Pentium® II Processor Performance Brief

January 1998

Order Number: 243336-004

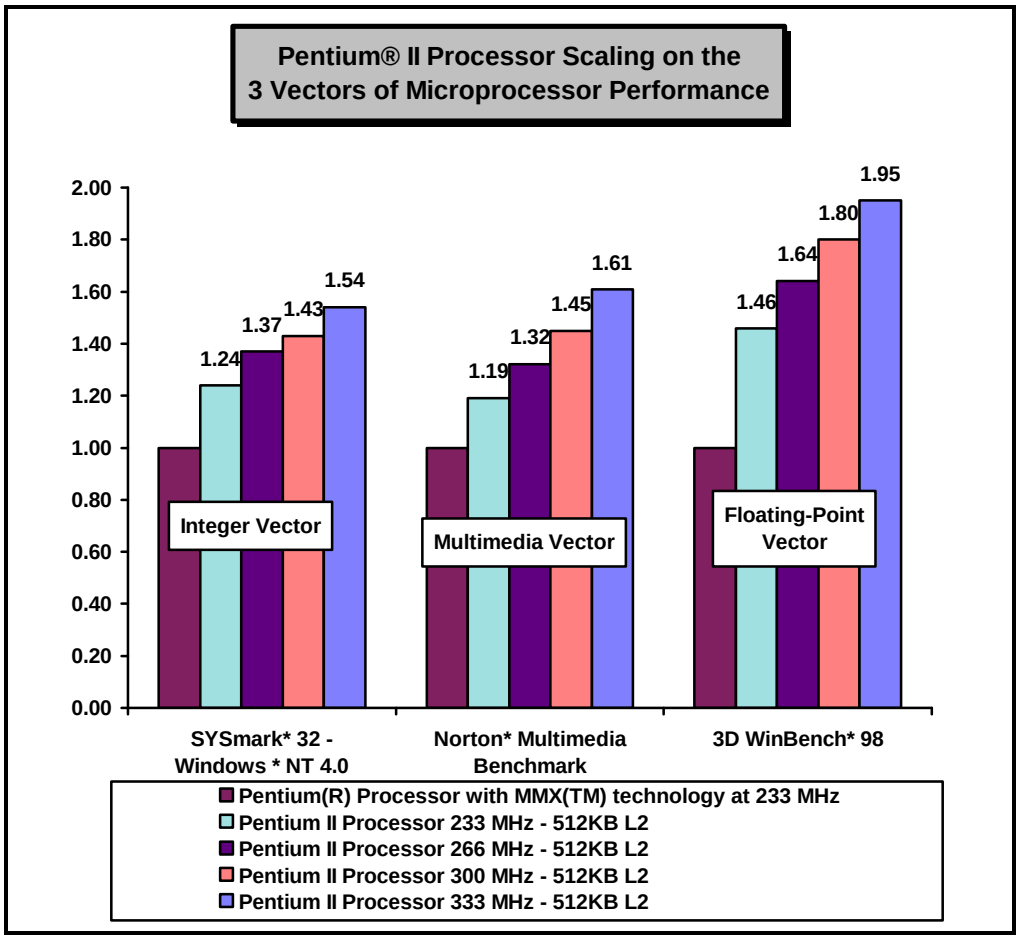
EXECUTIVE SUMMARY - INTEL PENTIUM Ò II PROCESSOR

The Pentium® II processor is a member of the P6 processor family. It combines the architectural advances in the Pentium Pro processor with the instruction set extensions of Intel MMX™ technology. The Intel Pentium II processor delivers excellent performance for all PC software and is fully compatible with the huge base of Intel architecture-based PC software.

Additionally, the Pentium II processor delivers new levels of performance for advanced media and communications software including powerful, realistic graphics and imaging capabilities, video conferencing, and the ability to run full-screen, full-motion video. The combination of these advanced technologies make the Pentium II processor the ideal choice for executing modern 32-bit compute-intensive and multimedia-enhanced application workloads using advanced 32-bit operating systems.

Note that the microprocessor and the PC of today are designed to run a broad range of powerful software applications. Not every processor is equally capable of the same performance for each type of application. Integer, multimedia (such as video and sound usage), and floating-point (such as 3D geometry calculations) performance comprise three vectors of performance that should be considered when evaluating systems. Specifically, benchmarks designed for evaluating these vectors should be used to look at the complete performance of the processor or the system.

The graph below highlights Pentium II processor performance, compared to the Pentium processor with MMX technology, on popular and industry standard benchmarks that demonstrate the three vectors of performance mentioned above.



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INTRODUCTION

The Intel P6 processor family provides excellent performance for all PC software. The Pentium® II processor combines the power of the Pentium Pro processor with the capabilities of Intel MMX™ technology. This enables the Pentium II processor to deliver the highest Intel processor performance, plus provide performance headroom for advanced media and communications software. The P6 processor desktop family consists of the following products:

- Pentium® II processor at 333 MHz
- Pentium II processor at 300 MHz
- Pentium II processor at 266 MHz
- Pentium II processor at 233 MHz
- Pentium Pro processor at 200 MHz (256KB, 512KB and 1 MB L2 Cache)
- Pentium Pro processor at 180 MHz (256KB L2 Cache)
- Pentium Pro processor at 166 MHz (512KB L2 Cache)
- Pentium Pro processor at 150 MHz (256KB L2 Cache)

When evaluating the performance of a microprocessor, it is important to get a complete picture of how it executes various tasks. The increasing use of 3D and multimedia content in software today is placing new demands on the microprocessor. Typical productivity applications, such as word processing, presentation applications, or personal finance programs, require the processor to have good integer performance. Applications such as video playback, 3D games, and PC imaging stress the multimedia and floating-point capabilities of the processor and the system. For the best all round computation, a system should deliver high performance in all three of these areas: integer, multimedia, and floating-point.

This report provides benchmarks results covering these three vectors of performance on Intel Pentium II processor systems. Details of the system configurations used in all the benchmarks throughout this brief are described in Appendix A.

Modern industry standard benchmarks were chosen to accurately demonstrate the excellent performance of the Intel Pentium II processor for all three vectors of performance. Integer performance is covered by compute-intensive benchmarks such as SPECint*95 and several 32-bit Windows*95 benchmarks as well as more system oriented benchmarks like BAPCo's SYSmark*32 test. Multimedia performance can be compared with the Norton* Multimedia Benchmark. Floating-point prowess can be seen with the compute intensive SPECfp*95 or the newest 3D benchmark from Ziff-Davis, 3D Winbench*98. Intel is committed to using the most robust and relevant benchmarks in characterizing its products' performance and, over time, Intel will adapt this mix as newer benchmarks appear.

Robust benchmark programs should be derived from how actual applications will execute. However, performance is often the result of combined characteristics of a given computer architecture and many other tightly coupled system software/hardware constituents in addition to the microprocessor. Operating system, compiler, library, memory design, and I/O subsystem characteristics may significantly impact the results and make comparisons difficult. This report is intended to show Intel Pentium II processor performance on a consistent set of benchmarks.

THE INTEL PENTIUM® II PROCESSOR

The Pentium® II processor combines the architectural advances in the Pentium Pro processor with the instruction set extensions of Intel MMX™ technology. The Intel Pentium II processor delivers excellent performance for all PC software and is fully compatible with the huge base of Intel architecture-based PC software.

Additionally, the Pentium II processor delivers new levels of performance for advanced media and communications software including powerful, realistic graphics and imaging capabilities, video conferencing, and the ability to run full-screen, full-motion video. The combination of these advanced technologies make the Pentium II processor the ideal choice for executing modern 32-bit compute-intensive and multimedia-enhanced application workloads using advanced 32-bit operating systems.

The Pentium II processor maintains the same high performance Dual Independent Bus (DIB) architecture as the Pentium Pro processor.

The Pentium II processor also introduces the single edge contact (S.E.C.) cartridge technology, developed by Intel, which enables high volume availability, improved handling protection, and a common form factor for future higher performance processors. Two S.E.C. cartridges can be used in a single system enabling a cost-effective symmetrical multi-processing solution which can facilitate improved performance or functional redundancy checking.

The Pentium II processor may contain design defects or errors known as errata. Current characterized errata are available upon request.

PENTIUM® II PROCESSOR PRODUCT FEATURE HIGHLIGHTS

The Pentium II processor is fully compatible with an entire library of PC software based on operating systems such as MS-DOS*, Windows* 3.1, Windows for Workgroups* 3.11, Windows* 95, OS/2*, UnixWare*, SCO UNIX*, Windows* NT, OPENSTEP*, and Sun Solaris*. Architectural features of the Pentium II processor include:

- Dynamic Execution Technology.
  - Dynamic execution incorporates the concepts of out of order and speculative execution. The Pentium® II processor's implementation of these concepts removes the constraint of linear instruction sequencing between the traditional fetch and execute phases of instruction execution. Up to 3 instructions can be decoded per clock cycle. Conceptually, these decoded instructions are put into a dataflow graph, which can hold up to 40 instructions. Instructions are executed from this graph when their operands are available (versus instruction order). Up to 4 instructions can be executed per clock cycle.
- Superpipelining.
  - The pipeline of the P6 processor family consists of approximately 12 stages versus 5 for the Pentium processor and 6 for the Pentium processor with MMX™ technology. This enables the Pentium II processor to achieve about a 50% higher frequency than the Pentium processor on the same manufacturing technology. The sophisticated dynamic, two-level, adaptive-training, branch prediction mechanism of the Pentium II processor is key to maintaining the efficiency of the Pentium II processor's superpipelined microarchitecture.

- Dual Independent Bus (DIB) Architecture.

  - This architecture consists of two distinct buses emanating from the Pentium® II processor: the L2 cache bus and the system bus (used for memory and I/O requests). The L2 cache bus speed scales with processor frequency. For the Pentium II processor at 266 MHz, the L2 cache bus operates at 133 MHz, which is twice the speed of the Pentium processor systems. The system bus for both processors runs at 66 MHz. The net result is that the Pentium II processor at 266 MHz has about 3X the peak bus bandwidth of the highest speed Pentium processor system, which has but one bus which runs at a peak of 66 MHz. Also, since speed of L2 cache accesses is one of the most important system factors in determining overall performance, system performance will scale well with higher processor frequencies. Unlike the Pentium processor's system bus, the Pentium II processor's system bus supports up to 8 outstanding bus requests (4 per processor). This allows more parallelism between processors and I/O, as well as, supporting smooth performance scaling to a 2 processor system. The GTL+ electrical signaling of the system bus facilitates the migration of this bus to higher frequencies as higher performance DRAM technologies come to market.

- High Performance Intel MMX ™ Technology:

  ⇒ Intel's MMX™ media enhancement technology is a major enhancement to the Intel Architecture which makes PCs richer multimedia and communications platforms. This technology introduces 57 instructions oriented to highly parallel operations with multimedia and communications data types. These instructions use a technique known as SIMD (Single Instruction, Multiple Data) to deliver better performance for multimedia and communications computation. Intel processors that provide MMX technology support are fully compatible with previous generations of the Intel Architecture and the installed base of software.

  ⇒ To further improve performance, the Pentium® II processor, like the Pentium processor with MMX™ technology, can execute 2 Intel MMX instructions at a time.

- Write Combining:

  ⇒ The Write Combining technology of the P6 Processor family can be utilized to get very high graphics I/O performance. This feature combines multiple writes to a region of memory (for example, a video controller's frame buffer) declared as WC type into a single burst write operation. This is well suited for the bus which is optimized for burst transfers. The combining also leads to burst writes of cache line sizes. These writes are further combined by the chipset leading to high throughput for graphics I/O. This will further enhance multimedia performance and enable more realistic full motion video and realistic, fast graphics performance.

- Caches:

  ⇒ The Pentium® II processor has 32 KB of non-blocking L1 cache, which is divided into a 16 KB instruction cache and a 16 KB data cache. Each of these caches run at the processor frequency and provide fast access to heavily used data.

  ⇒ The Pentium® II processor has a 512 KB L2 cache which is unified for code and data, and is non-blocking. There is a dedicated 64-bit bus to facilitate higher data transfer rates between the processor and the L2 cache.

- Floating-Point pipeline which supports the 32-bit and 64-bit IEEE 754 formats as

well as the 80-bit format. The FPU is object code-compatible with the Pentium® and 486™ processor FPUs.

- The GTL+ bus provides glueless support for two processors giving a cost-effective SMP solution. This can be used to significantly enhance OS and application performance in multi-threaded or multi-tasking environments or for functional redundancy checking.

- Testing and Performance Monitoring Features:

  ⇒ Built In Self Test (BIST) which provides single stuck-at fault coverage of the microcode and large PLAs, as well as testing of the instruction cache, data cache, Translation Lookaside Buffers (TLBs) and ROMs.

  ⇒ IEEE* 1149.1 Standard Test Access Port and Boundary Scan Architecture mechanism which allows testing of the Pentium®II processor through a standard interface.

  ⇒ Internal performance counters for performance monitoring and event counting.

iCOMP® INDEX 2.0

The iCOMP® index provides a simple relative measure of microprocessor performance. It is not a benchmark, but a collection of benchmarks used to calculate an index of relative processor performance intended to help end users decide which Intel microprocessor best meets their computing needs. iCOMP Index 2.0 comprehends:

1. The accelerating transition to 32-bit operating systems and applications on the desktop.
2. The proliferation of multimedia, communications and 3D applications.
3. Updated industry-standard benchmarks appropriate for emerging popular application profiles.

The iCOMP Index 2.0 ratings cannot be compared with the earlier version of iCOMP because a different base processor and different benchmarks were used for calculation of the rating.

The iCOMP Index 2.0 rating is based on the technical categories that encompass three separate aspects of 32-bit CPU performance: integer, floating-point, and multimedia. The multimedia portion is further divided into four sub-components: Audio, Imaging, Video and 3-D. The higher the iCOMP rating, the higher the relative performance of the microprocessor.

Figure 1 illustrates the iCOMP Index 2.0 ratings for six Intel microprocessors. System configurations used in iCOMP Index 2.0 measurements are listed in Appendix B.

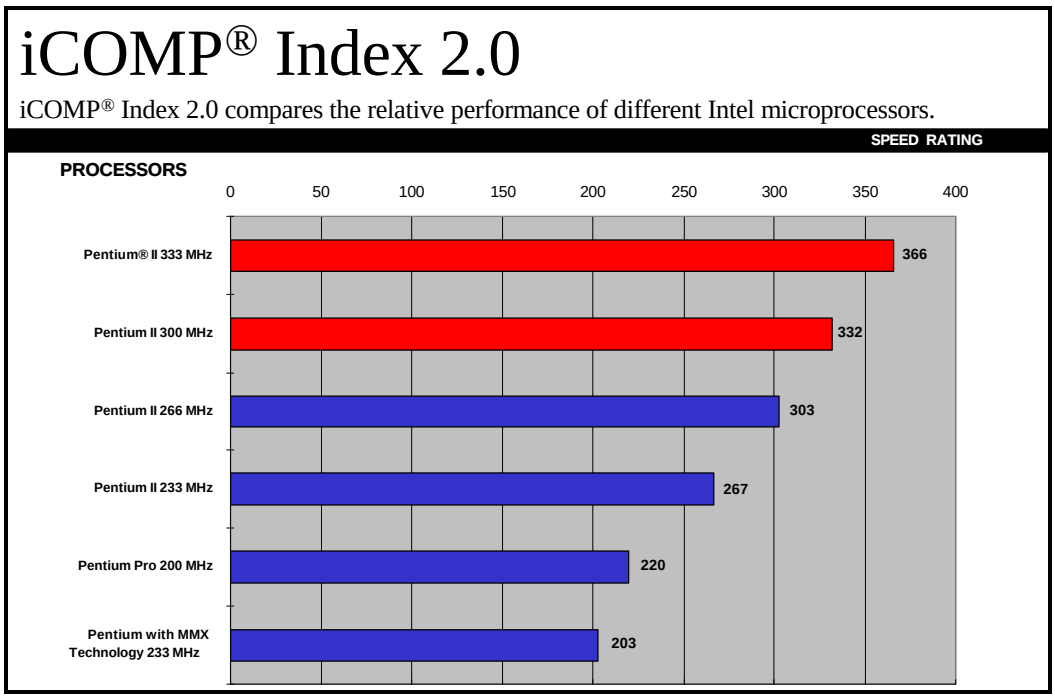

Figure 1. iCOMP® Index 2.0 Ratings for Intel Processors (System configuration for iCOMP Index 2.0 components is given in Appendix B).

iCOMP® Index 2.0 reflects the approximate, relative performance of Intel microprocessors on 32-bit applications and benchmarks. It combines five benchmarks: CPUmark*32, Norton*SI-32, SPECint*95, SPECfp*95, and the Intel Media Benchmark. Each processor's rating is calculated only at the time the processor is introduced, using a particular, well-configured, commercially available system. Ratings for Pentium® II processors were calculated with 512K L2 cache. Ratings for Pentium Pro processors were calculated with 256K L2 cache. Relative iCOMP Index 2.0 scores and actual system performance may be affected by differences in system hardware (other than microprocessors) or software design and configuration, including MMX™ media enhancement technology-enabled software. Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about iCOMP Index 2.0, including a description of the systems used to calculate ratings, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com and follow the appropriate links.

*Other brands and names are the property of their respective owners

3 VECTORS OF MICROPROCESSOR PERFORMANCE

The microprocessor and the PC of today are designed to run a broad range of powerful software applications. Not every processor is equally capable of the same performance for each type of application. Benchmarks specifically designed for evaluating the performance of processors and systems running integer-, multimedia-, and floating-point-,intensive applications should be used to look at the complete performance of the processor or the system.

Integer Benchmarks

Typical productivity applications such as word processing, spreadsheets, presentation applications, and personal finance programs, to name a few, depend on integer performance. Popular, industry integer benchmarks include:

Processor Level Benchmarks:

- SPECint*95
- CPUmark*32
- Norton* SI32

System Level Benchmarks:

- SYSmark*32
- SYSmark*NT

Multimedia Benchmarks

Traditional benchmark tools were not designed to measure the performance of systems running today's applications rich in graphics, audio and video attributes. Multimedia benchmarks are designed specifically to simulate the activities of end users utilizing video, such as MPEG1 and MPEG2, Dolby* Digital Sound, AVI, PC Imaging or Video Conferencing, and other similar media-rich applications. Some of the benchmarks that fall under this category are:

- Intel Media Benchmark
- Norton* Multimedia Benchmark from Norton* Utilities for Windows*95 Version 3.0

Floating-Point Benchmarks

Applications which use three-dimensional visualization techniques, such as games, are increasingly employing floating-point performance to support richer textures and enhanced lighting effects. Floating-point performance is also a critical factor for workstation applications such as Computer Aided Design (CAD). Benchmarks that measure floating-point performance include:

- SPECfp*95
- 3D graphics portion of the Norton* Multimedia Benchmark
- 3D WinBench* 98

MICROPROCESSOR PERFORMANCE SUMMARY

Integer Benchmarks

Processor Level Benchmarks

SPEC CPU*95 - SPECint*95

SPEC CPU*95 is a software benchmark product which can be run on Windows*NT and many varieties of UNIX*. SPEC CPU*95 is produced by the Standard Performance Evaluation Corp. (SPEC), a non-profit group of computer vendors, system integrators, universities, research organizations, publishers, and consultants throughout the world. It was designed to provide measures of performance for comparing compute-intensive workloads on different computer systems. SPEC CPU95 consists of two suites of benchmarks: CINT*95 for measuring and comparing compute-intensive integer performance, and CFP*95 for measuring and comparing compute-intensive floating-point performance. The two suites provide component-level benchmarks that measure the performance of the computer's processor, memory architecture and compiler. SPEC benchmarks are selected from existing application and benchmark source code running across multiple platforms.

More information on SPEC CPU*95 can be found at the website http://www.specbench.org. The CINT95 suite, written in the C programming language, contains eight CPU-intensive integer benchmarks. It is used to measure and calculate the following metrics:

- SPECint*95 -- The geometric mean of eight normalized ratios (one for each integer benchmark) when compiled with aggressive optimization for each benchmark.
- SPECint_base*95 -- The geometric mean of eight normalized ratios when compiled with the conservative optimization for each benchmark.

For information on SPECfp*95, please refer to the Floating-Point Benchmark section of this document.

Figure 2 shows the SPECint*95 performance on UNIX*. See Appendix A for configuration details.

Figure 3 shows the SPECint*95 performance on Windows* NT 4.0. See Appendix A for configuration details.

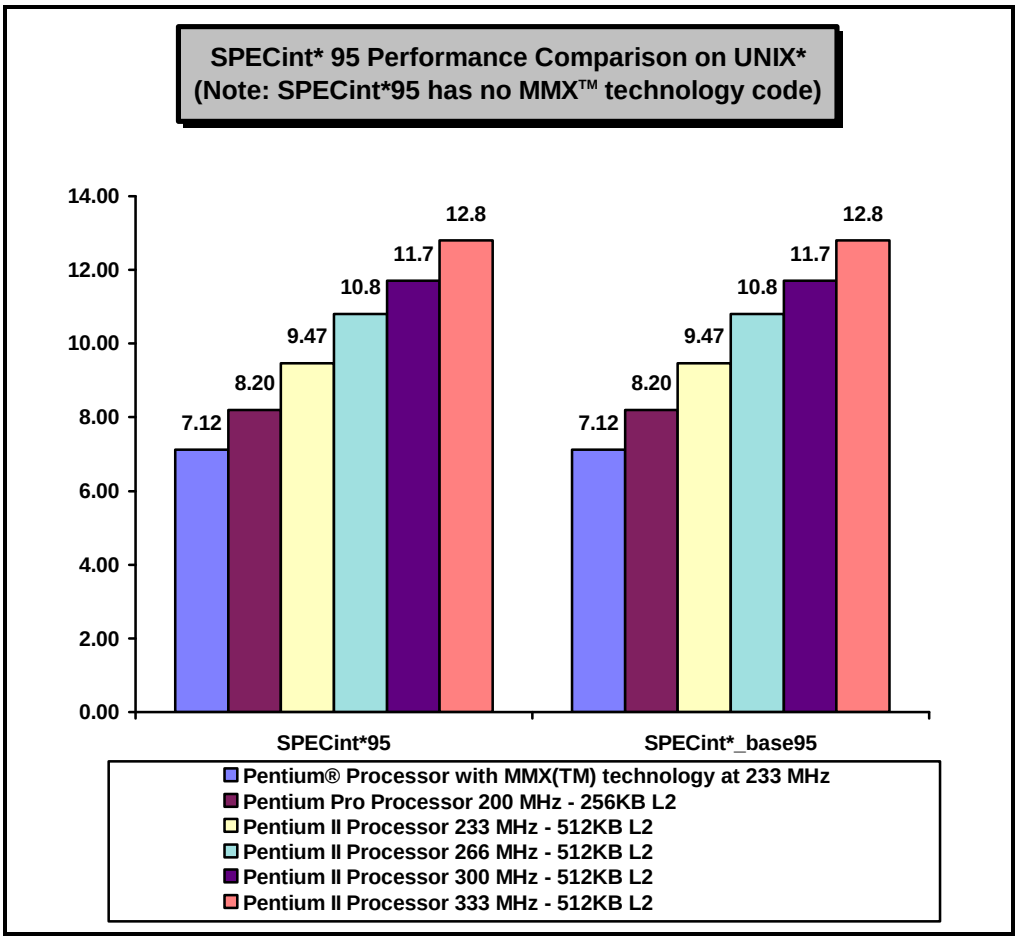

Figure 2. Intel Pentium ® II Processor Performance for the SPECint*95 Benchmark on UNIX*.

The SPECint*95 benchmark test reflects the performance of the microprocessor, memory architecture and compiler of a computer system on compute-intensive, 32-bit applications. SPEC benchmark tests results for Intel microprocessors are determined using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about SPEC*95, including a description of the systems used to obtain these test result, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com or call 1-800-628-8686.

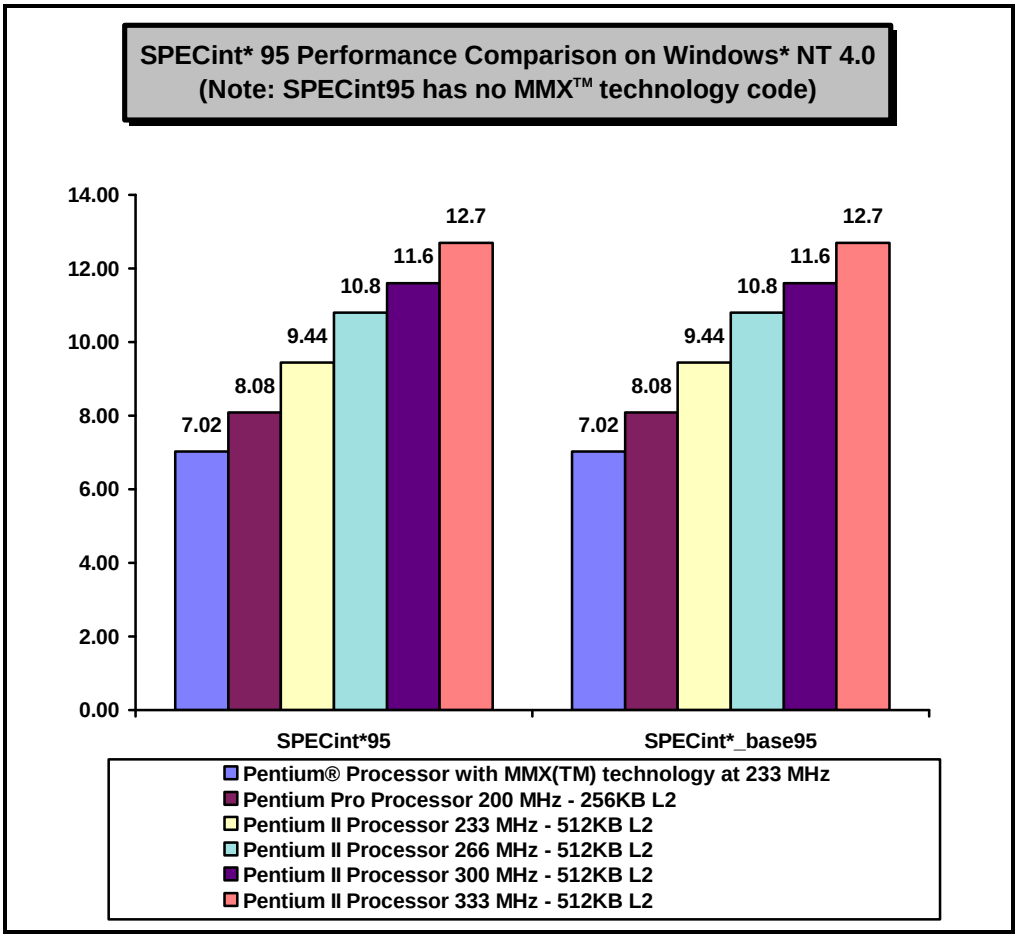

Figure 3. Intel Pentium ® II Processor Performance for the SPECint*95 Benchmark on Windows* NT 4.0.

The SPECint*95 benchmark test reflects the performance of the microprocessor, memory architecture and compiler of a computer system on compute-intensive, 32-bit applications. SPEC benchmark tests results for Intel microprocessors are determined using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about SPEC*95, including a description of the systems used to obtain these test result, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com or call 1-800-628-8686.

CPUmark*32

CPUmark*32 is a 32-bit Windows processor benchmark provided by Ziff-Davis Labs. It is designed to compare the performance potential for running 32-bit applications.

Figure 4 illustrates the Intel Pentium® II processor performance when executing this popular 32-bit benchmark.

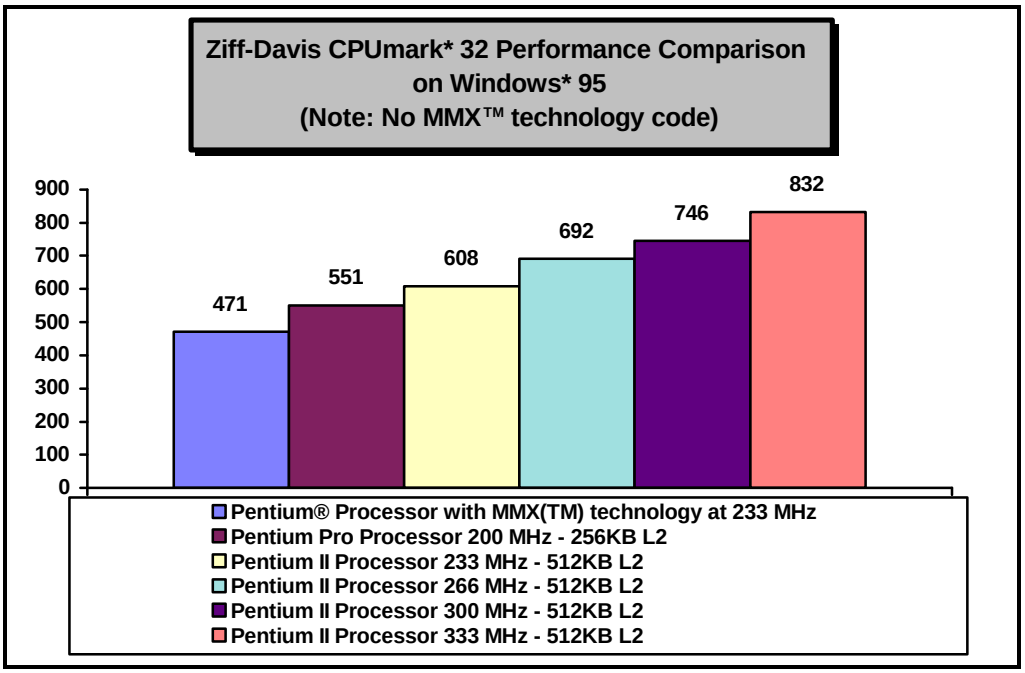

Figure 4. Intel Pentium® II Processor Performance for the Ziff-Davis CPUmark*32 Benchmark

Norton* SI 32

Norton* SI 32 is a 32-bit Windows* 95 benchmark designed to show the speed of a system (CPU, L2 cache, and memory), compared to the speed of other systems for running common 32-bit applications. This benchmark is part of the SYSINFO* module of the Norton* Utilities for Windows* 95.

Figure 5 illustrates the Intel Pentium® II processor performance when executing this popular 32-bit benchmark.

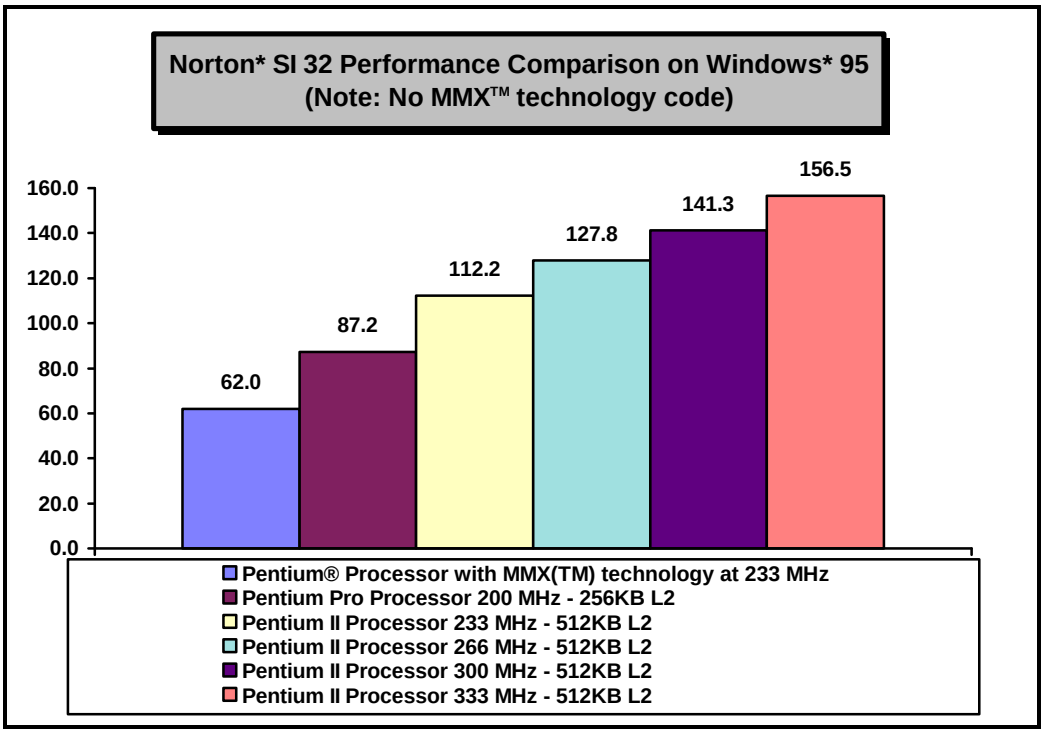

Figure 5. Intel Pentium® II Processor Performance for the Norton* SI 32 Benchmark

System Level Benchmarks

To measure realistic application performance, SYSmark*32 for Windows* 95 and Windows* NT 4.0 and SYSmark* for Windows NT 4.0 (32-bit applications) were chosen to gauge the performance of Intel Pentium ® II processor-based systems.

SYSmark*32 For Windows* 95 And Windows* NT 4.0

SYSmark32 for Windows 95 and Windows NT 4.0 is a suite of application software and associated benchmark scripts that have been developed by the Business Applications Performance Corporation (BAPCo), a non-profit consortium of PC OEMs, software vendors, semiconductor manufacturers and industry publications. SYSmark*32 is intended to provide a tool for accurate and realistic measurement of personal computer performance running popular business-oriented applications in the Microsoft Windows operating environment. The scripts are developed to reflect usage patterns of PC users in a business-oriented environment.

SYSmark32 includes 32-bit benchmark scripts for the following applications selected from six categories of application software:

- Word-processing — Microsoft Word* 7.0 and Lotus WordPro* 96.
- Spreadsheet — Microsoft Excel* 7.0.
- Database — Borland Paradox*.
- Desktop Graphics — Corel CorelDraw* 6.0.
- Desktop Presentation — Microsoft PowerPoint* 7.0 and Lotus Freelance* 96.
- Desktop Publishing — Adobe Pagemaker* 6.0.

Figure 6 and 7 illustrate the SYSmark*32 ratings under Windows* 95 and Windows* NT 4.0 respectively for the Intel Pentium II processor.

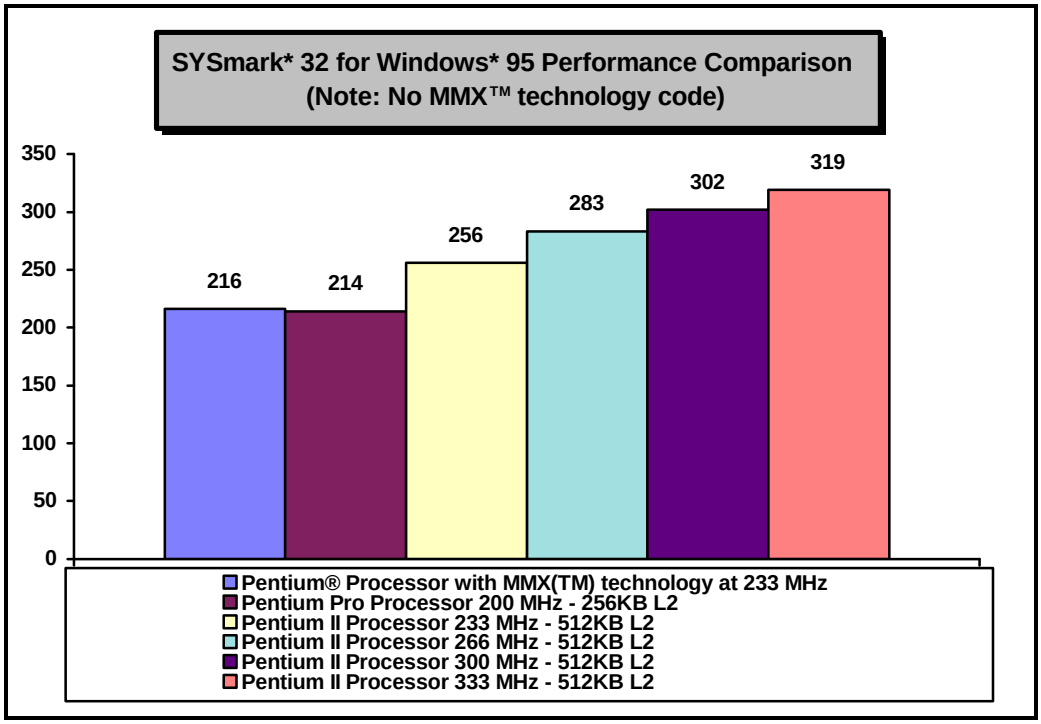

Figure 6. Intel Pentium ® II Processor Performance for SYSmark*32 on Windows* 95

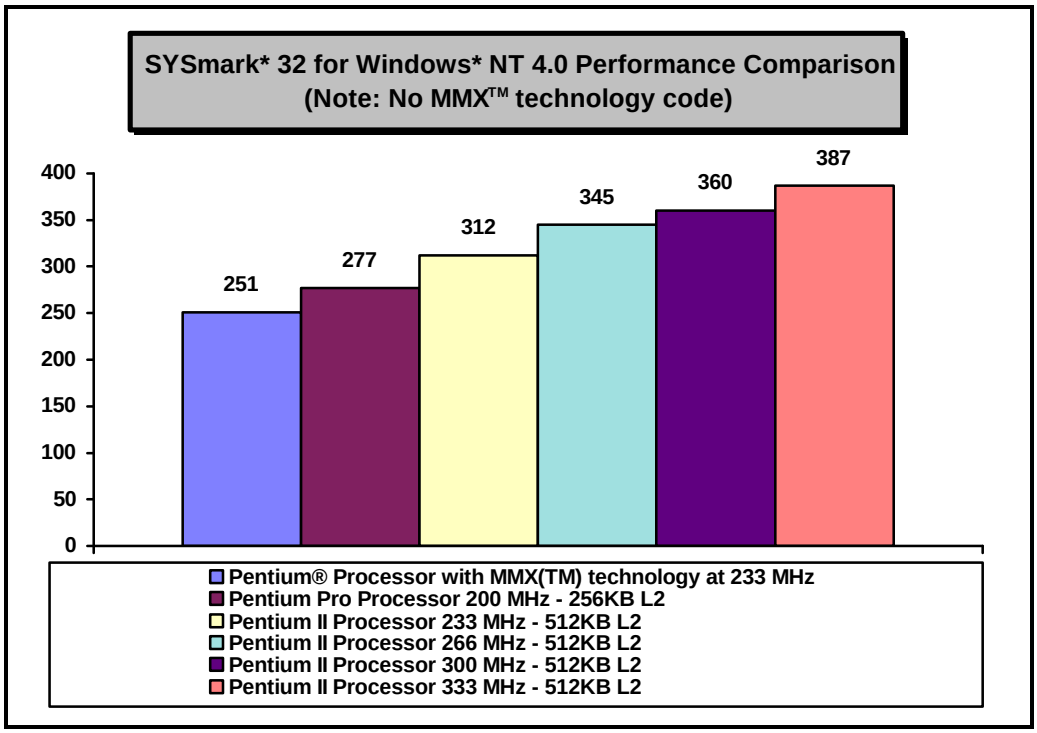

Figure 7. Intel Pentium ® II Processor Performance for SYSmark*32 on Windows NT*4.0

SYSmark* For Windows NT* Version 4.0

SYSmark* For Windows NT version 4.0 was developed to provide a benchmark that could be run on all platforms which support Windows NT. Workloads for SYSmark for Windows NT 4.0 were developed based on BAPCo's standardized practice of surveying users to determine how they exercise popular applications in day-to-day work. The following applications are included in SYSmark for Windows NT Version 4.0:

- Word-processing — MS Word* 6.0 (native 32-bit on all architectures)
- Spreadsheet — MS Excel* 5.0 (native 32-bit on all architectures)
- Project Management — Welcom Software Technology Texim* Project 2.0e (native 32-bit on all architectures)
- Computer-Aided Design — Orcad Layout* for Windows* 7.0 (PCB design tool) (native 32-bit on all architectures)
- Presentation Graphics — MS PowerPoint* 4.0 (16-bit Windows em ulation)

Figure 8 includes the SYSmark* NT Version 4.0 rating for Pentium ® II processor.

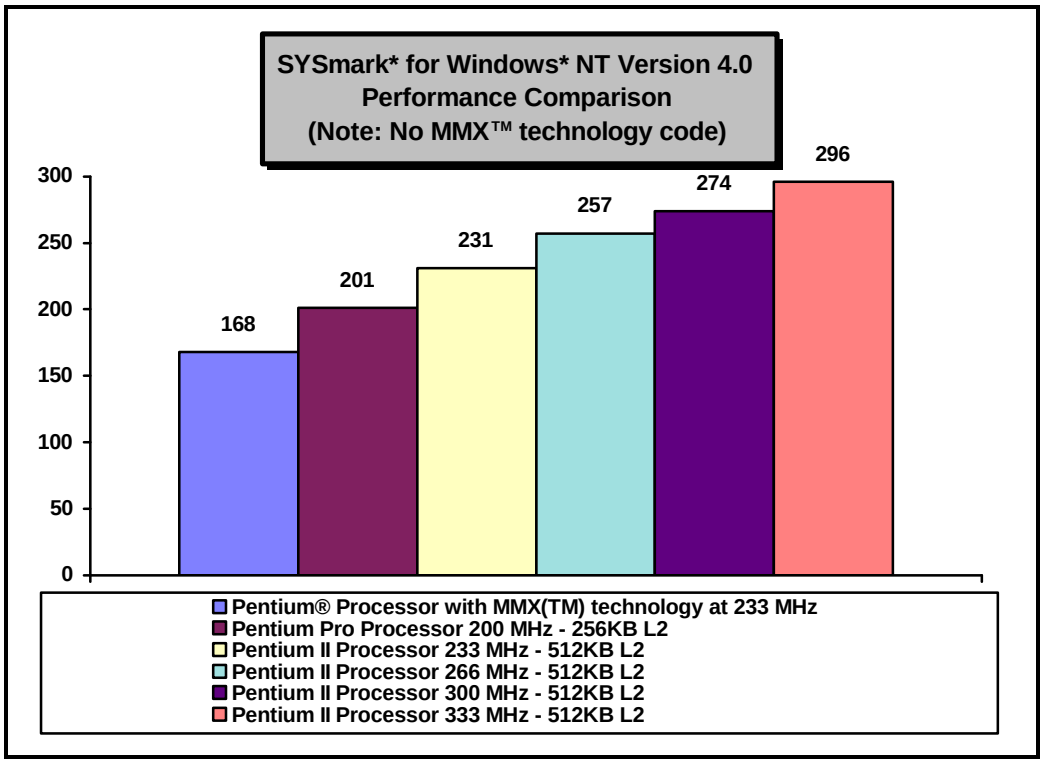

Figure 8. Intel Pentium Ò II Processor Performance for SYSmark* for Windows* NT 4.0

Multimedia Benchmarks

Intel Media Benchmark

Multimedia applications are proliferating rapidly. Intel developed the Intel Media Benchmark since an adequate industry standard multimedia benchmark does not currently exist to measure multimedia performance. The Intel Media Benchmark measures the performance of processors running algorithms found in multimedia uses. It incorporates audio and video playback, image processing, wave sample rate conversion, and 3D geometry.

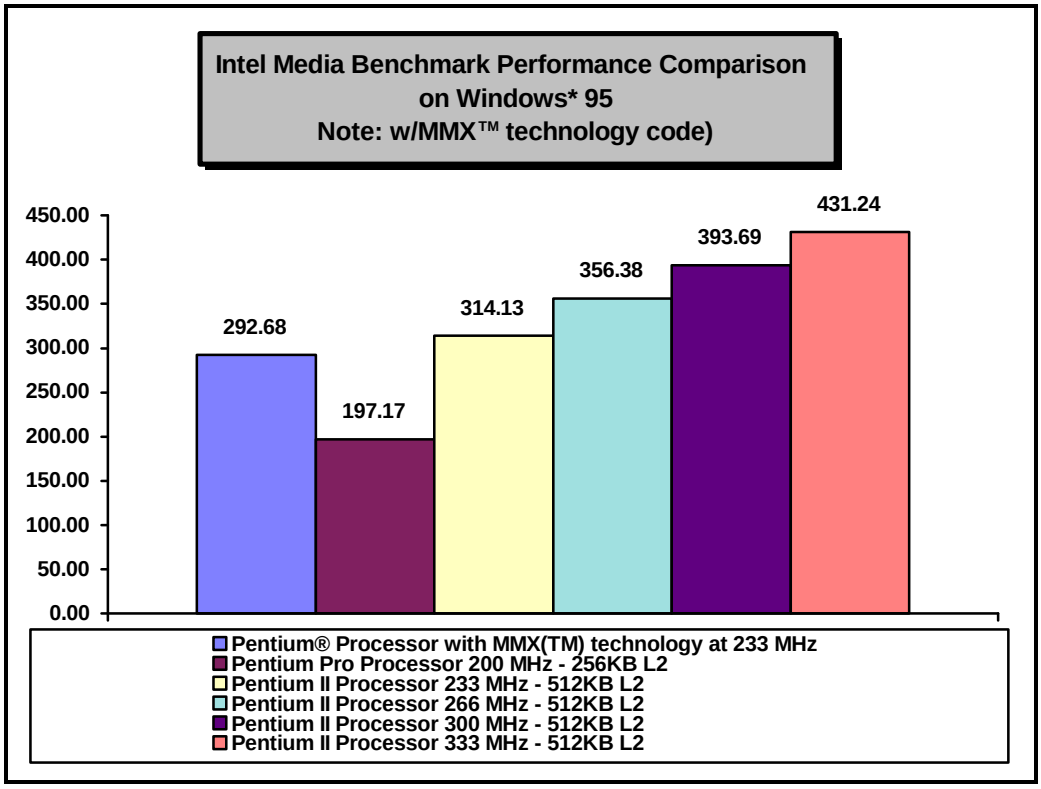

Figure 9. Intel Pentium® II Processor Performance for the Intel Media Benchmark

Norton* Multimedia Benchmark

The Norton* Multimedia Benchmark, from Norton Utilities for Windows*95 Version 3.0, tests a system's multimedia capabilities and compares the performance to that of a system conforming to the basic Multimedia PC (MPC) Level 2 specification. The benchmark reports performance in five multimedia areas:

- Video - benchmarks video performance. It measures MPEG video decompression and AVI video frame rates.
- 3D - tests rendering capabilities.
- Audio - measures audio mixing and MPEG audio performance.
- CD-ROM - measures the CD-ROM drive's maximum seek and transfer rates.
- Imaging - tests image processing manipulations.

The Norton Multimedia Benchmark overall score shows a system's overall multimedia performance rating compared to a standard MPC2 system.

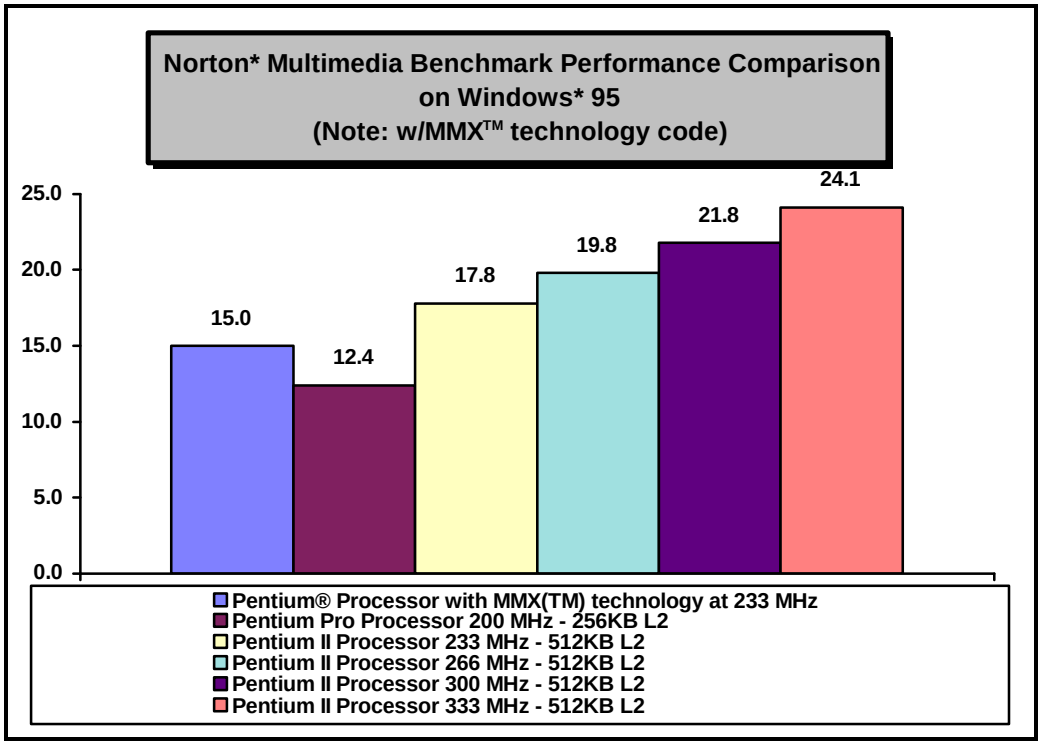

Figure 10. Intel Pentium® II Processor Performance for the Norton* Multimedia Benchmark (See Table 4 for individual component scores from the benchmark)

Floating-Point Benchmarks

SPEC CPU*95 - SPECfp*95

SPEC CPU*95 is a software benchmark product which can be run on Windows NT and many varieties of UNIX. SPEC CPU 95 is produced by the Standard Performance Evaluation Corp. (SPEC), a non-profit group of computer vendors, system integrators, universities, research organizations, publishers, and consultants throughout the world. It was designed to provide measures of performance for comparing compute-intensive workloads on different computer systems.

The CFP*95 suite, written in the FORTRAN programming language, contains ten CPU-intensive floating-point benchmarks. It is used to measure and calculate the following metrics:

- SPECfp*95 -- The geometric mean of 10 normalized ratios (one for each floating-point benchmark) when compiled with aggressive optimization for each benchmark.
- SPECfp_base*95 -- The geometric mean of 10 normalized ratios when compiled with conservative optimization for each benchmark.

For information on SPECint*95, please refer to the Integer Benchmark section of this document.

Figure 11 shows the SPECfp*95 performance on UNIX*. See Appendix A for configuration details.

Figure 12 shows the SPECfp*95 performance on Windows*NT 4.0. See Appendix A for configuration details.

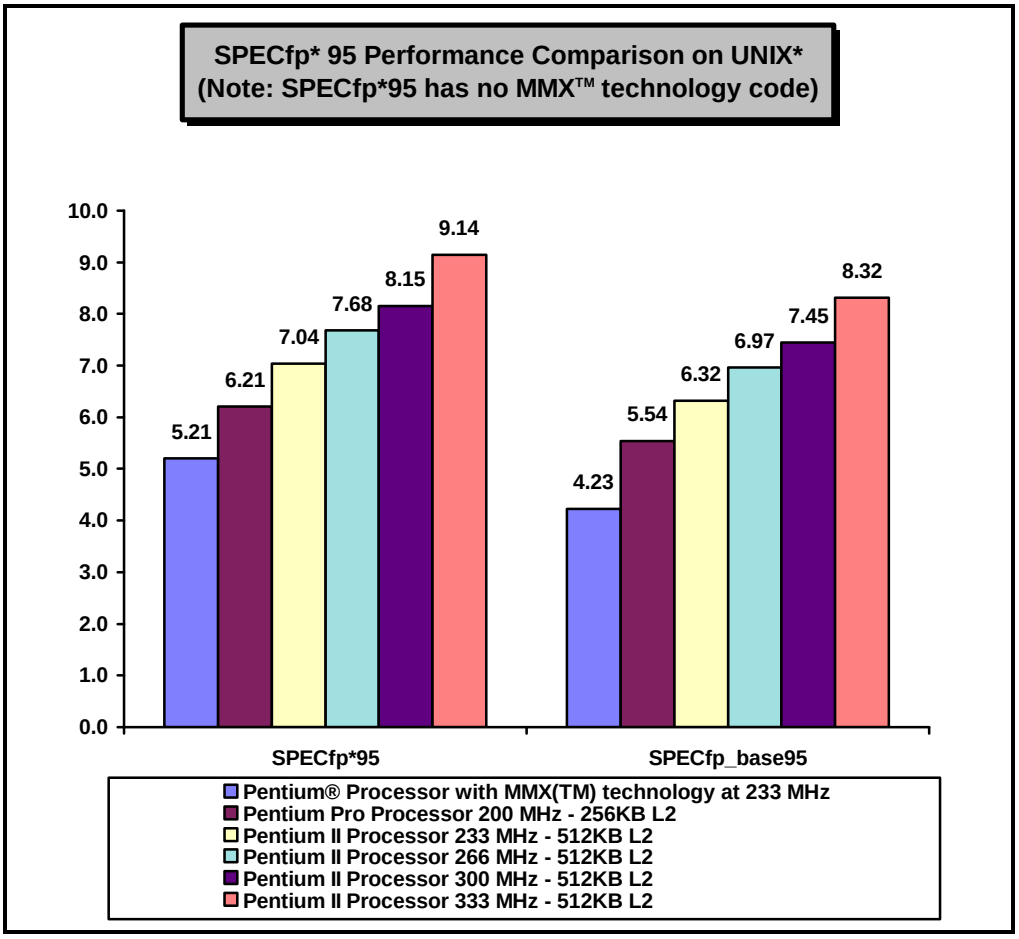

Figure 11. Intel Pentium® II Processor Performance for the SPECfp*95 Benchmark on UNIX*.

The SPECfp*95 benchmark test reflects the performance of the microprocessor, memory architecture and compiler of a computer system on compute-intensive, 32-bit applications. SPEC benchmark tests results for Intel microprocessors are determined using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about SPEC*95, including a description of the systems used to obtain these test result, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com or call 1-800-628-8686.

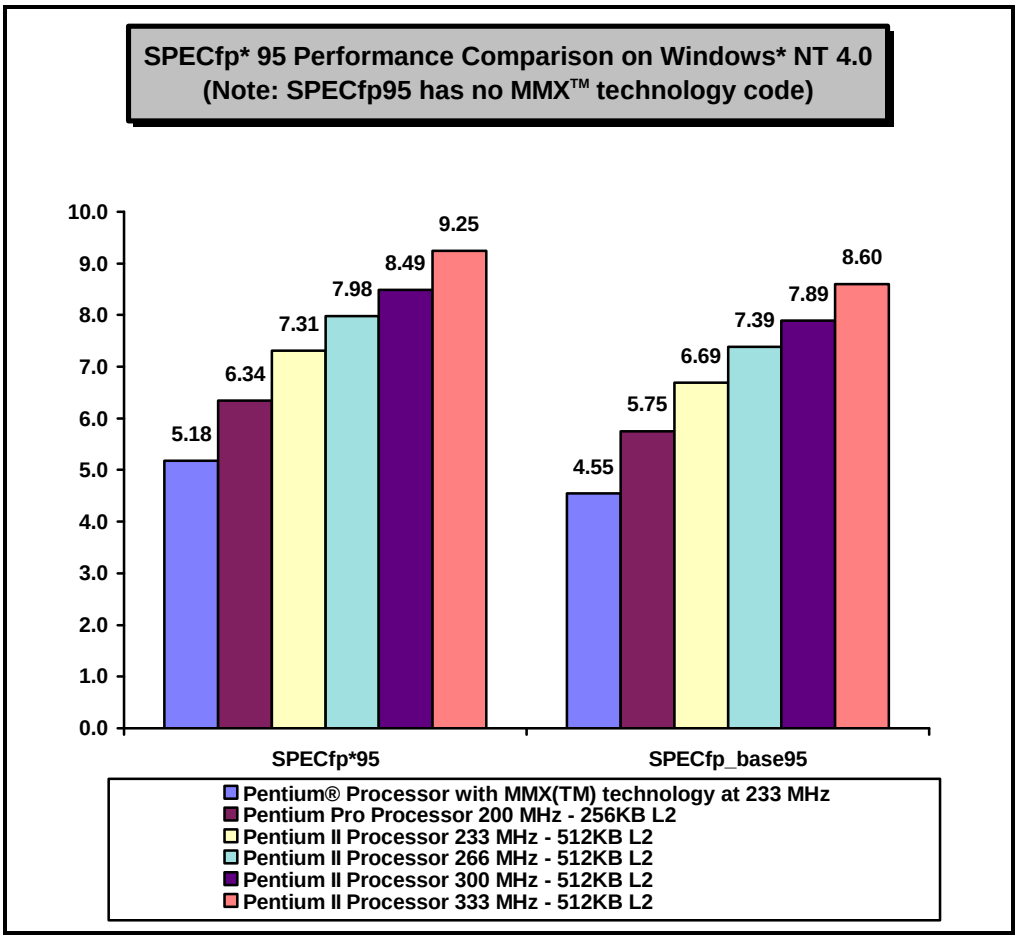

Figure 12. Intel Pentium® II Processor Performance for the SPECfp*95 Benchmark on Windows* NT 4.0.

The SPECfp*95 benchmark test reflects the performance of the microprocessor, memory architecture, and compiler of a computer system on compute-intensive, 32-bit applications. SPEC benchmark tests results for Intel microprocessors are determined using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about SPEC95, including a description of the systems used to obtain these test result, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com or call 1-800-628-8686.

Norton* Multimedia Benchmark – 3D Graphics

The Norton* Multimedia Benchmark, from Norton Utilities for Windows*95 Version 3.0, tests a system's multimedia capabilities and compares the performance to that of a system conforming to the basic Multimedia PC (MPC) Level 2 specification. The 3D Graphics portion of Norton Multimedia Benchmark uses floating-point operations in its execution.

Figure 13 shows 3D Graphics performance.

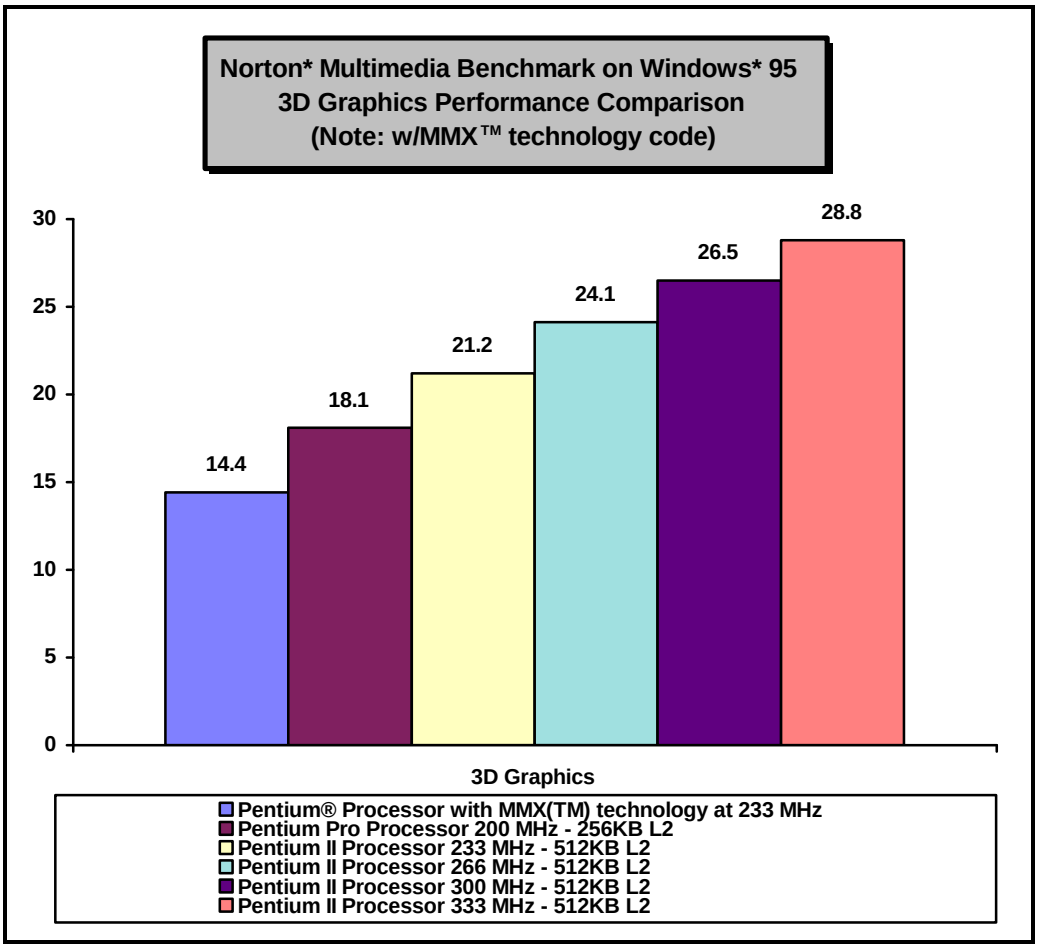

Figure 13. Intel Pentium® II Processor Performance for the Norton* Media Benchmark – 3D Graphics.

3D WinBench* 98

3D WinBench* 98, from Ziff-Davis, measures the 3D performance of a computer system (including the microprocessor and the graphics card) using Microsoft's Direct3D* interface under Windows* 95. It includes a series of 19 tests that vary in complexity - the number of triangles they use to form their objects - and the number of quality-enhancing options (such as fog, specular highlights, bilinear filtering and "mip-mapping", antialiasing) they employ and the amount of texture they use. The processing includes 3D geometry calculations, which are floating-point intensive, and rasterization. Each test flies through a scene using a predefined path and measures the rendering speed in frames per second. This suite returns an overall, unitless 3D WinMark* result summarizing the computer's performance on all tests.

Hardware acceleration is used when all quality-enhancing options for the given test are supported by the underlying hardware. Otherwise, software rasterization using MMX technology is employed if Microsoft's Direct3D* software rasterizer supports all the options for the test. If neither the graphics card nor the software rasterizer supports all the options, a score zero is granted.

The tests below have been run using the STB Velocity 128 card. An AGP based card was used for all Pentium II processor results, and a PCI based card was used for Pentium with MMX technology and Pentium Pro processor results.

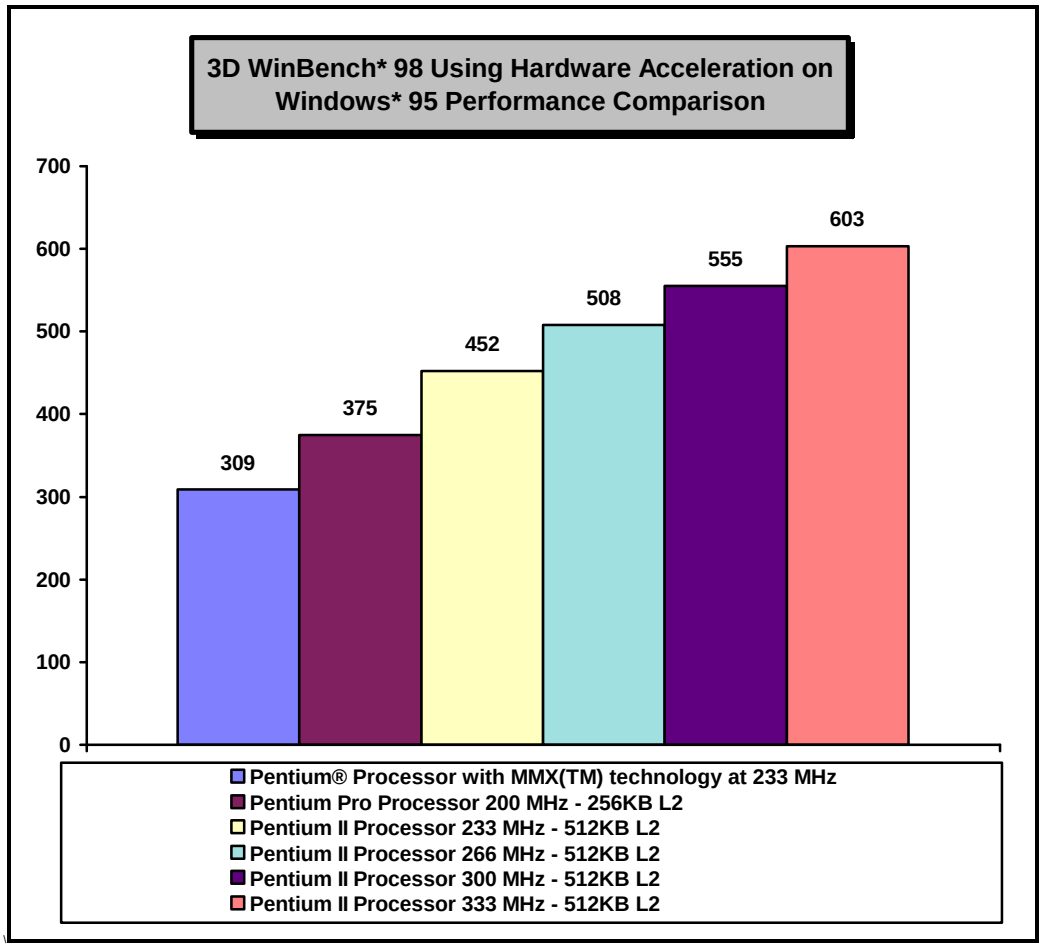

Figure 14. Intel Pentium ® II Processor Performance for the 3D WinBench* 98 (using hardware acceleration) Benchmark.

SUMMARY

Table 1 summarizes the iCOMP® Index 2.0 performance of processors representative of the Intel processor families. (Higher the number better the performance)

Table 1. iCOMP Index 2.0 Results

iCOMP® Index 2.0	Pentium® Processor with MMX™ technology 233 MHz	Pentium Pro Processor 200 MHz 256KB L2	Pentium II Processor 233 MHz 512KB L2	Pentium II Processor 266 MHz 512KB L2	Pentium II Processor 300 MHz 512KB L2	Pentium II Processor 333 MHz 512KB L2
Rating	**203**	**220**	**267**	**303**	**332**	**366**

Tables 2 and 3 summarize the performance of benchmarks for the Integer Benchmark vector, both processor level and system level, for processors representative of the Intel processor families. (Higher the number better the performance).

Table 2. Three Vectors of Performance Benchmark Results – Integer Benchmarks – Processor Level

Processor Benchmarks	Pentium® Processor with MMX™ technology 233 MHz	Pentium Pro Processor 200 MHz 256KB L2	Pentium II Processor 233 MHz 512KB L2	Pentium II Processor 266 MHz 512KB L2	Pentium II Processor 300 MHz 512KB L2	Pentium II Processor 333 MHz 512KB L2
INTEGER BENCHMARKS						
Processor Level Benchmarks						
SPEC CPU*95/ UNIX*						
SPECint*95	**7.12**	**8.20**	**9.47**	**10.8**	**11.7**	**12.8**
SPECint_base*95	7.12	8.20	9.47	10.8	11.7	12.8
SPEC CPU*95/ Windows* NT 4.0						
SPECint*95	**7.02**	**8.08**	**9.44**	**10.80**	**11.60**	**12.70**
SPECint_base*95	7.02	8.08	9.44	10.80	11.60	12.70
Windows*						
Ziff-Davis CPUmark*						
CPUmark*32/Win*95	**471**	**551**	**608**	**692**	**746**	**832**
Norton* System Index*/ Windows* 95						
Norton* SI 32/Win*95	**62.0**	**87.2**	**112.2**	**127.8**	**141.3**	**156.5**

Table 3. Three Vectors of Performance Benchmark Results – Integer Benchmarks – System Level

System Benchmarks	Pentium® Processor with MMX™ technology 233 MHz	Pentium Pro Processor 200 MHz 256KB L2	Pentium II Processor 233 MHz 512KB L2	Pentium II Processor 266 MHz 512KB L2	Pentium II Processor 300 MHz 512KB L2	Pentium II Processor 333 MHz 512KB L2
INTEGER BENCHMARKS						
System Level Benchmarks						
SYSmark*32/Windows* 95	**216**	**214**	**256**	**283**	**302**	**319**
Publishing	210	206	238	260	282	290
Graphics	236	234	281	326	349	377
Presentation	222	206	260	284	308	322
Word Processing	216	217	250	272	287	302
Spreadsheet	209	213	260	289	309	328
Database	217	220	249	279	296	315
SYSmark*32/ Windows* NT 4.0	**251**	**277**	**312**	**345**	**360**	**387**
Publishing	290	323	368	397	404	433
Graphics	281	320	349	397	423	458
Presentation	285	302	361	397	414	441
Word Processing	279	298	328	359	372	402
Spreadsheet	199	233	262	295	309	334
Database	243	269	294	319	336	357
SYSmark*/NT/ Windows* NT 4.0	**168**	**201**	**231**	**257**	**274**	**296**
Spreadsheet	154	169	190	208	220	237
Project Management	182	284	306	346	356	375
Word Processing	164	184	204	224	239	256
Presentation	167	207	242	271	297	324
CAD	174	178	227	257	279	306

Table 4 summarizes the performance of benchmarks for the Multimedia Benchmark vector for processors representative of the Intel processor families. (Higher the number better the performance).

Table 4: Three Vectors of Performance Benchmark Results – Multimedia Benchmarks

	Pentium® Processor with MMX™ technology 233 MHz	Pentium Pro Processor 200 MHz 256KB L2	Pentium II Processor 233 MHz 512KB L2	Pentium II Processor 266 MHz 512KB L2	Pentium II Processor 300 MHz 512KB L2	Pentium II Processor 333 MHz 512KB L2
Intel Media Benchmark/ Windows* 95	**292.68**	**197.17**	**314.13**	**356.38**	**393.69**	**431.24**
Norton* Multimedia Benchmark	**15.0**	**12.4**	**17.8**	**19.8**	**21.8**	**24.1**
Video	11.9	7.5	12.1	12.8	14.3	16.0
3D Graphics	14.4	18.1	21.2	24.1	26.5	28.8
Audio	25.5	17.0	26.6	30.3	33.7	38.2
CD - ROM	5.3	5.7	5.0	5.3	5.3	5.7
Imaging	31.2	17.1	42.0	47.2	51.2	55.7

Table 5 summarizes the performance of benchmarks for the Floating-Point Benchmark vector for processors representative of the Intel processor families. (Higher the number better the performance).

Table 5: Three Vectors of Performance Benchmark Results – Floating-Point Benchmarks

	Pentium® Processor with MMX™ technology 233 MHz	Pentium Pro Processor 200 MHz 256KB L2	Pentium II Processor 233 MHz 512KB L2	Pentium II Processor 266 MHz 512KB L2	Pentium II Processor 300 MHz 512KB L2	Pentium II Processor 333 MHz 512KB L2
SPEC CPU*95/ UNIX*						
SPECfp*95	**5.21**	**6.21**	**7.04**	**7.68**	**8.15**	**9.14**
SPECfp_base*95	4.23	5.54	6.32	6.97	7.45	8.32
SPEC CPU*95/ Windows* NT 4.0						
SPECfp*95	**5.18**	**6.34**	**7.31**	**7.98**	**8.49**	**9.25**
SPECfp_base*95	4.55	5.75	6.69	7.39	7.89	8.60
Norton* Multimedia Benchmark /3D Graphics	**14.4**	**18.1**	**21.2**	**24.1**	**26.5**	**28.8**
Ziff-Davis 3D WinBench* 98						
3D WinBench* 98	**309**	**375**	**452**	**508**	**555**	**603**

APPENDIX A — TEST CONFIGURATIONS

SPEC CPU*95 UNIX* System Configuration

	Pentium® Processor with MMX™ technology - 233 MHz	**Pentium Pro Processor- 200 MHz**	**Pentium II Processor 233, 266, 300 and 333 MHz[1]**
System	Intel 82430 TX PCIset based motherboard	Intel 82440 FX PCIset based motherboard	Intel 82440 LX AGPset based motherboard
Secondary Cache	512 KB WB	256 KB WB	233 and 266 MHz - 512 KB WB 300 and 333 MHz -512 KB WB with ECC
Memory Size	64MB SDRAM	64MB EDO	64MB SDRAM
Video Controller/Bus	Matrox Millennium*/ PCI		
Hard Disk Controller	E-IDE/integrated PCI		
Hard Disk	Quantum UDMA*	Quantum Fireball *1080 FBA	
Operating System	UnixWare* 2.0		
C Compiler	Intel C Ref. Compiler 2.3		
FORTRAN Compiler	Intel FORTRAN Ref. Compiler 2.3		

Windows* System Configuration

Processor	**Pentium® Processor with MMX™ technology - 233 MHz**	**Pentium Pro Processor- 200 MHz**	**Pentium II Processor 233, 266, 300 and 333 MHz[1]**
System	Intel 82430 TX PCIset based motherboard	Intel 82440 FX PCIset based motherboard	Intel 82440 LX AGPset based motherboard
FPU	Integrated		
Primary Cache	Pentium® Processor - 16 KB (8KB I + 8 KB D) Pentium Processor with MMX ™ Technology - 32 KB (16KB I + 16 KB D)	16 KB (8 KB I + 8 KB D)	32 KB (16KB I + 16 KB D)
Secondary Cache	512 KB WB	256 KB WB	233 and 266 MHz - 512 KB WB 300 and 333 MHz -512 KB WB with ECC
Memory Size	Windows*95 and Windows* NT 4.0 - 32 MB SDRAM SYSmark*/NT and SPEC CPU*95 under Windows* NT 4.0 - 64 MB SDRAM	Windows*95 and Windows*NT 4.0 - 32 MB EDO SYSmark*/NT and SPEC CPU*95 under Windows* NT 4.0 - 64 MB EDO	Windows*95 and Windows* NT 4.0 - 32 MB SDRAM SYSmark*/NT and SPEC CPU*95 under Windows* NT 4.0 - 64 MB SDRAM
Hard Disk Controller/Bus	Adaptec 2940UW* SCSI/PCI		
Hard Disk	Seagate ST34501W*		
Video Controller/Bus	For all benchmarks except 3D WinBench* 98: Diamond Stealth 3D 2000 Pro*/ PCI For 3D WinBench 98: Pentium® with MMX™ technology processor – STB Velocity 128 PCI based Pentium Pro processor – STB Velocity 128 PCI based Pentium II processor – STB Velocity 128 AGP based		
Video Memory Size/Type	Diamond Stealth 3D 2000 Pro *- 2 MB EDO STB Velocity 128 – 4MB SGRAM		

Operating System 1	**Windows* NT 4.0**
Video Driver Revision	Diamond* v2.1
Graphics	1024x768 Resolution, 256 Colors
	SPEC CPU*95 - Windows* NT 4.0
C Compiler	Intel C Compiler 2.4 Plug In
FORTRAN Compiler	Intel FORTRAN Compiler 2.4 Plug In
Operating System 2	**For all benchmarks except 3D WinBench* 98 - Windows* 95 - Build 1111** **For 3D WinBench 98 - Windows 95 - Build 1212**
Video Driver Revision	For all benchmarks except Norton* Multimedia Benchmark and 3D WinBench* 98: Diamond Stealth 3D 2000 Pro*- Diamond 4.03.00.3205 with Microsoft DirectX 3.0a* For Norton* Multimedia Benchmark: Diamond Stealth 3D 2000 Pro- Diamond* 4.03.00.3205 with Microsoft DirectX 5.0* For 3D WinBench* 98: STB Velocity 128 – STB 1.21 with Microsoft DirectX 5.0
Graphics	All benchmarks except Norton* Multimedia and Intel Media Benchmarks, 3D WinBench* 98 – 1024x768 Resolution, 256 Colors Norton Multimedia and Intel Media Benchmarks - 1024x768 Resolution, 16-bit color 3D WinBench 98 – 640 x 480 Resolution, 16-bit color

Processor	**Pentium® Processor with MMX™ technology - 233 MHz**	**Pentium Pro Processor- 200 MHz**	**Pentium II Processor 233, 266, 300 and 333 MHz[1]**
	Audio - Media Benchmarks		
CD ROM Drive	Toshiba 15X CD ROM Model XM-3801B*		
Sound Card	Creative Labs Sound Blaster* 16		

[1.] Frequency set by replacing the processor and setting system jumpers as described in the system documentation.

APPENDIX B — ICOMP Ò INDEX CONFIGURATION

System Configuration used in iCOMP® Index 2.0 Ratings

Processor	**Pentium® Processor with MMX™ technology - 233 MHz**	**Pentium Pro Processor- 200 MHz**	**Pentium II Processor 233 and 266 MHz[1]**	**Pentium II Processor 300 and 333 MHz**
FPU	Integrated			
System	Intel 82430 TX PCIset based motherboard	Intel 82440 FX PCIset based motherboard	Intel 82440 FX PCIset based motherboard (Portland PD440FX)	Intel 82440 LX PCIset based motherboard (Atlanta AL440LX)
Primary Cache	32 KB (16KB I + 16 KB D)	16 KB (8 KB I + 8 KB D)	32 KB (16 KB I + 16 KB D)	
Secondary Cache	512K WB	256K WB	512K WB	512K WB with ECC
Hard Disk	Quantum Fireball EIDE with Integrated EIDE disk controller			
Video	Matrox Millennium PCI			
Audio	Creative Labs Sound Blaster* 16			
Memory Size	64MB SDRAM	64 MB EDO		64MB SDRAM
	SPEC CPU*95			
Operating System	UnixWare* 2.0			
C Compiler	Intel C Ref. Compiler 2.3			
FORTRAN Compiler	Intel FORTRAN Ref. Compiler 2.3			
	Windows*95			
Memory Size	32 MB SDRAM	32 MB EDO		32 MB SDRAM
Graphics	All benchmarks except Intel Media Benchmark - 1024x768 Resolution, 256 Colors Intel Media Benchmark - 1024x768 Resolution, 16-bit color			

[1.] Frequency set by replacing the processor and setting system jumpers as described in the system documentation.

iCOMP® Index 2.0 Component Scores As Measured On Appendix B Configurations

Table 6: iCOMP® Index 2.0 Component scores on Appendix B Configurations

	Pentium® Processor with MMX™ technology 233 MHz	Pentium Pro Processor 200 MHz 256KB L2	Pentium II Processor 233 MHz 512KB L2	Pentium II Processor 266 MHz 512KB L2	Pentium II Processor 300 MHz 512KB L2	Pentium II Processor 333 MHz 512KB L2
iCOMP® Index 2.0 Rating	203	220	267	303	332	366
CPUmark*32	472	553	606	693	746	832
Norton SI*32	61.9	90.0	112.6	127.3	141.3	156.5
Intel Media Benchmark/ Windows* 95	293.27	196.29	310.25	351.10	387.92	423.48
SPECint_base*95	7.12	8.20	9.49	10.80	11.70	12.8
SPECfp_base*95	4.23	5.54	5.91	6.43	7.45	8.32

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