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GOT GAME?

Living-room consoles grapple for consumers' eyes, wallets

THE HOLIDAYS ARE HERE, SO IT MUST BE TIME FOR ANOTHER ROUND OF GAME-GEAR HYPE. ONLY ONE OF THE NEXT-GENERATION PLATFORMS IS IN PRODUCTION. REGARDLESS OF WHEN THEY EMERGE, THEY ALL PLAN TO EVOLVE THEIR CAPABILITIES BEYOND GAMING WITH AN EYE TOWARD BEING THE HOME'S ENTERTAINMENT CENTERPIECE.

Three years ago, when *EDN* last covered gaming consoles in a Hot Technologies edition, that industry was at a notable inflection point (Reference 1). Sony had been shipping its PlayStation 2 in the United States for a little more than a year; the company had launched the PS2 in Japan almost eight months earlier. Microsoft's Xbox was a month old, as was Nintendo's GameCube. Fast-forward three years, and all three consoles are success stories to varying degrees and defined by varying measurement criteria. Look at the Xbox, for example; on the one hand, Microsoft has, according to a recent article, lost \$4 billion over the last four years on the console (Reference 2). On the other hand, Microsoft reported in January that, by the end of 2004, the Xbox worldwide unit market share was 37%, up from zero two years earlier and against long-established console competitors (Reference 3).

The gaming industry had reached another crossroads as this article went to press in late November. Microsoft's Xbox 360, barring a last-minute introduction delay, will, by the time you read this article, have launched in all three primary geographies: the United States on Nov 22, Europe on Dec 2, and Japan on Dec 10, with the first wave of consoles likely sold out (Figure 1). Introduction dates for the Xbox 360's primary competitors are unknown; for now, Nintendo will say only that the Revolution



Microsoft hopes that lifelike game environments, along with other factors, will spur consumers to buy in abundance this holiday season and beyond.



AT A GLANCE

Latest generation living-room game consoles leverage semiconductor and storage innovations, but they must also address socio-economic dynamics.

Microsoft hopes to leverage Xbox 360's first-mover advantage to a sustainable leadership position.

Nintendo's Revolution strives to bring new users into the fold.

Sony's PlayStation 3 advances both the company's gaming- and movie-format aspirations.

unveiling won't be until some time after March 2006. However, the company recently asked game-industry insiders to mark their calendars for a May 9, 2006, press briefing—the first day of the E3 conference (Electronic Entertainment Expo, www.e3expo.com). As for the PlayStation 3, a recently published interview with Howard Stringer, Sony's chief executive officer and chairman, hints at a spring-2006 rollout in Japan, with US consumers not getting their hands on the console until the end of next year (Reference 4). This year also marked the unveiling of several significant next-generation handheld gaming consoles (see sidebar "Next time, portables get their turn").

With every passing generation, the success-or-failure stakes get dicier in the \$25

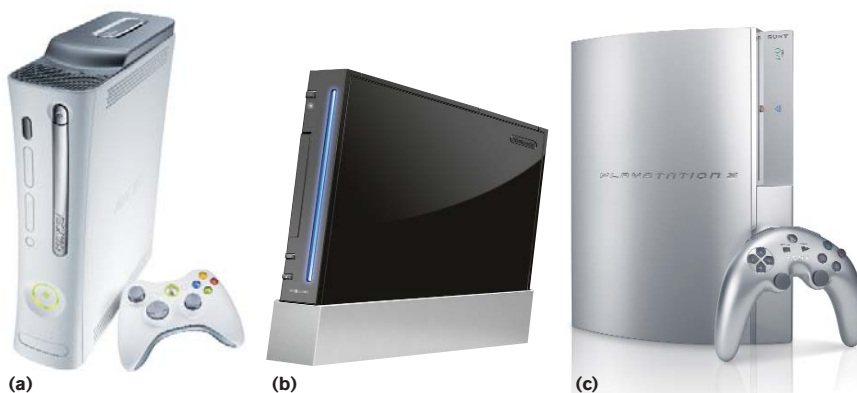


Figure 1 Microsoft's Xbox 360 (a), Nintendo's Revolution (b), and Sony's PlayStation 3 (c) will lead the next-generation console charge into consumers' living rooms.

billion gaming business for both hardware manufacturers and content developers (Reference 5). Echoing Microsoft's monetary morass, the PlayStation 3's development costs reportedly heavily influenced Sony's 46% drop in corporate profits in the second fiscal quarter of this year, compared with that same period a year earlier (Reference 6). Mark Thomas, the senior ISV (independent-software-vendor) manager for ATI Technologies, succinctly pointed out in his presentation at October's SID (Society for Information Display) ADEAC (Americas Display Engineering and Applications Conference) that game-development costs are seeing a fivefold increase per generation. (Given the new consoles' significant hardware incompatibilities, those costs are on track to meet or exceed that pace in the games' next iterations.) Meanwhile, only one in 10 games ever turns a profit. And Reggie Fils-Aime, executive vice president of sales and marketing for Nintendo, shared equally disturbing statistics about retrenching trends in the core gaming market during an early-November

briefing on the company's DS portable console's WiFi service. (See these statistics at the Web version of this article at www.edn.com/051216df2.)

With all of this gloomy news, why would any sane company seek its fortunes in the gaming business? Because the one title that is profitable can potentially far more than make up for the nine that incur losses. In the fourth quarter of 2004, the one quarter that Microsoft's Home and Entertainment division turned a profit, the group's fiscal triumph was the direct result of the mid-November 2004 unveiling of the franchise title *Halo 2*, which earned \$125 million in its first 24 hours on the market and had, by press time, sold more than 8 million copies at roughly \$50 a pop (Reference 7). One tempting title is often sufficient motivation for a consumer to take the console-purchase plunge. Granted, the hardware manufacturer may sell that console at a loss. But, once the consumer's on the hook, every subsequent game sale is a highly profitable enterprise, either directly—if the console manufacturer also sells the game—or

TABLE 1 KEY FEATURES OF NEXT-GENERATION LIVING-ROOM CONSOLES

	Microsoft Xbox 360	Nintendo Revolution	Sony PlayStation 3
CPU	3.2-GHz Xenon	Broadway PowerPC	3.2-GHz Cell
GPU	500-MHz ATI R500 Xenos and 10-Mbyte frame-buffer DRAM from NEC	Custom ATI design	550-MHz RSX, co-developed by Nvidia and Sony
Memory	512-Mbyte, 700-MHz GDDR3 DRAM	Unknown	256-Mbyte XDR RDRAM and 256-Mbyte, 700-MHz GDDR3 VDRAM
Networking	Bundled CAT5 Ethernet, 802.11a, b, and g as an accessory	802.11b	CAT5 Ethernet (one in, two out), 802.11b/g
I/O	Three USB 2.0, proprietary 2.4-GHz wireless	Two USB 2.0	Six USB 2.0, Bluetooth
Video	Composite and component come standard (component on the high-end-console version). S-Video and VGA cables are accessories.	Unknown	Two HDMI, component, composite
Audio	Dolby 5.1	At least Dolby 5.1	Dolby 5.1, DTS
Storage	Optional removable 20-Gbyte hard-disk drive, two media slots	SD card, 512-Mbyte flash memory	Hard-disk drive, memory stick, SD card, CompactFlash card
DVD media format	Dual-layer DVD	DVD	Blu-ray

through licensing revenue—if the game comes from a partner company. Microsoft forecasts that it will sell 2.7 million to 3 million Xbox 360s in the first three months the console is on the market and 10 million by the end of 2006. Over that initial three-month time frame, Microsoft believes it will earn approximately \$1.5 billion in revenue from the sales of not only consoles, but also games, peripherals, and online-gaming subscriptions (Reference 8).

Short-term success is exciting, but pragmatic long-term vision is equally important. If Nintendo's data indicating atrophy of the core gaming segment is true, then future growth will need to come from expanding beyond that core by attracting new gamers into the fold, by broadening the console function beyond gaming, or both. From a high-level perspective, the three first-tier next-generation living-room consoles might seem to be "kissing cousins"; Microsoft and Sony based their systems on the same IBM-developed PowerPC core, as Nintendo likely will (Table 1). But peer closer, and you'll see significant differences emerge, reflecting each company's unique view of what's necessary for success in this next round of the console wars. There is, however, one other notable similarity: The words "living room" are key parts of each company's strategy. The company whose console becomes the entertainment nexus for the home has control and influence over and, therefore, obtains direct and indirect revenue from, all content flowing into and out of that home.

XBOX 360

By basing the original Xbox on the PC architecture, Microsoft greatly simplified the game-development effort for partners already comfortable with PC-based software projects. However, a PC-derived console also has its fair share of downsides, not the least of which is the relative ease with which the open-PC architecture enables hackers' circumvention of copy protection and other DRM (digital-rights-management) restrictions. Therefore, Microsoft has embraced a PowerPC-based design in the follow-on Xbox 360, and the company has also moved from an Nvidia- to an ATI-developed GPU (graphics-processing-unit) subsystem.

Last time around, partner semiconduc-

tor suppliers such as Intel and Nvidia supplied the Xbox silicon building blocks. This time, Microsoft ultimately owns both the design and the manufacturing silicon; it licensed the IP (intellectual property) from other companies. Although the hardware differs in the modern-day Xbox 360 era, Microsoft still hopes to provide some degree of backward-compatibility. Scott Henson, director of the Xbox Advanced Technology Group, indicated in early November that Microsoft is "committed to ensuring compatibility with as many Xbox titles as possible," beginning with those at the top of the popularity list. *Halo 2*, he suggested, is at the pinnacle, and, based on his experience playing it on Xbox 360 hardware a few days earlier, "it runs really well." (Subsequently, Microsoft published a list of more than 200 Xbox titles that consumers can play, using software emulation, on the Xbox 360 at its launch. The goal is that Xbox 360 will support *all* Xbox games.)

IBM developed a die-size- and cost-optimized PPE (PowerPC processing element) processing core for the Xbox 360. Notably, in contrast with a PowerPC core in, for example, an Apple computer, it dispenses with out-of-order execution capability (Reference 9). The Xenon CPU in the Xbox 360 contains three PPE cores, each able to simultaneously process two instruction threads and each containing a 32-kbyte, two-way-instruction, Level 1 cache and a 32-kbyte, four-way-data L1 cache, and it also touts the VMX-128 vector-floating-point unit. Each PPE core runs at 3.2 GHz, and they share a common 1-Mbyte L2 cache, which the ATI-developed, GPU-inclusive north-bridge chip can directly access. The cache thereby provides a bridge between the CPU and the remainder of the system. Xenon communicates over a 5.4-Gbps-per-pin front-side bus that can simultaneously read and write at 10.8-Gbyte/sec peak transfer speeds. What will applications do with all that processing power? They will be able to accommodate immersive audio, for one thing; Xbox 360, on the CPU, does the audio processing that a dedicated DSP handled on the first-generation Xbox, and at least one title, *Project Gotham Racing 3*, dedicates an entire CPU core, or two threads' worth of resources, to just audio-related tasks.

NEXT TIME, PORTABLES GET THEIR TURN

Living-room consoles aren't the only commodities that have exciting, controversial, and contending current and future developments. Nintendo's Game Boy Advance SP, Game Boy Micro, and DS portables are squaring off against Sony's PlayStation Portable. Second-tier handheld consoles, such as Tiger Telematics' Gizmodo, are also competing for users' eyes and wallets, as are alternative platforms and potential platforms, such as PDAs, premium-featured cell phones, and enhanced portable multimedia players. Stay tuned for EDN's Jan 19, 2006, issue, in which we'll "go mobile" and explore this segment of the game market in more detail.

ATI delivered its 500-MHz Xenos GPU to Microsoft 16 months after signing the development contract (a time frame only one month shorter than the one IBM accomplished with Xenon). The dual-die Xenos design has impressive performance specifications, including 24 billion shader instructions/sec, a 4 billion-pixel/sec fill rate, and a 500 million-triangle/sec geometry-processing rate. Xenos comprises 250 million transistors in the main, TSMC-fabricated and logic-centric die and 80 million transistors in the daughter die that implements the 10-Mbyte, NEC DRAM-based frame buffer. Today's PC-targeted GPUs contain dual sets of shader processors, one handling vertex operations and the other handling pixel—that is, "fragment"—tasks. Xenos, conversely, includes 48 unified shaders that tackle either vertex or fragment processing, along with other functions, such as physics and video processing using the console's enhanced variant of the DirectX v9 API (Reference 10). ATI Vice President of Engineering Robert Feldstein admits that the company's embrace of a unified-shader approach



wasn't risk-free; specifically, there was concern that the task-switching delay between vertex and fragment algorithms might hinder the chip, performance-wise. Feldstein happily reports that real-life performance results are even better than simulations suggested and that the company's future-generation PC-graphics chips, along with, he predicts, those of primary competitor Nvidia, will also migrate to a unified-shader approach.

With the first-generation Xbox, a few games ended up supporting a greater-than-480-line display resolution, but CPU-plus-GPU horsepower was generally insufficient to throw additional pixels on the screen at an adequate frame rate and maintain a rich and engaging gaming experience in all other necessary respects. Xbox 360 games, in contrast, must support wide-screen, 720-line progressive resolutions by default. (Note, however, that preliminary screenshot evidence suggests that at least one game, *Project Gotham Racing 3*, is a native 600-line-resolution title.) The games' developers handle 4-to-3 aspect-ratio displays using either letter-boxing or pan-and-scan cropping. The Xenos GPU takes care of downscaling to 480-line or upscaling to 1080-line interlaced resolutions. It also supports pro-

gressive-scan DVD playback, a capability that the first-generation Xbox lacked, and also upscales and antialiases Xbox titles, such as *Halo* and *Halo 2*. Microsoft has decided, at least in the near term, to omit a blue-laser-based optical drive. Instead, Xbox 360 contains a mainstream, dual-layer, 12×, red-laser DVD drive (Reference 11). Users can currently achieve a high-definition video display on Xbox 360 in two ways: by downloading WMV (Windows Media Video)-encoded films from partners such as CinemaNow and Movielink to the console's hard-disk drive or by using the console's built-in Windows Media Extender capabilities to play video off a Windows XP Media Center Edition-based PC's hard-disk drive. (Additional ways to achieve this high-definition display may come in the future, such as playing a red-laser DVD encoded with Microsoft's WMV or derivative VC-1 formats.) Whereas Microsoft restricted the Windows Media Extender add-on for the Xbox, along with stand-alone Extenders now available in the market, to standard-definition video with two-channel audio, Xbox 360's capabilities remove both constraints. Xbox 360 owners can also access audio and still-image content—although not currently video con-

tent—stored on a Windows XP- and Windows Media Connect-based PC or on another UpnP (Universal Plug 'n' Play)-supporting network device.

Xbox 360 will at least initially come in two product variants in the United States. The \$299 "Core" version doesn't include the 20-Gbyte, removable hard-disk drive that is necessary for playing first-generation Xbox titles, and it supplies a conventional wired controller. The \$399 variant comes with the hard-disk drive, along with a remote control, headset, and additional audio/video and network cabling. All of these features, along with an 802.11a/b/g wireless network adapter, a camera, and other accessories, are also available separately. This version also switches to a wireless controller based on a proprietary 2.4-GHz protocol. Xbox 360 purchasers will automatically be eligible for free Xbox Live Silver accounts, which allow them to maintain Friends lists and send and receive text and audio messages from other Live members, purchase additional game features and online arcade games, and automatically obtain game- and console-firmware updates. Update capability is critical for Microsoft and its content partners, allowing them to stay one step ahead of

TABLE 2 ESTIMATES OF INITIAL AND THREE-YEAR-LATER XBOX 360 BILL-OF-MATERIALS COSTS

Xbox 360	Component	Estimated cost at launch	Estimated cost after three years
CPU	IBM PPC	\$100	\$35
GPU	ATI GPU	\$100	\$30
Optical media	DVD-ROM	\$25	\$10
Memory	512-Mbyte GDDR3	\$50	\$25
Hard-disk drive	Detachable 20-Gbyte hard-disk drive	\$25	\$15
USB	Three ports	\$5	\$3
Ethernet	Ethernet	\$5	\$4
Wireless controller transceiver	Proprietary 2.4 GHz	\$5	\$3
Controllers	As many as four wireless	NA	NA
Other	Analog IC, ASICs, I/O	\$25	\$20
Total		\$340	\$145

TABLE 3 ESTIMATES OF INITIAL AND THREE-YEAR-LATER PLAYSTATION 3 BILL-OF-MATERIALS COSTS

PlayStation 3	Component	Estimated cost at launch	Estimated cost after three years
CPU	IBM Cell	\$160	\$50
GPU	550-MHz Nvidia RSX	\$100	\$30
Optical media	Blu-ray	\$100	\$30
Memory	256-Mbyte XDR/256-Mbyte GDDR3	\$60	\$30
Hard-disk drive	Detachable 2.5-in. hard-disk drive	NA	NA
USB	Six ports	\$5	\$3
Ethernet	Gigabit Ethernet	\$5	\$4
WiFi	802.11b/g	\$5	\$3
Bluetooth	Bluetooth 2.0	\$10	\$5
Other	Analog IC, ASICs, I/O	\$50	\$40
Total		\$495	\$195

DRM hackers (Reference 12). Full-blown Xbox Live Gold account holders can engage in online multiplayer gaming, among other service enhancements.

REVOLUTION

A lot of detailed information on Microsoft's next-generation console is public, and a large chunk of that information has been public since mid-May's E3 (Electronic Entertainment Expo) conference. This is not the case with Nintendo, which, trivia buffs might be interested to know, released its groundbreaking NES console in the United States 20 years and six months ago; *Mario* turned 20 years old in September. The company's next-generation console's official name hasn't even been unveiled yet; Revolution is just a project-name placeholder. Revolution will employ an IBM-developed PowerPC CPU. However, it's still unknown how many cores and what else that CPU will contain; how many threads each core will process; and whether the core will be the PPE that Microsoft and Sony are using, an Apple- or Xilinx-reminiscent core, or something completely new. And Revolution will, like the Xbox 360, contain ATI Technologies-developed graphics. Again, though, aside from revealing that Revolution will not support high-resolution video-output capability, Nintendo has released no specifications except, presumably, to software developers under NDAs (nondisclosure agreements).

What Nintendo has revealed, however, in conjunction with corporate executives' big-picture comments, strongly suggests that the company is taking a clean-slate approach to the console- and corresponding content-development processes. At E3, Nintendo gave the public, among other things, a first glimpse into the console's case design, which will be available in multiple color options, and indicated that it will be able to both play Revolution-native, DVD-based games and legacy GameCube titles on the proprietary small-diameter optical disc. At the follow-on Tokyo Game Show in mid-September, Nintendo's President Satoru Iwata unveiled the console's controller (Figure 2). Judging from the promotional video clip that Nintendo released at the time, the console will be able, most likely by using RF-based triangulation, to

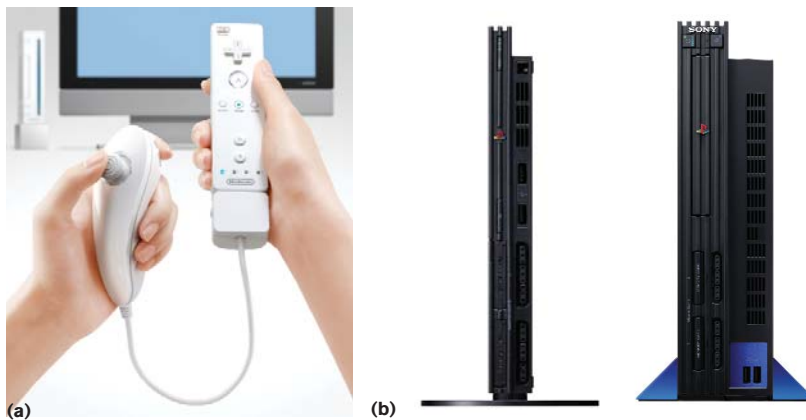


Figure 2 Nintendo's aspirations for future living-room success hinge on innovations such as the Revolution's controller (a), whereas Sony for now will have to hope that a slimmer—and, potentially, cheaper—PS2 console will be enough incentive to extend the lifetime of its current, four-year-old franchise, until the PlayStation 3 is ready to ramp (b).

determine and respond to the “nunchakustyle” controller's position in 3-D space, and its direction and speed of motion, in addition to the user's manipulation of controller buttons (Reference 13).

The video clip showed Revolution players, among other things, chopping food and stirring it in a wok, fishing, playing the drums, holding a flashlight, swatting flies, and conducting a symphony orchestra. These are notably nontraditional console applications, and many of the players are equally nontraditional: the very young, the very old, and mixtures of the two, suggesting the family and communal collaboration opportunities that Revolution will encourage. Even in the more traditional gaming genres in the video clip, such as hitting a ball with a racquet or a bat, shooting a pistol, sword-fighting, and making *Mario* jump, Nintendo portrayed the Revolution's controller as enabling players to implement these actions in innovative ways. And, Nintendo will also sell an accessory that provides a more conventional control layout when a user slips a controller into it. This accessory will satisfy both the desires of traditional developers and players and the need for backward compatibility with GameCube.

None of these scenarios is terribly surprising; Nintendo has a long history of designing hardware and software that consumers can pick up and quickly and intuitively begin using with little to no perusal of tedious and time-consuming instructions. Nintendo argues that Microsoft and Sony, with their latest offer-

ings, instead focus on technology for technology's sake. Neither the Revolution controller's similarity to a TV remote control nor the console's placeholder name is coincidental. Quotes from Iwata throughout this year echo the statistics Nintendo shared with the press in early November, and they further flesh out the company's direction with Revolution. These quotes include:

“If we cannot expand the market, all we can do is wait for the industry to slowly die,” “it is our responsibility to make games for all skill levels ... including people who are not playing games now,” “technology alone can't advance video games ... which is why we plan to take Revolution in a dramatic new direction,” and “Revolution ... does not follow the conventional path of new game systems.”

How much will Revolution cost? Again, specifics aren't public, but Fils-Aime in early November said, “Certainly, from the standpoint of being a single-minded gaming device, it will absolutely be much more affordable than any of the other competing systems.”

PLAYSTATION 3

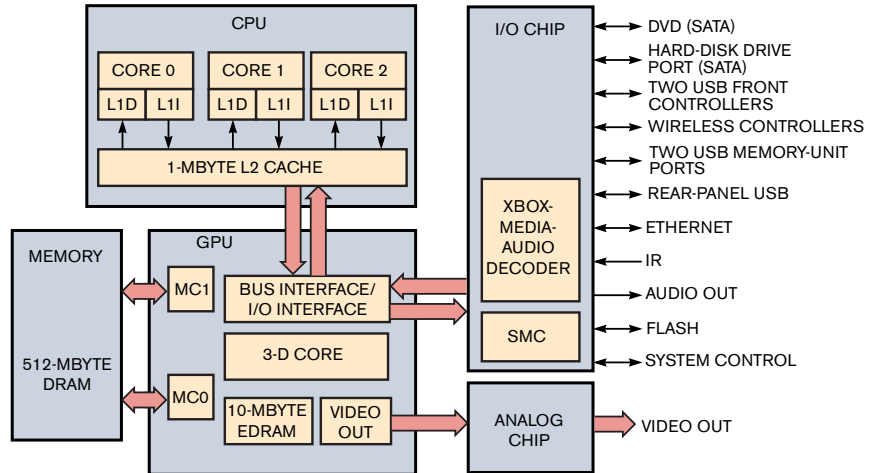
The discrepancies between Microsoft's Xbox 360 and Sony's PS3 (PlayStation 3), whose release schedule and price aren't yet public, begin with their CPUs (Figure 3). The Cell CPU swaps out two of the three Xenon PPEs, along with half of the L2 cache, for eight SPEs (synergistic processor elements). Only seven of the eight SPEs in Cell are developer-accessible in PlayStation 3; at E3, Sony



indicated that it reserved the eighth SPE for “redundancy,” suggesting that the lack of a full complement of SPEs was a yield-boosting and cost-saving maneuver. More recent rumors, however, suggest that the eighth SPE is fully operational, but the PS3 reserves it for DRM or other operating-system-controlled functions. The Cell SPE performs single-precision SIMD (single-instruction-multiple-data)

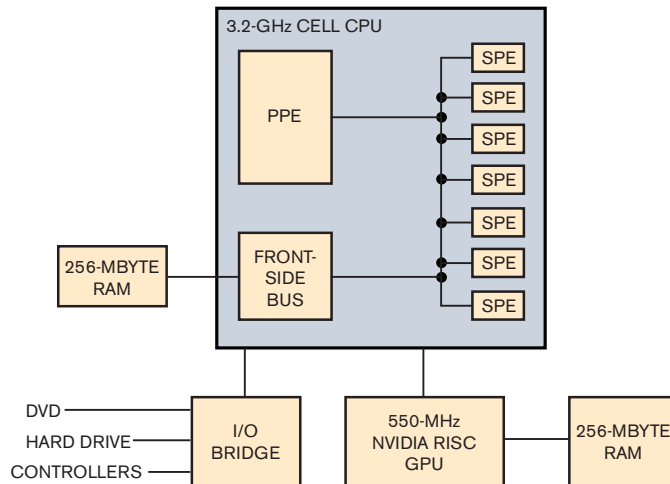
computation, and each SPE partners with 256 kbytes’ worth of dedicated single-port instruction SRAM.

Sony, in competitively positioning Cell against Microsoft’s Xenon, vigorously touts its processor’s greater-than-200-Gflops’ worth of single-precision peak computational capability (with all eight SPEs enabled) and at 3.2 GHz. Microsoft counters with Xenon’s more “balanced”



NOTES:
L1D=LEVEL 1 DATA CACHE.
L1I=LEVEL 1 INSTRUCTION CACHE.

(a)



NOTES:
PPE=POWERPC PROCESSING ELEMENT.
SPE=SYNERGISTIC PROCESSOR ELEMENT.

(b)

Figure 3 Peer closely, and you’ll find several significant architecture discrepancies between the Xbox 360 (a) and PlayStation 3 (b), reflecting the companies’ philosophical differences on partitioning.



multicore approach, 9 billion-dot-product-operations/sec capability, and “greater than one teraflop of system floating-point performance.” The Xbox 360’s floating-point specification sums both the CPU’s and the GPU’s capabilities (**Reference 14**). The Cell and Xenon have 235 million and 165 million transistors and 235- and 168-mm² die sizes, respectively, both at 90-nm process geometries. These specifications are instructive for folks who want to make cost and yield forecasts. ATI Technologies is also quick to point out that Microsoft is using a console-optimized GPU, whereas rumors have it that the PS3’s RSX is nothing more than a 90-nm shrink of Nvidia’s PC-tailored GeForce 7800 GTX, which Nvidia slightly tweaked to mate up to the Cell’s BIC (bus-interface controller) rather than a PC’s PCI Express bus.

What, if anything, do the specification, feature, and partitioning differences between the two consoles translate to in actual game playing? It’s impossible to say with any degree of certainty, because Sony has yet to publicly demonstrate actual hardware running actual game code. Sony has to date showcased only prerendered game sequences and video clips that the company claims show the console spitting out pixels, along with an E3 video clip purportedly demonstrating that a single Cell processor can simultaneously decode 48 standard-definition MPEG-2 streams, downscale each of them by a factor of nine, and display them tiled within a 1920×1080-pixel HDTV window.

Microsoft’s Corporate Vice President J Allard gleefully points out that all the PS3 consoles and pictures of consoles that Sony has shown the public so far lack ventilation holes, suggesting that they’re mechanical mockups with no functional chips or other hardware inside. Conversely, Microsoft invited the public to testdrive early Xbox 360 game code at the mid-May E3, running on G5 Power Mac console-emulation systems. Microsoft began shipping Xbox 360 hardware to developers at the end of June; demonstration systems started arriving at US retailers, such as EBGames, GameStop, and Wal-Mart, in mid-October; and Microsoft opened the Xbox Lounge demo facility in the Omote Sandō district of Tokyo at the same time. Perhaps Sony will finally show function-

al PS3s at next month’s Consumer Electronics Show in Las Vegas.

At E3, Sony mocked Microsoft’s reluctance to definitively assure consumers of the Xbox 360’s full compatibility with first-generation Xbox titles. However, more recent data suggests that Sony may be in the same boat; the latest slim variant of the PlayStation 2 doesn’t play all PlayStation 2 titles, due to cost-slimming internal-circuitry changes that Sony made, and Sony officials don’t rule out similar limitations in the PlayStation 3. Skeptics also point to a patent Sony received late last year, which describes “A device and method for protection of legitimate software against used software and counterfeit software in recording media ... A specific title code is read, and if this title code has been registered, the main unit shifts to a normal operation. If the code has not been registered, verification software is initiated ... If matching does not occur, the disk is processed as illegitimate software ... Since only titles for which legitimate software has actually been purchased and which have been initially registered in the machine table can be used, resale (so-called used software purchase) after purchase by an end-user becomes practically impossible” (**Reference 15**). In other words, if Sony were to apply this technique to the PlayStation 3, a game would be playable only from the console in which it first resided, thereby squelching not only game piracy, but also the used- and rental-game markets, and

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even game-trading with friends.

Sony intends for PlayStation 3 to be much more than a gaming console. Among other things, it will act as a Trojan horse to get the company's championed blue-laser optical-storage format, Blu-ray, into consumers' homes worldwide. The game-subsidized console will likely be much less expensive than the first generation or few of stand-alone Blu-

ray players. But Blu-ray's relative immaturity versus red-laser DVDs will fiscally burden PS3; some estimates place the cost of the Blu-ray drive alone at more than \$100 (Reference 16). More generally, investment firm Merrill Lynch recently predicted that "PS3 will not only be significantly more costly than Xbox 360 at launch, but will continue to operate at a cost disadvantage for several years"

(Reference 17). The company's detailed cost analysis reveals the added burden Sony is shouldering versus Microsoft, due to factors such as the Blu-ray drive, larger die CPU, and Rambus DRAM. This burden will still be present three years into both consoles' high-volume production ramps (tables 2 and 3). A subsequently published analysis of the Xbox 360 by iSuppli was more pessimistic about Microsoft, estimating that the at-launch bill-of-materials cost of the console's \$399 Premium configuration would be \$525 (Reference 18).

Console profitability for Sony will depend on price, which has yet to be announced, but the higher the price, the lower the potential sales volume of consoles, games, and Blu-ray movies sold and, consequently, the slower the cost-reducing pace due to volume efficiencies, lithography reductions, and the like. Sony hasn't yet announced whether PS3 will come with a hard-disk drive. Like Microsoft, the company may create two SKUs (stock-keeping units) with the hard-disk drive as a separate accessory on the lower priced console. Sony has recently announced that it will not offer a centralized game-server service, such as Xbox Live, but instead, as with PS2, rely on game developers to implement their own online capabilities (Reference 19). This move will reduce costs but will also reduce revenue and, potentially, profit. It is a bit surprising, for two reasons: With games such as *EverQuest*, Sony has shown that it has the expertise to create such a service. Second, competitors Microsoft and Nintendo, which plans to offer the Virtual Console for purchasing and storing downloadable versions of legacy console games on Revolution's flash memory, see online services as key to the communal experience, along with the profits, they're attempting to cultivate. Microsoft even rolled an Xbox Live development environment into its Xbox 360 software-development kit so that console users will have a consistent, rich experience on Xbox Live. **EDN**

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