

## Integrated Development Solutions for Today's Embedded Systems

### Overview

In today's highly competitive embedded systems market, it is essential that each new product generation provides higher functionality yet lower cost than its predecessor. Furthermore, with market windows shrinking, time-to-market has become more important than ever.

The combined forces of shrinking design cycles and ever-more-complex systems have created a formidable challenge for embedded designers. With software development and hardware/software integration emerging as the greatest hurdles in embedded systems design, robust software development solutions have become more important than ever. In fact, the availability of a set of powerful and interoperable tools is one of the key selection criteria for an embedded processor.

Recognizing the importance of development tools, Motorola has worked with the industry leaders to provide a comprehensive set of software development and hardware-software co-design tools for the M•CORE processor. Motorola has also established an Application Binary Interface (ABI) standard for the M•CORE architecture. By providing standards for object file format and debug information, the ABI enables all ABI-compliant tools for the M•CORE architecture to interoperate together, eliminating delays resulting from integration problems.

### Evolution of embedded system development

Embedded systems developers have responded to the dual challenge of increased complexity and shorter time-to-market by optimizing their development process. Rather than waiting for hardware prototypes to be developed before beginning software development and integration, these processes are now done in parallel. While the hardware is under development, as much software is developed as possible using standard desktop tools. Once a working simulation of the embedded target hardware exists, integration can proceed immediately, enabling many hardware-software interaction problems to be resolved before actual hardware is built.

### Today's development tool needs

As the embedded systems development process has become more complex, several software tools have attained critical importance. To maximize system performance and minimize memory costs, highly optimizing compilers are required. These are typically tightly integrated with a debugger in an integrated development environment to shorten the edit-compile-debug cycle.

Equally important in meeting time-to-market requirements are real-time operating systems. These products reduce development time by eliminating the need to develop all of an embedded application's software from scratch. In addition, use of robust third-party software modules reduces maintenance requirements and frees engineering resources for new projects.

Hardware-software co-design tools are the most recent addition to an embedded developer's arsenal. These tools shorten time-to-market by increasing parallelism in the development process. Co-design enables developers to execute their embedded software application on a simulated version of their hardware. This overlaps the integration phase with the software and hardware developments phases rather than delaying it until they are near completion.

### M•CORE tools portfolio

Motorola has worked with industry recognized vendors with reputations for high quality products to deliver a robust tool suite for the M•CORE architecture. These vendors complement each other to provide complete support for all phases of the embedded software development cycle. As a result, customers can be confident that the M•CORE architecture is backed by the powerful software development tools they require to meet their market window.

**Third-party developers: Our partners in delivering your success**

Motorola has long enjoyed strong relationships with third-party software tool vendors and has worked closely with them to deliver a complete software development solution for the M•CORE architecture. These tools are available on both UNIX (SunOS, Solaris, and HP-UX) and Windows95 and WindowsNT PC platforms, whichever is your preferred choice as a development host.

The following tools will be available at the launch of the M•CORE architecture:

**Compilers:**

- **Diab Data:** Diab Data's Power Compiling Solutions™, which includes a C and C++ compiler, linker, and assembler, provides the premier compiler suite for the M•CORE architecture. Diab is noted for its advanced optimization technology that produces very high performance and compact code for execution in the embedded target. Windows95, WindowsNT, SunOS, Solaris, and HP-UX hosts are supported.
- **Motorola:** Motorola provides the GNU C compiler and the GDB debugger. These are available free of charge for M•CORE. These may be downloaded from the web site at <http://mcore.sps.mot.com>. Combined with the low-cost M•CORE evaluation board, the GNU tools enable customers or developers to experiment with the M•CORE architecture to verify that it meets their requirements. Windows95, WindowsNT, SunOS, Solaris, and HP-UX hosts are supported.

**Debuggers**

- **Software Development Systems:** Software Development Systems offers the SingleStep® debugger, an easy-to-use visual debugging environment for embedded software developers. SingleStep integrates with a range of tools to support development throughout the project life cycle. The instruction-set simulator enables you to develop your application and estimate performance before target hardware is available. Support for target monitor and OnCE links provide powerful debugging connections to the embedded target. Windows95, WindowsNT, SunOS, Solaris, and HP-UX hosts are supported.

**Real-time Operating Systems**

- **Integrated Systems, Inc.:** Integrated Systems produces pSOSystem®, a complete yet scaleable real-time operating system. pSOSystem includes a multitasking kernel, a file system, and a broad range of networking protocols. In addition, it has a sophisticated set of integrated development tools to enable a developer to start development right out-of-the box. Windows95, WindowsNT, SunOS, Solaris, and HP-UX hosts are supported.
- **Microtec, A Mentor Graphics Company:** Microtec provides the VRTXmc® kernel, the latest member of the proven VRTX® real-time operating system product family. VRTXmc is optimized to minimize ROM and RAM footprints and has built-in support for using low-power modes. Windows95, WindowsNT, SunOS, Solaris, and HP-UX hosts are supported.

**Hardware-Software Co-design**

- **Simulation Technologies:** The Virtual-CPU™ is a complete co-verification environment. Virtual-CPU enables the developer to perform "virtual integration" early in the design cycle by allowing the embedded software application to interact with a simulated version of the hardware. By detecting hardware-software integration problems earlier in the development cycle, co-verification shortens the hardware-software

integration phase and reduces the risk of producing hardware that does not work properly with the software. SunOS, Solaris, and HP-UX hosts are supported.

**OnCE: The window into your embedded target**

Motorola has built its powerful on-chip-debugging module, known as OnCE (ON Chip Emulation), into the M•CORE architecture. OnCE uses the standard JTAG interface to connect to the chip. This enables the developer to quickly establish a robust debug connection to the target. OnCE utilizes a scan-chain specific to software debugging to ensure high performance.

However OnCE is more than just a JTAG interface. It provides an array of powerful debugging aids such as debug registers that enable developers to track down data corruption problems by monitoring reads or writes to program variables.

**The M•CORE Application Binary Interface: A foundation for integration**

In the past, even if many third-party tools existed for an architecture, a lack of common standards often severely limited the choice really available to developers. Learning from this, Motorola has defined an Application Binary Interface (ABIs) for the M•CORE architecture to ensure all ABI-compliant tools from different vendors will interoperate. This enables developers to quickly assemble an integrated yet diverse set of tools.

The ABI enforces compatibility across a broad spectrum of issues, including:

- Object module format
- Debug information records
- Calling conventions
- Library formats

The object module format and debugging information are based on the ELF/DWARF standard. This ensures that a debugger will be able to debug applications regardless of which compiler was used to generate them. The standard object module format also enables modules produced by different compilers to be linked together.

With off-the-shelf software components, such as real-time operating systems and protocols, becoming increasingly important to embedded developers, it is critical that third-party component libraries are guaranteed to successfully work with an application. To ensure that an application can easily use libraries of third-party components, the ABI standardizes function calling conventions by defining which registers are preserved upon entry into a function and which registers are used as the stack pointer and the link register.

Motorola has established a tools validation program that verifies a tool's ABI compliance and its ability to interoperate with other tools. In addition, the tools are tested for functional correctness, compliance to industry test suites such as Plum-Hall for C and C++ compilers, ability to properly run benchmarks, ease of use, and documentation/installation issues. This ensures the availability of a high-quality, easy-to-integrate tool set.

**Summary**

As market pressures continue to shorten the time-to-market window, robust, well-integrated tool solutions are becoming critical for embedded-systems developers. Motorola has worked with established third-party tool vendors to ensure the new M•CORE architecture is supported by a broad range of tools that address productivity throughout the product development cycle. These include highly optimizing compilers, debuggers, and real-time operating systems. In addition, hardware-software co-design tools are available, further shortening the development cycle by enabling software-hardware integration to begin earlier.

<b>Tool</b>	<b>Vendor</b>	<b>Host</b>
C & C++ compiler, linker, & assembler	<b>Diab Data</b>	PC, Sun, & HP
pSOS Real-time operating system & development environment	<b>Integrated Systems</b>	PC, Sun, & HP
GNU C compiler and GDB Debugger	<b>Motorola</b>	PC, Sun, & HP
VRTXmc real-time operating system	<b>Microtec</b>	PC, Sun, & HP
Virtual-CPU co-verification environment	<b>Simulation Technologies</b>	Sun, & HP
SingleStep C/C++ Debugger, simulator and OnCE support	<b>Software Development Systems</b>	PC, Sun, & HP

**Table 1: M•CORE Tools Solutions**

Motorola has established an Application Binary Interface (ABI) that enables each tool to interoperate with those from other vendors, eliminating delays caused by tool incompatibility. Each tool has been verified by Motorola's tool validation program to ensure high-quality tools are available simultaneously with the release of the processor.

For more information, please refer to the M•CORE web site at <http://www.motorola.com/mcore> or call the Motorola Technical Resource Center at 800.521.6274.