Highlights of Power Architecture® Technology Differentiation

With a powerful instruction set, multicore capabilities, virtualization and best-in-class ecosystem, Power Architecture technology is a stand-out.

by Power.org

Power Architecture® processing technology is the common thread for a very broad range of devices, from 32-bit micro¬controllers to 64-bit ASICs. A ubiquitous architecture, more than a billion Power Architecture technology-based chips have been built into electronics equipment since 1991.

Every Power Architecture technology-based chip is rooted in the Power Instruction Set Architecture (ISA), a processing specification spanning server and embedded computing capabilities. Power ISA is the only architecture in the market that has proven implementations from the smallest devices to the largest supercomputers while covering a diverse set of markets. Power ISA features are familiar to thousands of software, hardware and tool developers who have worked with PowerPC devices for many years. The most recent Power ISA 2.06 extends the edge Power ISA has in HPC and computation-intensive workloads, provides enhancements to the server space such as memory management, processor version compatibility features, cache management, and also introduces a number of capabilities for the embedded space such as embedded hypervisor, energy management, multi-core and multi-threading.

Diversity and Breadth of Applications

Power Architecture technology is the basis for an extraordinary range of products, from supercomputers with 213,000 processors to tiny automotive controllers dissipating less than a watt of power. Power Architecture technology is used in everyday household electronics -- printers, HDTVs, video recorders, game consoles -- as well as more exotic electronics, such as satellites and the Mars Rover Lander. This makes it well-suited for any advanced electronic application offering the best performance per watt.

Power Architecture – Power ISA Key Differentiation

Scalability, reliability, flexibility, and the open collaborative model of Power.org are some of the characteristics that differentiate the Power ISA from all others and influence the evolution of Power Architecture technology into a unique position.

Scalability

"Set-tops to Teraflops." is the tagline that Power.org uses to communicate the inherent scalability of the Power Architecture technology to the industry. The architecture covers the most diverse set of markets including consumer electronics, industrial control, telecommunications and networking, high performance computing, IT and commercial systems, aerospace and defense, high end printers and imaging solutions. This is a testament to Power Architecture technology's scalability in that it can address a vast array of applications while preserving the binary compatibility of software. In addition, Power Architecture technology is a 64-bit architecture with a proper 32-bit subset. All code, which is written for the 32-bit subset, will run on a 64-bit engine -- this is unique in the industry.

Reliability

The reliability of Power Architecture implementations is evidenced by the many mission critical applications in aerospace and defense, such as all three Mars Rover landings that used Power Architecture chips. Power Architecture technology maintains the leading share of safety-critical automotive embedded systems and has a proven track record of reliability in servers with the lowest soft error rates under a barrage of proton and neutron radiation.

Flexibility

The fact that Power Architecture technology has been implemented on platforms from game consoles to supercomputers shows its great level of flexibility. This flexibility comes from its unique advantage of being the world's most scalable, open processor architecture backed by a collaborative ecosystem that eases customization. The ecosystem also benefits from "raw" technology advantages, enabling relatively small die sizes. This makes the architecture ideal for SoC designs. Finally, this many Power Architecture implementations enable OEMs to choose from a variety of parts for high performance, balanced power and performance, or low power.

Leading Companies Use Power Architecture Technology

Power Architecture technology underlines many well-known, market-leading chip families, including the Cell Broadband Engine from IBM, Sony and Toshiba; the QorIQ and PowerQUICC processors and automotive controller lines of Systems on a Chip (SoCs) from Freescale; IBM PowerPC 4xx including the recent announcements of the 476; POWERx including the recent announcement of POWER7 server chips from IBM; full featured Virtex FPGAs from Xilinx and hybrid processing devices.

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Energy Management

Power usage at a system level is dominated by two elements:

- How many instructions are required to accomplish a fixed element of work
- How many data reads and writes are required to execute a specific code sequence

RISC architecture helps reduce power consumption because of its simplicity, making it an inherently "green architecture."

Power Architecture cores provide important capabilities for dynamic power management. Some of these are enabled internally in the core. Furthermore, Power Architecture cores offer software-selectable power-saving modes. These power-saving modes reduce function in other areas, with some modes limiting cache and bus-snooping operations, and some modes turning off all functional units except for interrupts. These techniques are an effective way to reduce power.

Power Architecture Embedded Supervisor architecture provides application software with a means for power-optimized solutions through the wait instruction (Power ISA 2.06). This instruction allows software to initiate power savings when it is known that there is no work to do until the next interrupt. The combination of CPU power-savings modes, the wait instruction, and the ability to wake on an interrupt has been demonstrated to achieve deep sleep power savings with wake up on external event—with no packet loss.

Multi-core and Virtualization

Power Architecture technology was an early participant in the world of multi-core. IBM Systems and Technology Group and Power Architecture embedded partners and customers have been implementing multi-core designs for many years. The ubiquitous PowerQUICC processors from Freescale, which were launched in the mid '90s, have always been heterogeneous multicore devices. In 1995, Freescale introduced MPC860 which had two cores – one based on Power Architecture technology and the other was proprietary RISC architecture. In 2001, IBM's POWER4 incorporated dual cores on a single die. It also was the first to implement a multi-chip-module containing four POWER4 microprocessors in a single package. More recently, Freescale's QorIQ families (P1, P2, P3, P4 and P5) implement from 1 to 8 Power Architecture cores, emphasizing hypervisor and virtualization. Additionally, the POWER7-based supercomputer, Blue Waters, was announced to support 200,000 processors, bringing multi-petaflops performance in 2010-2011.

Now, that the industry has shifted its full focus to the challenge of how to efficiently program and automate software development for multi-core devices. Power.org is addressing this challenge via multiple ISA and technical initiatives. Power ISA v2.04 was finalized in June 2007 and includes changes regarding virtualization, hypervisor functionality, logical partitioning and virtual page handling. Additional enhancements resulted in ISA v.2.05, released in December 2007, which supports decimal arithmetic and server hypervisor improvements. Recently, Power ISA v.2.06 was released in February 2009. This included extensions for IBM's POWER7 processor and Freescale's e500-multi-core including embedded specification regarding hypervisor and virtualization on single and multi-core implementations for the embedded market. Thus, Power ISA 2.06 has enabled virtualization for embedded hypervisor and other virtualization technologies.

ISA support for embedded hypervisor simplifies software development by creating an abstraction layer of capabilities for the underlying cores.

SoC Platforms

The Power Architecture ecosystem is focused on balanced system designs using multi-core technology. One advantage for Power Architecture technology is the use of a highly scalable memory model. The memory model enables high-performance memory operations with relaxed ordering rules. These relaxed rules allow multi-threaded ordering requirements to be enforced only when required by software, providing much greater throughput in hardware, as operations can be processed as quickly as possible. Most of the coherence and bandwidth optimizations used in IBM's POWER-based enterprise servers would not be possible with less advanced memory models.

Software Development Environment

Power Architecture technology has the largest breadth and depth of development tools support in the industry. As expected, tools naturally congregate around the market segments where Power Architecture technology is popular: servers, storage, networking, communications, automotive and digital media. Power Architecture technology is supported by virtually all major operating system platforms and most minor ones as well.

Full system simulation provides virtualization capabilities for the Power Architecture community and helps software developers debug at the system level instead of at the individual board level. Developers are able to run simulations of their full systems, sometimes containing hundreds of different boards with many different kinds of processors, SoCs, devices and communication buses. This simulation helps identify performance enhancements and improves time to market through early identification of system trouble spots.

Conclusion

Power.org and its members further advanced Power Architecture technology, completing a number of vital initiatives including Power ISA standards, hypervisor, virtualization and energy management, enabling the highest performing processors and cores for the server and embedded space.

Advancements in the Power Architecture technology continue to provide designers and developers with scalability, reliability and flexibility needed in their diverse markets. Moving forward, Power Architecture technology's focus on energy management, multicore/virtualization, SoC platforms and software development environments will enable Power Architecture technology to continue to be a ubiquitous architecture in the industry, helping drive many new and exciting applications.