THE TOLLY GROUP

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Intel® Corporation

Ultra Low Voltage Intel® Celeron® M Processor at 600 MHz with a 512K Level 2 Cache

Competitive Performance Evaluation versus VIA C3 Nehemiah 1-GHz 64K Level 2 Cache, VIA C3 Ezra-T 933-MHz 64K Level 2 Cache, VIA C3 Samuel2 600-MHz 64K Level 2 Cache

TOLLY 16 YEARS 1989-2005 Test Summary

Premise: Architects of PC and embedded systems need to know the comparative CPU performance and memory access characteristics of various "motherboards" that they are considering as base platforms in order to make an informed decision as to the relative value propositions of competing products and vendors. Standard benchmarks provide this required information.

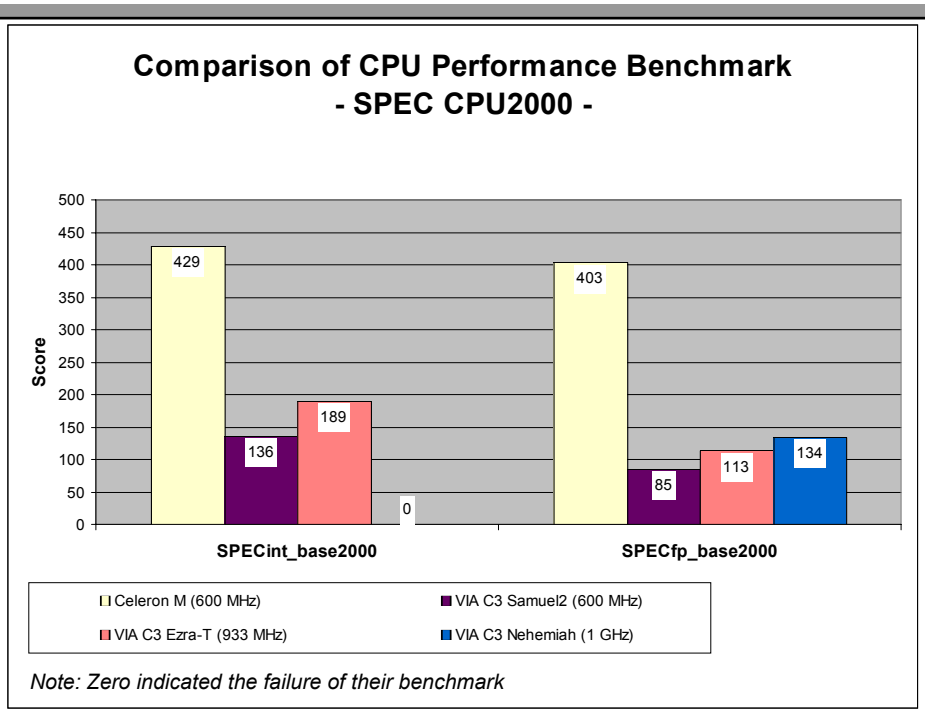
Intel Corporation commissioned The Tolly Group to benchmark the performance of its Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz and equipped with a 512K Level 2 cache alongside three other similar products from VIA Technologies: the VIA C3 Nehemiah 1-GHz processor with a 64K Level 2 cache, the VIA C3 Ezra-T 933-MHz processor with a 64K Level 2 cache, and a VIA C3 Samuel 2 600-MHz processor with a 64K Level 2 cache.

All four products support the Mini-ITX form factor for motherboards where a processor is soldered to the motherboard with an array of communications and graphics subsystems.

The Ultra Low Voltage Intel® Celeron® M processor is designed for communication appliances such as media center appliances, network-attached storage, Web pads, point-of-sale terminals, kiosk and other applications where exceptional

Test Highlights

- Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz successfully completes compute-intensive integer and floating-point SPEC CPU2000 tests while VIA Technologies C3 1-GHz processor failed to run tests
- Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz delivers superior performance compared to VIA Technologies C3 processors in SYSmark 2004 and WebMark 2004 tests
- Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz outperforms trio of VIA Technologies C3 processors operating between 600 MHz and 1 GHz during PCMark04 tests
- Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz surpasses the performance of three VIA Technologies C3 processors during SANDRA arithmetic and floating point benchmark tests

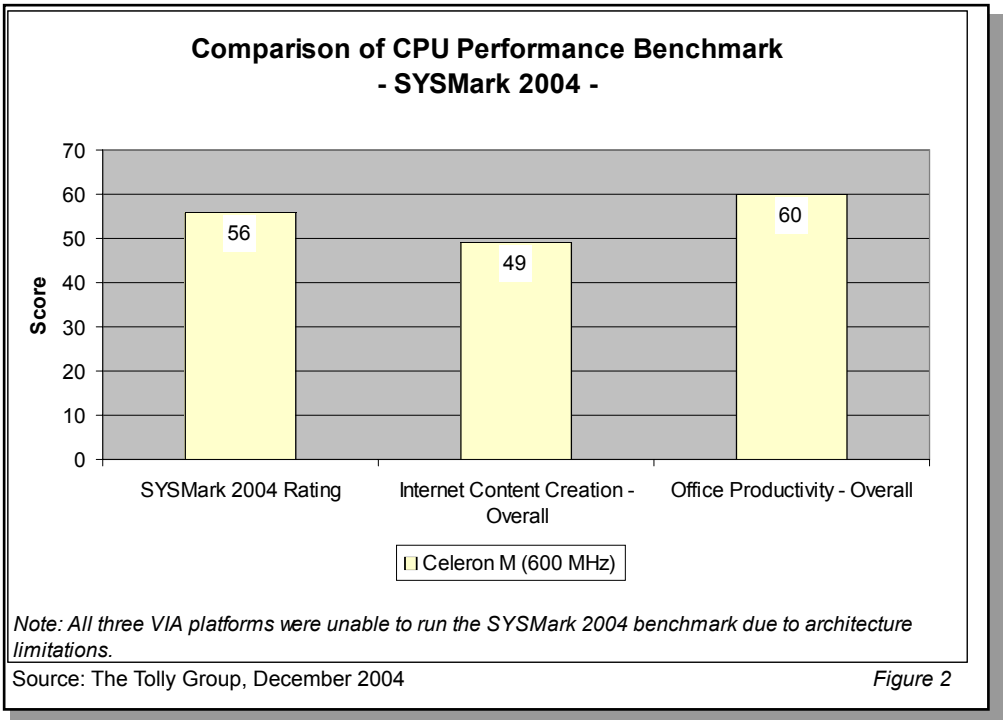


Note: Zero indicated the failure of their benchmark

Source: The Tolly Group, December 2004 *Figure 1*

performance and low power are required.

Tolly Group engineers subjected all four systems to a battery of benchmark tests exercising the full range of capabilities of the devices. Performance comparisons were drawn from the devices that were subjected to industry-standard benchmarks utilizing the PCMark04, SYSmark 2004 and WebMark 2004 from Futuremark Corp., SANDRA 2004 from SiSoftware Ltd., and SPEC CPU2000 V1.2 from Standard Performance Evaluation Corp.



Note: All three VIA platforms were unable to run the SYSMark 2004 benchmark due to architecture limitations.

Source: The Tolly Group, December 2004 *Figure 2*

Benchmark tests conducted by The Tolly Group reveal that the Ultra Low Voltage Intel® Celeron® M processor consistently outperformed the competitive products tested, demonstrating that Intel delivers greater CPU performance. Tests were conducted during November-December 2004.

Results

SPEC CPU2000 Benchmark

Engineers utilized SPEC CPU2000 ver. 1.2. With respect to both the compute-intensive integer and floating-point performance, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz generated the maximum scores with values of 429 and 403 respectively for both tests. (See Figure 1). The VIA Technologies 1-GHz C3 Nehemiah failed to complete the test. The results were the same even after engineers replaced memory modules. The VIA Technologies 1-GHz C3 Nehemiah managed a score of 134 in the floating point test. The VIA 933-MHz C3 Ezra-T chipset posted scores of 189 and 113 in the integer and floating point tests, respectively. The 600-MHz VIA C3 Samuel 2 scored 136 and 85 in the integer and floating point tests.

SYSmark 2004

In the SYSmark 2004 tests, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz successfully completed both the Internet content creation and office productivity tests, earning scores of 49 on the Internet-related tests and 60 for the office productivity tests. These scores combined for an average rating of 56 for the Ultra Low Voltage Intel® Celeron® M processor. Tolly Group engineers were unable to successfully run these tests on each of the three VIA Technologies processors, even altering configurations in an attempt to have the tests run. (See Figure 2.)

PCMark04 Benchmark

Engineers conducted all the tests included in the System, CPU and Memory Test Suites of PCMark04 on the four devices under test. Tests were conducted with PCMark04 version 1.2.0. The best performance for this benchmark was observed with the 600-MHz Ultra Low Voltage Intel® Celeron® M processor, which delivered a top PCMark score of 1,226 - or 60% greater than the 1-GHz VIA Technologies C3 Nehemiah chipset. (See Figure 3.)

CPU performance scores clearly favored the Ultra Low Voltage Intel® Celeron® M processor, which delivered an average score of 1,254, versus the VIA Technologies processors that scored from a low of 432 for the 600-MHz VIA C3 Samuel 2 processor to 763 for the 1-GHz VIA Technologies C3 Nehemiah processor.

Scores for the memory tests conducted on both devices show that the 600-MHz Ultra Low Voltage Intel® Celeron® M processor

achieved an average memory test score of 1,586 versus 418 for the 1-GHz VIA Technologies C3 Nehemiah, the highest performer among competitive products tested.

WebMark 2004

In these tests, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz successfully completed both the information processing and the commercial transaction tests, earning average scores of 38 and 35, respectively. (See Figure 4.) These scores combined for an average rating of 36 for the Ultra Low Voltage Intel® Celeron® M processor. Tolly Group engineers were unable to successfully run these tests on each of the three VIA Technologies processors, even altering configurations in an attempt to have the tests run.

SANDRA 2004 Benchmark

Engineers conducted tests in four areas: CPU arithmetic, CPU multimedia, memory bandwidth and cache memory. Tests were conducted using SANDRA 2004 ver. 10.9.133.

For the integer-based arithmetic benchmark, Dhrystone ALU, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz generated the highest score - 2,469 - followed by a score of 1,572 for the VIA Technologies C3 Nehemiah, 1,188 for the VIA Technologies C3 Ezra, and 750 for the VIA Technologies Samuel 2 processor.

For the floating point-based benchmark, Whetstone FPU, the Ultra Low Voltage Intel Celeron M processor at 600 MHz scored nearly three times greater than its nearest competitor. The Intel processor scored 837 versus 298 for the VIA Technologies C3 Nehemiah, which led all VIA Technologies devices. (See Figure 5.)

For the CPU multimedia benchmarks provided by the SANDRA suite, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz led all devices again for both the integer-based and floating point-based benchmarks with scores of 5,705 and 6,294, respectively. Tests scores on the multimedia benchmarks demonstrate more than three times greater performance of the Ultra Low Voltage Intel® Celeron® M processor compared to the VIA Technologies devices.

In the SANDRA memory bandwidth benchmarks, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz led all devices again for both the integer-based and floating point-based memory benchmarks, delivering up to eight times greater performance than the lower-speed VIA Technologies processors.

In the cache memory benchmark, set the performance watermark with a score of 2,458 MB per second or (MB/s), versus 1,143 for the VIA Technologies C3 Nehemiah, which led all VIA Technologies devices.

In cache memory speed factor tests, which provide a ratio between cache speed and memory, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz generated the best speed factor score at 5.9, versus 8.7 to 12 for the various VIA C3 processors. (For a more detailed explanation of speed factor, see the SANDRA CPU2000 section in the Test Methodology section of this report.)

Intel Corporation

Intel® Celeron® M Processor at 600 MHz with a 512K Level 2 Cache

CPU Performance Evaluation

TOLLY Up to Spec CERTIFIED

Intel Corporation
Intel® Celeron® M Processors at 600 MHz with a 512K Level 2 Cache
Product Specifications*

Feature

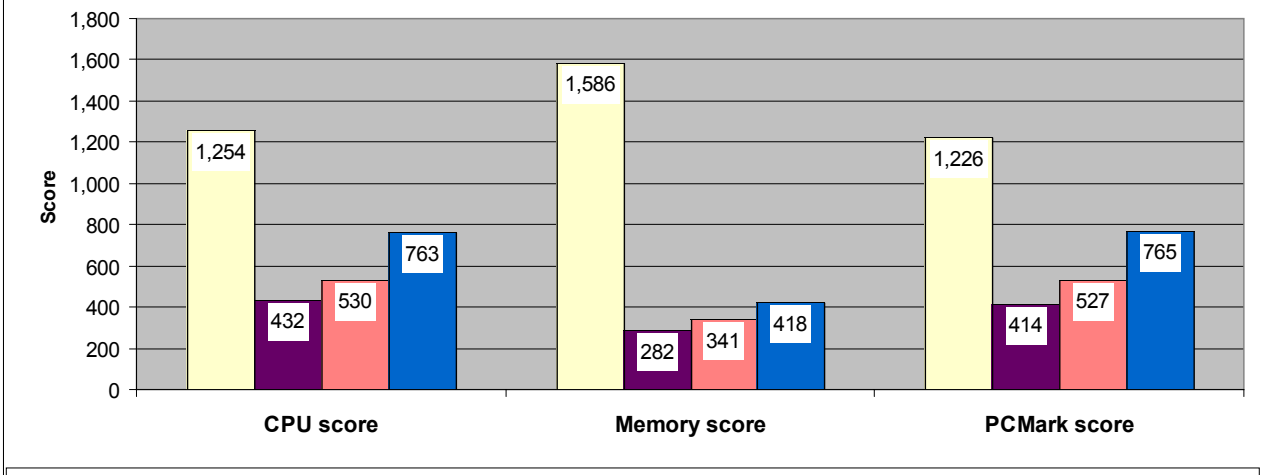
- Core speed: 600 MHz
- Front-side bus speed: 400 MHz
- Level 2 cache: 512 KB
- Thermal design power: 7.0W
- VID: 1.004V
- Package: 479 µFC-BGA
- Product number: RJ80535VC600512

Feature

- Validated with Intel® 852GM chipset
  - 400 MHz or 533 MHz system bus
  - DDR 266/333
  - ECC
  - Integrated graphics utilizing Intel® Extreme Graphics 2 technology
  - Package: 732 µFC-BGA
  - Product number: RG852GME
- Validated with Intel® ICH4 I/O Controller Hub
  - (6) USB ports with USB 2.0 support
  - Integrated LAN connect interface
  - Package: 421 µBGA
  - Product number: FW82801DB

For more information contact:
Intel Corporation
Attn: Todd Paredes
Phone: (480) 554-4066
URL: http://www.intel.com

**Vendor-supplied information not verified by The Tolly Group*



Source: The Tolly Group, December 2004

Figure 3

Analysis

Test results show that processor clock speed, alone, is not a proven arbiter of overall performance. Operating at almost one-third less the clock speed of the VIA Technologies 1-GHz C3 Nehemiah, Intel's Ultra Low Voltage Intel® Celeron® M processor at 600 MHz delivers greater performance consistently across the PCMark04, SANDRA 2004, SPEC CPU2000, SYSmark 2004 and WebMark 2004 tests.

From the results of the SPEC CPU2000 suite benchmarks executed on the Ultra Low Voltage Intel® Celeron® M processor and the VIA Technologies C3 processors, it is evident that the Ultra Low Voltage Intel® Celeron® M devices performed better in integer-based and floating point-based benchmarks than the VIA Technologies devices. The VIA devices have half the performance scores for most of the integer-based benchmarks when compared to the Ultra Low Voltage Intel® Celeron® M processor. The VIA C3 processors also significantly lagged the Ultra Low Voltage Intel® Celeron® M processor in the floating-point-based benchmarks as reflected by the test scores.

The reason could be attributed to platform-based features of these devices, especially caching capabilities. Benchmark scores are always disputable, as they are based upon simulated workloads, and seldom on real workloads. Therefore, the actual performance of the processors should be assessed based on real applications and the benchmarks should be a guideline to make a performance comparison.

In the PCMark04 tests, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz outperformed all three VIA Technologies processors, including the 1-GHz C3 Nehemiah - in both CPU and memory score tests. Such extra performance headroom assures developers that the processor can accommodate surges in load without jeopardizing system design.

Looking at the results of CPU Arithmetic and CPU Multimedia benchmarks from SANDRA 2004, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz again bested the VIA Technologies processors in integer-based and floating point-based benchmarks.

Related Tests

Intel commissioned The Tolly Group in September 2003 to benchmark the performance of its Ultra Low Voltage Intel® Celeron® processors operating at 400 MHz and 650 MHz alongside

a pair of VIA Technologies, Inc. mainboard CPUs: the EPIA M10000 C3 Nehemiah and EPIA M6500 C3 Samuel 2.

Engineers subjected all four devices to a battery of benchmark tests exercising the full range of capabilities of the devices. Performance comparisons were drawn from the devices that were subjected to industry-standard tests utilizing the PCMark 2002 (Futuremark Corp.), SANDRA (SiSoftware Ltd.) and SPEC CPU2000 V1.2 (Standard Performance Evaluation Corp.) benchmarks.

For more information or to access the Test Summary report, go to: http://www.tolly.com/DocDetail.aspx?DocNumber=203124

Test Configuration and Methodology

For performance tests, The Tolly Group tested the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz, a device outfitted with 64KB of Level 1 cache memory, 512KB of Level 2 cache memory and 512 MB RAM. The Ultra Low Voltage Intel Celeron M device was housed in a 250W ATX form factor with a 60-Gbyte Maxtor ATA 7200 RPM hard drive, Rosewill 52x24x52/16x Combo Drive (CD-RW & DVD-ROM) and Windows XP Professional with Service Pack 2 (also installed 20 additional patches from Microsoft Windows Update).

The Tolly Group tested the Ultra Low Voltage Intel Celeron M device against a trio of VIA Technologies C3 processors. The 1-GHz C3 Nehemiah processor was outfitted with 64KB of Level 1 cache memory, 64KB of Level 2 cache memory and 512 MB RAM. Both the 933-MHz VIA C3 Ezra-T processor and the 600-MHz VIA C3 Samuel2 processor were outfitted with 128KB of Level 1 cache memory, 64KB of Level 2 memory cache and 512 MB RAM. The VIA C3 processors were housed in a 250W ATX form factor with a 60-Gbyte Hitachi/IBM ATA 7200 RPM hard drive, Rosewill 52x24x52/16x Combo Drive (CD-RW & DVD-ROM) and Windows XP Professional with Service Pack 2 (also installed 20 additional patches from Microsoft Windows Update).

Each device was set with a stable configuration in order to avoid any benchmark failures during each run. For Video Display Settings, engineers configured the color quality and screen resolution to Medium (16-bit) and 1024x768 pixels, respectively. For Visual Effects, engineers set each device with "Adjust for best performance" option. For Virtual Memory configuration, engineers set a memory range from 672 MB to 1,344 MB. Lastly, engineers disabled the following services from the operating system in order to reduce the number of processes running in the background: Automatic Updates, Security Center, and Wireless Zero Configuration.

Each device was subjected to the following tests independently using the exact same steps with the following industry standard benchmarks. Each test was run for three iterations in order to improve the accuracy of performance analysis.

SPEC CPU2000

The SPEC benchmarks are published by the Systems Performance Evaluation Cooperative and consist of a group of codes that are run on various computers by the hardware vendors to compare the speed of different computers. SPEC CPU2000 focuses on compute-intensive performance, which means these benchmarks emphasize the performance of the computer's processor (CPU), the memory architecture, and compilers. SPEC CPU2000 provides a comparative measure of integer and/or floating point compute intensive performance. The benchmark codes are selected so that they represent different types of calculations and they are an excellent indication of the cumulative performance of a computer. The source codes are written in FORTRAN, C, C++ and hence needed compilers should be installed in the device under test for compiling the codes. The ratio for each of the benchmarks is calculated using a SPEC-determined reference time and the run time of the benchmark. For SPEC CPU2000, the reference machine is a Sun Ultra5_10 workstation with a 300-MHz SPARC processor and 256MB of memory, and this machine is given a SPECint2000 and SPECfp2000 score of 100. More information on this test tool is available at www.spec.org/cpu2000

Tests were performed to obtain benchmark scores for the four processors under consideration with identical test conditions. Intel provided the configuration files for the SPEC measurements with the same flag settings for both Intel and VIA Technologies devices.

Engineers generated measurement scores by executing all the benchmarks provided by the tool on all the devices under consideration. The scores of SPECint_base2000 and SPECfp_base2000 were used for performance comparison of

the devices. The larger the SPECFP or SPECINT number the faster the computer.

Tests were conducted as per the instructions provided by the test tool. The desired benchmarks were selected and executed.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

SYSmark 2004

SYSmark 2004 is a mainstream office productivity and Internet content creation benchmark used to characterize the performance of a business client. Engineers utilized SYSmark 2004 ver. 10.9.133.

Tests were conducted using the default settings provided by the test tool which reflects the usage patterns of business users in the areas of Internet Content Creation and Office Productivity. All benchmarks were selected and executed. For the Internet Content Creation benchmark, the following programs were used: Adobe® After Effects® 5.5, Adobe® Photoshop® 7.01, Adobe® Premiere® 6.5, Discreet® 3ds max™ 5.1, Macromedia® Dreamweaver® MX, Macromedia® Flash MX, Microsoft® Windows Media® Encoder 9 Series, Network Associates® McAfee® VirusScan® 7.0, WinZip Computing WinZip® 8.1. For the Office Productivity benchmark, the following programs were used: Adobe® Acrobat® 5.0.5, Microsoft® Access 2002, Microsoft® Excel 2002, Microsoft® Internet Explorer 6, Microsoft® Outlook® 2002, Microsoft® PowerPoint® 2002, Microsoft® Word 2002, Network Associates® McAfee® VirusScan® 7.0, ScanSoft® Dragon Naturally Speaking® 6 Preferred, WinZip Computing WinZip® 8.1.

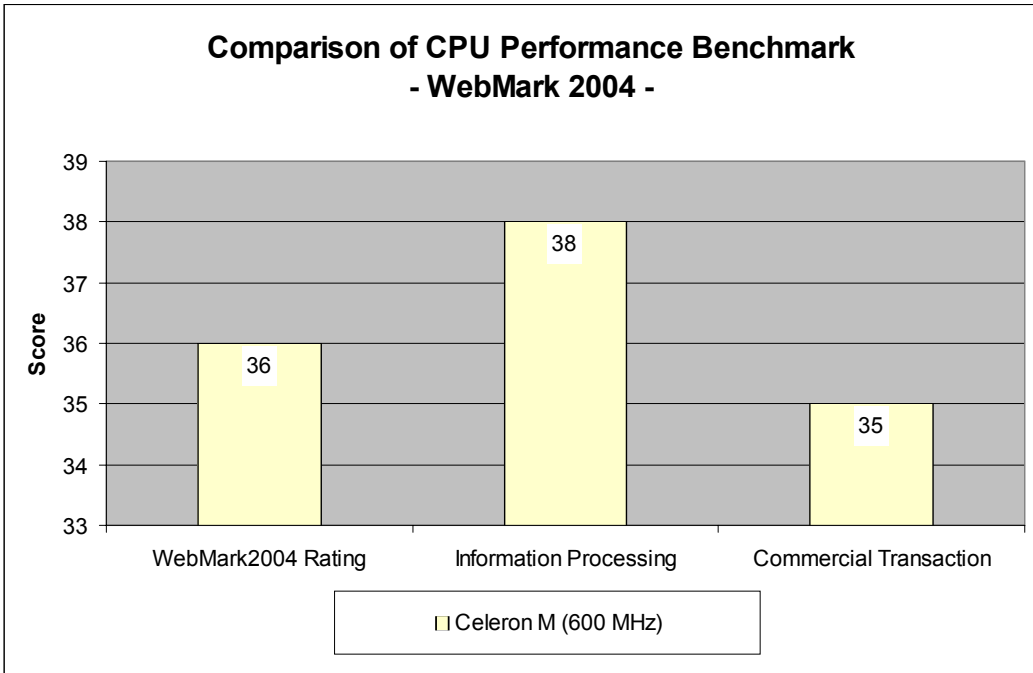
All programs used for Internet Content Creation and Office Productivity were supplied by SYSmark 2004 during the installation.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

PCMark04

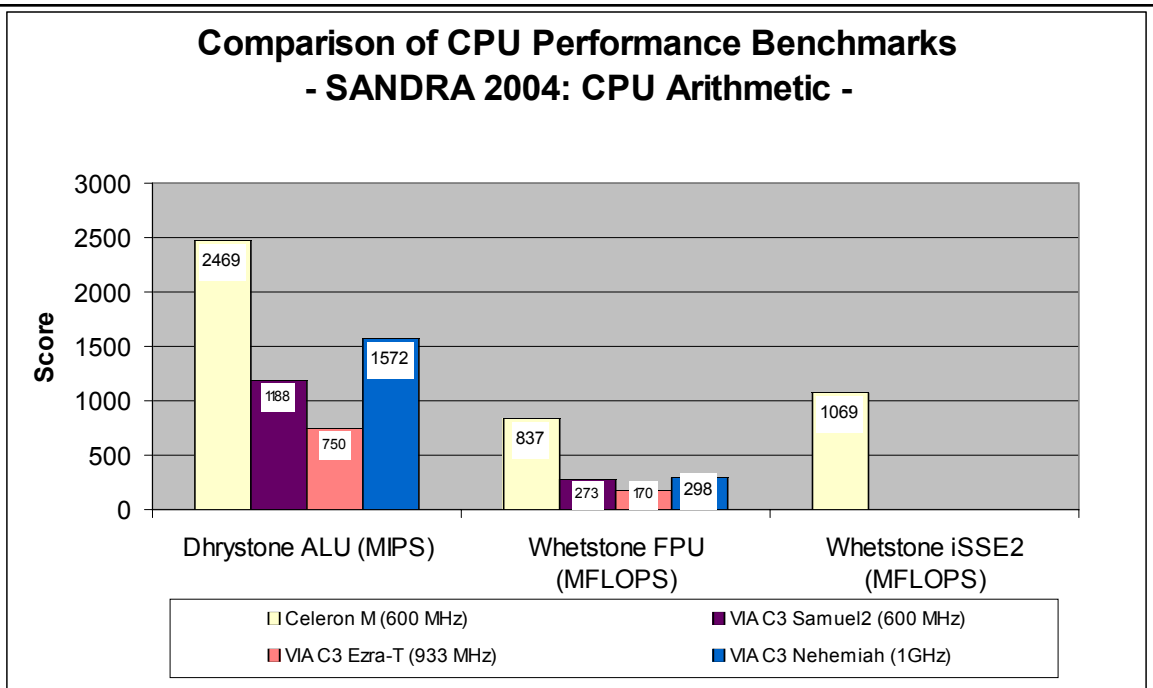
PCMark04 basically is a component-level benchmark developed and distributed by Futuremark. It is designed to be a unified benchmark to test PCs on any platform, specifically geared towards home and office users (laptops, desktops and workstations). More information on PCMark04 is available at www.futuremark.com.

In these tests, the algorithms used to measure six CPU-specific tests stressed both the integer and the floating-point unit and included some Intel® Streaming SIMD Extensions (SSE) and SSE2 optimizations. They are designed to test the performance of the processors where cache size is one of the major parameters affecting processor performance. In the 25 memory tests conducted, different operations were performed using



Note: All three VIA platforms were unable to run the WebMark 2004 benchmark due to architecture limitations.

Source: The Tolly Group, December 2004 *Figure 4*



Source: The Tolly Group, December 2004 *Figure 5*

several different block sizes in order to determine the speed of Level 1 and Level 2 cache as well as system memory. These operations were read, write, read-modify-write and random access. The overall CPU and memory scores were calculated based on the performance of the processor with these individual benchmarks.

The tests were conducted as per the instructions provided by the test tool. The desired benchmarks were selected and executed.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

WebMark 2004

WebMark 2004 is the latest version of the Internet client metric based on real-world Internet technologies that measures PC performance and enables performance comparisons for clients and servers. For these tests, Tolly Group engineers utilized the WebMark 2004 client only, Version 1.0.1.1.

Tests were conducted using the following settings provided by the test tool which reflects usage patterns for business users in two Internet usage categories: Information Processing and Commercial Transactions. Information Processing is composed of activities focused on users viewing, researching and managing information on the Internet. Three Web sites - Portal, Research and Training were created to represent common Internet sites and activities that fall in this scenario. Commercial Transactions is composed of activities involved in the commercial exchange of goods or services. Three Web sites - Purchasing, Finance and Marketplace were created to represent common Internet sites and activities that fall in this scenario. For more detailed information about WebMark 2004, please go to http://www.bapco.com.

Engineers set for each device the following settings to run the test tool: Offline mode, Custom Run, Standard Suite, 3 Iterations. Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

SANDRA 2004

SiSoftware SANDRA 2004 (the System Analyzer, Diagnostic and Reporting Assistant) is an information and diagnostic utility. The SANDRA suite used for this testing, basically consisted of four benchmark sets: CPU Arithmetic Benchmark, CPU Multimedia Benchmark, Memory Bandwidth

Benchmark and Cache Memory Benchmark. This tool measures the processor performance scores based on both integer and floating point based measurements. More information on the SANDRA 2004 benchmark is available at www.sisoftware.co.uk

For the SANDRA 2004 benchmark, engineers employed the following tests: on the CPU arithmetic side, the Dhrystone ALU (MIPS) and the Whetstone FPU (MFLOPS) were used. For the CPU multimedia benchmark, engineers used Integer and Floating Point tests to measure the processors' instruction per second (it/s) rate. For the Memory Bandwidth benchmark, engineers measured "RAM Bandwidth Integer Buffered iSSE2 (MB/s)" and "RAM Bandwidth Floating Buffered iSSE2 (MB/s)." Lastly, for the Cache Memory benchmark, engineers measured the "Combined Index (MB/s)" as well as "Speed Factor" on the processors.

The speed factor is just the ratio of the cache bandwidth (Level 1) to memory bandwidth (Memory). Thus it is a measure of how much faster the processor cache is compared to the memory system. As cache bandwidth is directly proportional to processor frequency while the memory bandwidth to memory the speed factor is an indication of the match between processor and memory sub-system. A very high ratio would mean that the processor would require large caches (Level 2/Level 3) to keep working as cache misses would be expensive.

Tests were conducted as per the instructions provided by the test tool. The desired benchmarks were selected and executed.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

Tests were conducted according to The Tolly Group's Fair Testing Charter; VIA Technologies was invited to comment on the test results but never responded.

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

Vendor	Product	Web address
ATEN International Co. Ltd.	ALTUSEN KVM Switch	http://www.aten.com

Tolly Group Services

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TOLLY FAIR TESTING CHARTER

For info on the Fair Testing Charter, visit: http://www.tolly.com/Corporate/FTC.aspx

Project Profile

Sponsor: Intel Corp.
Document number: 205107
Product Class: Processors for small form factor boards
Products under test:

- Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz with a 512K Level 2 cache
- VIA Technologies C3 Nehemiah 1-GHz processor with a 64K Level 2 cache
- VIA Technologies C3 Ezra-T 933-MHz processor with a 64K Level 2 cache
- VIA C3 Samuel 2 600-MHz processor with a 64K Level 2 cache

Testing window: November/December 2004

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at http://www.tolly.com, send E-mail to sales@tolly.com, call (561) 391-5610.

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