Preface

The global games and interactive entertainment industry is expanding at a rapid rate. Industry revenues were estimated at $28 billion for 2004 and are anticipated to double by 2008 (based on the PricewaterhouseCoopers report *Global Entertainment and Media Outlook: 2005–2009*). Of the current revenues, $2.8 billion is addressable by information technology (IT) companies such as IBM through hardware, software, and services. The IT segment is projected to grow to $7.6 billion by 2008.

This dynamic market is characterized by opposing market forces and technical challenges. Game developers and publishers are pressured by a relentlessly increasing demand from game players to produce ever more compelling and technically advanced games within compressed development cycles, and to do so at low costs. This tension between innovation and return on investment makes early technical-design decisions crucial in meeting market demand. The industry also faces many technical challenges, including issues of scalability, utilization, data persistence, customer-relationship management (CRM), billing, latency, and security. The various requirements of online games, such as heterogeneity, scalability, collaboration, immersive computing, and performance, are very likely to be similar to those that are foreseen for other on demand computing industries.

In the midst of these market and technical challenges, great opportunity exists, brought about by innovation in the microelectronics arena. The next generation of game consoles, fueled by IBM's PowerPC*-architecture-based processors, enables a new universe of options for game creation and play. Nintendo (Revolution), Sony (PS3**), and Microsoft (Xbox** 360) will all run on the PowerPC architecture, granting IBM a leadership position in the console processor market. This unprecedented success is due to the PowerPC architecture's high performance and scalability and to IBM's facility in customizing processors to add or enhance game-specific features through services. Microsoft and Sony are heavily invested in the idea that game players are looking for new entertainment experiences beyond games. To that end, Microsoft Xbox 360 streams media from portable audio devices, digital cameras, and the Media Center PC; whereas Sony's PS3 (a "supercomputer" in the home) is expected to stream media from portable audio devices, digital cameras, PCs, the Internet, and so forth.

The innovation driven by the game industry will impact markets well beyond that of interactive entertainment. Games are driving the emergence of a new kind of application profile that is characterized by the requirements of advanced games; that is, real-time, immersive (virtual worlds), scalable, and massively collaborative applications, supporting nearly 100,000 simultaneous players. Advanced games are at the cutting edge of the technology curve and are more akin to high-performance simulations, such as those used in defense applications. They favor leading-edge platforms (high-end PC clients or consoles) and often demand that new technology be invented, especially in hardware (e.g., custom PowerPC architecture microprocessors for Nintendo, Sony, and Microsoft), but often in the exploitation of the infrastructure and network as well. This is driven by a need for higher perfor-

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mance, better graphics, smarter artificial intelligence, and a richer and more immersive user experience. The application profile represented by the game industry is likely to serve as a test bed for future generations of enterprise applications that combine highly responsive, interactive, collaborative environments with rich media and a network of integrated service providers in the value chain.

Online games are fundamentally about communities and collaboration. Communities are a major element of all types of games as a means of promotion and consumer support. CRM systems and portals are a key supporting technology. Game publishers provide a Web portal for interaction, providing game-oriented functions such as player matching and other associated "lobby" services. Game hosting platforms use portals for administration, personalization, and aggregation management. Web services are being adopted by game platforms to enable easy integration with third parties for different provisioning and management tasks.

Game development is evolving to use supply-chain production with a shift in investment from code development (20 percent) to digital content production (80 percent). There are strong opportunities for vendors of tools and services to advance complex digital-media application development. Mobile game platforms are emerging that combine advanced integrated-service-platform environments with content management, provisioning, and messaging. There are possibilities for new platform vendors and game-hosting service providers to take leadership in the mobile network operator market. As the game industry evolves as an e-business, new business models are emerging, creating new virtual economies and marketplaces. New revenue models such as subscription and pay per play have emerged to support online revenue streams from episodic content; those in the Eastern Hemisphere tend to adopt the former, and those in the Western Hemisphere, the latter.

Games are an incubator of important technologies for IT companies such as IBM in the broad sense, and presage the use and scaling of technologies such as grid computing, the 64-bit PowerPC architecture, the Cell Broadband Engine** (BE) architecture and e-commerce. The purpose of this special issue on online game technology is to highlight some of the relevant activities and technology directions within IBM that address the challenges facing the game industry and its evolution. The papers in this issue are divided into the following areas of interest:

- *On demand operating environment for games*

  Most online games use dedicated hardware, software, and networking infrastructure deployed for individual titles. Because of the unpredictable and shifting popularity of any given game title, the ability to share or retarget resources across titles and automatically scale the server infrastructure mitigates the risks involved in launching a new game, simplifies server management, and reduces costs. The On Demand Operating Environment (ODOE) technology infrastructure supports this type of flexibility, virtualization, and IT simplification.

  Papers in this section describe three key components in the design of an ODOE for games. The first paper, "On demand platform for online games" by Shaikh et al., presents a prototype implementation of a service platform for online games that can automatically provision game server resources in response to various metrics in a shared server environment. In the second paper, "Running Quake II on a grid," Deen et al. describe the application and adaptation of IBM OptimalGrid technology to the game Quake II**, transforming it from a server-based game limited to 16 players into a massively multiplayer (MMP) game capable of supporting more than 500 players. The paper describes the process by which the OptimalGrid technology can be used to enable a game application for an ODOE. The third paper, "System-performance modeling for massively multiplayer online role-playing games" by Ye et al., describes a method for modeling the system performance of massively multiplayer online role-playing games (MMORPGs) and applies it to one of the most popular games running in China. The system performance model, a key component of the ODOE for games, relates infrastructure resources to game performance for use in automatic provisioning.

- *Deep computing for games and game development*

  We are seeing an increasing trend toward the convergence of movies and games (e.g., the game *The Matrix Online***) as these two forms of

entertainment begin to share the same world and characters. This trend is increasing the need for very high performance content creation and for development environments that can render photo-realistic images in real time. Game technology must keep up with the ever more complex images, special effects, and physics simulations commonly found in today's motion pictures. Interactive MMP online games traditionally have not achieved the level of realism or performance typical of single-user console games. This has been due to various technical problems, including communication latencies, bandwidths, and the tremendous computational efforts necessary to realistically simulate such large, complex game worlds. MMP online games have generally addressed these challenges by imposing design constraints and reducing the level of interactivity or realism provided in the game. However, the emergence of powerful next-generation game processors such as the Cell BE processor promises to eliminate this online game "computation barrier."

This section presents three papers on novel programming tools and techniques that unlock the potential of the Cell BE processor for online games. The first paper in this section, "Using advanced compiler technology to exploit the Cell Broadband Engine architecture" by Eichenberger et al., describes a variety of compiler techniques that exploit the Cell BE architecture's unique performance potential, which enables multilevel heterogeneous parallelism and delivers vast computational capability for online games. The second paper, "MPI microtask for programming the Cell Broadband Engine processor" by Ohara et al., proposes a novel two-phase "microtask" scheduler for distributed parallel computations on the Cell BE processor, which leverages the existing, widely used explicit message-passing-interface (MPI) communication model. The third paper, "High-performance server systems and the next generation of online games" by D'Amora et al., builds on the technologies of the first two papers, applying the technologies to the creation of a complete online game prototype for the Cell BE processor.

- *Business integration for games*

The massively scalable, collaborative, immersive environments provided by massively multiplayer games are being used as marketplaces for new digital economies, handling business-to-consumer (B2C), business-to-business (B2B), and consumer-to-consumer (C2C) transactions. These environments are becoming places where different kinds of communities are congregating (for reasons not related to the game), indicating the suitability of the medium as a multipurpose community and collaboration tool with particular applicability to commercial markets. The papers in this section focus on the integration of business functions, including in-game and out-of-game commerce, game content management, and secure distribution in the game environment.

With the increasing monetization of online games, content protection has become a serious issue for the game industry. In their paper, "Content protection for games," Myles and Nusser review the state of the art in content protection for games and describe the capabilities and shortcomings of existing solutions. Additionally, they present two novel approaches to addressing some of these shortcomings, based on an open, standards-based architecture, and illustrate their applicability to game copy protection.

CRM is a fundamental "pain point" and concern for MMP games, as the success of an online game hinges on the careful maintenance of its customer community. The online game industry, being relatively young and free from legacy infrastructure for CRM, is ideally positioned to exploit the latest developments in CRM. In their paper, "A context-aware smart-call-center solution: Improving customer service for online games," Luo et al. present a solution of particular relevance to online game operators, delivering contextually relevant information to both players (customers) and game operator personnel and leveraging voice-over-IP (VoIP) technology for a truly embedded solution.

Finally, Sharp and Rowe, in their paper "Online games and e-business: Architecture for integrating business models and services into online games," describe the current business models employed in the online game industry, and how they may converge with more traditional enterprise integration approaches for delivering online services. An in-depth description of prototype middleware known as Business Integration for Games is

described, with some thoughts on how e-business on demand relates to the online game industry.

The issue also contains a paper unrelated to the issue theme by Hirschheim et al., entitled "A marketing maturity model for IT: Building a customer-centric IT organization." This paper discusses the need for improving the relationship between IT and business management and proposes a marketing maturity model for use by IT executives in order to determine the best way to enhance their relationship with the business.

The next issue of the *Journal* is devoted to the *celebration of the tenth anniversary of XML.*

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