



WITH LEGAL-GAMBLING REVENUES SKYROCKETING AND ELECTRONICS TECHNOLOGY AT CENTER STAGE, EMBEDDED-SYSTEM MANUFACTURERS ARE LINING UP TO BET ON THE FUTURE.

BY WARREN WEBB • TECHNICAL EDITOR



EMBEDDED ELECTRONICS GUIDES

CASINO GAMING

When you step into a casino in Las Vegas or thousands of other gambling venues around the world, you immediately face a bombardment of multimedia sounds and images from a vast collection of embedded devices, all carefully designed to provide entertainment and maximize stockholder revenue. These modern electronic gambling machines employ the latest high-performance computing and graphics technology along with built-in security to protect the system integrity and guard against hacking. In addition to the multitude of gaming devices, the industry has adopted electronics technology to provide real-time player tracking, surveillance, security, data analysis, and accounting. Casinos also depend on system manufacturers and embedded-system designers to provide a constant flow of increasingly complex gaming products to attract the next generation of casino patrons.

An enormous potential market exists in the gaming industry for embedded boards and devices. Experts predict that worldwide revenues from casino gambling will grow from almost \$70 billion in 2004 to more than \$100 billion in 2009. The United States alone generates approximately 60% of this revenue. As these revenues increase and new venues, such as American Indian casinos, proliferate, operators are investing in the latest electronic-gaming machinery to attract players from the competition. Other gambling operations, such as legal bookmaking, lotteries, pari-mutuel wagering, and even charitable bingo games, are also turning to embedded electronics to speed play and enhance information delivery.

Electronics in gaming has its roots in the slot machines that casino owners in Las Vegas placed in the early days to entertain the wives and girlfriends of serious gamblers. Slot machines have since transformed from these vintage mechanical contraptions that accept and pay off in coins to today's electronic marvels that accept only paper currency and pay out with a voucher. Although modern slot machines may offer denominations as low as one penny, designers structure these games to encourage players to increase their bets with multiple pay lines and hidden bonuses. Even traditional table games, such as blackjack, poker, and roulette, have electronic equivalents or add-ons to enhance the experience and to speed play. Electronic gaming today accounts for 70 to 80% of casino revenue.

WEB THREAT

If you ignore the nongaming entertainment that casinos provide, the Internet provides most of the elements necessary to be a potential threat to the legal-gambling industry. For example, a reasonably fast desktop computer connected to the Internet can duplicate the entire visual and acoustic stimulus necessary to duplicate most casino games. An online-gambling site should be able to entice players with higher payouts by eliminating the labor, real estate, and even the specialty electronics that brick-and-mortar casinos require. Although many of these Web sites do exist, Internet gambling runs into a complicated series of laws and regulations. The Federal

AT A GLANCE

- ▶ Casino gaming is a huge and growing industry that depends solely on embedded electronics and software for new devices.
- ▶ Gaming devices must incorporate sophisticated physical and software obstacles to discourage hackers and safeguard internal circuitry.
- ▶ Embedded boards for the gaming industry must guarantee an extended life cycle and pass a detailed configuration certification.
- ▶ New casino industry trends, such as mobile and server-based gaming, will require a new generation of hardware, software, and security.



Wire Act prohibits gambling businesses from using telecommunications wires to transmit bets, and credit-card regulations forbid these wires' use in online gambling. To avoid these regulations, gambling Web sites require prepayment by check and reside outside the United States.

Despite the possible challenge from the Internet, the casino-gaming industry is stable and offers plenty of opportunities for embedded-system designers and manufacturers. Similar to the military and aerospace segments, the highly regulated casino-gaming devices require certified manufacturing and testing processes. Before an electronic slot machine appears on a casino floor, it must undergo a detailed certification audit by an outside testing organization, such as GLI (Gaming Laboratories In-

ternational). These audits examine physical security, random-number generation, software integrity, documentation, and all electronic circuitry. GLI offers a series of gaming-machine standards, which regulating agencies can use as is or modify.

Product certification is an expensive process and is valid for only a single hardware and software configuration. Because regulating agencies must recertify any changes or updates, system designers usually employ tried and true subsystems with long-term availability. The cost of certifying a new embedded board will easily exceed the cost of purchasing or remanufacturing a board even if it means using old technology with components nearing end-of-life status. Manufacturers in highly regulated industries have developed multiple techniques, such as bulk component purchases and extended production contracts with silicon vendors, to extend product life cycles.

Gaming devices must incorporate physical deterrents to dissuade hackers and safeguard internal circuitry. Manufacturers typically use a hardened enclosure requiring specialized equipment to open. Designers should build the internal parts of PCBs (printed-circuit boards) with security in mind. For instance, hiding the critical signals inside the internal layers in BGA (ball-grid-array) packages makes probing and reverse-engineering the devices more difficult. Although hackers can remove some formulations with acid, the use of epoxies and conformal coatings also protects all or part of a product's sensitive internal circuitry. In addition to physical protection, embedded-system designers also employ open security standards. For example, the TCG (Trusted Computing Group) Standard 1.2 limits access to protected data, authenticates the identity of computers, and manages user privacy. An embedded TPM (Trusted Platform Module) enables these functions by monitoring the boot process to create hash values or checksums for the important elements, such as the BIOS, device drivers, and operating-system loaders. The TPM stores these values and compares them with the reference values that define the trustworthy status of the platform. The TPM also provides public/private-key RSA (Rivest/Shamir/Adleman) encryp-



Figure 1 The iQ965-CI single-board computer combines Trusted Platform Module security technology and multimedia I/O for gaming-device applications.

tion and decryption along with a tamper-proof on-chip memory for keys and passwords.

Advansus, a joint-venture company of ASUS and Advantech, recently released a single-board computer addressing the multimedia, security, and longevity needs of the gaming industry. The iQ965-CI combines TPM-security technology and 7.1-channel amplified-audio performance with Intel's Q965 chip set and the Core 2 Duo processor (Figure 1). The MiniITX motherboard module features the Infineon SLB 9635 TPM chip set to ensure authenticity, software integrity, and confidentiality in network communications. The iQ965-CI receives its power from Intel 3000 graphics-media-accelerator technology, which supports DirectX 9.0c, Pixel Shader 2.0, 256 Mbytes of video memory, and a dual independent display through advanced digital-display or media-expansion cards. The motherboard accommodates one 16-lane PCI Express slot for a secondary display and includes one GbE (Gigabit Ethernet), two SATA (serial-advanced-technology-attachment), six USB, and two serial ports.

GAMING STANDARDS

As gaming-device manufacturers slowly adopt newer embedded-system technology, open standards for communications between boards, subsystems, servers, and management systems from multiple manufacturers become critical. The GSA (Gaming Standards Association) offers a series of communications specifications for free downloading at its Web site. The association's GDS (Gaming Device Standard) communications protocol controls the flow of information between a slot-machine controller and the local array of peripheral devices, including bill validators, card readers, and ticket printers. The GSA also supplies a G2S (Game-to-System) standard based on Ethernet, TCP/IP (Transmission Control Protocol/Internet Protocol), and XML (Extensible Markup Language), which will allow the industry to securely migrate to new technologies, such as server-based games over intranet or Internet environments.

Embedded technology in gaming also extends to the traditional table games. With the right data-capture tools, casino operators can monitor player behavior to detect card counting, adjust



Figure 2 The Table iD system collects information from RFID chips and card readers to provide a snapshot of each player's gambling activity.

promotions, and minimize dealer errors. For example, International Game Technology, Shuffle Master, and Progressive Gaming International have joined forces to create the Table iD table-game-automation system. The system combines a software-based table manager, an RFID (radio-frequency-identification) chip-scanner module, and an optical card-shuffling shoe. The latest RFID gaming chips operate in the 13.56-MHz frequency range and store more than 10 kbits. During play, chip readers at each position identify and record the bets that each player makes. The multideck card shuffler and integral optical shoe record every card dealt to each player, exposing game-play patterns. The Table iD system calculates player betting patterns, summarizes dealer activity, and records player decisions per hour (Figure 2). The system automatically updates information such as average bet and win/loss record without user interaction.

In a technology advancement that could revolutionize gaming devices,

PureDepth Inc recently signed an agreement with International Game Technology to develop slot machines with 3-D displays. PureDepth's patented MLD (multilayer-display) technology uses two distinct screens to simulate depth (Figure 3). One of the two screens sits in front of the other, and a clear interstitial layer lies in between. When the system displays coordinated foreground and background images, they appear to be 3-D from any angle and without any loss of resolution. MLDs overcome issues of left- and right-eye convergence and restrictions in the viewing angle because they do not use a stereoscopic-3-D approach. The technology will allow slot-machine developers to replace the mechanical reels still present in many devices with a 3-D simulation. This all-digital approach also enables casinos to remotely change individual games to meet real-time demand.

Immersion also promises to upgrade the slot-machine- and video-poker-interaction experience with TouchSense



technology, which provides a haptic response that synchronizes with sound and graphical-image changes. Active touchscreens can measure as much as 32 in. diagonally, and various responses depend on the ongoing action. For example, dragging a finger across displayed cards produces a click as each card is passed. Similarly, moving an on-screen slot lever produces a slight pulse as each rolling display comes to a stop. A small electro-mechanical actuator, like the vibrator in mobile phones, provides the physical movement; a tactile “effect” library controls this actuator. Immersion offers developers a TouchSense integration kit that includes the components, software, and guidelines for integrating the technology into production-ready designs.

ON-THE-RUN GAMBLING

The casino industry is revamping its networking infrastructure to prepare for the newest enterprise-level technologies: mobile and server-based gaming. The NGC (Nevada Gaming Commission) recently indicated that it will permit gambling on mobile devices within the



Figure 3 With two distinct screens sitting one behind the other to simulate depth, PureDepth’s MLD provides a realistic 3-D display.

casino and surrounding hotel grounds. Because the NGC is a leader in gaming trends, mobile gambling could easily become standardized worldwide. In a typical scenario, the casino would provide players with a mobile device that would

connect wirelessly with the enterprise network. The player can then select various games and gamble while roaming in certain areas of the casino grounds. Obviously, this mobility creates a set of device- and network-security problems



for embedded-system designers. Devices must provide physical security, location awareness, and strong network authentication but still retain the size necessary for portability.

Server-based gaming consists of networks of individual gambling devices that are controlled from a central location. Each server can control networks at a single casino or multiple sites to

provide software updates, schedule maintenance, or change the mix of games. Casino operators can target the game collection to the player demographics as well as experiment with new games for little cost. Server-based gaming also allows operators to coordinate bonus prizes among multiple groups of machines. The overall objective of server-based gaming is to reduce the cost

-  For more on secure embedded systems, go to www.edn.com/article/CA434871.
-  For another look at hack-proof design, see www.edn.com/article/CA6351284.
-  Go to www.edn.com/071214df1 and click on Feedback Loop to post a comment on this article.

of individual gaming devices by simplifying the internal computing requirements and eliminating device diversity. As with mobile gambling, server-based gaming creates security problems for system designers because data communications may travel outside the controlled casino environment.

Although casino gaming is a highly regulated and controlled industry, vendors are infusing new embedded technologies into the mix with each device generation. The size and growth rate of the industry continue to lure embedded-system designers and manufacturers for a share of the profits. The only potential risk to the industry's continued success is the possible legalization of Internet gambling, a scenario in which any hotel could transform itself into a casino using nothing more than a group of Internet-connected desktop computers. **EDN**

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www.advansus.com.tw | International Game Technology
www.igt.com |
| Advantech
www.advantech.com | Nevada Gaming Commission
gaming.nv.gov |
| ASUS
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You can reach
 Technical Editor
Walter Webb
 at 1-858-513-3713
 and wwebb@edn.com.

