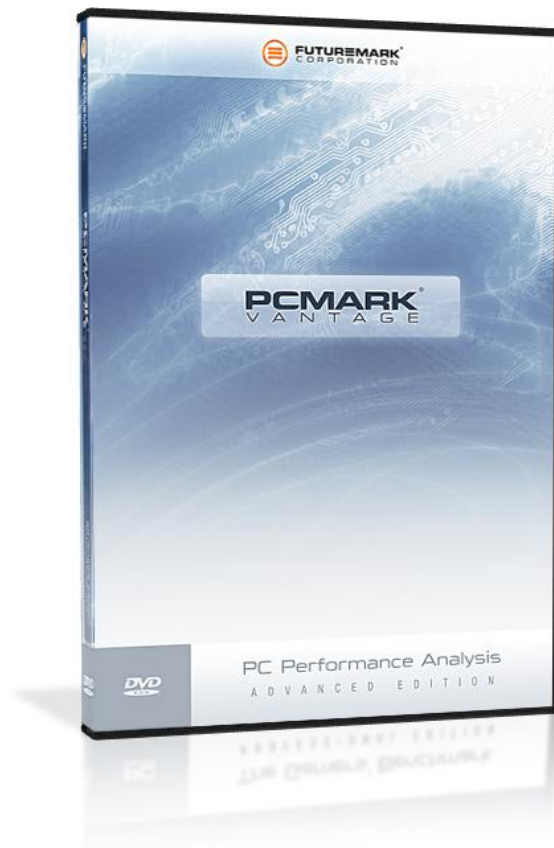


PCMARK[®]

VANTAGE

Whitepaper v1.0

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Introduction

This paper introduces PCMark® Vantage, the latest in the PCMark benchmark series built by Futuremark® Corporation. The name PCMark has become a standard in PC system benchmarking; since the first version released in 2002 it has grown to be used by most on-line and paper publications. It has proven itself as an impartial and highly accurate tool for benchmarking PC system performance of the latest PC hardware.

Futuremark's latest version, PCMark Vantage, introduces an exciting collaboration of tests specially designed and programmed for Windows Vista® 32 and 64 bit.



**PCMark Vantage – the complete PC system performance tool
in Windows Vista environments and user scenarios.**

PCMark Vantage is an all new PCMark version utilizing new and rich features of Windows Vista. The previous versions of PCMark have been, while very popular and good benchmarks, rather theoretical and technical. In PCMark Vantage the focus is on the everyday usage of Windows Vista and how well the system copes with various tasks such as image manipulation, video playback, 3D gaming etc. This new approach has been widely praised and gives a very distinctive perception of the systems' Windows Vista performance and capabilities.

New Elements, Suites and Philosophy

PCMark Vantage is different in many ways in comparison to its predecessor, not to mention the new operating system requirement; Windows Vista. Since the everyday usage of home PC's have taken a huge leap forward in terms of productivity, entertainment, gaming etc. PCMark Vantage has been designed to benchmark different user group's needs and everyday tasks. With previous versions of PCMark users have been able to study their system's low-level performance (i.e. detailed component performance such as memory, L1 and L2 cache etc.) but since such low-level information is no longer a key element in normal, or even enthusiast PC usage, PCMark Vantage has been re-designed from top to bottom.

PCMark Vantage comes with pre-defined consumer test-suites to accommodate the new Windows Vista consumer scenarios:

- Memories
 - Photos, backups of home videos etc.
- TV and Movies
 - Record favourite TV shows, watch movies etc.
- Gaming
 - Next generation gaming and entertainment
- Music
 - Organize your music, play your favourite songs etc.
- Communication
 - Surf the web, schedule your kids hockey practice etc.
- Productivity
 - Document your ideas etc.

In addition to the Windows Vista consumer scenarios PCMark Vantage also includes a special HDD test scenario (or suite) which has been developed to target the most demanding usage of HDD's in everyday usage of home PC's.

The PCMark Suite is the default suite, which is a mixture of all user scenarios, in other words includes a bit of everything. In all, PCMark Vantage has 8 different suites to cope with the needs of various users and user groups. The PCMark Suite is the default and standard suite, and the other suites are for more targeted benchmarking of a certain group of interest.

PCMark Vantage comes with a set of new sub-scores for better in-depth hardware analysis:

- Memories Score
- TV and Movies Score
- Gaming Score
- Music Score
- Communication Score
- Productivity Score
- HDD Score

In addition to these very well defined and useful sub-scores, PCMark Vantage outputs the PCMark Score which is fully comparable on all systems capable of running PCMark Vantage.

System and Component Benchmarking

System benchmarking allows users to accurately evaluate the overall performance of their PC hardware for a defined usage type. Component benchmarking, by contrast, measures the performance of individual PC components such as CPU, memory, graphics card etc. Benchmarking PCs can be a complex process as hardware comes in a tremendous variety. Each PC component – motherboard, CPU, system memory, graphics card, etc. – has multiple possible manufacturers and variations. Furthermore, the rapid pace with which manufacturers introduce improved versions of these components makes system benchmarking a very challenging task.

PCMark Vantage supports both system and high-level component benchmarking. System benchmarking produces a measure of the PC's overall performance for a specific type of usage. In previous versions of PCMark this was limited to general home usage, but in PCMark Vantage this has been leveraged into a wider variety of different usages. Despite the increased target audiences and workloads in PCMark Vantage, it is still the single PCMark Score that is fully comparable to other PCs. Advanced users and professional testers may want to further explore the performance of the hard disk, using the HDD Suite.

Consumer Scenarios

A well-defined usage scenario allows us to design the set of tasks that are run and measured by the benchmark – the workload. The workload must have the characteristics of the chosen usage scenario. In PCMark Vantage there are several different consumer scenarios, targeting most common usage of a modern PC. Thus, PCMark Vantage stresses the PC in a similar manner as PCs would experience in real life home usage of Windows Vista.

In the world of benchmarking there are two common approaches for building the workload: *Application based* and *Synthetic based* benchmarking.

Application based benchmarks include complete applications the user would typically run. Such benchmarks would include the complete word processor, email client, graphics authoring software, etc. The primary benefit of this approach is that the performance results are likely to correlate closely with the actual performance of using the included applications. However, application benchmarks have some drawbacks in their usability. Typically a user uses the pre-installed applications which ship with the operating system, but some users are more used to 3rd party applications. In this case the workloads and performance measurements in e.g. web browsing may differ. Generally all applications are highly optimized and the difference between two similar applications is very slim, but in some cases there may be greater differences. PCMark Vantage is designed to stress the built-in applications shipped with Windows Vista and thus performance using 3rd party applications may differ from the results given by PCMark Vantage.

Synthetic based benchmarks tend to have the opposite strengths and weaknesses as application benchmarks. They include code fragments written specifically to mimic the work performed by real-world applications. This allows them to be small in file size and quick to run. However, synthetic benchmarks often face the criticism of not being the “real thing” as actual applications is not being used. Despite this, synthetic benchmarks can be powerful tools for isolating performance of certain parts of the hardware. PCMark Vantage has a few tests which are “synthetic” for more in-depth benchmarking. In the real world no everyday application stress solely one subsystem (such as L2 cache or System Memory), and thus the tests in PCMark Vantage were designed based on existing applications all found in Windows Vista.

Complete Benchmarking Cycle

A good benchmark provides an accurate performance measurement as well as assists the user through the full benchmarking cycle of analyzing the results; comparing results against other PCs, exploring PC improvements, and leading finally to higher performing PCs. PCMark Vantage and Futuremark's online service tools were designed to support this process.

PCMark Vantage's "PCMark Score" is a single, globally recognized number that represents the overall PC performance for typical home usage. PCMark Vantage also produces several sub-scores, which are fully comparable to other systems' sub-scores. The complete benchmark data available to the user consists of results from numerous tests and over 400 pieces of detailed PC configuration information. As benchmark results are useless in isolation, the user can take the next step and submit the results to Futuremark's Online ResultBrowser (ORB). The ORB allows the user to compare the results to millions of other benchmark results in Futuremark's benchmark database. With this comparison, the strengths and weakness of the user's PC are revealed. This provides the user unique insights into how much performance improvement each component upgrade may yield. As a result, the user is more educated and can make a more informed purchasing decision.

Other PC System Benchmarks

There have been several efforts in PC benchmarking. Some prominent programs are listed below:

- SPEC (www.spec.org), a non-profit consortium of companies, produces CPU integer-workload and floating point-workload component benchmarks.
- SYSmark®, MobileMark® and Webmark® series from the BAPCo® Corporation (www.bapco.com) are application benchmarks for internet content creation and office productivity usage. They include a large set of complete applications such as the Microsoft® Office suite and Adobe® Photoshop®.
- SiSoftware™ Sandra™ (<http://www.sisoftware.net/>) consists of a large set of different diagnostic tools. It also includes several components-level benchmarks.

With PCMark Vantage, it has been our goal to create a benchmark that is easy to use and accessible to all users. We want to help users understand their PC performance in Windows Vista. For this reason, we have made the benchmark very intuitive to run. With a single click, the user is able to get performance results in minutes. We also have tried to keep the installation size reasonable to enable quick downloads and faster access to results. Furthermore, we have worked hard to make the benchmark as accurate as possible. We have worked in cooperation with all key players in the industry to ensure that the workload accurately reflects real-world usage. Lastly, we provide online tools that allow users to put their PC performance results in context and make intelligent purchasing choices.

Our Development Methodology

Futuremark approaches all of the benchmarks it creates with a standard development methodology. We believe that the process we follow is central to the development of a successful and dependable benchmark. The key part of the development process is cooperation with all major manufacturers. For PCMark, we have found that groups with the most interest in this process are: graphics chipset makers, CPU manufacturers, HDD manufacturers and PC system manufacturers. These companies are keen to cooperate with us because they share the vision that strong, objective benchmarks are in everyone's interest. We have been running a formalized Benchmark Development Program (BDP) that allows these vendors to participate in designing leading benchmarking standards in the PC industry. The cornerstones of our design process are *transparency* and *neutrality*. We make a strong effort to document all processes that make up the benchmark; we continuously strive to make these documents better. Also, we always try to maintain the highest standards of neutrality, neither favouring nor ignoring any party.



Benchmark Development Methodology

Step One

In this first step, we use a variety of resources to enumerate a first set of possible features for the benchmark. We draw upon our own experience with previous benchmarks and the feedback we have subsequently received. Communications with the gamer and game developer communities also provide valuable input. The BDP member group is another source of insights. From these, we develop high-level ideas of features we may include in the benchmark. At this early stage, features and implementation options are intentionally kept open.

Step Two

The document produced in the previous step is a proposal. It is designed to present features and implementation options in a format amenable for getting constructive feedback. This proposal is circulated to our BDP members. The feedback received helps us in choosing features and implementation methods.

Step Three

In the third step we create a written benchmark specification. Each of the workload tests is specified in detail with exact versions of the technologies used. The specification is circulated to the BDP members. The feedback is analyzed and incorporated at our discretion.

Step Four

In the next step we implement prototype code to see if the available technology will support our plans. We may discover the certain tests are not possible, or may be surprised to discover that more can be achieved. The results are incorporated into the specification and again circulated.

Step Five

The fifth step consists of implementing the workloads or tests. Periodic releases are made to the BDP members and their feedback may again be taken into account.

For more information and an up-to-date list of participating BDP members, please refer to www.futuremark.com/bdp.

PCMark Vantage Overview

PCMark Vantage uses Windows Vista built-in applications in several tests which enable users to examine the performance under everyday tasks.

PCMark Vantage's main target audience is basic home PC users. The workload is designed to stress the PC in the same manner as typical home, and small office, usage does. The workload includes a test suite that gives an overall PCMark score as well as several profiles (Consumer Scenarios) which give individual scores measuring various usage scenarios of PCs. Some of the tests run concurrently in separate threads. Multithreading is commonly used in software design to maximize performance and resource utilization. Lastly, PCMark Vantage includes the ability to define custom test suites that are tailored to your own specific needs. The user can choose various tests and compose them in multithreaded sets. This allows the user to model real-life usage where several applications running in a multithreaded fashion compete for PC resources.

PCMark Vantage Main Features

- PCMark Suite
 - A collection of various single- and multi-threaded CPU, Graphics and HDD test sets with the focus on Windows Vista application tests
 - Tests have been selected to represent Windows Vista Consumer Scenarios
 - Only the PCMark Suite will provide a PCMark Score
- Windows Vista Consumer Scenario Suites
 - Memories Suite
 - Gives a PCMark Memories Score
 - TV and Movies Suite
 - Gives a PCMark TV and Movies Score
 - Gaming Suite
 - Gives a PCMark Gaming Score
 - Music Suite
 - Gives a PCMark Music Score
 - Communications Suite
 - Gives a PCMark Communications Score
 - Productivity Suite
 - Gives a PCMark Productivity Score
- HDD Suite
 - Gives a PCMark HDD Score
- A number of settings for in-depth hardware comparison (resolution, AA, texture filtering etc.)
- Latest SystemInfo Module for hardware component detection
- Completely new Graphic User Interface (GUI)
- Enhanced Online ResultBrowser (ORB) and Online ResultAnalyzer (ORA ☺)
- 32 bit and 64 bit executables

PCMark Vantage Optimizations and Compiler Switches

We also allow vendors to examine any code that was written by us. The vendors may suggest generic optimized code paths, which we review for accuracy and implemented at our discretion. PCMark Vantage is compiled with Microsoft® Visual Studio® .NET 2005 with the following compiler switches (these differ a bit between different test dlls):

```
/Ox /Ob2 /Oi /Ot /Oy /GT /GL /GF /FD /EHsc /MD /Gy /arch:SSE2 /W3 /nologo /c /Wp64 /TP
```

Note that vendors are not allowed to detect a running PCMark Vantage instance in any of their drivers or software and use that to reduce the workload or alter the behavior. Our policy for generic optimizations is available on Futuremark website (www.futuremark.com).

3D Engine

The 3D engine used in PCMark Vantage (GPU gaming test) is the 3D engine used in 3DMark06. The engine dynamically builds shaders for each material in HLSL format. These shaders are then runtime compiled to best fit the installed hardware, or the user may manually set which compilation profile to use. A professional hardware reviewer can compare the performance difference using different shader compiler profiles for the same hardware. Handling all materials and shaders, and all other rendering related tasks like the shadow system discussed below, adds quite a bit of work to the CPU and memory.

DirectX

All tests have been compiled and linked with **DirectX 9.0c (DX August 2007 Update)** libraries. The GPU gaming test requires DirectX 9 hardware with support for Pixel Shader 2.0 or higher. The GPU image manipulation test requires DirectX 9 hardware with support for Pixel Shader 3.0 or higher.

Shaders

DirectX shader technology was introduced with DirectX 8, which brought ShaderModel 1.0 (SM1.0). Shaders are short programs for manipulating vertices and pixels in a Direct3D scene, and these can be efficiently executed on dedicated graphics hardware. There are two types of shaders: vertex shaders and pixel shaders. SM1.0 brought quite a huge leap forwards from fixed function vertex transformation and lighting to fully programmable vertex shaders and from fixed function multitexturing to programmable pixel shaders. Just transformation and lighting, and multitexturing, naturally can be done using shaders, but they can do so much more. The GPU gaming test requires and utilizes Shader Model 2.x and higher. It doesn't require Shader Model 3.0 or 4.0, but has some performance optimizations for Shader Model 3.0.

Materials

The ground material in the GPU gaming test is doing a Blinn-Phong reflection, but with added diffuse, diffuse detail, normal and normal detail maps. The rock surfaces also have a specular map. The tree branches are also a modified metal material without a specular map and with a diffuse cube map and no bump mapping. The sky is created using a procedural light scattering shader.

Lighting

The moonlight is directional, generating CSM. The illuminating fireflies are shadow mapped point lights with a cubemap mask. The illuminating fireflies are masked point lights, throwing shadows using a 1024x1024x6 cube depth map/hardware shadow maps.

Dynamic Shadow Rendering

The 3D engine uses a type of depth shadow maps called Cascaded Shadow Maps (CSM). The implementation is a new approach to achieve angle independent quality on dynamic shadows for all objects on screen. This method works by dividing the view frustum in to 5 sections along the z-axis. Each section gets shadowed by a standard uniform 2048x2048 shadowmap. If the hardware supports depth textures, a D24X8 or DF24 depth map is used. If Depth Textures are not supported, an R32F single component 32 bit floating point texture will be used as a depth map. Hardware shadow mapping is on by default and cannot be switched off. A single buffer will be reused for all 5 sections.

Shadows from point light sources use a 1024x1024x6 cube map of the format R32F as depth map, unless the hardware supports D24X8 or DF24 depth textures. These depth maps sound enormous, and one would think they take up quite a bit of fill rate. They most certainly do, and PCMark Vantage's GPU gaming test is therefore less sensitive to changes of the screen resolution.

In order to smoothen out the edges of the shadows, the 3D engine uses a 4 point sample rotated grid kernel to produce relatively smooth edges for the shadows, unless the hardware supports D24X8 Percentage Closer Filtering (PCF) or DF24 & FETCH4. For hardware with support for PCF or FETCH4, only one bilinear sample is fetched.

Texture compression

All color maps are DXT1 compressed, the alpha maps are DXT3 compressed, and all normal maps are DXT5 compressed.

System Requirements

The minimum hardware and software requirements and recommendations are:

- Processor
 - Requirement: SSE2 support
 - Recommendation: Similar level of performance as an Intel Pentium D at 3.0 GHz or equivalent AMD multi core processor
- Graphics Card
 - Requirement: Fully SM2.0 compliant graphics hardware
 - Requirement: Minimum requirement for GPU image manipulation test is SM3.0
 - Recommendation: 256MB of graphics memory for the GPU gaming test
- System Memory
 - Requirement: Windows Vista minimum requirement
 - Recommendation: 1024MB (1GB) or more
- Hard Disk
 - 1.7GB of free hard disk space
 - NTFS file system
- Operating System
 - Windows Vista
 - Supported Editions
 - Windows Vista Ultimate
 - Windows Vista Business *)
 - Windows Vista Enterprise *)
 - Windows Vista Home Premium
 - Windows Vista Home Basic *)
 - The N-Series (EU only) **)
 - Unsupported Editions
 - Any server editions of Windows Vista
- Additional Required Applications
 - Windows Media Player 11
 - ships with Windows Vista, except with Windows Vista N versions in EU
 - Direct3D9 runtime for Windows Vista
 - Shipped with PCMark Vantage
 - Microsoft Internet Explorer 7
 - Ships with Windows Vista

*) = Unable to run the Video playback – MPEG-2 Blu-ray test due to lack of Windows Media Center. The results of the tests in sets with these tests are “1”.

**) = Unable to run the Video playback tests and the Video and Audio transcoding tests due to lack of built-in components in Windows Vista N-Series. The results of the tests in sets with these tests are “1”.

To confirm if your system is capable of running PCMark Vantage, please visit the following page for a quick online system compatibility analysis: <http://www.yougamers.com/gameometer/10205>

Test Suites

The Test Suites in PCMark Vantage have been divided in different “Consumer Scenarios”. The six Consumer Scenario suites are based on collections of actual real-world end user applications, and reflect the system performance a typical user would expect when running those applications. Each test suite contains a subset of the following tests as applicable: data encryption, decryption, compression and decompression, GPU and CPU image manipulation, video playback, editing and transcoding, audio playback and transcoding, GPU and CPU game tests, game data loading, web page rendering, mail operations, contacts search, text editing and applicable HDD tests. Each Consumer Scenario test suite generates a unique, fully comparable performance score for that series of tests. A comprehensive, overall PCMark score is generated by running the PCMark Suite. The HDD Suite produces its own fully comparable HDD performance score. All results can be uploaded, stored and compared in Futuremark’s exclusive Online ResultBrowser (ORB) dependant on which edition of PCMark Vantage that the user is running.

In this chapter the actual Test Suites are described. The individual tests are described in technical detail later in this document.

PCMark Suite

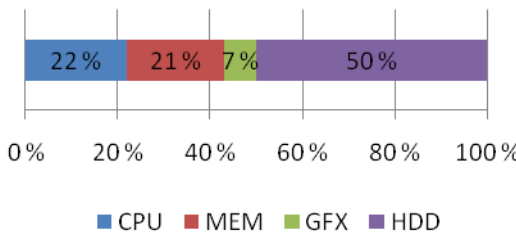
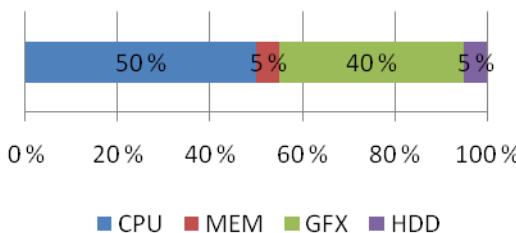
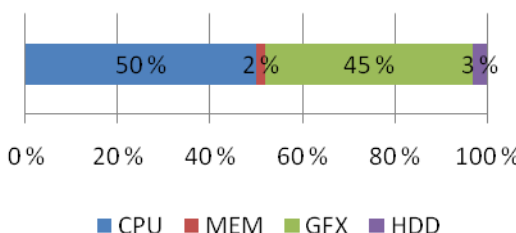
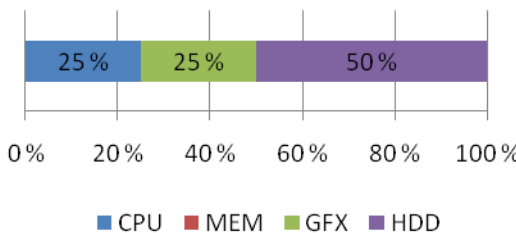
The PCMark Suite is a collection of various single- and multi-threaded CPU, Graphics and HDD tests with the focus on Windows Vista application tests. Tests have been selected to represent a subset of the individual Windows Vista Consumer Scenarios. The PCMark Suite includes a subset of Consumer Suite tests. Note: Only the PCMark Suite will provide a PCMark Score.

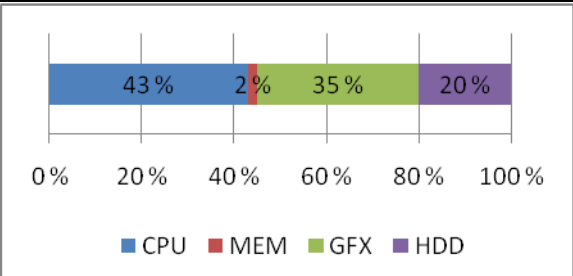
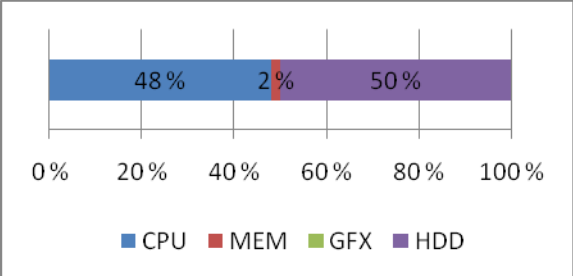
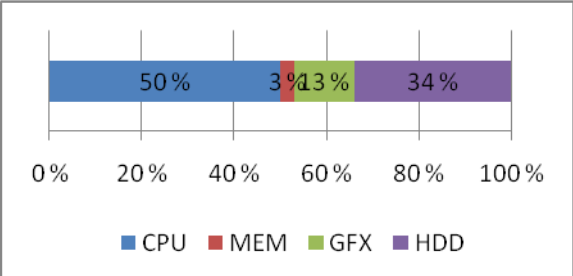
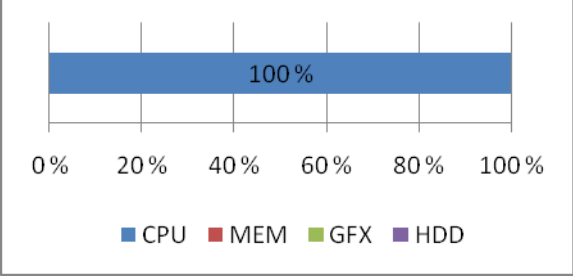
Our computers play an important role in our lives these days. We rely on them to store and help us relive our memories as digital photos. We use them to watch the latest high definition TV broadcasts and movies. They entertain all ages with exciting, graphically detailed games. When we play today’s games, high performance graphics cards, CPUs and HDDs help us avoid irritating delays and sluggish performance. Online music shops have changed the way we purchase music, letting us buy exactly the tracks we want, right from home. Transcoding our audio files from one format to another is much quicker and easier using high performance CPUs. Cataloguing our music library is a breeze for fast and powerful HDDs. As we spend more time online, and share music and files, security is more important than ever before. To minimize our security maintenance tasks, high performance CPUs and HDDs are recommended. Our busy lives find us hard at work, balancing multiple tasks; with little time for breaks. It’s the same for our computers.

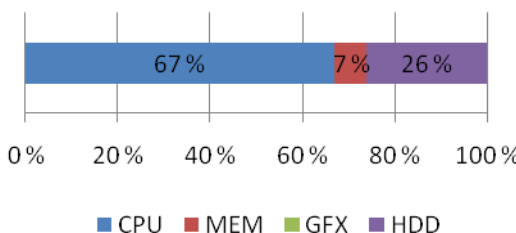
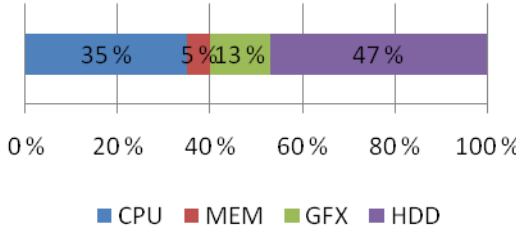
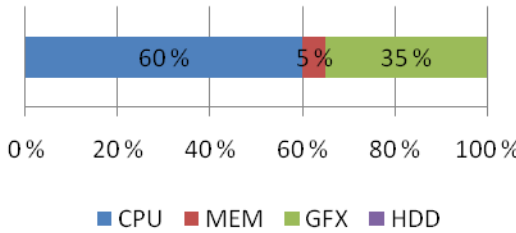
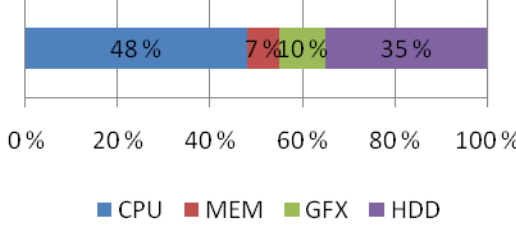
NOTE: The Test Sets in the PCMark Suite are not the same as in the individual Suites. I.e. PCMark Memories 1 in PCMark Suite is not the same as Memories 1 in the Memories Suite. The tests included in the PCMark Suite are a selection of the most common everyday tasks users perform with their systems.

The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The PCMark Suite includes the following mixture of test sets:

Sets	Workload Distribution Estimates	Set Info
PCMark Memories 1	 <p>22% 21% 7% 50%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. CPU image manipulation 2. HDD – importing pictures to Windows Photo Gallery
PCMark Memories 2	 <p>50% 5% 40% 5%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Video transcoding – VC-1 to WMV9.</p> <ul style="list-style-type: none"> - Transcoding from the media server archive (HD [high definition] VC-1 1280x720p 11 Mbps) to a portable video player (SD [standard definition] WMV9 320x240p 1.0 Mbps). Uses two cores if available.
PCMark TV and Movies 1	 <p>50% 2% 45% 3%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Video transcoding – VC-1 to VC-1 <ul style="list-style-type: none"> - Transcoding from HD DVD (HD VC-1 1920x1080p 28 Mbps) to the media server archive (HD VC-1 1280x720p 11 Mbps). Uses two cores if available. 2. Video playback – VC-1 HD DVD with SD commentary <ul style="list-style-type: none"> - Playing HD DVD (VC-1 1920x1080p 28 Mbps) with SD (VC-1 720x480p 3 Mbps) commentary.
PCMark TV and Movies 2	 <p>25% 25% 50%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. HDD – Windows Media Center 2. Video playback – VC-1 HD DVD with HD content <ul style="list-style-type: none"> - Playing HD DVD (VC-1 1920x1080p 28 Mbps) with HD (VC-1 1280x720p 7 Mbps) content.

Sets	Workload Distribution Estimates	Set Info
PCMark Gaming 1	 <p>43% 2% 35% 20%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. GPU gaming <ul style="list-style-type: none"> - Performing basic GPU (graphics processing unit) tasks utilizing PS (pixel shader) 2.0 and VS (vertex shader) 2.0 operations found in most 3D games using DX (DirectX) 9. This test utilizes SM (shader model) 3.0 (if available) performance optimizations which do affect visual quality. 2. Data decompression <ul style="list-style-type: none"> - Loading compressed level from hard drive and decompressing it into system memory.
PCMark Gaming 2	 <p>48% 2% 0% 50%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. CPU gaming <ul style="list-style-type: none"> - Executing heavy AI path finding algorithms. Uses all available cores up to 16 cores. 2. HDD – gaming
PCMark Music 1	 <p>50% 3% 13% 34%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Web page rendering – music shop <ul style="list-style-type: none"> - Opens a web page in IE7 with music shop kind of content. 2. Audio transcoding – MP3 to WMA 3. HDD – adding music to Windows Media Player
PCMark Music 2	 <p>100%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>CPU MEM GFX HDD</p>	<p>Audio transcoding – WAV to WMA lossless</p>

Sets	Workload Distribution Estimates	Set Info
PCMark Communications 1	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Data encryption – CNG AES CBC 2. Data compression 3. Windows Mail – copying - Runs Message Rules.
PCMark Communications 2	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Web page rendering – news serial - Opens various news pages in IE7 in separate tabs and closes them one by one. 2. Data decryption – CNG AES CBC 3. HDD – Windows Defender
PCMark Productivity 1	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Text editing</p>
PCMark Productivity 2	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Four simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Windows Contacts – searching - Searches contacts. 2. Windows Mail – searching - Searches mails for words in the message body, subject and sender. 3. Web page rendering – favorites group parallel - Opens various news pages from IE 7 Favorites in separate tabs and closes them one by one. 4. HDD – application loading

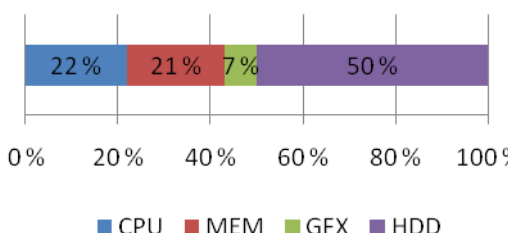
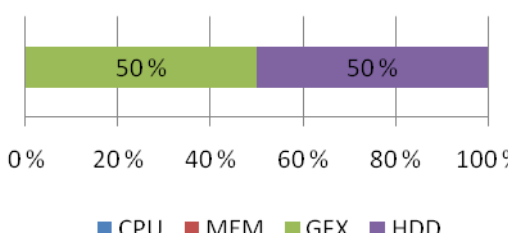
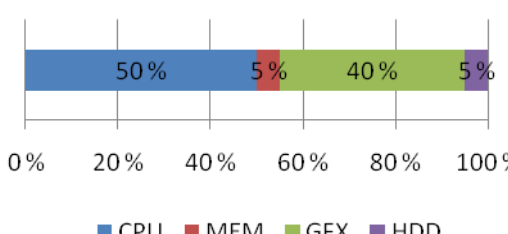
Memories Suite

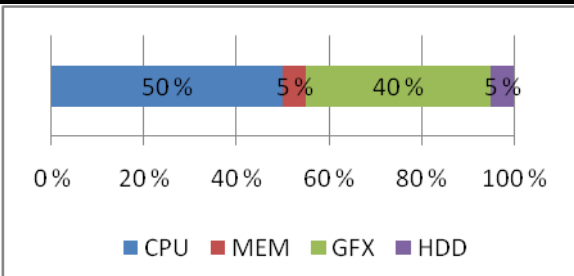
The tests in the Memories Suite have been selected to represent the Windows Vista Memories Consumer Scenario. The combination of test sets covers the common Memories scenario usage. Memories Suite gives a separate PCMark Memories Score which does not affect the overall PCMark Score.

Our memories are often kept in digital form. Here, large digital photos in HD Photo format are stretched, flipped and rotated using the CPU. Plenty of system memory is highly beneficial for manipulating large images. Importing digital photos to Windows Photo Gallery is where a high performance HDD shines. More and more image manipulation is being done using the GPU, enabling instantaneous color correction, sharpening and softening of images. Home video editing with Windows Movie Maker can be very time-consuming – unless you have a high performance HDD. Home videos recorded on digital video cameras are sometimes transcoded and transferred to a portable media player. High definition videos are often archived in media servers. It may, however, be handy to have them transcoded and transferred to a portable media player. A fast CPU with many cores can handle transcoding swiftly.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The Memories Suite includes the following test sets:

Sets	Workload Distribution Estimates	Set Info
Memories 1	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. CPU image manipulation 2. HDD – importing pictures to Windows Photo Gallery
Memories 2	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. GPU image manipulation 2. HDD – video editing using Windows Movie Maker
Memories 3	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Video transcoding – DV to WMV9 - Transcoding from DV (720x480p 35.38 Mbps) to a portable player (SD WMV9 320x240p 1.0 Mbps). Uses two cores if available.</p>

Sets	Workload Distribution Estimates	Set Info										
Memories 4	<div><p>A horizontal stacked bar chart showing the workload distribution for the 'Memories 4' set. The x-axis represents the percentage of workload from 0% to 100% in 20% increments. The bar is divided into four segments: CPU (blue, 50%), MEM (red, 5%), GFX (green, 40%), and HDD (purple, 5%). A legend below the chart identifies the colors: CPU (blue), MEM (red), GFX (green), and HDD (purple).</p><table><thead><tr><th>Component</th><th>Percentage</th></tr></thead><tbody><tr><td>CPU</td><td>50%</td></tr><tr><td>MEM</td><td>5%</td></tr><tr><td>GFX</td><td>40%</td></tr><tr><td>HDD</td><td>5%</td></tr></tbody></table></div>	Component	Percentage	CPU	50%	MEM	5%	GFX	40%	HDD	5%	<p>Video transcoding – VC-1 to WMV9</p> <ul style="list-style-type: none">- Transcoding from media server archive (HD VC-1 1280x720p 11 Mbps) to a portable player (SD WMV9 320x240p 1.0 Mbps).
Component	Percentage											
CPU	50%											
MEM	5%											
GFX	40%											
HDD	5%											

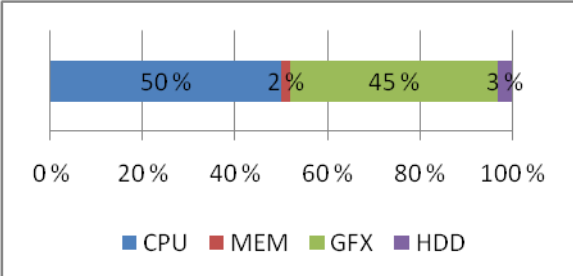
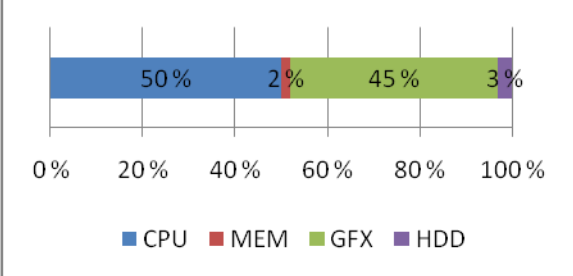
TV and Movies Suite

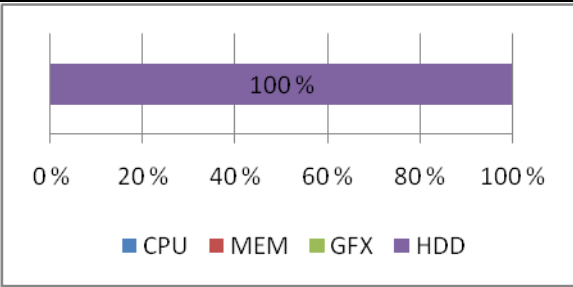
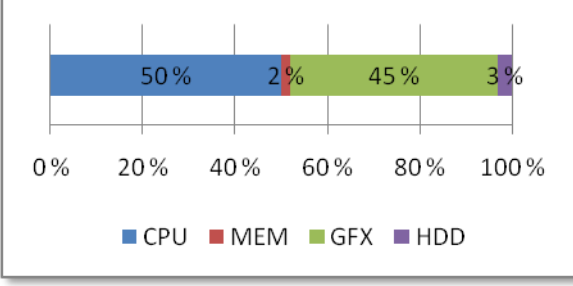
The tests in the TV and Movies Suite have been selected to represent the Windows Vista TV and Movies Consumer Scenario. The combination of test sets covers the common TV and Movies usage. TV and Movies Suite give a separate PCMark TV and Movies Score which does not affect the overall PCMark Score.

High definition TV broadcasts and movies have arrived. Playing an HD DVD with additional HD content, a Blu-ray movie, or watching HDTV smoothly (while making a backup of an HD DVD by transcoding to a media server or transcoding from a media server archive to a portable media player) requires lots of computing and graphical power. Windows Media Center with a high performance HDD can handle simultaneous video recording, time-shifting, and streaming to an Extender for Windows Media Center, such as Xbox 360™.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The TV and Movies Suite include the following test sets:

Sets	Workload Distribution Estimates	Set Info
TV and Movies 1	 <p>0 % 20 % 40 % 60 % 80 % 100 %</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Video transcoding – VC-1 to VC-1 <ul style="list-style-type: none"> - Transcoding from HD DVD (HD VC-1 1920x1080p 28 Mbps) to the media server archive (HD VC-1 1280x720p 11 Mbps). Uses two cores if available. 2. Video playback – VC-1 HD DVD with HD content <ul style="list-style-type: none"> - Playing HD DVD (VC-1 1920x1080p 28 Mbps) with HD (VC-1 1280x720p 7 Mbps) content.
TV and Movies 2	 <p>0 % 20 % 40 % 60 % 80 % 100 %</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Video transcoding – VC-1 to VC-1 <ul style="list-style-type: none"> - Transcoding from HD DVD (HD VC-1 1920x1080p 28 Mbps) to the media server archive (HD VC-1 1280x720p 11 Mbps). Uses two cores if available. 2. Video playback – MPEG-2 HDTV <ul style="list-style-type: none"> - Playing terrestrial HDTV (HD MPEG-2 1920x1080i 19.39 Mbps).

Sets	Workload Distribution Estimates	Set Info
TV and Movies 3	 <p>A horizontal stacked bar chart showing workload distribution for 'TV and Movies 3'. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is entirely purple, indicating 100% usage by HDD. A legend below the chart identifies the components: CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	HDD – Windows Media Center
TV and Movies 4	 <p>A horizontal stacked bar chart showing workload distribution for 'TV and Movies 4'. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is divided into four segments: blue (CPU) at 50%, red (MEM) at 2%, green (GFX) at 45%, and purple (HDD) at 3%. A legend below the chart identifies the components: CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Video transcoding – VC-1 to WMV9 <ul style="list-style-type: none"> - Transcoding from the media server archive (HD VC-1 1280x720p 11 Mbps) to a portable player (SD WMV9 320x240p 1.0 Mbps). Uses two cores if available. 2. Video playback – MPEG-2 Blu-ray <ul style="list-style-type: none"> - Playing Blu-ray (HD MPEG-2 1920x1080p 48 Mbps).

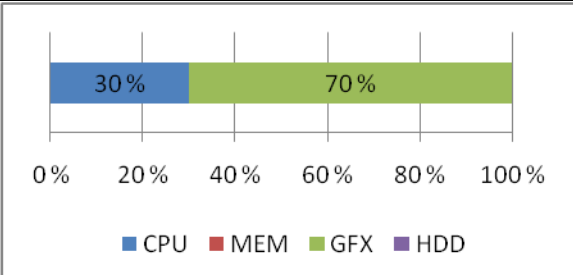
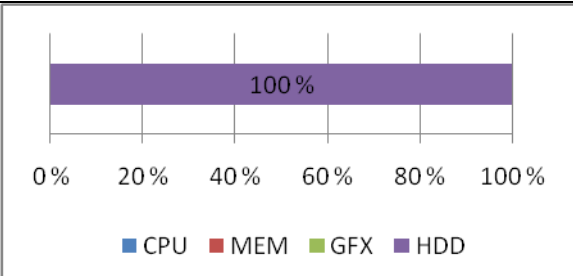
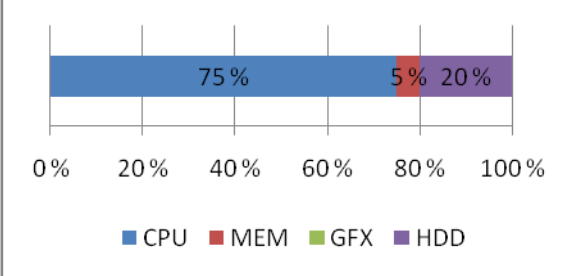
Gaming Suite

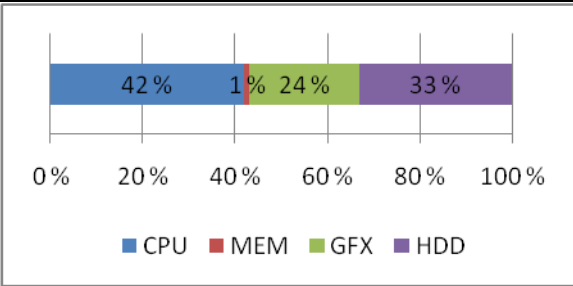
The tests in the Gaming Suite have been selected to represent the Windows Vista Gaming Consumer Scenario. The combination of test sets covers the common Gaming usage. Gaming Suite gives a separate PCMark Gaming Score which does not affect the overall PCMark Score.

Gaming is one of the most popular forms of entertainment for all ages. Today's games demand high performance graphics cards and CPUs to avoid delays and sluggish performance while playing. Loading screens in games are yesterday's news. Streaming data from an HDD in games – such as Alan Wake™ – allows for massive worlds and riveting non-stop action. CPUs with many cores give a performance advantage to gamers in real-time strategy and massively multiplayer games.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The Gaming Suite includes the following test sets:

Sets	Workload Distribution Estimates	Set Info
Gaming 1	 <p>A horizontal stacked bar chart for Gaming 1. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is divided into two segments: a blue segment for CPU (30%) and a green segment for GFX (70%). A legend below the chart identifies CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>GPU gaming</p> <ul style="list-style-type: none"> - Performing basic GPU (graphics processing unit) tasks utilizing PS (pixel shader) 2.0 and VS (vertex shader) 2.0 operations found in most 3D games using DX (DirectX) 9. This test utilizes SM (shader model) 3.0 (if available) performance optimizations which do affect visual quality.
Gaming 2	 <p>A horizontal stacked bar chart for Gaming 2. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is a single purple segment for HDD (100%). A legend below the chart identifies CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>HDD – gaming</p>
Gaming 3	 <p>A horizontal stacked bar chart for Gaming 3. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is divided into three segments: a blue segment for CPU (75%), a red segment for MEM (5%), and a purple segment for HDD (20%). A legend below the chart identifies CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Data decompression <ul style="list-style-type: none"> - Loading compressed level from hard drive and decompressing it into system memory. 2. CPU gaming <ul style="list-style-type: none"> - Executing heavy AI path finding algorithms. Uses all available cores up to 16 cores.

Sets	Workload Distribution Estimates	Set Info
Gaming 4	 <p>42 % 1 % 24 % 33 %</p> <p>0 % 20 % 40 % 60 % 80 % 100 %</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. GPU gaming <ul style="list-style-type: none"> - Performing basic GPU (graphics processing unit) tasks utilizing PS (pixel shader) 2.0 and VS (vertex shader) 2.0 operations found in most 3D games using DX (DirectX) 9. This test utilizes SM (shader model) 3.0 (if available) performance optimizations which do affect visual quality. 2. CPU gaming <ul style="list-style-type: none"> - Executing heavy AI path finding algorithms. Uses all available cores up to 16 cores. 3. HDD – gaming

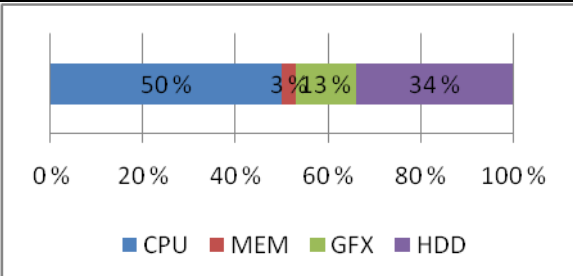
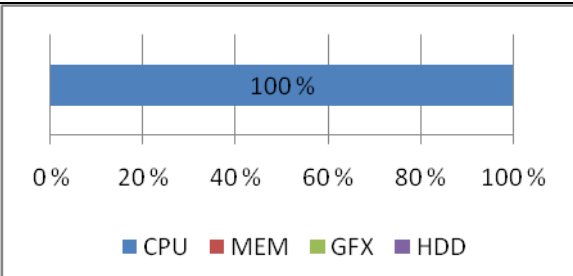
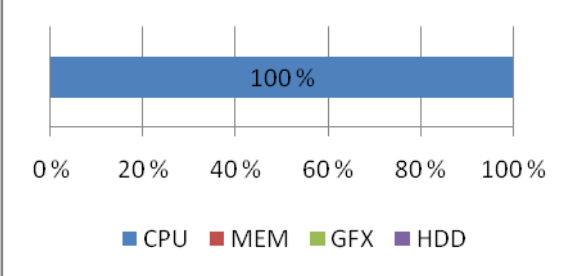
Music Suite

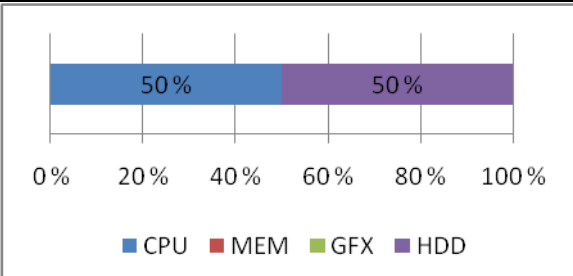
The tests in the Music Suite have been selected to represent the Windows Vista Music Consumer Scenario. The combination of test sets covers the common Music usage. Music Suite gives a separate PCMark Music Score which does not affect the overall PCMark Score.

Online music shops have changed the way we purchase music, letting us buy exactly the tracks we want, right from home. Cataloguing your music library is a breeze for fast and powerful HDDs. The most common audio file formats decrease your music's audio quality which is undesirable. Luckily, lossless audio file formats are becoming more popular. Transcoding from non-compressed audio to a lossless format is heavily taxing on the CPU. Transcoding your audio files from one format to another is much quicker and easier using high performance CPUs.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The Music Suite includes the following test sets:

Sets	Workload Distribution Estimates	Set Info
Music 1	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Web page rendering – music shop - Opens music shop kind of content. 2. Audio transcoding – WAV to WMA lossless 3. HDD – adding music to Windows Media Player
Music 2	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Audio transcoding – WAV to WMA lossless</p>
Music 3	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Audio transcoding – MP3 to WMA</p>

Sets	Workload Distribution Estimates	Set Info
Music 4	 <p>50% 50%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Audio transcoding – WMA to WMA 2. HDD – adding music to Windows Media Player

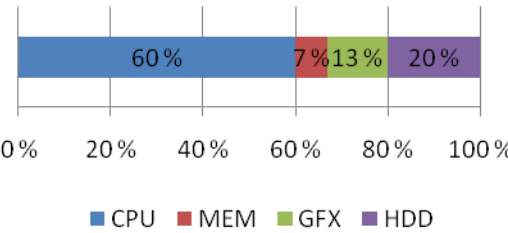
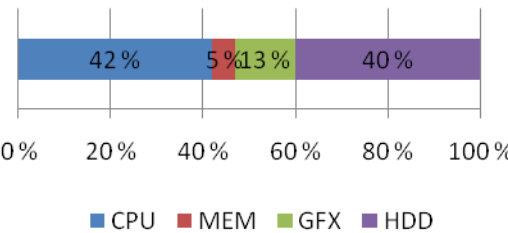
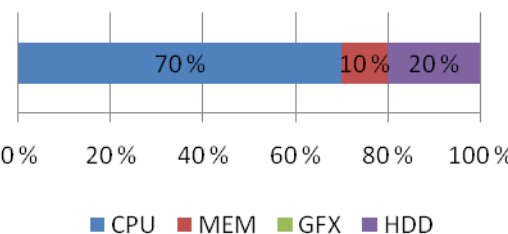
Communications Suite

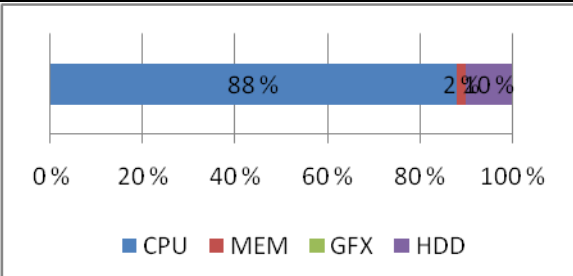
Tests in the Communications Suite have been selected to represent the Windows Vista Communications Consumer Scenario. The combination of test sets covers the common Communications usage. Communications Suite gives a separate PCMark Communications Score which does not affect the overall PCMark Score.

Security is more important today than ever before. To compress and encrypt all personal information is vital for safe computing. Emails are the most important type of communication, whether it is personal or business. To keep the workflow smooth and enjoyable, high performance CPUs and HDDs are recommended. Reading news online while having your cup of coffee is quality-time. Often one site isn't enough, so tabbed browsing is a perfect solution for news-hungry people. Spyware is very common on systems without protection against it, letting Windows Defender scan & protect your system is recommended. Voice over IP – with Skype™ or Windows Live Messenger – is very popular these days. Encrypted messaging for home and workplace gives additional security.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The Communications Suite includes the following test sets:

Sets	Workload Distribution Estimates	Set Info
Communications 1	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Data encryption – CNG AES CBC 2. Data compression 3. Web page rendering – pictures <ul style="list-style-type: none"> - Opens a web page with many large pictures.
Communications 2	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Web page rendering – favorites group parallel <ul style="list-style-type: none"> - Opens various news pages from IE 7 Favorites in separate tabs and closes them one by one. 2. Data decryption – CNG AES CBC 3. HDD – Windows Defender
Communications 3	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Windows Mail – searching</p> <ul style="list-style-type: none"> - Searches mails for words in the message body, subject and sender.

Sets	Workload Distribution Estimates	Set Info
Communications 4	 <p>88 % 2 % 10 %</p> <p>0 % 20 % 40 % 60 % 80 % 100 %</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Data encryption – CNG AES CBC 2. Audio transcoding – WMA to WMA <ul style="list-style-type: none"> - Measures audio transcoding performance in VOIP usage.

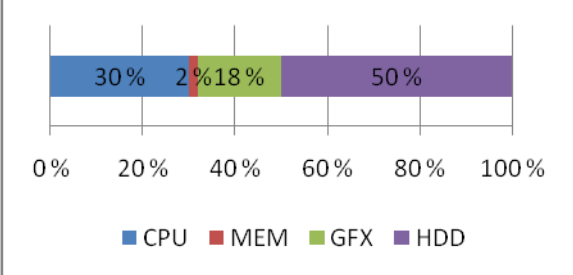
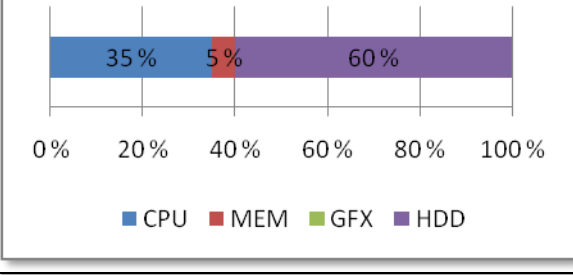
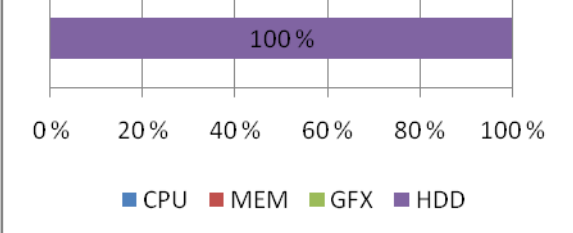
Productivity Suite

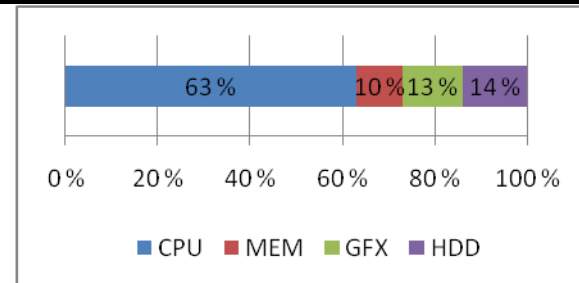
Tests in the Productivity Suite have been selected to represent the Windows Vista Productivity Consumer Scenario. The combination of test sets covers the common Productivity usage. Productivity Suite gives a separate PCMark Productivity Score which does not affect the overall PCMark Score.

Starting various applications can take a long time – unless you have a high performance HDD. Editing text with WordPad is a breeze when done with fast CPUs and graphics cards. Often one site isn't enough, so tabbed browsing is a perfect solution for highly productive people. Spyware is very common on systems without protection against it, letting Windows Defender scan & protect your system is recommended. Starting Windows Vista is a rather demanding task for the storage device, but a fast HDD will notably decrease the loading time. Our busy lives find us hard at work, balancing multiple tasks; with little time for breaks. It's the same for our computers. Multiple tasks, running simultaneously, put your system under a lot of stress. Having a modern, up-to-date CPU, HDD, graphics card and board full of system memory increases your computer's productivity and reduces your stress.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

The Productivity Suite includes the following test sets:

Sets	Workload Distribution Estimates	Set Info
Productivity 1	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Text editing 2. HDD – application loading
Productivity 2	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>Two simultaneous tasks.</p> <ol style="list-style-type: none"> 1. Windows Contacts – searching - search 2. HDD – Windows Defender
Productivity 3	 <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>HDD – Windows Vista start up</p>

Sets	Workload Distribution Estimates	Set Info										
Productivity 4	 <table><thead><tr><th>Component</th><th>Percentage</th></tr></thead><tbody><tr><td>CPU</td><td>63%</td></tr><tr><td>MEM</td><td>10%</td></tr><tr><td>GFX</td><td>13%</td></tr><tr><td>HDD</td><td>14%</td></tr></tbody></table>	Component	Percentage	CPU	63%	MEM	10%	GFX	13%	HDD	14%	<p>Three simultaneous tasks.</p> <ol style="list-style-type: none">1. Windows Contacts – searching - Searches contacts.2. Windows Mail – copying - Runs Message Rules.3. Web page rendering – favorites group parallel - Opens various news pages from IE 7 Favorites in separate tabs and closes them one by one.
Component	Percentage											
CPU	63%											
MEM	10%											
GFX	13%											
HDD	14%											

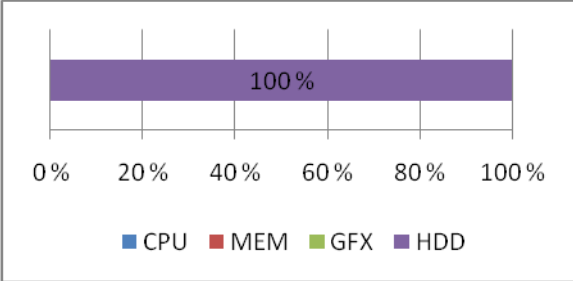
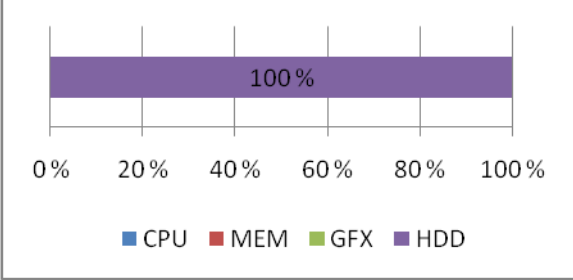
HDD Suite

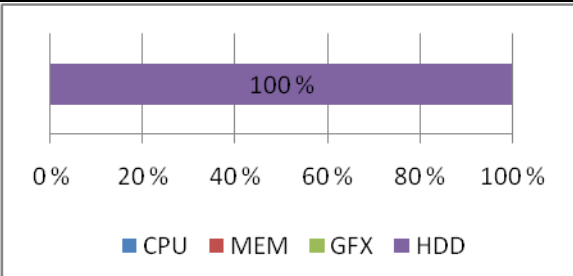
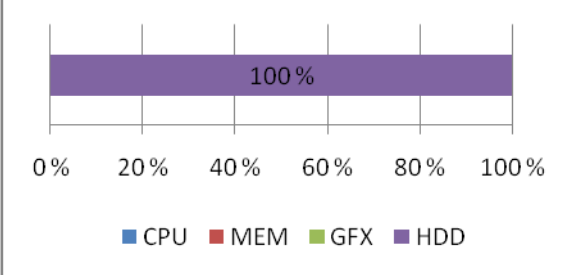
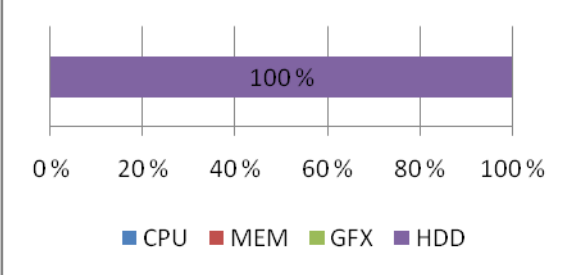
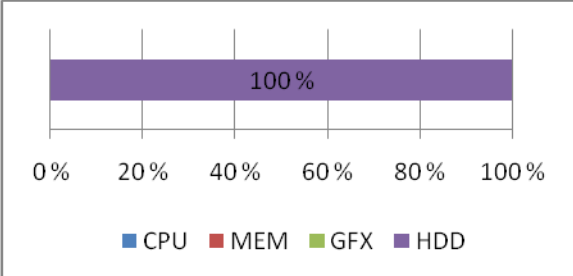
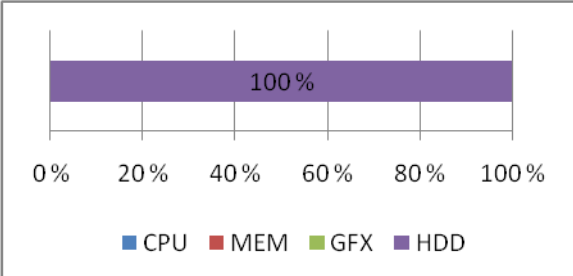
Tests in the HDD Suite are a combination of tests covering the common HDD usage. HDD results use the new 4K block size. HDD Suite gives a separate PCMark HDD Score which does not affect the overall PCMark Score. Although the name of the suite is HDD Suite, it is perfectly suitable for testing any writable local disk systems ranging from USB sticks to HDDs and SSDs by selecting the HDD Suite Target in the Benchmark settings.

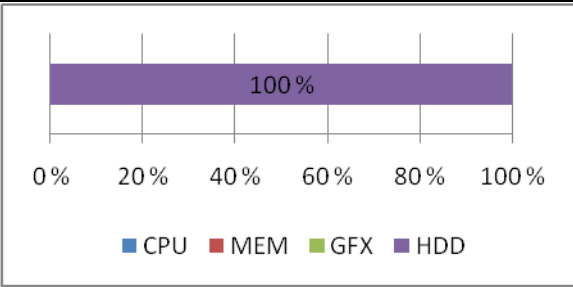
Spyware is very common on systems without protection against it, letting Windows Defender scan & protect your system is recommended. Streaming data from an HDD in games – such as Alan Wake™ – allows for massive worlds and riveting non-stop action. Importing digital photos to Windows Photo Gallery is where a high performance HDD shines. Starting Windows Vista is a rather demanding task for the storage device, but a fast HDD will notably decrease the loading time. Home video editing with Windows Movie Maker can be very time-consuming – unless you have a high performance HDD. Windows Media Center with a high performance HDD can handle simultaneous video recording, time-shifting, and streaming to an Extender for Windows Media Center, such as Xbox 360™. Cataloguing your music library is a breeze for fast and powerful HDDs. Starting various applications can take a long time – unless you have a high performance HDD.

NOTE: The workload for each subsystem depends heavily on the overall system configuration. Different components can be severe bottlenecks and cause variance in the results of the actual component performance measurement. Fragmented HDDs, old drivers, cluttered OS, 3rd party applications etc. are all factors which will affect the benchmark results. This is why these indications below are estimates.

The HDD Suite includes the following test suites:

Sets	Workload Distribution Estimates	Set Info
HDD 1		HDD – Windows Defender
HDD 2		HDD – gaming

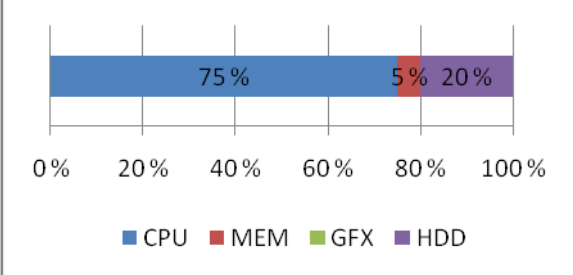
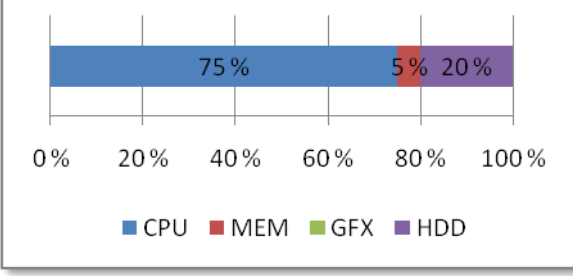
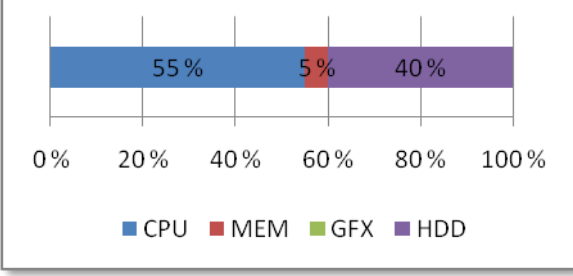
Sets	Workload Distribution Estimates	Set Info
HDD 3		HDD – importing pictures to Windows Photo Gallery
HDD 4		HDD – Windows Vista start up
HDD 5		HDD – video editing using Windows Movie Maker
HDD 6		HDD – Windows Media Center
HDD 7		HDD – adding music to Windows Media Player

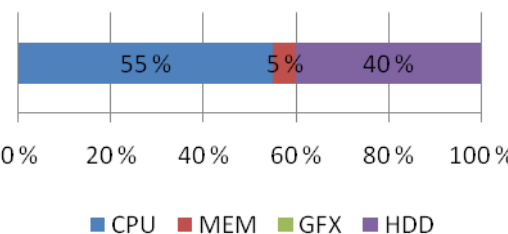
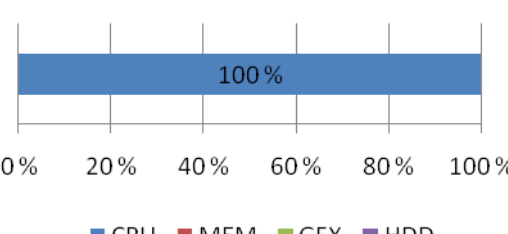
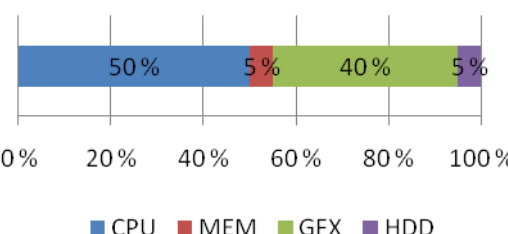
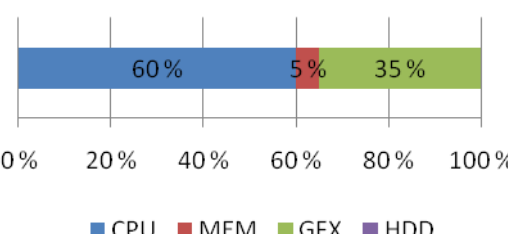
Sets	Workload Distribution Estimates	Set Info
HDD 8	 <p>100 %</p> <p>0 % 20 % 40 % 60 % 80 % 100 %</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	HDD – application loading

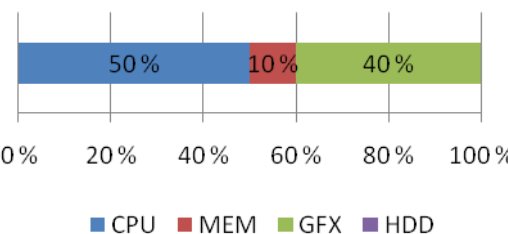
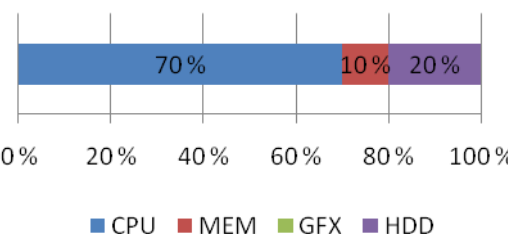
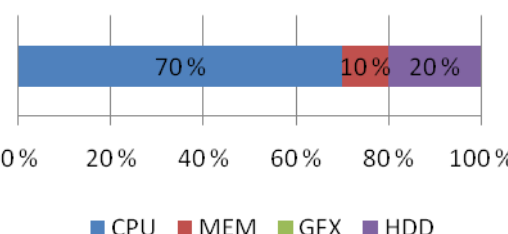
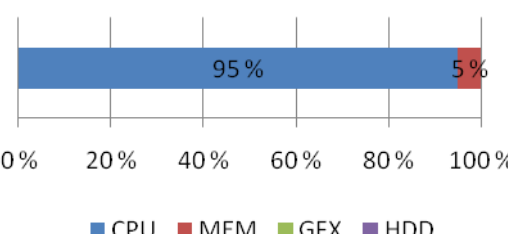
The Tests

Numbers in CPU / MEM / GFX / HDD columns indicate an estimate of subsystems being more stressed by the test. I.e. Web page rendering test stresses the CPU (processor), MEM (memory) and GFX (graphics) subsystems, but does not particularly stress the HDD (hard disk drive) subsystem. The workload for each subsystem depends heavily on the overall system configuration. In some cases where the CPU is targeted to be stressed, it can be bogged by a very slow and fragmented HDD. This is why these indications below are estimates.

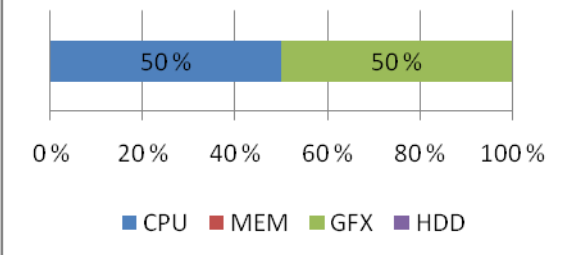
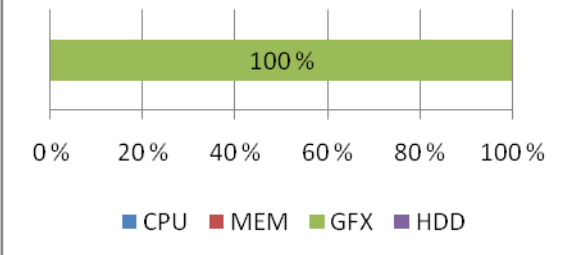
CPU Tests

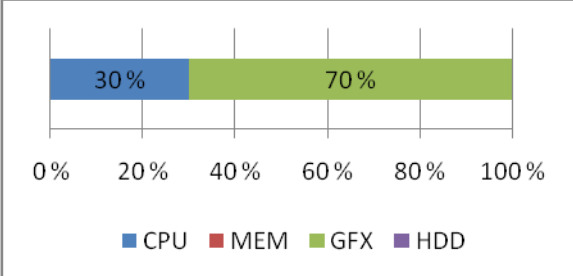
Tests	Workload Distribution Estimates	Test Info
Data encryption CNG AES CBC	 <p>A horizontal stacked bar chart showing workload distribution for Data encryption CNG AES CBC. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is divided into three segments: CPU (blue, 75%), MEM (red, 5%), and HDD (purple, 20%). A legend below the chart identifies the colors: CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>We use built-in Windows Vista Cryptography API: Next Generation (CNG, using AES [Advanced Encryption Standard] CBC [Cipher Block Chaining] with 256 bit key sizes). We measure the whole time it takes to encrypt the data with HDD access. (If this was a pure CPU test, only the data encryption in memory part would have been measured.) Unit is MB/s.</p>
Data decryption CNG AES CBC	 <p>A horizontal stacked bar chart showing workload distribution for Data decryption CNG AES CBC. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is divided into three segments: CPU (blue, 75%), MEM (red, 5%), and HDD (purple, 20%). A legend below the chart identifies the colors: CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>We use built-in Windows Vista Cryptography API: Next Generation (CNG, using AES CBC with 256 bit key sizes). We measure the whole time it takes to decrypt the data with HDD access. (If this was a pure CPU test, only the data decryption in memory part would have been measured.) Unit is MB/s.</p>
Data compression	 <p>A horizontal stacked bar chart showing workload distribution for Data compression. The x-axis represents percentage from 0% to 100% in 20% increments. The bar is divided into three segments: CPU (blue, 55%), MEM (red, 5%), and HDD (purple, 40%). A legend below the chart identifies the colors: CPU (blue), MEM (red), GFX (green), and HDD (purple).</p>	<p>We use built-in Windows Vista compression API: FSCTL_SET_COMPRESSION DeviceIoControl function. We measure the whole time it takes to compress the data with HDD access. (If this was a pure CPU test, only the data compression in memory part would have been measured.) Unit is MB/s.</p>

Tests	Workload Distribution Estimates	Test Info
Data decompression	 <p>55% 5% 40%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use built-in Windows Vista LZRead decompression function. We measure the whole time it takes to decompress the data with HDD access. (If this was a pure CPU test, only the data decompression in memory part would have been measured.) Unit is MB/s.</p>
CPU image manipulation	 <p>43% 43% 14%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use built-in components of Windows Vista: Windows Presentation Foundation (WPF) Imaging Component (WIC). Source images are in HD Photo format. This test is built so that it is affected by the system memory speed and size as well. We measure the time it takes to complete the given image manipulation task(s) using CPU. Those tasks are: Stretch, flip and rotate. Unit is MB/s.</p>
Audio transcoding	 <p>100%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use MP3 and WMA formats, supported natively by Windows Vista. What is the difference of audio compression and transcoding? Compression is a subset of transcoding where the source is WAV. We measure the time it takes to complete the given audio transcoding task(s). Unit is MB/s.</p>
Video transcoding	 <p>50% 5% 40% 5%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We transcode using built-in codecs of Windows Vista: VC-1, WMV9 and DV. We measure the time it takes to complete the given video transcoding task(s). Uses two cores if available. Unit is fps.</p>
Text editing	 <p>60% 5% 35%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use WordPad (shipped with Windows Vista) and perform search & replace operations on the given document. We show the opened document. We measure the time it takes to complete the search & replace operations. Unit is kB/s.</p>

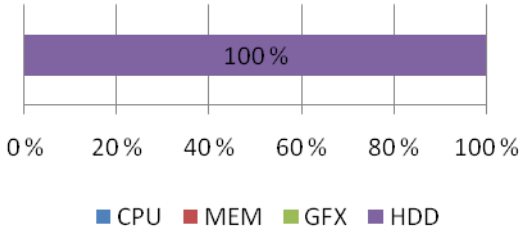
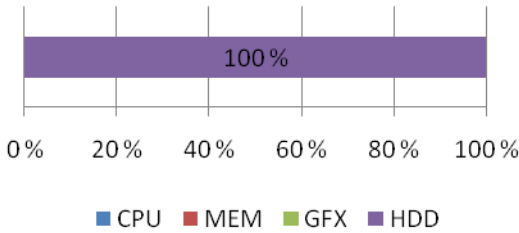
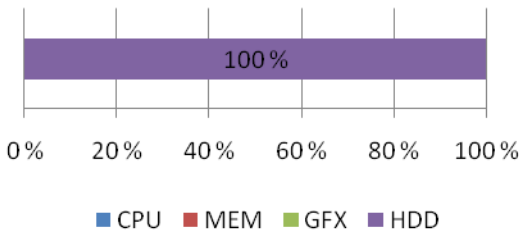
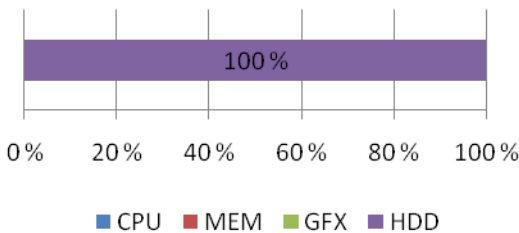
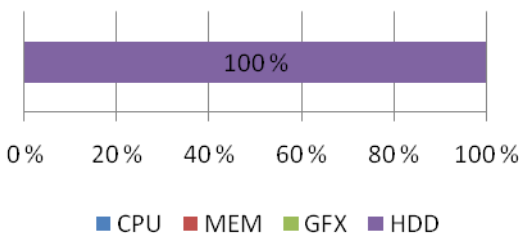
Tests	Workload Distribution Estimates	Test Info
Web page rendering	 <p>50% 10% 40%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use embedded Internet Explorer 7 (shipped with Windows Vista) to open pages in new tabs instead of always closing and opening new instances of IE. These tests include single page rendering and serial and parallel tab rendering. We show the opened pages. We measure the time it takes to open pages. Unit is pages/s.</p>
Windows Mail	 <p>70% 10% 20%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use Windows Mail (shipped with Windows Vista) with our own set of emails and message rules. This test includes searches for words in the message body, subject and sender, and running message rules (copying messages). Unit is operations/s.</p>
Windows Contacts	 <p>70% 10% 20%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>We use Windows Contacts (shipped with Windows Vista) with our own set of contacts. This test includes searches from contacts. Unit is contacts/s.</p>
CPU gaming	 <p>95% 5%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>This test is graphically very simple CPU test (it does not show anything) executing basic CPU calls found in most games. These tasks are heavy AI path finding algorithms. This test stresses the CPU and scales dynamically according to the number of cores. Unit is operations/s.</p>

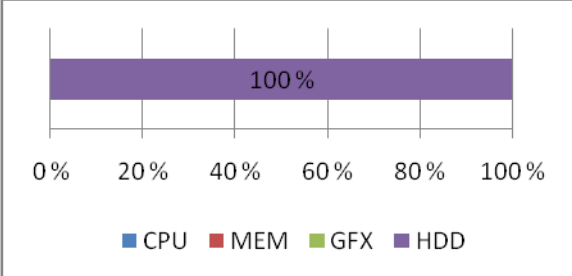
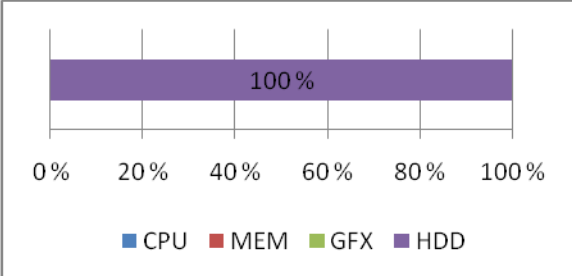
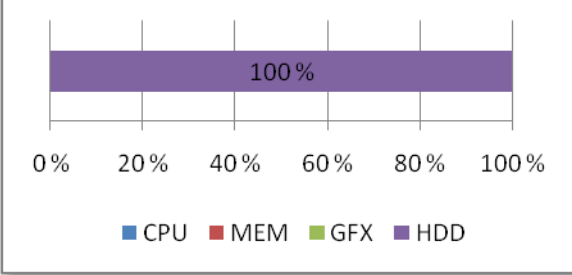
Graphics Tests

Tests	Workload Distribution Estimates	Test Info
Video playback	 <p>A horizontal stacked bar chart showing workload distribution for video playback. The x-axis ranges from 0% to 100% in 20% increments. The bar is divided into two equal segments: a blue segment for CPU (50%) and a green segment for GFX (50%). The legend below the chart identifies CPU as blue, MEM as red, GFX as green, and HDD as purple.</p>	<p>These tests measure the performance of playing back a video file. The tests use high definition video content with Windows Vista built-in video codecs. The codecs are MPEG-2 (built-in in Windows Media Center that ships with Windows Vista Home Premium and Ultimate) and VC-1.</p> <p>The video files are in high definition resolutions and are rendered through Video Mixing Renderer 9.</p> <p>The video streams are played at the default frame rate. Possible video stream combinations are:</p> <ul style="list-style-type: none"> - HD - HD + SD (HD DVD with SD commentary) - HD + HD (HD DVD with additional lower bitrate HD content from HDD, downloaded from internet). <p>It is very possible (and desirable!) that in future all systems can play content provided in this test at default frame rate without dropped frames.</p> <p>These tests will only be used in multithreaded test sets, so they are never run by themselves.</p> <p>Unit is fps.</p>
GPU image manipulation	 <p>A horizontal stacked bar chart showing workload distribution for GPU image manipulation. The x-axis ranges from 0% to 100% in 20% increments. The bar is a single green segment representing 100% workload for the GFX component. The legend below the chart identifies CPU as blue, MEM as red, GFX as green, and HDD as purple.</p>	<p>This test measures everyday image manipulation on the graphics hardware (in the shaders): colour correction, sharpen and soften.</p> <p>Unit is fps.</p>

Tests	Workload Distribution Estimates	Test Info
GPU gaming	 <p>30% 70%</p> <p>0% 20% 40% 60% 80% 100%</p> <p>■ CPU ■ MEM ■ GFX ■ HDD</p>	<p>This test measures basic GPU tasks performed in typical 3D games. The test utilizes both pixel shaders (2.0) and vertex shaders (2.0). This test does not require SM3.0 but uses its performance optimizations if it is available. Test is modified from 3DMark06 Graphics Test 2 – Firefly Forest, but changed to run in windowed mode. The average number of triangles is 100.000-300.000. Unit is fps.</p>

HDD Tests

Tests	Workload Distribution Estimates	Test Info
HDD Windows Defender		<p>Measures disk drive performance of Windows Defender Scan on Windows Vista Ultimate. Unit is MB/s.</p> <p>Read[%] Write[%] 99,38 0,62</p>
HDD gaming		<p>Measures seamless data streaming performance from disk drive in Alan Wake™. Unit is MB/s.</p> <p>Read[%] Write[%] 99,95 0,05</p>
HDD importing pictures to Windows Photo Gallery		<p>Measures disk drive performance of importing a large collection of images to Windows Photo Gallery. Unit is MB/s.</p> <p>Read[%] Write[%] 84,09 15,91</p>
HDD Windows Vista start up		<p>Measures disk drive performance of Windows Vista Ultimate start up. Unit is MB/s.</p> <p>Read[%] Write[%] 84,67 15,33</p>
HDD video editing using Windows Movie Maker		<p>Measures concurrent disk drive performance of video editing tasks using Windows Movie Maker: A) video read and skip, and B) video write. Unit is MB/s.</p> <p>Read[%] Write[%] 53,41 46,59</p>

Tests	Workload Distribution Estimates	Test Info
HDD Windows Media Center		<p>Measures concurrent disk drive performance of MC tasks: A) SDTV video playback, B) SDTV video streaming to Extender for Windows Media Center, and C) SDTV video recording. Unit is MB/s.</p> <p>Read[%] Write[%] 50,12 49,88</p>
HDD adding music to Windows Media Player		<p>Measures disk drive performance of adding music to Windows Media Player 11. Unit is MB/s.</p> <p>Read[%] Write[%] 77,93 22,07</p>
HDD application loading		<p>Measures disk drive performance of loading the following applications: Microsoft Word 2007, Adobe Photoshop CS2, Internet Explorer 7 Web Browser and Outlook 2007. Unit is MB/s.</p> <p>Read[%] Write[%] 87,17 12,83</p>

Important notes about the HDD Tests:

- With RankDisk we emulate the given HDD trace. By playing the trace using a temporary sandbox file, we measure the time it takes to complete the given trace.
- HDD Tests use new 4K block size*.
- All HDD Tests use RankDisk using Intel's IPEAK Storage Performance Toolkit.
- RankDisk is modified and compiled by Futuremark.
- WinTrace is used to record the HDD traces.
- AnalyzeTrace is used to analyze precisely what the traces are doing.
- RankDisk is non-destructive: All the write operations are committed to a temporary sandbox file.
- All the read operations using the trace are actually done as in the HDD they were recorded on.

* NOTE: Clean installation of Microsoft Windows Vista has proper 4 K Logical Block Addressing (LBA) alignments. Upgrading to Windows Vista from Windows XP causes possible alignment issues. Also using some 3rd party partition tools may cause alignment issues. Futuremark strongly suggest using a clean instalment of Windows Vista before running PCMark Vantage.

Score Calculation

PCMark Vantage provides an overall PCMark score and six component scores. The PCMark score is a measure of the overall performance of the PC and is obtained by running the PCMark Suite. Other Suite Scores are obtained by running the corresponding Suites: Memories Suite, TV and Movies Suite, Gaming Suite, Music Suite, Communications Suite, Productivity Suite and HDD Suite. Note that no overall score will be presented for custom test suites. However, using the “Export to Microsoft® Excel” feature the user can implement this functionality as an Excel formula¹.

PCMark Score

The PCMark score is calculated by using the results of the various tests in the systems test suite. The individual test scores are combined using a geometric mean. The geometric mean provides a fair mechanism to combine a large number of test results as compared to assigning arbitrary weights to individual scores. Geometric means are used in other successful benchmarks such as those from SPEC. The geometric mean is scaled using results from reference systems to produce the appropriate range of scores. The general formula for the geometric mean is:

Geometric mean = $(\text{item1} * \text{item2} * \text{item3} * \text{item4} * \dots * \text{itemN})^{1/N}$.

Geomean is shorthand for geometric mean. If there are any tests the hardware or the version of the operating system isn't capable of running, the results of those particular tests are “1”. Also other tests in that same set are not run and given results of “1”.

The formula for the overall PCMark score is:

$$\text{PCMark Score} = 261.92 * [\text{geomean of the PCMark Suite test results}]$$

Memories Score

The Memories Score is also the geometric mean calculated from the Memories Suite test results. The scaling factor is created in a same manner as for the PCMark score. The score formula is:

$$\text{Memories Score} = 240.14 * [\text{geomean of the Memories Suite test results}]$$

TV and Movies Score

The TV and Memories Score is calculated from the TV and Memories Suite test results using a geometric mean. The scaling factor is created in a same way as for the PCMark score. The score formula is:

$$\text{TV and Movies Score} = 1465.63 * [\text{geomean of the TV and Movies test results}]$$

Gaming Score

The PCMark Vantage Gaming Score is calculated also using the geometric mean. The formula used is:

$$\text{Gaming Score} = 29.34 * [\text{geomean of the Gaming Suite test results}]$$

Music Score

The Music Score is calculated from the Music Suite test results using a geometric mean. The scaling factor is created in a same way as for the PCMark score. The score formula is:

$$\text{Music Score} = 993.13 * [\text{geomean of the Music Suite test results}]$$

¹ Note that such custom scores are not comparable to official PCMark scores.

Communications Score

The PCMark Vantage Communications Score is calculated also using the geometric mean. The formula used is:

$$\text{Communications Score} = 683.58 * [\text{geomean of the Communications Suite test results}]$$

Productivity Score

The Productivity Score is also the geometric mean calculated from the Productivity Suite test results. The scaling factor is created in a same manner as for the PCMark score. The score formula is:

$$\text{Productivity Score} = 47.73 * [\text{geomean of the Productivity Suite test results}]$$

HDD Score

As in the other test suites, also the HDD Score is calculated using the geometric mean:

$$\text{HDD Score} = 214.65 * [\text{geomean of the HDD Suite test results}]$$

Benchmark Usage, Settings & Options

The new interface of PCMark Vantage is very easy and simple to use. Upon loading PCMark Vantage, you will see this main window (image below is from the Professional Edition):



PCMark Vantage GUI – new design and easy to use.

There are 3 main sections in the window and 5 main buttons.

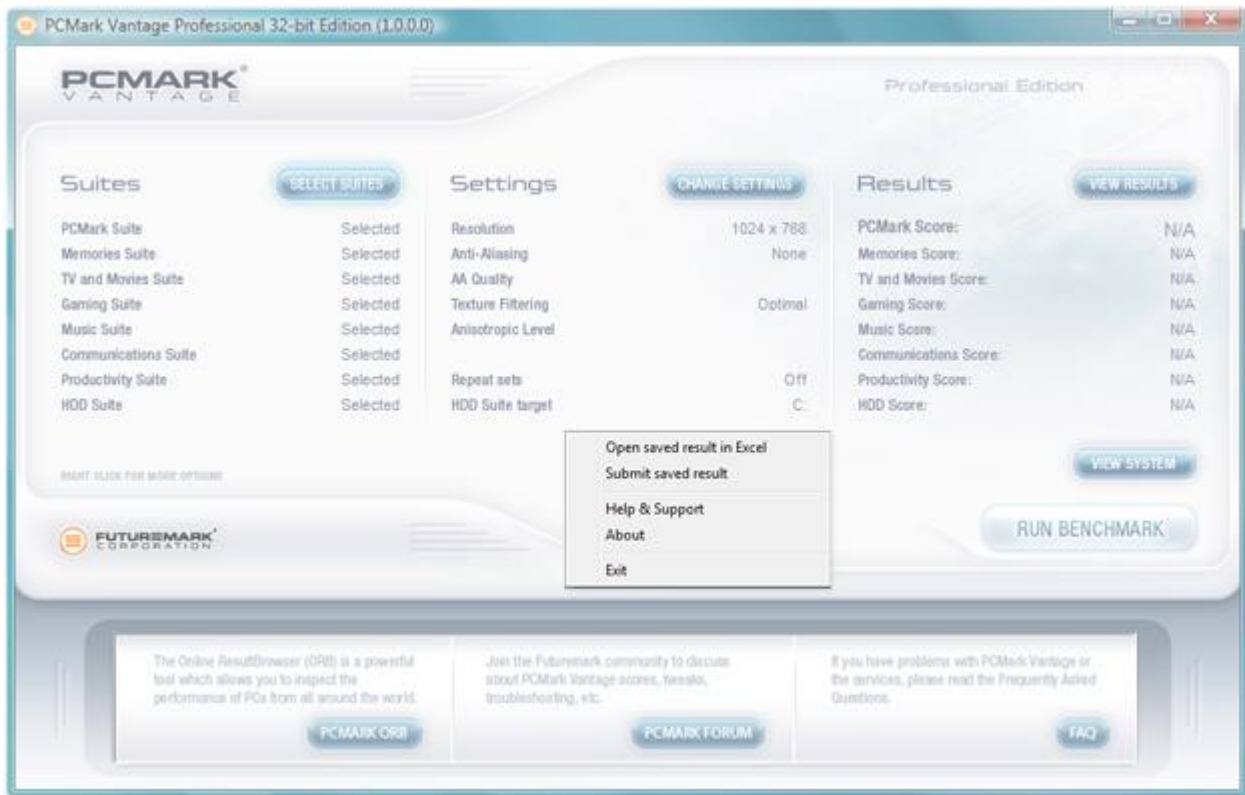
Sections:

- Suites – displays the suites which are selected
- Settings – reports on the display and test configurations for the benchmark run
- Results – displays the PCMark Score and all other sub-scores after benchmarking

Main buttons:

- Select Suites – opens up the Select Suites dialogue (read more below)
- Change Settings – opens up the Benchmark settings dialogue (read more below)
- View Results – opens up the PCMark results dialogue (read more below)
- View System – opens up the SystemInfo window (read more below)
- Run Benchmark – runs the benchmark according to the selected benchmark settings and suites

The 'banner space' below the main GUI is dedicated to information related to PCMark Vantage or other important announcements from Futuremark Corporation. The Advanced and Basic Editions also have a second 'banner space' intended for 3rd party announcements and/or advertisements.



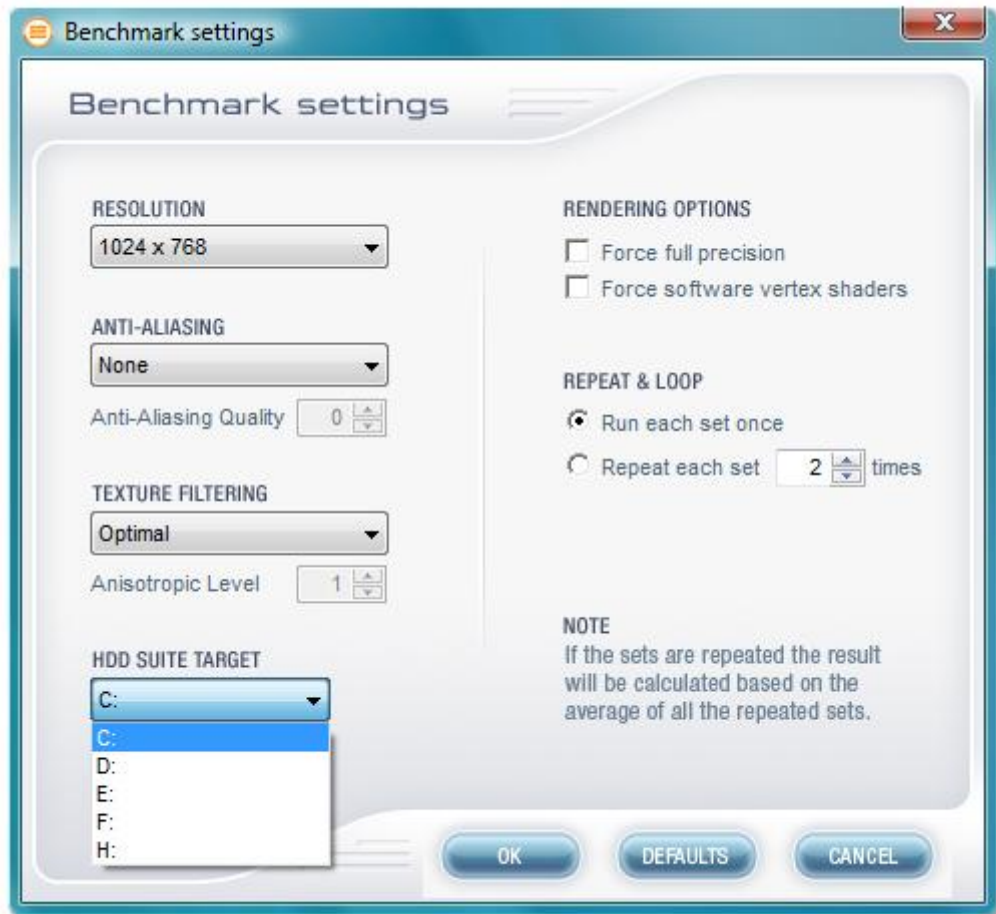
PCMark Vantage Options Menu – the options menu can be opened by clicking the right mouse button anywhere on the GUI.

The options menu allows you the following:

- Open saved result in Excel – opens one or many saved PCMark Vantage result file(s) in Microsoft Excel. This option is not available in the Basic or Advanced Editions. Multiple result files can be selected for comparison in Excel by holding the 'Ctrl' key and selecting many result files.
- Submit saved result - submits a previously saved PCMark Vantage result file to the Online ResultBrowser (ORB).
- Help & Support – opens up PCMark Vantage online help.
- About – shows the About PCMark Vantage dialogue.
- Exit - exits PCMark Vantage.

Benchmark Settings

The Benchmark Settings in PCMark Vantage Advanced and Professional Editions introduce a multitude of options even for the most demanding benchmarkers.



PCMark Vantage Benchmark Settings.
 (Advance and Professional Editions only)

Resolution

This drop-down menu allows you to select the frame resolution that all the tests are rendered at. Choosing a setting higher than the default value of 124 x 768 may result in lower scores in the 3D gaming test than with the default values. The range of resolutions available depends on what the graphics adapter and monitors support. PCMark Vantage uses 32 bit colors, with an 8-8-8-8 bit RGBA color palette in all tests. This setting only affects the GPU gaming test.

Anti-Aliasing

This drop-down menu selects which level of Full Scene Anti-Aliasing (FSAA) to use, provided the graphics adapter has support for FSAA via DirectX. Choosing higher levels of anti-aliasing will produce a finer looking rendering, but the test results will be lower. You can choose between non-maskable anti-aliasing (IHV and driver dependent), or anti-aliasing of certain sample counts, depending on what your hardware supports. If you choose non-maskable FSAA, PCMark Vantage automatically uses the lowest quality level. There is also an option to choose FSAA quality, which is offered by some hardware and drivers. The meaning of these

quality levels varies a lot from one graphics card to another. Please refer to the documentation of your graphics hardware to find out what these quality levels offer on your hardware. This setting only affects the GPU gaming test.

Texture Filtering Mode

This drop-down menu allows you to select what form of texture filtering is applied in all tests. There are various options:

- **Optimal** - a mixture of bilinear and trilinear filtering is used, depending on what objects will benefit most from the higher quality textures.
- **Bilinear** - all textures are filtered using the standard bilinear interpolate. Depending on the test and graphics adapter, this setting may produce higher test results than the default setting.
- **Trilinear** - all textures are filtered using a trilinear interpolate. Depending on the test and graphics adapter, this setting may produce lower test results than the default setting.
- **Anisotropic** - all textures are filtered using anisotropic filtering. Depending on the test and graphics adapter, this setting may produce lower test results than the default setting.

If you select anisotropic filtering, you can set the anisotropy amount below the Texture Filtering drop-menu. The default anisotropy level is 1. Some value lookup textures are not affected by filtering mode changes, since this would not change the rendering in any way. This setting only affects the GPU gaming test.

HDD Suite Target

This drop-down menu allows you to choose the disk drive to be used in the HDD Suite, such as a HDD, USB, and iRAM. It is recommended to defragment the hard drive prior to running the HDD Suite. This is a precaution to make sure that the hard drive is in good condition and the test results are as accurate as possible. This setting only affects the HDD Suite.

Force Full Precision

The *Force full precision* check box enables you to choose between partial (at least 16 bit) and full (at least 24 bit) floating point precision in shader calculations. By default, partial precision is used in a pixel shader but only in places where the rendering quality is at the required level; otherwise full precision is used. This setting forces full precision to be used in all shader calculations. Cards that only support a single shader calculation precision are not affected by this setting. An image quality analysis was made during benchmark development and it was pre-set which shaders may use partial precision. This setting only affects the GPU gaming test.

Force Software Vertex Shaders

The *Force software vertex shaders* check box controls whether vertex shading routines in the tests are processed by the graphics adapter or the CPU. Note that if the graphics adapter does not support hardware processing, all vertex shaders will be processed by the CPU anyway. Selecting *Force software vertex shaders*, if hardware accelerated is available, may result in some tests producing significantly lower results. On the other hand, running the default benchmark with forced software vertex shaders is an excellent way to test CPU performance. By default all vertex shaders are run in the graphics hardware if supported. This setting only affects the GPU gaming test.

Repeat & Loop

Selecting Repeat will cause each test to run the number of times chosen. The final result is given as an average of the repeated runs. Loop will make PCMark Vantage run all of the selected tests in a continuous loop until the ESC key is pressed or by clicking on the 'Cancel' button in the HUD). This feature is useful for testing the long-term stability of a system. Please note that other issues than system stability may cause the loop to be interrupted.

The default benchmark settings in PCMark Vantage are as follows:

- Rendering Resolution for the GPU gaming test: 1024x768
- Multi Sampling Anti-Aliasing for the GPU gaming test: None
- Texture Filtering for the GPU gaming test: Optimal (Mix of Bilinear & Trilinear)
- HDD Suite target: Automatic
 - HDD tests in other suites than HDD Suite are run on the system drive (where the Microsoft Windows Vista is installed)
 - HDD tests in HDD Suite are run on the freely selectable target drive
- Precision for the GPU gaming test: Partial where applicable
- Force Software Vertex Shaders for the GPU gaming test: Depending on the graphics hardware capabilities
- Repeat & Loop: Run each set once

Test Suite Selection

Clicking the 'Select Suites' button in the main windows opens the Select Suites dialog:



PCMark Vantage Suite Selection (Advance and Professional Editions only)

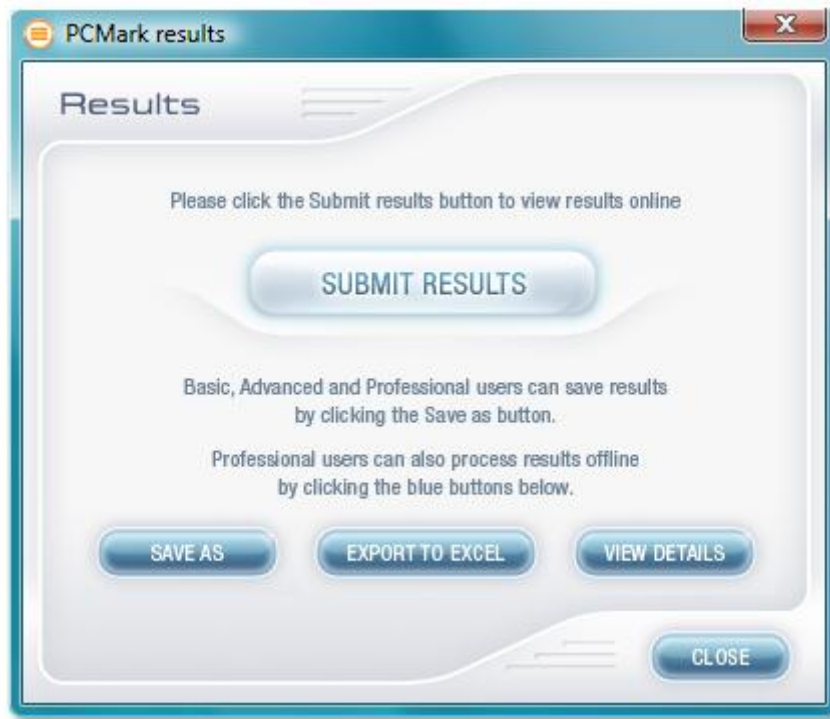
- Suite Presets
 - PCMark Suite
 - A pre-defined selection of test tests measuring the system's holistic performance in everyday tasks
 - This is the suite which produces the PCMark Score
 - Memories Suite
 - A pre-defined selection of test sets measuring the system's performance in Memories scenario
 - TV and Movies Suite

- A pre-defined selection of test sets measuring the system's performance in TV and Movies scenario
- Gaming Suite
 - A pre-defined selection of test sets measuring the system's performance in Gaming scenario
- Music Suite
 - A pre-defined selection of test sets measuring the system's performance in Music scenario
- Communications Suite
 - A pre-defined selection of test sets measuring the system's performance in Communications scenario
- Productivity Suite
 - A pre-defined selection of test sets measuring the system's performance in Productivity scenario
- HDD Suite
 - A pre-defined selection of test sets measuring the storage system's performance

As default in the Basic Edition, PCMark Suite is the only suite available and is pre-selected. In the Advanced and Professional Editions all suites are available and pre-selected. This is noteworthy since the time it takes to only run the PCMark Suite (which gives the PCMark Score) is much shorter than running all suites. Running the PCMark Suite alone only takes approx. 25 minutes, whereas running all suites takes up to 1 hour and 30 minutes. The time it takes for the suite(s) to complete depends on the hardware's performance.

Benchmark Results

After each benchmark run, or by clicking the 'View Results' button in the main window, the PCMark Vantage result dialog is displayed.



PCMark Vantage Benchmark Result Dialogue

In Professional Edition the PCMark Score of the latest benchmark run is displayed in large letters. The Basic and Advanced Edition only show the results online.

This dialog also has a number of buttons for result handling:

- **Submit Results** – initiates a network connection to Futuremark's Online ResultBrowser (ORB), and then submits the score to the database upon a successful link. The default web browser will then launch, displaying a web page with the test details plus other links to online features and services offered by Futuremark.
- **Save As** – opens the standard save file window and saves the result in .pcr format. The .pcr file can later be submitted to the Online ResultBrowser, or it can be opened in Microsoft Excel. The Excel functionality can be used by right-clicking on the program window (GUI) of PCMark Vantage.
- **Export to Excel** - if installed, this will open Microsoft Excel and display the benchmark details in a spreadsheet. This functionality requires that Microsoft Excel is installed. This option is available in the Professional Edition.
- **View Details** – opens the "Results details" dialogue for more detailed test result data. This option is available in the Professional Edition.
- **Close** – closes the PCMark Vantage result dialogue.

It is also possible to view the results of each test using the Online ResultBrowser.

Command Line Options

PCMark Vantage Professional Edition has a large number of command line options. These can be used for benchmarking automation and automatic PCMark start-up after system boot. Command line options are options that are entered when PCMark is started. The traditional way to enter command line options is to open a command prompt, and type manually the name of the executable that is to be run and the command line options for it. The examples of using the -help options shows two other ways to use command line options.

All available command line options are presented in a window, when you start PCMark Vantage with the switch -help. Here's how to do it:

- Edit the PCMark Vantage shortcut on your desktop by clicking it with the right mouse button. Select properties and edit the Target: text field. Move the cursor to the end of the text, add a space, type -help and click OK. Next time you click the PCMark Vantage desktop shortcut the command line switches will be displayed. Remember to change the shortcut back to the way it was, so that you can run PCMark Vantage again.

Use all command line switches the same way you used the -help switch. Many command line options can be used concurrently. The command line switches are the following:

All Editions:

-help	Show all command line options.
-upgrade	Show the upgrade dialog at startup.
-unregister	Unregister PCMark Vantage. Warning: Does not ask for confirmation!

Professional Edition:

-help	Show all command line options.
-upgrade	Show the upgrade dialog at startup.
-unregister	Unregister PCMark Vantage. Warning! Does not ask for confirmation!
-verbose	Enable verbose output to a log file.
-nosplash	Disable splash window.
-loop=<x>	Set loop count, where <x> is off, loop or a number. Default value is off.
-repeat=<x>	Set repeat count, where <x> is off or a number. Default value is 2.
-drive=<x>	Set the target for the HDD suite, where <x> is a drive letter from A to Z. Default target is the drive PCMark Vantage is run from. Default target for HDD tests in other suites than HDD suite is the Windows Vista system drive.
-all=<x>	Set all suites where <x> is on or off. Default values are listed below.
-pcmark=<x>	Set PCMark suite, where <x> is on or off. Default value is on.
-memories=<x>	Set Memories suite, where <x> is on or off. Default value is on.
-tvandmovies=<x>	Set TV and Movies suite, where <x> is on or off. Default value is on.
-gaming=<x>	Set Gaming suite, where <x> is on or off. Default value is on.
-music=<x>	Set Music suite, where <x> is on or off. Default value is on.
-communications=<x>	Set Communications suite, where <x> is on or off. Default value is on.
-productivity=<x>	Set Productivity suite, where <x> is on or off. Default value is on.
-hdd=<x>	Set HDD suite, where <x> is on or off. Default value is on.
-res=<w>x<h>	Set benchmark resolution <w>x<h>. The aspect ratio must be 4:3. Example: -res=1024x768
-filter=<x>	Set texture filtering mode, where <x> can be 'optimal', 'bilinear', 'trilinear' or 'anisotropic'. Example: -filter=optimal which is the default
-aniso=<x>	Set maximum anisotropy to be used with anisotropic filtering.

-aa=<x>	Set pixel processing mode, where <x> can be 'off', 'nonmaskable' for non-maskable anti-aliasing or the sample count for anti-aliasing. Example: -aa=4 for four sample anti-aliasing. The default value is not to use any pixel processing.
-aaq=<x>	Set anti-aliasing quality.
-fullprec	Forces full floating point precision in shader calculations.
-vshader=<x>	Enable or disable forced software vertex shaders, where <x> can be 'hw' or 'sw'. Example: -vshader=sw for software forced vertex shaders. The default value is 'hw'.
-services=<x>	Enable or disable system services (Windows Search, Volume Shadow Copy and SuperFetch) during the benchmark run, where <x> is on or off. Default value is off.
<filename>	The result output file. The results are saved in the given output file. [filename] MUST have a .pcr extension (i.e. 'pcmark_result.pcr').

Example:

Edit the PCMark Vantage shortcut on your desktop by clicking it with the right mouse button. Select properties and edit the Target: text field. Move the cursor to the end of the text, add a space, type -nosplash and click OK. Next time you click the PCMark Vantage desktop shortcut, PCMark Vantage will start without the splash screen at the beginning. Remember to change the shortcut back to the way it was, in case you want the splash screen back. It is also possible to have more than one command line option enabled. For instance:

```
"C:\Program Files\Futuremark\PCMark Vantage\bin\PCMark.exe" -nosplash -res=1600x1200
```

This command line will run PCMark Vantage without the splash screen, and run the GPU gaming test at 1600x1200 resolution.

Batch Run

If you want to run a number of results on a system using different settings and test selections, this can easily be done using the batch run functionality. The batch run functionality works like standard Microsoft Windows batch files, which use the file ending '.bat'. Just write a text file with a number of PCMark Vantage runs, using various settings as command line options, save that text file in the PCMark Vantage installation directory, and rename the file the ending from '.txt' to '.bat'. The batch run can now be run by double clicking the .bat file. The obtained result files can be viewed with the Online ResultBrowser, with the 'Submit Saved Result' functionality of the right-click menu, or they can be viewed in Microsoft Excel, using the 'Open saved result in Excel' functionality of the right click menu.

Example 1:

Create a new note in Notepad, and type in the following line:

```
PCMark.exe results1.pcr
```

Save the text file into the bin-folder (installation folder of PCMark Vantage) as 'results1.txt'. Rename the filename, and change the ending '.txt' to '.bat'. If everything went ok, you should now have a file named 'results1.bat'. Double clicking the bat-file will run the default benchmark suites and save the results in the file 'results1.pcr'

Example 2:

Create a new note in Notepad, and type in the following lines:

```
PCMark.exe -repeat=3 -all=off -music=on results2.pcr  
PCMark.exe -res=800x600 -filter=trilinear -all=off -gaming=on results3.pcr
```

Save the text file into the bin-folder (installation folder of PCMark Vantage) as 'results2.txt'. Rename the filename, and change the ending '.txt' to '.bat'. If everything went ok, you should now have a file named 'results2.bat'.

Double clicking the bat-file will run will run the Music Suite, repeat all the sets in it for 3 times and save the results (averages of those three runs) into a file named 'results2.pcr'. Then it will run Gaming Suite in 800x600 resolution, using Trilinear Filtering and save the results in the file 'results3.pcr'

The Basic and Advanced Editions of PCMark Vantage cannot do batch runs. The Professional license is required for batch run functionality.

Online ResultBrowser (ORB)

The utility of a benchmark result can be rather limited in isolation. Without a mechanism to compare your system to others, it is difficult to say if your system is a high-end state-of-art PC, a mid-end system, or even a low-end beige box. To allow benchmark users to come together to compare and analyze results, we provide a web service called the Online ResultBrowser or ORB.



PCMark Vantage Online ResultBrowser (ORB)
The Result Analyzer Tool

The ORB has become Futuremark's most popular online service. It provides the users a web application to manage and compare their benchmark results. The ORB database contains over 20 million results. After running the benchmark, the user can choose to *upload* the results and system information to the ORB. We enforce data privacy, so no one except the user will be able to see the individual results. Futuremark also verifies the uploaded results for accuracy. The ORB helps the user by giving context to the benchmark data; it allows the user to compare the results with those from other PCs. The user is able evaluate the PC's relative performance - determine the PC's weaknesses and its strengths.

Users can decide to share their results by explicitly *publishing* them. This allows them to show their results to the rest of the world. For many users, their performance results are a point of pride. For some, their position in our top performing PC rankings is the source of a bit of fame. Many proud PC owners include ORB URL links to their published benchmark result in their email signatures.

The ORB is the user's virtual benchmark laboratory. Users can experiment with different system configurations such as increasing the RAM or upgrading the CPU. They can get the new PC performance by searching through results published by others. Users can also maintain their own performance track record

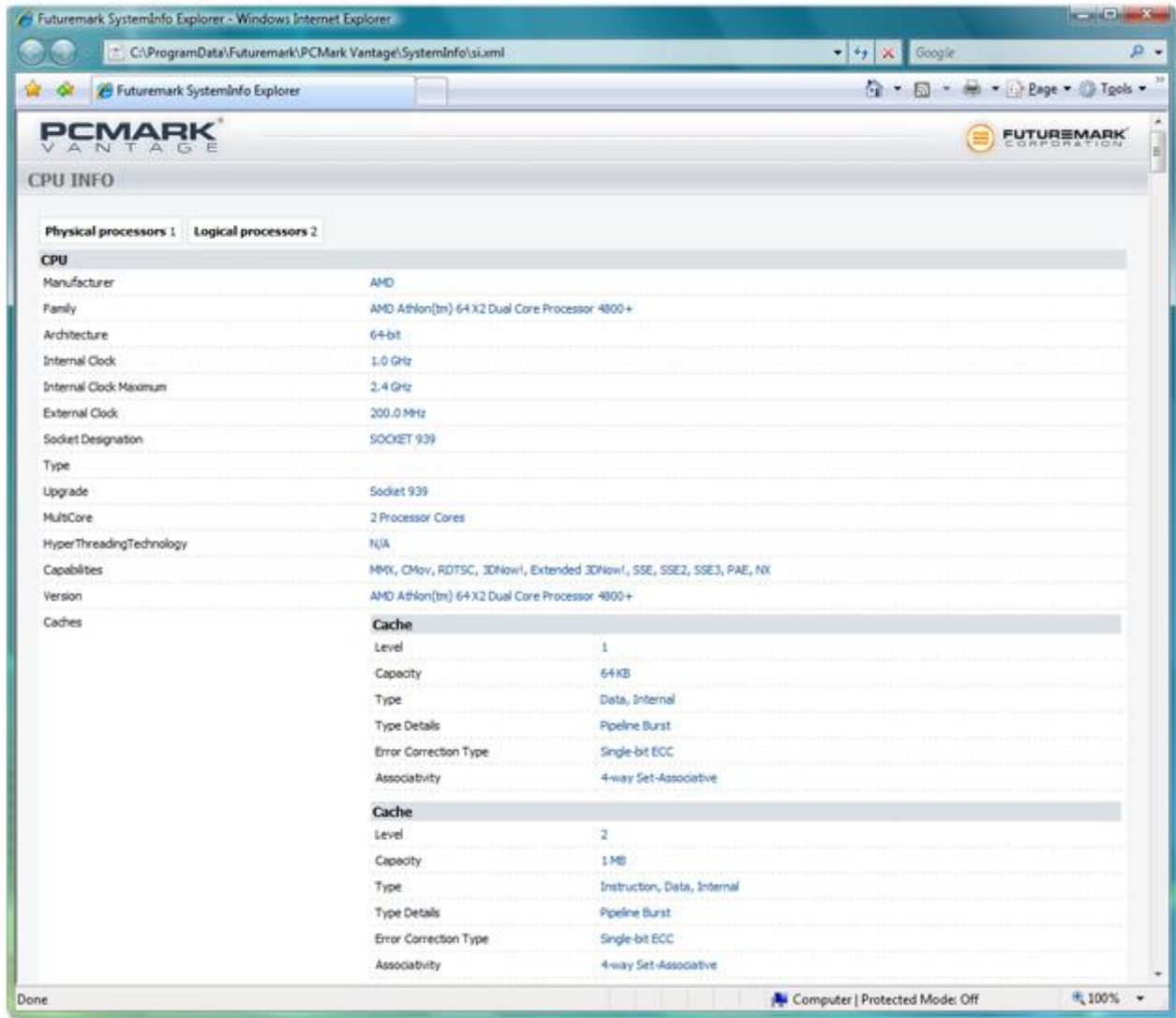
by submitting multiple projects to the ORB over time. This is especially useful for keeping track of what effect new driver versions have on performance. They can assemble custom multi-compare sets to compare their PC to multiple other configurations.

As the ORB is an online service, Futuremark continues to improve it by adding new functionality. The benchmark data collected by Futuremark is used for generating statistics and recommendations for the user community. This means that every result submitted helps all users to select reliable hardware upgrades. The ORB is a great help in making buying decisions; before spending money, the user can validate expectations of different hardware options.



System Information

Associated with each benchmark result is the complete profile of the target PC; we call this the *System Information*. The system information not only provides detailed configuration information (CPU speed, RAM, graphics card/chipset, etc.) to go along with the performance data, but it also gives the system state (open applications, AGP mode, PCI-E factor, free system memory, etc.).



PCMark Vantage SystemInfo Window

The complete system information consists of over 300 fields². These include:

- **CPU** Information – clock speeds, internal and external caches, amount of physical and logical CPUs
- **DirectX**[®] Information – display drivers, direct draw/show attributes, texture formats, 3D capabilities
- **Memory** Information – memory arrays and modules
- **Motherboard** Information – bios, card slots, system devices
- **Monitor** Information – monitor attributes
- **Power Supply** Information – batteries
- **Operating System** Information – version, installed service packs
- **Open Processes** Information – applications, processes
- **Logical Drives** Information – local and network logical drives
- **Hard Disk** Information – disk drive attributes

The ORB uses the system information to enable the search and compare functionality. System information also allows Futuremark to verify the accuracy of published benchmark results. These increasing numbers of system information records are used to provide information back to the users in the form of lists of most popular and powerful hardware components shown on our web site. We also use system information data to build other tools such as the Futuremark Performance Analyzer – an online tool used for product comparisons.

² Note that no private information is ever collected.

Limitations

We have presented the features and benefits of PCMark Vantage. We have detailed where PCMark Vantage is particularly useful. It is equally important to consider what PCMark Vantage is not. Below we list what we consider inappropriate uses and limitations of this benchmark tool.

- PCMark Vantage is not a tool to evaluate the performance of your PC in one particular application. For example, it is not appropriate for comparing the performance of only Microsoft® Word on two PCs. It measures the overall performance of your PC in everyday home and small office usage.
- The PCMark Suite represents average home usage. It may not correlate perfectly with other types of usage.
- As most test suites include multithreaded tests, scores will naturally be higher on multiprocessor / multicore and hyper threading systems.
- The graphics tests only measure the performance of outputting graphics and not the quality of images rendered. Futuremark's graphics oriented benchmarks, like 3DMark06, include image quality tools that can help with this.

Conclusion

PCMark Vantage is an application based benchmark with application-based tests that has been designed to be easy to install and run. We have taken the application-based benchmark approach by including only the relevant parts of real applications shipped with Windows Vista. This has allows PCMark Vantage to represent real home usage and reasonably quick to run (default (PCMark Suite only) run approx. 25 minutes). PCMark Vantage needs neither 10 gigabytes of disk space or days to run.

Futuremark cooperates with all major PC industry players, following a neutral and transparent development process, to ensure that the benchmark results are highly accurate.

PCMark Vantage is unique in enabling the complete cycle for benchmarking PCs – running the benchmark, analyzing the results, comparing results against other PCs, exploring PC improvements, leading finally to higher benchmark results and a more powerful PC.

As PCs and PC components continue to improve at a rapid pace, we believe PCMark Vantage will serve as a highly dependable tool for the benchmarking professional.

Any Questions Unanswered?

If you have any questions about the PCMark Vantage, or need more information about anything of the above, please don't hesitate to contact us at:

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