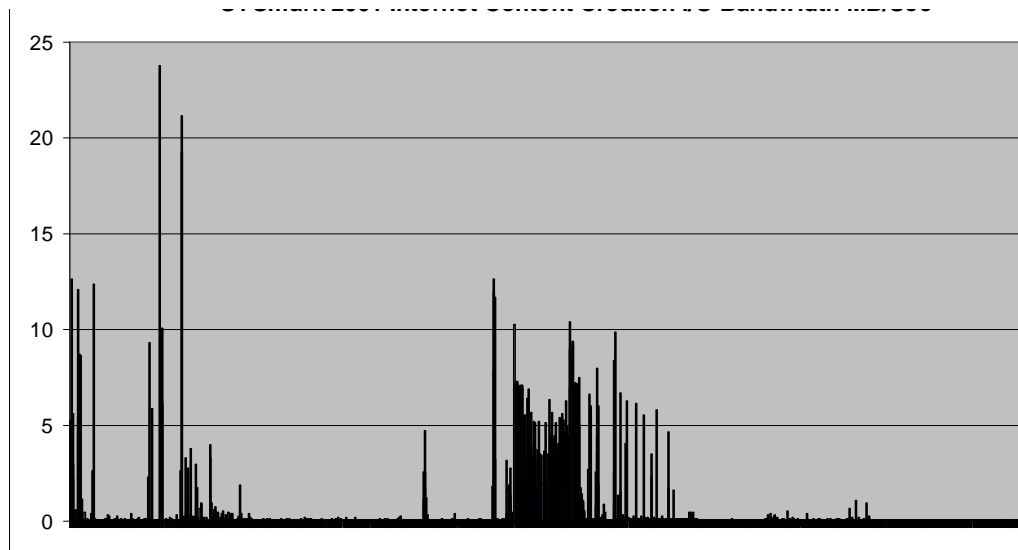


Figure 10 - SYSmark 2001 Internet Content Creation I/O Bandwidth Profile (MB/s)

Figure 9 and Figure 10 depict the temporal I/O profiles of SYSmark 2002 and SYSmark 2001 Internet Content Creation workloads.

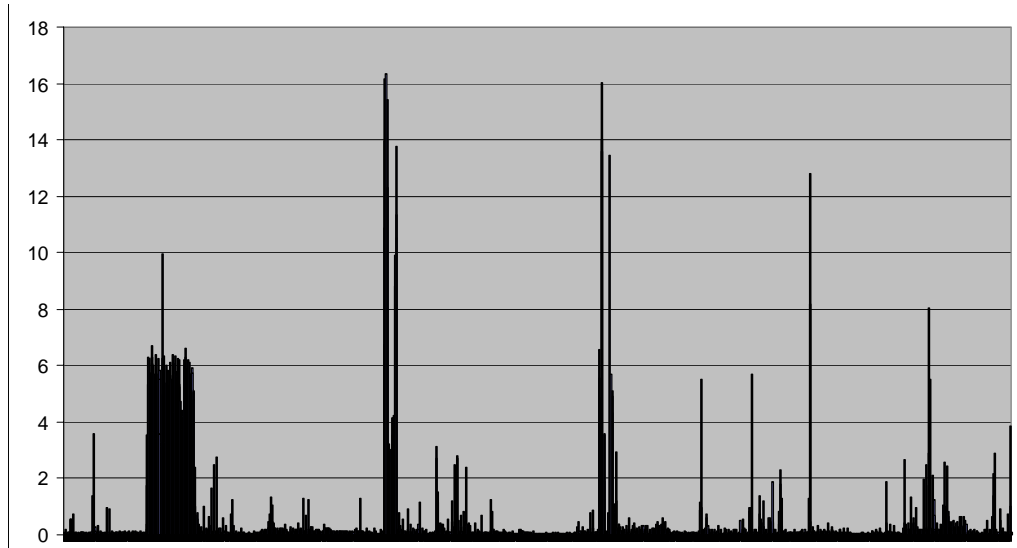


Figure 11 - SYSmark 2002 Office Productivity I/O Bandwidth Profile (MB/s)

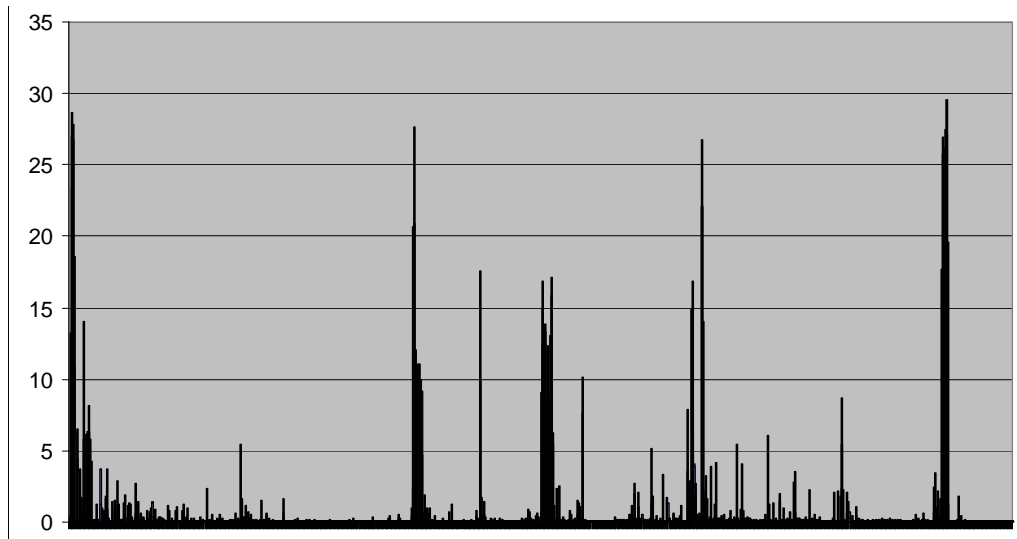


Figure 12 - SYSmark 2001 Office Productivity I/O Bandwidth Profile (MB/s)

Figure 11 and Figure 12 show the temporal I/O profiles of SYSmark 2002 and SYSmark 2001 Office Productivity workloads.

4.0 Conclusion

SYSmark 2002 is the latest performance benchmark suite from BAPCo and is designed to evaluate personal computer performance in business environments. The new and improved benchmark suite fully supports Windows XP, includes new applications, incorporates a new command line operation mode, provides simple one-click installation and automated error reporting. SYSmark 2002 uses Office XP, the leading office applications suite, Photoshop 6.0.1 and includes an updated version of Windows* Media Encoder.

Some features have been carried forward from SYSmark 2001. Like SYSmark 2001, SYSmark 2002 continues to use the same industry accepted user categories: Office Productivity and Internet Content Creation. Usage characteristics like Concurrent Execution, Switching between open applications and User Think Time remain in the new benchmark suite. Response Time continues to be the fundamental unit of performance.

Since SYSmark 2002 was primarily an enhancement to SYSmark 2001 instead of a complete overhaul, it was possible to devote more time to workload analysis. As a result, the workload of SYSmark 2002 is more balanced than its predecessor with measurable improvements being made to the Office Productivity category. The rebalanced workloads spend more time executing system level operations and therefore provide more insight into how the platform configuration contributes to overall system performance.

To summarize, SYSmark 2002 is easier to install, run and maintain. It carries forward the features that made SYSmark 2001 the premier performance evaluation tool for business environments. And finally, it includes full support for the latest operating system, Windows XP, the latest office productivity suite, Office XP and has improved the workload characteristics to reflect how business workers use personal computers in their day-to-day activities.

APPENDIX A: Application Program versions

1. Microsoft Office XP:

- Word 2002 (v10.2627.2625)
- Excel 2002 (v10.2614.2625)
- PowerPoint 2002 (v10.2623.2625)
- Outlook 2002 (v10.2627.2625)
- Access 2002 (v10.2627.2625).

This version does not include the recently released Service Pack 1 as it was released after the code freeze date for SYSmark 2002.

2. Netscape Communicator: Mozilla 5.0 version.

3. Dragon NaturallySpeaking: Version 5.

4. McAfee VirusScan: Version 5.13

5. WinZip: Version 8.0 (v305).

6. Microsoft Windows Media Encoder: Version 7.01.00.3055. Additionally, this application uses the Windows Media v8 codec (wmv8dmoe.dll – v8.20.0.5029)

7. Macromedia Flash: Version 5.

8. Macromedia Dreamweaver: Version 4.

9. Adobe PhotoShop: The version is 6.0.1. SYSmark 2002 uses two updates from the Adobe web site. 1) Adobe Photoshop 6.01 update released on March 9, 2001. 2) Adobe PhotoShop 6.0.1 plug-ins update released on May 01, 2001.

10. Adobe Premiere: Version 6.0.

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