enriching the human experience through powerful digital technology

MIPS Technologies

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MIPS Technologies Inc., a pioneer of RISC Reduced Instruction Set Computing microprocessor technology, designs and licenses Instruction Set Architecture (ISA) technology, processors, cores, custom instruction-set architecture (ISA) technology, and foundry designs and may choose to develop and manufacture their own derivative designs. Since its founding in 1994, MIPS Technologies has been a leader in the development of high-performance processors and graphics-imaging technology. Now, MIPS Technologies is focusing its efforts on designing modular, high-performance processors and graphics-imaging technology. The design and implementation of MIPS processors and core designs is supported by a wide range of tools and services. MIPS Technologies and foundry companies, MIPS, create and manufacture MIPS-based designs and may choose to develop and manufacture their own derivative designs.

"We required a processor architecture that is high-performance, cost-effective, well supported by software development tools, and development.

MIPS Technologies has strong industry-wide support. MIPS Technologies is able to meet all of those requirements."

Dr. Henry T. Nicholas II, Chairman, President and CEO

The new Intelligent Processor Unit (IPU) offers tremendous, drastically undercutting the price of the PowerPC and StrongARM processors."

Monolithic Microprocessor Report, June 1, 1998

"The [MIPS] architecture appears in most, if not all, of the newest high-volume market segments."

Monolithic Microprocessor Report, June 1, 1998

S"
exponential growth

MIPS Technologies and its strategic partners
are on a dramatic growth curve, providing the processors for many
of today’s most successful digital embedded products. In 1997,
MIPS-based processors dominated the RISC marketplace with 48
million processors shipped — twice the volume of our nearest
competitor — and also achieved the highest growth rate of RISC
processor shipments.

MIPS Technologies and its licensees also attained these performance
and support achievements in the 1997 processor market:

- The industry leader in price/performance (Dollars per MIPS)
- An industry leader in performance/power (MIPS per Watt)
- Greatest number of RISC-processor implementations (over 50)
- Broader range of RISC semiconductor licensees and
development-tool vendors
- Largest group of experienced RISC-based system developers

The breadth of MIPS-based product lines and their support
infrastructure is the result of powerful alliances with licensees.
MIPS licensees provide multiple sourcing of standard parts,
competitive pricing, and specialty parts. OEM system developers
value the ability to quickly select from a broad range of off-the-
shelf MIPS-compatible processors, quickly customize core designs
in alliance with MIPS licensees, quickly select familiar development
tools, and quickly port or modify a huge base of existing system
and application software using those development tools.

The high performance and low cost of MIPS-based processors
has made them especially successful in the video games market,
where price/performance is a dominant factor. But the diversity
of MIPS-based processors currently in production, plus the number
of new implementations in the design phase, make these processors
competitively available for virtually all existing and emerging
digital applications.
MIPS Technologies is a pioneer of RISC architecture. The company was founded in 1984 by researchers and design engineers from the Stanford University/Silicon Valley community. RISC architectures move execution complexity out of the processor hardware and into the compiler, to support the design and manufacture of simpler, faster, lower-cost processors.

MIPS Technologies designed its first ISA in 1984 and implemented it a year later in the R2000, the world's first commercial VLSI RISC processor. There have been four upward-compatible ISA extensions since then. The complete set of ISAs is:

- **MIPS II (1990).** Added instructions and registers for 64-bit floating-point math and multiprocessor synchronization. Implemented in the R6000 processor and derivatives.
- **MIPS III (1991).** Added 64-bit instructions, addresses, and data types, plus more floating-pointing instructions. Implemented in the R4000, R4200, R4300i, R4400, R4600, and R4700 processors and derivatives.
- **MIPS IV (1994).** Added prefetching and further refinements for floating-point operations. Implemented in the R5000, R8000, and R10000 processors and derivatives.
- **MIPS V (1996).** Added SIMD (single-instruction, multiple-data) operations on floating-point values for high-performance graphics.

Each ISA extension includes the former levels, and each new processor can implement any ISA level.

In recent years, the demand for embedded 32- and 64-bit processors in high-volume applications has created the need to support a greater range of high-performance graphics in low-cost products. In 1996, the company defined two Application Specific Extensions (ASEs) for these special needs:

- **MIPS Digital Media eXtensions (MDMX):** Added instructions for high-performance signal processing, including multimedia applications such as audio and video.
- **MIPS16:** Added compression of 32-bit and 64-bit instructions into 16-bit instructions for improved code density and reduced memory-chip requirements in low-cost systems.
strengths of the
MIPS architecture

MIPS Technologies has its roots in high-performance design. It has one of the industry’s richest track records in the design of high-performance functions — such as superscalar and superpipelined execution, out-of-order execution and register renaming, speculative execution across multiple branches, dynamic instruction issue, instruction predecoding, dynamic branch prediction, cache structures for out-of-order instruction fetching, multiprocessor virtual-memory management and coherence, supercomputing floating-point operations, and split-transaction system buses. MIPS Technologies has implemented these features in scalable designs running at very high clock rates.

By first creating an architecture to solve the most challenging computational problems, MIPS Technologies is positioned to bring its huge portfolio of high-performance design solutions to the cost- and power-sensitive digital consumer and high-end control-oriented embedded markets. This top-down approach distinguishes the MIPS architecture from others that target only embedded applications and attempt to scale up in performance.

The MIPS architecture has proven to be highly scalable. MIPS-based implementations now range from a low-end 2 mm² die executing 50 Dhrystone MIPS — at its introduction, the world’s smallest commercial RISC processor — to high-end 290 mm² die executing more than 500 Dhrystone MIPS. With over 50 implementations to choose from, developers can find a processor for almost any price point or performance level.

a shared and diversified architecture expands the market

Because MIPS strategic partners are free to develop and manufacture their own derivative designs, as well as those provided by MIPS Technologies, a shared and diversified architectural standard is emerging. Diverse implementations provide broad choice of compatible processors for the ever-growing group of MIPS system developers. This greatly benefits system developers in all market segments, and it is a powerful stimulus to the expansion of the entire market for MIPS-based products.
the largest selection of RISC development tools and tool vendors

There are well over 150 hardware and software development tools available for MIPS-based system development — more tools than for any other RISC architecture. The tools include several types of compilers, debuggers, real-time and handheld operating systems, hardware and software simulators, software models, software-development environments, evaluation boards, logic analyzers and preprocessors, in-circuit emulators, network interfaces, page-description languages, and printer interfaces.

These tools are provided by more than 50 tool vendors, each of whom has made a substantial investment in their MIPS-compatible products. Chances are very good that the tool an OEM developer is using today also supports the MIPS Technologies processor family.

To complement this large selection of development tools, OEM developers also have the advantages of multiple sources for MIPS-based processors, system-controller chip sets tailored for MIPS-based processors, the industry's largest body of RISC developer talent, and a wealth of experience from past MIPS-based system designs.

The MIPS Technologies Web site — www.mips.com — lists all of the development tools, processors, and chip sets. Select the Development Tools link at the home page.

integration and testing support

MIPS Technologies is a founding member of the Virtual Socket Interface (VSI) Alliance, a group of the most prominent ASIC vendors, EDA tool vendors, and design firms. The VSI Alliance is targeting system-on-a-chip products. It will accomplish this by creating interchange standards for ASIC macros.

MIPS Technologies was the first commercial processor organization to provide OEMs with complete and timely documentation on chip errata, a practice since embraced by Intel and other processor vendors. MIPS Technologies and its licensees recently began development of an enhanced JTAG (EJTAG) in-circuit emulation (ICE) standard for the MIPS architecture. This specification — an extension of the Joint Test Action Group (JTAG) standard — enables engineers to more easily debug new MIPS chips by designating a common interface for accessing the CPU and debug code. Standardizing on an efficient debug tool results in faster product time-to-market and reduced testing costs.

These efforts to make the system development process more efficient and reliable are part of MIPS Technologies' commitment to support its licensees and system developers.
strength in strategic alliances

MIPS licensees

**MIPS Technologies creates investment** strength and market dominance through strategic alliances. Licensees fabricate MIPS-based designs, create and fabricate derivative designs, and sell the resulting products in the open market. In 1997, there were over 37 chip-design teams working on various implementations of standard MIPS designs and MIPS-derivative implementations.

Current licensees include:

- **IDT**
  Integrated Device Technology Inc., (IDT)
  www.idt.com

- **LSI Logic**
  LSI Logic Corporation
  www.lsilogic.com

- **NEC**
  NEC Electronics Inc.
  www.nec.com

- **NKK**
  NKK Corporation
  www.nkk.co.jp/LSi

- **PHILIPS**
  Philips Semiconductors
  www.semiconductors.philips.com

- **Quantum Effect Design, Inc.**
  Quantum Effect Design, Inc., (QED)
  www.qedinc.com

- **TOSHIBA**
  Toshiba America
  Electronic Components Inc.
  www.toshiba.com/taec
licensing and business model

The MIPS Technologies licensing model encourages innovative development, diversity, multisourcing, and competitive pricing. MIPS Technologies provides its licensees with design information on standard parts, down to the mask level. Each licensee is able to create derivative products from the licensed core designs. Together, the licensees — each focusing on their unique strength — offer a broad selection of standard, enhanced, or application-specific processors for the market segments in which they are best suited.

The MIPS Technologies business model leverages the cost of developing, fabricating, and marketing this broad selection of processors through its strategic alliances. This collaboration allows the entire MIPS team, including tool vendors, to make the very high investments required for leading-edge processor development, fabrication, and sales. Each team member shares in the total market created by all members working together. The proof of the success of this strategy lies in the fact that MIPS licensees have already gained nearly 50% of the RISC-processor market.

a simple choice

RISC architectures deliver higher performance at lower cost than any other type of processor architecture. And MIPS Technologies is the RISC-technology leader, with the longest and strongest consistent growth, the best track record for price/performance and power/performance innovation, the technological diversity to serve the emerging digital consumer and high-end control-oriented embedded applications, and the financial strength to push its growth curve well into the future.

No other architecture offers the breadth, scalability, and sustainability of the MIPS RISC architecture.