HANDS-ON PROJECT

AND THEN THERE WAS ONE

FIVE YEARS AGO, I BUILT A MULTIMEDIA-ENHANCED PC PLATFORM FOR THE LIVING ROOM. NOW FOR THE ENCORE: JUST HOW MUCH COULD I SQUEEZE INTO ONE BOX, HOW SMALL COULD THE BOX BE, AND WOULD THE RESULT MEET OR BEAT THE MULTIPLE BOXES IT REPLACED?

By the end of last year, more than 30 manufacturers were reportedly shipping living-room-targeted PCs in all shapes and sizes, based on Microsoft's Windows XP Media Center Edition. This statistic bears testimony to the vision of of the PC as the information hub for the home, which companies such as Apple, Intel, and Microsoft had long been promoting and which *EDN* first covered indepth nearly five years ago (**Reference 1**). Equally significant, vendors showed a plethora of products based on PC building blocks at January's Consumer Electronics Show. These systems included numerous devices whose foundations were the exact same ones this project uses (see **sidebar** "Pragmatic conclusions").

PC derivation, after all, is the primary purpose of a project such as this one. Tear apart an Xbox, for example, and you'll essentially find a PC inside—a fact that the hacking community, who to date has figured out how to run Linux and Windows CE on the Xbox—makes clear (**Reference 2**). Although few *EDN* readers (percentagewise) design PCs, for many of you, the ever-increasing capabilities and decreasing costs of PC components, software, and subsystems make them a natural fit for your system designs, whatever end form they may take. Executives at Via Technologies, the CPU and motherboard manufacturer this project employs, had exactly this trend in mind when the company recently announced its Embedded Platform Division.

Compare the specifications of **Reference 1**'s "high-end" system with those of this project's machine, which I call Spirit in honor of NASA's Mars Rover, and you might feel a twinge of nostalgia (**Table 1**). Ironically, as you'll soon see, many of the components I used this time aren't markedly higher in performance than those I employed in the previous article. Focusing only on performance, though,would give you an incomplete perspective on the big-picture problem I attempted to solve in this project. Immediately after the conclusion of the 1999 article, my wife insisted that I remove the PC from our living room. Aesthetics drove her demand: The PC was big, it was loud, and it projected a lousy image on the TV.

This time, in the hope of potentially extending the system's living-room occupancy, I began the project with two admittedly stringent requirements. First, Spirit could be no bigger than the

other components in my home-theater cabinet: an audio/video receiver, a Voyetra Turtle Beach Audiotron, an HDTV receiver, an Xbox, an analog tape deck, a DVD player, a ReplayTV 4040, and a VCR. It also couldn't be audible over the normal ambient room noise if I was farther than a few feet away from it. But I also wanted one box to encompass as many as possible of the functions those other components currently performed. Challenging? You bet.

BUILDING BLOCKS

My case-size constraints precluded any of the ATX motherboard form factors; Intel's upcoming BTX (Balanced Technology Extended, formerly known by its Big Water codename) form-factor portfolio includes smaller footprint versions. My requirements also precluded the use of the so-called Shuttle form factor, which is flexible in its expansion capabilities but is too tall for my needs even in its newest Zen variant. Keeping consumer-electronics' low cost requirements in mind, I wanted to avoid any single-vendor proprietary system-board and case formats. The remaining option was the Via-championed Mini-ITX form factor, which other companies are now beginning to support (see **sidebar** "Next steps" on the Web version of this article at www.edn.com). For more information on Mini-ITX, visit the Epiacenter and Mini-ITX Web sites.

Via's M10000 motherboard crams a tremendous number of functions into a four-layer board measuring 17×17 cm (6.7 in. per side) (**Figure 1**). The board contains Via's CLE266 and VT8235 core-logic chip set and 1-GHz Nehemiah C3 microprocessor. (A fanless, 800-MHz version is also available.) A six-channel AC'97 codec is onboard, accompanying an S/PDIF (Sony/Philips-digital-interface) audio-output option, along with a dual-channel FireWire transceiver, and the board provides as many as four USB 2.0 ports of the six total ports that the VT8235 south-bridge chip supports.

Other peripherals on the M10000 include a TV-out encoder, which I didn't test, because both monitors I used natively supported VGA inputs, and a 100-Mbit Ethernet chip, which, you'll later see, caused me all sorts of problems. The M10000 supports two UltraDMA 133 mass-storage channels, along with a floppy-drive connection, and it hooks up to a single DDR-266 DIMM. A graphics accelerator onboard the CLE266 north-bridge chip employs system memory as its frame buffer, handles 128-bit 2-D and rudimentary 64-bit, 3-D graphics acceleration, and also includes hardware support for various MPEG-2-decoding tasks. The M10000 board offers only a single PCI slot and no AGP-expansion capability.

I chose Morex's Cubid 2699 case, whose height, depth, and width measurements are 6.35×27.3×29.5 cm (2.5×10.7×11.6 in.) and that contains a 55W power supply (**Figure 2**). Looking inside the case from the top with the front of the case pointing down, you'll notice that the 3.5-in. hard-disk drive sits in the bottom-left corner, and the floppy-disk drive, if present, sits on top of it (**Figure 3**). A slim optical drive attaches above the power supply in the bottom right corner, and the optional PCI card mounts on a right-angle riser and resides in the upper-left corner. The motherboard resides in the upper-right quadrant of the case. With PVR (personal-video-recorder) applications in mind but also mindful of my low-noise and minimal-heat aspirations, I squeezed a Maxtor 5400-rpm, 300-Gbyte hard-disk drive into the 3.5-in. drive housing, connected to the primary IDE channel, along with a Corsair 512-Mbyte DDR-266 module in the DIMM slot.

Toshiba supplied its SD-R6112 slim optical drive, which reads and writes *both* CD- and DVD-format media. I used a small adapter to translate its bus and power interface connectors to standard variants, hooked to the secondary IDE channel. I was determined *not* to put a floppy drive in this system, although I almost gave in when I discovered that Mitsumi made a combo floppy drive and memory-card reader. Being full-sized, though, the Mitsumi drive wouldn't fit into the slim drive bracket and I couldn't find a slim-sized dedicated memory-card reader, either. I also thought about putting a 2.5-in. hard-disk drive into the floppy-drive cavity but couldn't find an appropriate adapter and didn't want to attach the drive to the case with duct tape. So, although **Figure 3** shows an installation that is chock-full of equipment, there's room for another drive inside. I routed two USB connections to the case's front panel, along with one of the FireWire ports and the audio-line output and microphone-input connections. If I wanted to output six-channel audio, I planned to do so using the M10000 S/PDIF output in conjunction with an external audio/video receiver.

POWER CRISIS

For the moment, at least, Microsoft's Windows XP Media Center Edition software is not available in the retail channel—only to OEMs and subscribers of the Microsoft Developer's Network. This limitation derives from the fact that the software closely ties to specific graphics, TV-tuner, and other hardware configurations. Instead, I went with Windows XP Professional, and the initial installation was problem-free. Whereas the first revision of XP Professional didn't support hard drives larger than 137 Gbytes (128 Gbytes binary), the version of the CD I had included Service Pack 1, which added the necessary 48-bit LBA (logical-block-addressing) support and enabled me to use the entire 300-Gbyte hard-drive capacity. NTFS (New Technology File System)-formatting the hard drive took more than an hour, and some system peripherals and capabilities, such as hibernation and other power-management features, were unavailable on initial installation. However, installing the drivers on the included Via CD fixed that problem. I've subsequently upgraded to the latest drivers available on Via's Web site, and I also attempted to upgrade to the latest BIOS revision. Via's FlashPort BIOS-update utility refused to accept the BIOS binary file as valid, however, and a fix was available too late for me to incorporate the newer BIOS in my testing.

My first hint of trouble came when I tried to activate Windows online and received a "no-network-connection-found" message. The amber "link-valid" and green "link-activity" LEDs on the back-panel Ethernet port were both illuminated, which left me stumped until I noticed that the activity LED was rapidly and perpetually blinking even in the absence of network traffic. By attempting to "ping" other equipment on the LAN, as well as disconnecting and reconnecting the network cable and repeatedly power-cycling the board, I discovered—and Via later confirmed—that the culprit was an excessive current surge from the system on initial boot, beyond what the case's built-in supply could deliver. How appropriate, given my California location: I was experiencing an inadequate-power crisis.

Most of the time when I powered up Spirit (and all of the time after the first time, unless between power-up attempts I removed power from the system by disconnecting the external ac/dc converter's input or output), I'd get the perpetually blinking activity LED in conjunction with sporadic network access. Some of the time, I'd get no activity on either LED, and the system would dutifully report a "disconnected network cable" after Windows finished booting. In roughly one out of every 20 attempts, though, everything would come up as I expected. I found that as long as I didn't have a board in the PCI slot, I could reliably obtain a fully functioning system by employing a USB2-based D-Link 100-Mbit, wired-Ethernet adapter or (free after rebate) Syntax 802.11b wireless-Ethernet adapter as my network connection.

Note that, even with the motherboard's Ethernet adapter disabled in the BIOS, the chip still draws system power. My temporary fix fell apart when, later in the project, I started putting cards in the PCI slot; occasionally, then, the hard drive would come up unrecognized on system boot, or it would lock up at some random point during system operation. A miniature add-in 100W supply from iTuner, custom-designed to fit on top of the M10000 board, worked well for about five power cycles and then quit (with no detectible whiff of burning silicon to mark its demise). I finally gave up, took off the case top, and hooked up a conventional 320W PC power supply to the system. All has been fine since then.

BENCHMARKING BLUES

My initial impressions of Spirit's performance were positive, especially in comparison to the notebook PC I use daily; it rapidly booted and task-switched, and it also quickly exited standby and hibernation modes (**Reference 3**). Before putting a graphics card or another peripheral into the PCI slot, though, I wanted to get a more quantifiable sense of the system's native speed, especially since I was running a latest generation Via C3 microprocessor. In comparison to the earlier generation Ezra products, the Nehemiah CPU core delivers several key enhancements. A deeper pipeline enables higher clock rates, and the on-chip FPU now runs at full, not half, speed. Via mi-

AT A GLANCE

- ▷ Stringent size requirements drove my choice of the Mini-ITX form factor.
- ▷ Small cases sometimes also mean too-small power supplies.
- ▷ Benchmarks pinpoint deficiencies, but the imperfections' impacts on real-life operation aren't definitive.
- ▷ Hardware acceleration for video encoding and decoding is of no use if software doesn't exploit its presence.
- ▷ Performance and stability on traditional and even some untraditional PC functions were stellar.

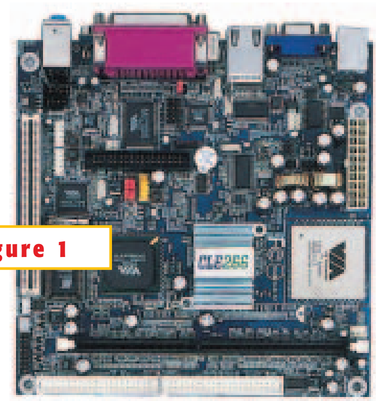
A MINIATURE ADD-IN 100W SUPPLY, CUSTOMED-DESIGNED TO FIT ON TOP OF THE M10000 BOARD, WORKED WELL FOR ABOUT FIVE POWER CYCLES AND THEN QUIT.

grated from the AMD-compatible 3Dnow! instruction-set support of Ezra to Intel-compatible (streaming-SIMD-extensions) support in Nehemiah, and a more efficient cache architecture minimizes the probability of redundant L1- and L2-cache contents.

For my first set of tests, I turned to the synthetic benchmarks from SiSoftware in its free Sandra Standard 2004 product. I began with the all-inclusive Combined Performance Index test, comparing Spirit with benchmark results prebuilt into Sandra for a system similarly equipped to my now-primary desktop PC. Spirit held its own on the network and storage performance benchmarks but fell far behind the reference system in tests that stressed the CPU and memory subsystem (**Figure 4**). (For high-resolution screenshots of this and the benchmarks described below, see the Web version of this article at www.edn.com.)

Searching for more detailed results, I turned to the other tests in the Sandra suite. For the CPU arithmetic and multimedia benchmarks, I put the 1-GHz Nehemiah processor up against the 3.2-GHz HyperThreaded P4 in the desktop system I'm building, the 2-GHz P4 in my current primary desktop, the previous-generation 1-GHz Ezra C3 from Via, and the StrongARM processor in my Pocket PC. The test system barely outperformed its Ezra predecessor and, I'm thankful, outpaced the StrongARM but fell far behind its Intel P4 counterparts. If you believe Sandra's numbers, this CPU is not only slower in clock rate than Intel's latest processors, but also less clock-efficient than Intel's in Via's implementation of SSE. Other reviews of the M10000 motherboard estimate the 1-GHz Nehemiah C3 CPU's performance as roughly on par

Figure 1



The M10000 motherboard was the foundation of this hands-on project (courtesy Via Technologies).

with that of a 500-MHz Intel Pentium III processor; based on my observations, I agree with that approximation.

Next, let's look at how the hard and optical drives perform. The Maxtor drive in Spirit runs at only 5400 rpm, but it contains an ATA-133 interface. This drive outran *both* 5400- and 7200-rpm counterparts with comparable 2-Mbyte buffers but sporting slower ATA-100 interfaces. It even *more* definitively clobbered a 4200-rpm drive like the one originally in my notebook PC. The Toshiba DVD drive was also a capable performer; its benchmark results varied depending on which CD or DVD I had in it when I ran the tests. The screenshot on the *EDN* Web site shows the results for the Windows XP installation CD.

Finally, let's look at memory testing. The memory-bandwidth benchmark led to the most baffling set of Sandra results. The Via CLE266 north-bridge chip, mated to single-channel DDR-266—that is, PC2100 DRAM—was predictably unable to keep pace with Intel's showcase D875P chip set and its dual-channel DDR-400 interface in the system I'm building now. The CLE266 also failed to match the Intel D845 chip set and companion single-channel DDR-266 DRAM array in my now-primary desktop system. Why, though, was there such a performance disparity between the CLE266 and the Via KT266A chip set, given that both ran identical-speed DRAM in identical single-channel configurations? The CLE266 devotes a portion of system DRAM and therefore some amount of system-DRAM bandwidth to various graphics functions, but considering the 512 Mbytes of DRAM installed in the system and the fact that Sandra wasn't doing any 3-D graphics operations, I find it difficult to believe that graphics factors accounted for the entire performance disparity.

Similarly, why did the CLE266 benchmark results come so close to those of the now-ancient Intel i810e chip set, which I chose because it also contains an integrated graphics accelerator but which interfaces to conventional PC100 SDR SDRAM? Although I have so far been unable to obtain confirmation from SiSoftware, I suspect that the memory-bandwidth benchmark tests not only main memory, but also L1 and L2 cache, which would put the Via processor at a competitive disadvantage with AMD and Intel CPU counterparts. I set up this system's BIOS to autoconfigure the DRAM controller based on the DDR SDRAM DIMM's SPD (serial-presence-detection) EEPROM data; it's also possible that the BIOS is initializing parameters in a nonoptimal manner.

REALITY DISPARITY

The other synthetic benchmark I ran was Futuremark's PCMark 2004, which contains no built-in data against which

TABLE 1—COMPARISON OF THE 1999 "HIGH-END" SYSTEM WITH SPIRIT

	1999 "high-end" system	Spirit
Dimensions (height×depth×width, in.)	16×18×8	2.5×10.7×11.6
Microprocessor	550-MHz Intel Pentium III	1-GHz Via Nehemiah C3
Core-logic chip set	Intel 440BX	Via CLE266
Motherboard	Intel SE440BX-2	Via M10000
DRAM	768-Mbyte PC100 SDRAM	512-Mbyte DDR-266 (PC2100) SDRAM
Sound	Diamond Multimedia MX300 six-channel analog with S/PDIF (PCI)	Via six-channel AC'97 with S/PDIF (motherboard-resident)
Graphics	16-Mbyte 3dfx Voodoo 3500 (PCI), 32-Mbyte Creative Labs TNT2 Ultra (AGP)	Integrated Via/S3 UniChrome with unified-memory shared frame buffer (internal AGP)
Hard-disk drive	13-Gbyte 5400-rpm Western Digital ATA-66 with 2-Mbyte buffer	300-Gbyte Maxtor 5400-rpm ATA-133 with 2-Mbyte buffer
DVD-ROM drive	Hitachi GD-2500	Toshiba SD-R6112 (also supports CD and DVD writing)
CD/RW drive	Philips PCA460RW	
Operating system	Windows 98 Gold, DirectX 6.1	Windows XP Professional, DirectX 9.0b

you can compare your results. Instead, you upload your data to the Online ResultsBrowser area of Futuremark's Web site and then enable the "publish" option. You can then compare your results with those of other PC-Mark users, just as they can compare their results with yours. You can peruse my results, run at both 800×600- and 1024×768-pixel resolutions, both at 32-bit color depth, at their respective URLs: http://service.futuremark.com/compare?pcm04=113537 and http://service.futurmark.com/compare?pcm04=113793. I've also uploaded the voluminous data that PCMark 2004 outputs to the *EDN* Web site in the form of Excel spreadsheets; you can access them via this article's Web-site-based addendum (see **sidebar** "Web-site extras").

Next, I ran some benchmarks that exercised the system using real-life software applications. First up was Futuremark's 3D-Mark, based on commercially available PC-game-engine technology. My first indication that I'd be severely taxing the CLE266's graphics subsystem came when 3DMark 2003 reported that it couldn't run, because my system's graphics accelerator didn't fully support the several-year-old DirectX 7 API. The 3DMark 2001 SE benchmark *did* run, but the results aren't stellar, either at 1024×768- or less-system-stressing 800×600-pixel resolution, again, both at 32-bit color depth. You can find those respective results at http://service.futuremark.com/compare?2k1=7412523 and http://service.futuremark.com/compare?2k1=7412555. The CLE-266's best result across the extensive suite of tests was a hair over 20 frames/sec; single-digit frame rates were far more common. One of the test scenarios wouldn't run at all due to a lack of hardware support for environment bump mapping, and a lack of hardware-accelerated antialiasing resulted in visible jagged aliasing artifacts (**Reference 4**).

Finally, I turned to BAPCo's SysMark 2004, which Futuremark markets. SysMark subdivides into two sets of test suites: Internet Content Creation and Office Productivity. The Internet Content Creation test script times out, assuming a system error, if it doesn't complete within 90 minutes. And time out it did on Spirit, both at 800×600- and 1024×768-pixel resolutions. Rendering a single video frame from a 3-D model of an automobile, using Discreet 3ds max, took more than an hour by itself. The Office Productivity suite, encompassing Adobe Acrobat 5.0.5, Microsoft's Access 2002 SP-2, Excel 2002 SP-2, Outlook 2002 SP-2, PowerPoint 2002 SP-2, Word 2002 SP-2 and Internet Explorer 6.0 SP1, ScanSoft Dragon NaturallySpeaking 6 Preferred, Network Associates McAfee VirusScan 7.0, and WinZip Computing WinZip 8.1, did complete, and you can find the results in this article's Web-site addendum.

Figure 2

The PC's volume was smaller than that of several other pieces of equipment in my living room, although its plethora of functions encompassed those of most of my other gear.

Figure 3

Although the system looks crowded, there's still room inside for a slim floppy drive or form-factor-compatible-equivalent peripheral.

Clearly, the CLE266's built-in graphics needed some heavy-duty help if this system was ever to be usable as a game console. I also needed to somehow get a TV tuner into the PC and was interested in being able to input other analog-video sources, too. My first stab at exploiting the PCI slot, therefore, involved adding an ATI Technologies All-In-Wonder VE card, based on ATI's DirectX 7-compliant Radeon 7500 graphics accelerator, to the system. Unfortunately, this experiment failed, because you cannot disable the CLE266's integrated graphics in the BIOS. With the display connected to the ATI card, I could see the BIOS boot messages and the initial Windows splash screen, but I then got a blank display, although the system otherwise completed boot. With the display connected to the CLE266, I saw a blank screen until Windows Desktop was *supposed* to appear; instead, I then saw a "garbage" display containing nothing but a series of alternating-color vertical lines.

VIDEO TRAVAILS

Put aside 3-D graphics, at least for the moment. (As you'll soon see, the All-In-Wonder VE's reliance on software-based MPEG-2 encoding would have made it unusable in Spirit, anyway.) I switched gears and installed an external ATI TV Wonder USB analog-TV tuner. ATI based this first-generation version of the product on the restricted-bandwidth USB 1.1 interface, so the product's digitized frame size is only 320×240 pixels at 30 frames/sec, and it employs lossy compression to reliably get that limited data rate across the USB bus. The TV Wonder USB tuner worked well, but there is a huge gap between its included software's features and those of the ReplayTV in my living room. The recording interface is primitive, as is the integration between ATI's software and the Gemstar-TV Guide GuidePlus+ channel-listing service. TV Wonder USB's software does not support time-shifting, the video frame's QVGA resolution and crude field deinterlacing produced blatant and distracting artifacts, and my only file format options when recording were uncompressed AVI and archaic MPEG-1.

SnapStream Media had been for months exhorting me to testdrive its Personal Video Station program, now renamed Beyond TV, so I tried it next. First, the good news: The combination of Beyond TV and a PC containing a leading-edge microprocessor and graphics subsystem yields an impressive piece of

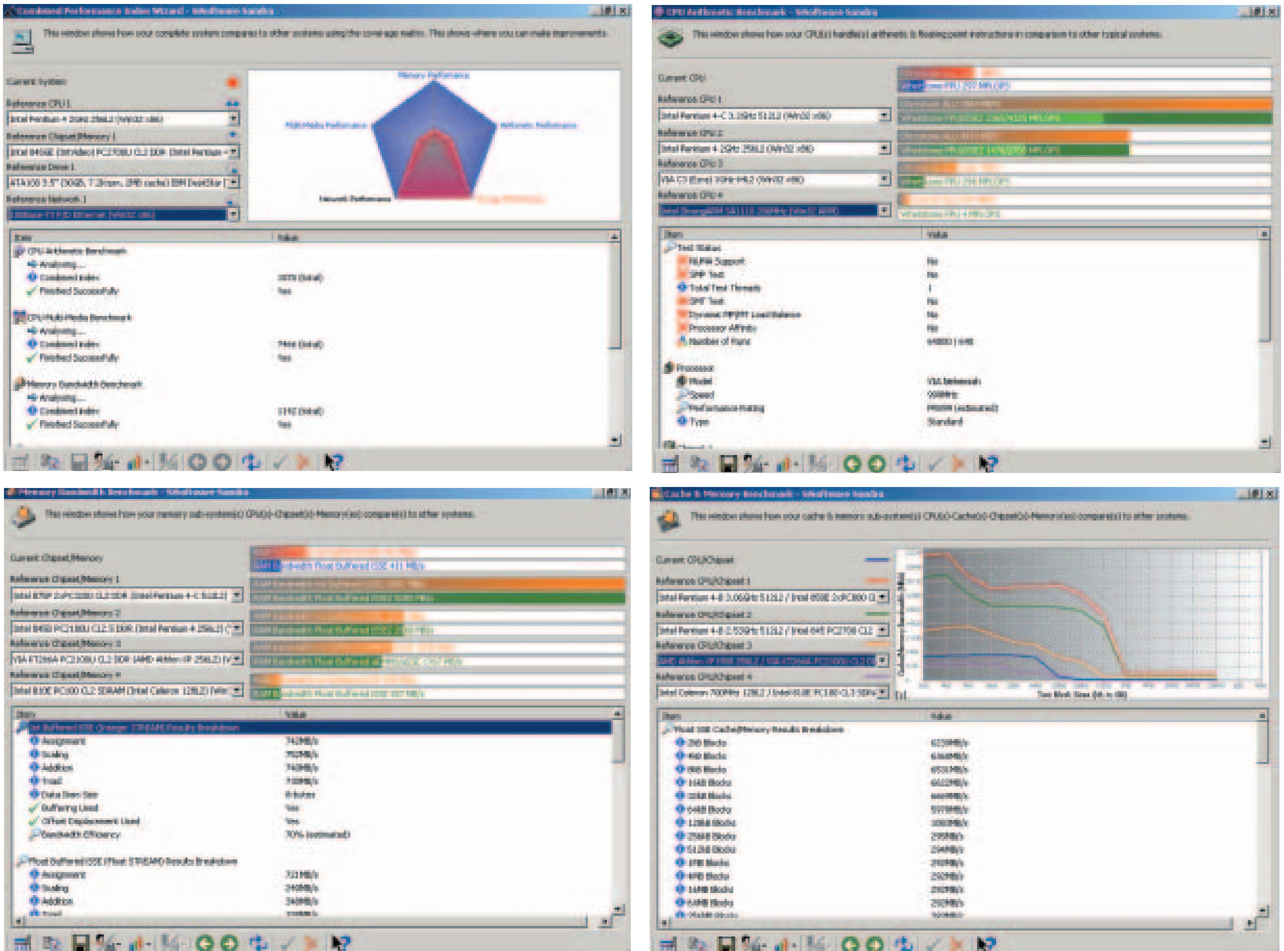


Figure 4 SiSoft Sandra's suite of tests exposed Spirit's strengths and shortcomings.

software. You can record shows to the hard drive in either MPEG-2 or Windows Media Version 9 formats, choosing among a variety of preconfigured quality profiles, customizing them if necessary for your needs and later transcoding the files to DivX format if you wish. (Direct-to-DivX recording is coming soon.) You can time-shift broadcast television, pausing a program for a nature break, rewatching a touchdown pass, or skipping through commercials. You can control and configure the Beyond TV-equipped PC through a Web browser from any other device on the LAN or, after punching a hole in your firewall, WAN, as well as through the SnapStream.net Web site. You can also stream or copy recorded shows to other LAN or WAN clients. Beyond TV incorporates Decisionmark's TitanTV channel-guide service, and, unlike ReplayTV or TiVo, after you buy Beyond TV, you pay no one-time or monthly subscription fees to continue using TitanTV.

When I first fired up Beyond TV on Spirit and tried to watch live television through the TV Wonder USB tuner, however, I saw low-frame-rate, stutter-step video. I first thought that I might have a heavily fragmented hard drive, but defragmentation didn't solve the problem. Then, I remembered that, unlike ATI's software, which directly feeds incoming video to the graphics subsystem, "live TV" in SnapStream terminology means that Beyond TV, like ReplayTV or TiVo, simultaneously compresses the video and stores it to the hard drive and then reads it from the hard drive and decompresses it, thereby enabling time-shifting. Altering the various recording format and quality options didn't appreciably improve the frame rate, and a perusal of Windows' Task Manager confirmed that the CPU was swamped. You need to be careful when interpreting Task Manager results, because it puts an incremental load on the CPU. But in this case, Beyond TV's needs went far beyond what the Via C3 could supply. Fixing this problem required hardware help, but where: in the MPEG-2-encoding process, the decoding process, or both?

MPEG-2 is an asymmetric algorithm, meaning that, all other factors being equal, encoding a bit stream is more processing-intensive than decoding it (**Reference 5**). Because this system already had hardware-decoding help in the form of inverse-DCT, motion-compensation, color-transformation, and other MPEG-2-tailored circuits in the CLE266 and because the MPEG-2 software decoder in Beyond TV *should* be tapping into that hardware acceleration through the DirectX VA API, I first focused my attention on the encoding link in the Beyond TV chain. Indeed, by installing a Hauppauge WinTV-PVR-250 PCI card and by ensuring that I was only recording in Beyond TV—that is, not simultaneously playing back—I managed to decrease the CPU usage to less than 20%.

The WinTV-PVR-250 addition wasn't without its trade-offs, however. I could no longer select Windows Media as a recording-format option. In this case, I wouldn't have wanted to anyway, because Windows Media is an even more processing-intensive encoding algorithm than MPEG-2, and I didn't have any hardware-acceleration support for it in my system. The WinTV-PVR-250 also seemed to override the various quality settings I'd configured in Beyond TV; five of the six default recording-quality modes gave me nearly identical approximately 1-Gbyte files for half-hour shows, whereas the lowest quality "fair" mode generated a file slightly larger than 500 Mbytes. One other Beyond TV bug, which may relate to the Hauppauge encoder card or the CLE266 graphics subsystem, bears mentioning. In attempting to overcome the palpable interlacing artifacts, I overrode the default "none" deinterlacing option. Selecting "hardware" had no visible effect. Selecting either of the two "software"-deinterlacing modes crashed Beyond TV.

Figure 5

The RF-based wireless keyboard, mouse, and remote control worked *just* to the desired 10-foot distance.

Even with the WinTV-PVR-250 in place, viewing live TV resulted in a maxed-out CPU and irregular, less-than-30-frame/sec playback, as did playback of all prerecorded shows except those encoded in "fair" mode. In fair mode, CPU usage still averaged more than 80%, and frames may still have occasionally dropped, although, if so, it wasn't obvious to my eye. On a hunch, I installed CyberLink's PowerDVD, which my previous experiments on my CPU-deficient notebook PC had suggested to be a full-featured, but system-resource-thrifty, product. After I enabled hardware acceleration in the configuration menus, playback of *all* previously recorded Beyond TV shows, even those encoded in the highest quality "best" mode, was silky smooth in PowerDVD. Clearly, Beyond TV's built-in MPEG-2 decoder wasn't leveraging the CLE266 chip's hardware resources. Because of its DirectX-based GUI, Beyond TV can interface with only those external MPEG-2 decoders that support DirectShow filters. PowerDVD, apparently and unfortunately, does not support DirectShow. I also tried InterVideo's WinDVD, but it disabled Beyond TV's live-TV feature, and SnapStream's testing suggests that this version of InterVideo's decoder also lacks support for all possible MPEG-2 bit streams that Beyond TV's encoder can generate. Given that MPEG-2 is at this point a nearly 10- or, depending on what you choose as your starting point, 20-year-old technology, the incompatibilities are disappointing.

THE TOSHIBA DRIVE, IN CONJUNCTION WITH AHEAD SOFTWARE'S NERO, HAPPILY BURNED A SMORGASBORD OF RECORDABLE CD AND DVD MEDIA.

FLYING-COLOR FUNDAMENTALS

CyberLink's PowerDVD also did an excellent job of playing back DVDs. With the S/PDIF or conventional two-channel analog-audio outputs selected, CPU usage was well below 25% except on complex scenes with high bit rates, and, even in those situations, it rarely and barely exceeded 50%. Even if I enabled the resource-intensive Dolby Headphone surround-sound virtualization algorithm, I saw no dropped frames, and CPU usage didn't exceed 75% if I throttled the display color depth down to 16 bits. Windows Media Player seemed to have sufficient CPU horsepower available to decode and play various lossless and lossy audio formats without glitching, even with visualization and surround-virtualization plug-ins enabled and in both analog and S/PDIF audio-output modes.

This system is first and foremost a traditional PC, and as such, it also adroitly handled traditional PC tasks, such as sending and receiving e-mail, browsing the Web, performing word processing, and creating and editing spreadsheets (**Figure 5**). It stably entered and exited standby and hibernation modes, and the various peripheral drivers from Via seem to be rock-solid. The Toshiba drive, in conjunction with Ahead Software's Nero, happily burned a smorgasbord of recordable CD and DVD media and rejected none of the numerous prerecorded optical discs I had had tossed into the tray.

I even successfully experimented with using this system as a file server for my LAN. For more than a year now, I've had connected to my network a Toshiba Magnia SG10 server appliance, which I'm using as a file server and print server and have occasionally also used as an FTP (File Transfer Protocol) and Web server. However, because the SG10 accepts only a maximum of two 2.5-in. hard-disk drives and because the older Red Hat Linux variant that runs on it doesn't work with drives larger than 32 Gbytes, the storage capacity on it is capped. Given that my wife and I now both own digital cameras, I forecast that I would soon be running out of space on the SG10 and would need some additional network storage.

The 300-Gbyte hard-disk drive in Spirit was an option for more storage, but I'm uncomfortable with the idea of allowing other network clients to alter the contents of the primary drive on a PC, and I also didn't want network-initiated read and write operations to disrupt its primary PVR and other tasks. The 160-Gbyte Ximeta NetDisk was another likely candidate, but it isn't a true NAS (net-worked-attached-storage) appliance; it requires that at least one system on the LAN have interface software. Once you install that software, however, other LAN gear can access the NetDisk through that system via Windows' file sharing or a Linux or another OS-equivalent approach. Ideally, I would have installed the NetDisk interface software on the always-running SG10, but its obsolete Linux distribution was again a barrier; Ximeta doesn't support it.

Instead, I installed the NetDisk drivers on Spirit, and the setup works great. A small but constant amount of network traffic travels between Spirit and the NetDisk on the other side of the house, and other LAN gear, including devices for which installing Ximeta's software isn't an option, such as my Audiotron, Xbox, and Pocket PCs, treat it as if it were a drive built into Spirit. I've noticed only two minor downsides: First, I had to create a command-line batch file that runs on Windows start-up to ensure that the drive would come up shared each time I booted Spirit. Also, the Ximeta drivers keep Spirit from going into its power-conserving standby and hibernation modes; ideally, the system would go to sleep when the NetDisk wasn't in use, and appropriate LAN traffic would wake it up when necessary. For more information, including a discussion of the GUI, visit the Web version of this article at www.edn.com.□

Talk to us

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References

You can find all the references to this article in its Web version at www.edn.com.

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Technical editor Brian Dipert wonders if he'll be able to convince his wife to keep this system in the living room for the long term. Reach him at 1-916-454-5242, fax 1-617-558-4470, bdipert@edn.com, and www.bdipert.com.

WEB-SITE EXTRAS

You'll find plenty more about this project when you read the Web version at www.edn.com. In addition to several sidebars, I'll include, in this sidebar, a link to a Web-site-only addendum that I'm cobbling together. Among other things, I'll make available for your viewing and downloading the various reports, screenshots, and other files that the benchmarking software generated, as well as direct links to the benchmark reports I published on Futuremark's Web site.

FOR MORE INFORMATION...

For more information on products such as those discussed in this article, contact any of the following manufacturers directly, and please let them know you read about their products in *EDN*.

Adobe Systems
www.adobe.com

Advanced Micro Devices (AMD)
www.amd.com

Ahead Software
www.ahead.de

Apex Digital
www.apexdigitalinc.com

ATI Technologies
www.ati.com

BAPCo
www.bapco.com

Bofinit
www.bofinit.com

Casetronic
www.casetronic.com

Corsair Memory
www.corsairmicro.com

CyberLink
www.gocyberlink.com

Decisionmark
www.decisionmark.com

Discreet, a division of Autodesk
www.discreet.com

Dish Network
www.dishnetwork.com

DivXNetworks
www.divxnetworks.com

D-Link
www.dlink.com

Dolby Labs
www.dolby.com

EnTech Taiwan
www.entechtaiwan.com

Epiacenter
www.epiacenter.com

Field Software
www.fieldsoftware.com

Futuremark
www.futuremark.com

Gemstar-TV Guide
www.gemstartvguide.com

Hauppauge Computer Works
www.hauppauge.com

Hush Technologies
www.hushtechnologies.com

Intel
www.intel.com

InterVideo
www.intervideo.com

iTuner
www.ituner.com

Lipper t Automationstech-nik
www.lippert-at.com

Maxtor
www.maxtor.com

Microsoft
www.microsoft.com

Mini-ITX
www.mini-itx.com

Mirra
www.mirra.com

Mitsubishi
www.mitsubishi.com

Mitsumi
www.mitsumi.com

Morex International
www.morexintl.com/2699spec.htm

myHTPC
www.myHTPC.net

Network Associates
www.networkassociates.com

Niveus Media
www.niveusmedia.com

Phonature
www.phonature.com

Portrait Displays
www.portrait.com

Princeton Graphics
www.prgr.com

Red Hat
www.redhat.com

Sasem
www.usbhdtv.com

ScanSoft
www.scansoft.com

Shuttle
www.ximeta.com

SiSoftware
www.sisoftware.co.uk

SnapStream Media
www.snapstream.com

Syntax
www.ecost.com

Toshiba
www.toshiba.com

Tranquil PC
www.tranquilpc.co.uk

Transmeta
www.transmeta.com

Via Technologies
www.viaembedded.com

Video Without Boundaries
www.vwbinc.com

Voyetra Turtle Beach
www.audiotron.net

WinZip Computing
www.winzip.com

X10
www.x10.com

Ximeta
www.ximeta.com

NEXT STEPS

I haven't given up on getting a functional graphics accelerator going in the PCI connector and plan to continue my experimentation in coming weeks. And, although my initial TV-on-PC experiments were analog in nature, the idea of digitizing and MPEG-2-compressing content is outmoded in an era when broadcasters are airing multiple channels of already-compressed digital television in my neighborhood. (Now you understand the *real* reason for putting the 300-Gbyte hard-disk drive in Spirit.) Sasem recently released a USB 2.0-based high-definition-digital-TV tuner, and a product sample arrived the day before I finalized this article's first draft. If I can get the OnAir USB HDTV working, I'll be able to concentrate the PCI port on a higher performance graphics-only board.

ITuner has sent me a replacement 100W power supply, and Morex has shipped me an upgraded alternative to the supply that came with their case. Via also provided a slightly taller enclosure from Casetronic, which comes with a built-in 120W power supply and supports PCI cards that need dual back-panel slots. Using them, I should be able to solve my power crisis and ditch the bulky 320W external supply. I'd also like to "stitch" the various PC applications together, as Windows XP Media Center Edition nicely manages, by experimenting with the myHTPC user interface.

If I find that the M10000, even with the hardware assistance I've added, lacks sufficient horsepower to do everything I want it to, I'll turn to Lippert's Thunderbird Mini-ITX system board, which also arrived from Germany the day before I wrapped up this article and is based on a 1.6-GHz Pentium M processor. (The company also offers a fanless variant that it bases on a 1.3-GHz Pentium M CPU.) Finally, I'd like to do more testing of the other PCs in my office to confirm or deny the reference benchmark numbers that SiSoftware includes in Sandra. Stay tuned for the April 29, 2004, issue, in which I plan to discuss these and, likely, other topics in detail.

PRAGMATIC CONCLUSIONS

After examining this project's benchmark results and its Beyond TV and other travails, you might walk away with a pessimistic viewpoint of the Via M10000 platform. That perception would be unfortunate and inaccurate. As AMD and Intel have learned, to their distress, even several-year-old CPUs are adequate for servicing most traditional PC functions—a fact that consumers are also increasingly figuring out. And, when performing these functions, Spirit felt as nimble to me as my 2-GHz desktop PC and was noticeably faster than my 800-MHz Transmeta Crusoe-equipped notebook.

The network-connectivity problem I encountered traces back to an inadequate power supply in the system's case, coupled, perhaps, with a too-greedy Ethernet chip on the board, along with nonoptimized power sequencing of that board. Via provided sufficient MPEG-2-decoding resources in its chip set; SnapStream Media for some reason chose not to use them. The addition of an MPEG-2 encoder neatly solved the video-compression problem, and if I had been able to get a graphics card working in the PCI slot, it would have likely made similar improvements to Spirit's game-console-incorporating potential.

Plenty of commercially available examples showcase the M10000's validity as a system foundation. Mirra's Personal Server and Dish Network's 921 HD-DVR, for example, are constructed of building blocks similar to those I used in my project. Niveus Media's ONEbox Media Center is a Spirit-like all-in-one system based on the M10000, as are Tranquil PC's TSS Internet Server and Video Without Boundaries' MediaREADY 4000 Series. In contrast, Hush Technologies' Hush Mini ITX PC and Niveus' Blackbox Personal Server adopt the M10000's close cousin, the dual-Ethernet CL10000. In some cases, these systems and others like them boost overall performance by employing Windows XP Embedded, Windows CE, or a streamlined-Linux distribution. On that note, I'm confident that the M10000 delivers sufficient horsepower to handle a plethora of embedded-system applications.

Silicon evolution will also shortly resolve some of the issues I encountered in this project. Via is readying its next-generation 1.4-GHz C3 processor, which sports a 200-MHz front-side bus, for production, along with a companion CN400 chip set that supports DDR-400—that is, PC3200—SDRAM. This CPU and chip set, along with a discrete AGP-based graphics accelerator and Windows XP Embedded, form the foundation of the upcoming Apex Digital ApeXtreme game console.