CHINA GETS RIGHT WITH MIPS

New Architectural Licenses Bless Godson/Loongson Processors

By Tom R. Halfhill {7/13/09-01}

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PowerPoint pitches typically feature a slide filled with logos of the company's customers. The aim is to dazzle the onlooker with graphic evidence of the company's popularity. And the slide often enlarges the badges of the biggest customers to the biggest proportions.

Now MIPS Technologies can decorate its PowerPoint presentations with a logo for the biggest customer of all: China. For the first time, the world's most populous nation has licensed the MIPS microprocessor architecture directly from MIPS Technologies. The landmark deal ends all questions about the legitimacy of China's Godson and Loongson processors—MIPS-compatible chips developed independently by Chinese engineers.

The official licensee is the Institute of Computing Technology (ICT) at the Chinese Academy of Sciences in Beijing. Although ICT is a government-owned academic and research institution, the MIPS licenses are full-fledged commercial contracts, not the limited academic licenses usually granted to universities.

MIPS says ICT paid a "substantial" licensing fee, as other commercial licensees do, though MIPS isn't disclosing the amount (normal practice). Likewise, the MIPS-compatible processors manufactured under license will generate chip royalties for MIPS, as other commercial licenses do.

ICT's Licenses Are Broad

An important provision of the new licenses is that they cover other entities in addition to ICT. These entities may include one or more companies that handle manufacturing, sales, and commercial distribution of the chips, while ICT handles development. MIPS isn't naming the commercial entities at this time but expects to make a formal announcement with ICT this fall.

This provision of the license was necessary because ICT is not a business concern. ICT transfers the finished designs to a for-profit company that handles production, sales, distribution, and technical support. (This division of labor accounts for the different names of these MIPS-compatible processors. As translated into English, the processors are called "Godson" at ICT and "Loongson" when sold commercially. Another name is "Dragon.")

In the past, one company that handled commercial functions for ICT was BLX IC Design Corp. Ltd., jointly owned by ICT and private investors. At this time, BLX IC Design appears to be out of the picture. Another Chinese company, Jiangsu Lemote Tech Corp. Ltd., has assumed that role. Lemote Tech was founded in June 2006 and is based in Changshu (Jiangsu Province). It is jointly owned by ICT and Jiangsu Menglan Group Co., Ltd., a textile company also based in Changshu.

Another important aspect of the licensing deal is that ICT has purchased rights to both the MIPS32 and MIPS64 instruction-set architectures (ISA). These architectural licenses go beyond processor-core licenses by allowing ICT to design new MIPS-compatible microarchitectures and cores, as ICT has been doing for years. By licensing both the 32- and 64-bit ISAs, ICT can create a variety of designs focusing on lower power or higher performance.

Only a few companies have MIPS architectural licenses. Examples include Broadcom, Cavium Networks, NEC, PMC-Sierra, RMI (recently acquired by Netlogic), STMicroelectronics, and Toshiba.

The ICT deal helps to compensate for MIPS's recent stumbles. In June, MIPS sold its analog and mixed-signal group to Synopsys for $22 million. Less than two years ago, MIPS acquired that group by paying $147 million for Chipidea, a Portuguese company. Although the Chipidea divestiture weakens MIPS in Europe, the ICT deal will strengthen MIPS in China—a market with more growth potential. (See *MPR 6/29/09-02*, "Tough Times Bring Change.")

MIPS Makes Inroads in China

Until now, there was lingering doubt over the legal status of Godson processors. ICT began designing MIPS-compatible chips in 2001 without any MIPS relationship at all, which wasn't too difficult. The MIPS architecture—a seminal RISC architecture introduced in 1985—is relatively clean and simple. It's widely documented and is often used as a teaching tool by universities. Thousands of college students have written MIPS compilers as an academic exercise in computer-science classes.

ICT adopted the MIPS architecture for all those reasons and for its versatility. Originally designed for high-performance workstations and servers, the MIPS architecture is now one of the world's leading embedded-processor architectures. MIPS and its architectural licensees have designed numerous 32- and 64-bit implementations, including high-performance embedded cores with superscalar pipelines, out-of-order execution, hardware multithreading, and support for symmetric multiprocessing. An optional subset of 16-bit instructions is ideal for smaller, low-power designs. The ISAs are user extendable and configurable.

The Chinese government's long-term goal is to develop independent technology in vital fields, especially computer technology. In China, Loongson processors are finding their way into consumer electronics, low-cost personal computers for schools, industrial embedded systems, servers, and massively parallel supercomputers. To reduce costs, these systems typically run the Linux operating system and other open-source software. (See *MPR 6/26/06-02*, "China's Microprocessor Dilemma," and *MPR 7/25/05-01*, "China's Emerging Microprocessors.")

To avoid legal conflicts, particularly if Loongson chips are exported in consumer-electronics products, ICT omitted some patented MIPS instructions from its early designs. Legal disputes over those instructions and patents eventually led to the downfall of Lexra, a U.S. company that designed unlicensed MIPS-like processor cores in the 1990s. (See *MPR 12/6/99-03*, "MIPS vs. Lexra: Definitely Not Aligned.")

Bypassing STMicro

In 2007, MIPS began allowing ICT to design fully MIPS-compatible processors through an indirect licensing arrangement with STMicroelectronics. Under those terms, ICT was to function essentially as an independent design house for STMicro, creating MIPS-compatible processor cores that STMicro could use commercially. (See *MPR 4/23/07-01*, "Embedded Systems Conference Highlights.")

Last year, however, the STMicro arrangement seemed broken when ICT unveiled its latest Godson-3 processor at the Hot Chips conference in Silicon Valley. STMicro told *Microprocessor Report* it had no plans to use the Godson-3—a turn of events that didn't conform with our understanding of the licensing arrangement. Nevertheless, MIPS told *MPR* that it considered the Godson-3 to be a legitimate MIPS-compatible processor. (See *MPR 11/3/08-01*, "Godson-3 Emulates x86.")

In any event, the new licensing deal with ICT should erase all doubt. By selling commercial 32- and 64-bit architectural licenses directly to ICT, MIPS has bypassed STMicro's intermediary role.

MIPS has spent years negotiating these licenses with ICT. One can only imagine the difficulty of hammering out a deal with an institution controlled by the Chinese government. Now the persistence has paid off. In effect, the most populous nation in the world is an official MIPS licensee.

Mainly for the Mainland

MIPS says the ICT licenses have no extraordinary restrictions, beyond the usual U.S. regulations governing exports of technology to China. ICT can manufacture its MIPS-compatible chips in any fab and sell them in any market—including international markets.

However, MIPS expects most Loongson processors to be reserved for domestic consumption. And, for political reasons, the chips will almost certainly be manufactured in mainland fabs. (*MPR* doubts that this licensee will be a new customer for TSMC anytime soon.)

Because the licenses are architectural, ICT can continue designing original MIPS-compatible processor cores and can add instructions to the MIPS32 and MIPS64 ISAs, as long as the new designs maintain baseline MIPS compatibility. Indeed, ICT has already been going its own way. Most notably, the Godson-3 adds more than 200 new instructions and other features to accelerate x86-to-MIPS dynamic binary translation. These modifications allow Godson-3 processors to run x86 software with optimized emulation, much as Transmeta's proprietary VLIW architecture did. (See *MPR 12/26/07-01*, "Transmeta's Second Life.")

MIPS wasn't involved in the design of the Godson-3 or the x86 extensions. To our knowledge, ICT hasn't licensed any intellectual property (IP) from Intel or Transmeta (since acquired by Novafora). However, in our previously cited Godson-3 article, we concluded that the Godson-3 extensions probably don't violate Intel's or Transmeta's protected IP.

ICT doesn't represent the Godson-3 as an x86-compatible processor, as Transmeta did with its Crusoe and Efficeon processors. The Godson-3 is simply a little faster at x86 emulation than a processor based on the standard MIPS64 ISA would be. In any case, the licensee—not MIPS—is

responsible for independent extensions to the ISA and for any IP issues those extensions may raise.

A Strategic Move for MIPS

For MIPS, the ICT licenses are very strategic. ICT's embrace of the architecture has always given MIPS an important beachhead in China, but expanding that beachhead has been difficult. MIPS has sold a few core licenses to Chinese companies and to other companies that do business in the region. For instance, MIPS recently licensed the MIPS32 24KEc core to Taiwan-based EE Solutions, which designs ASICs and SoCs for customers in Taiwan and China.

Archenemy ARM is even more popular there. For years, ARM has been licensing processor cores for Chinese-designed SoCs, and those chips are in millions of cellphones and other embedded systems. But so far, ARM hasn't sold an architectural license in China. Although it's unlikely that MIPS will replace ARM in low-power mobile systems, the ICT deal cements a relationship that gives the MIPS architecture an aura of government approval.

MIPS already has a corporate presence in China. An office in Shanghai, staffed mostly by Chinese employees, handles sales, technical support, and engineering. MIPS says business activity and investment are picking up steam in China, suggesting the beginning of recovery from the recession. MIPS's recent support for the Android open-source operating system is another strategic move.

One possible downside of the ICT deal is that the licenses are rather broad. They cover any present and future entities

For More Information

MIPS Technologies' announcement of the licensing deal with the Chinese Institute of Computing Technology is here: *www.mips.com/news-events/newsroom/index.cfm?i=43093*

For information about Jiangsu Lemote Tech Co. Ltd., see: *www.lemote.com/english/index.html*

that handle manufacturing, sales, and distribution for ICT. These business relationships should be easy to arrange for any Chinese company that has some element of government participation, a common case in the People's Republic. It's possible that ICT will so dominate the Chinese market for MIPS-compatible processors that MIPS will never sell another architectural license there—and perhaps not many more core licenses, either.

On the other hand, MIPS had little to lose, considering the alternatives. ICT and affiliated companies have already been making MIPS-like processors for eight years without paying licensing fees or royalties. The licenses establish a legitimate business relationship that will generate revenue for MIPS and boost the popularity of its architecture in one of the world's biggest and fastest-growing economies.

All told, *MPR* thinks that MIPS is taking important steps to emerge from the worldwide economic downturn with new potential for growth in a vital region. ◇

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