



## MontaVista Software Real-Fast Linux team

BY PAUL RAKO, TECHNICAL EDITOR

# Innovators get Linux to boot in 1 second

DOING REAL-TIME LINUX IS HARD ENOUGH. MAKING IT BOOT IN 1 SECOND TOOK REAL INNOVATION.

..... MontaVista Software has always been a leader in embedded-Linux commercialization. The company has developed Linux-development platforms since 1999, when founder Jim Ready pledged to bring “100% pure Linux” to the world under the GNU (GNU’s not Unix) GPL (general public license). Since then, MontaVista has specialized in embedded and real-time Linux.

Its approach is not simply an RTOS (real-time operating system) that runs Linux as one of its tasks. The company has changed the Linux kernel to provide determinism and real-time performance in a real Linux operating system. Cavium

Networks recently acquired the company, which just announced the release of Version 6 of its operating system.

In addition to designing real-time Linux, MontaVista has been working on the development of real-fast Linux, a Linux operating system that boots in less than 1 second. The team who worked on the project includes Alexander Kaliadin, Nikita Youshchenko, and Cedric Hombourger. Many on the team also worked on the MontaVista real-time Linux. “One of the first things we did years ago was to make the Linux scheduler pre-emptive and deterministic,” says Hombourger. These fast-boot developments are not necessarily limited to real-time or an embedded Linux; however, they can get a conventional Linux distribution

to boot in 1 second, as well.

“The methods we have developed are independent of whether [you use] a real-time kernel,” notes Kaliadin. He says that the team first considered netbooks and mobile Linux fast-boot approaches. It could not adapt them, however, because they needed a fairly heavyweight Linux distribution, and the requirements for a 1-second boot are far more extreme than those of any netbook or notebook application. “We had to devise a set of new techniques in both the kernel and the boot loader,” says Kaliadin.

A customer who needed his automotive-dashboard system to come up quickly prompted the development of a fast-booting Linux. Kaliadin remarks that the customer loved the MontaVista OS but had a fixed requirement to show data on the screen in less than a second. “Our first reaction was that it was impossible,” says Kaliadin.

The 1-second-boot-time achievement came in three stages. The first stage was optimization in all the obvious places, including the boot loader. The team could eliminate some of

CONTINUED ON PAGE 53

The MontaVista team includes Alexander Kaliadin (left) and Cedric Hombourger (right).



**MONTAVISTA CONTINUED FROM PAGE 49**

the boot time in the boot loader because the hardware is the same for everything the system boots. The team also omitted many drivers the OS didn't need and minimized the OS configuration. "Even [Linux founder] Linus Torvold admits that Linux is getting pretty bloated," says Kaliadin. This first stage got the team members down to a 7-second boot time.

The second stage required an intimate knowledge of the hardware. The Linux boot loader is a serial process. The team's epiphany came when the developers realized that they could use DMA (direct-memory-access) methods to parallel many tasks in the boot process.

The DMA agents can move many boot tasks between flash memory and the processor memory and can accomplish this task in the background without processor overhead. "These days, CPUs have a pretty large cache memory, so they are capable of doing all these things in parallel," says Kaliadin. Using DMA and the processor cache saves 3 more seconds, which further reduces the optimized boot time to 4 seconds from 7.

The next logical place to reduce the

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boot was in the user's application, but customers fix and determine that variable. The MontaVista team then looked at the loading of the customer's applications. The developers could use the RAM disk that has been available in the Linux kernel since Revision 2.4, but Linux still cached that memory, and that process slowed things down. Since the development of the 2.6 kernel, Linux has supported loading the file system into this RAM disk. "We ditched the whole buffer scheme and just loaded the customer's application into the Linux page-cache memory," says Kaliadin.

The second part of this innovation was the developers' realization that they didn't have to load the customer's entire

application, just the parts that the initial application required to start up. That realization allowed the boot time to near 1 second. "We made some big advances but then had to find 100 milliseconds here and there," he says.

Even though they worked with a customer's automotive dashboard, the developers' work is applicable to any application that needs to have an embedded Linux, complete with a file system, boot in less than a second. Although this application is processor-specific, MontaVista says that it can help you apply the technology to any 32- or 64-bit processor. "We designed the fast-boot process to be architecture-independent," notes Hombourger. He comments that the only hardware-specific features involve the DMA commands that speed the boot loader, but it is a relatively small task to port that function to different hardware.

For those who wonder why a processor doing billions of instructions per second needs to take minutes to boot up, wonder no more; MontaVista has shown that you can boot up a complete modern operating system in less than a second. **EDN**