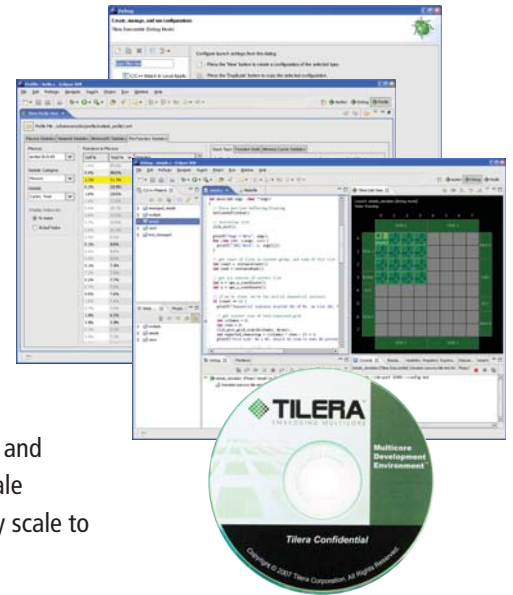


## Tilera's Multicore Development Environment

Tilera's Multicore Development Environment (MDE) is a complete, standards-based multicore programming solution that enables developers to take full advantage of the parallel-processing potential of the Tile Processor™ architecture. Older multicore models required all programming operations to be done in a core-by-core fashion, making it impossible to efficiently program, debug, or profile more than a handful of cores. The great innovation of Tilera's MDE suite is that it enables developers to move to ever-larger and more complex multicore applications in an easy, step-by-step way.

Tilera's MDE suite enables developers to take a "gentle slope" approach to multicore that gives them both performance and ease of programming. Developers can begin with a set of tools that are solidly rooted in familiar, industry-standard solutions that will have them up and running in minutes on their existing code. As developers become more familiar with large-scale multicore, they can take advantage of new tools Tilera has developed to make multicore truly scale to many cores.

The MDE programming suite reflects a mix of the best of the current tools and technology with next-generation solutions designed for the large-scale multicore world that is just around the corner. MDE's familiar development environment helps developers get their applications to market quickly, while the new tools help them take full advantage of the technology Tilera offers.



## The Best Industry-Standard Tools and the Most Innovative Next-Generation Solutions for Multicores

Industry Standard Tools	Next Generation Programming Solutions
<ul style="list-style-type: none"> <li>• ANSI-standard C and C++ programming</li> <li>• Standard runtime environment using full SMP Linux 2.6</li> <li>• Standards-based Eclipse Integrated Development Environment (IDE)</li> <li>• Standard command line tools such as GDB, gprof, and OProfile</li> <li>• Complete system simulator and hardware development platform</li> </ul>	<ul style="list-style-type: none"> <li>• iLib parallel programming library for efficient inter-core communication               <ul style="list-style-type: none"> <li>– Process management</li> <li>– Socket-like streaming channels</li> <li>– Message passing</li> </ul> </li> <li>• Multicore application profiling and performance tuning tools</li> <li>• Debugging applications for parallel processing</li> </ul>

## Tilera's Gentle Slope Programming™ Model Yields Instant Results

Tilera's Gentle Slope Programming model enables the user to begin with familiar programming tools and move to advanced, large-scale multicore programming in three steps.

**First Step:** The user can immediately run off-the-shelf applications on one tile without modifying his or her current source code using Tilera's:

- ANSI-standard C and C++ programming
- Full SMP Linux 2.6
- Full-featured, general-purpose processors

**Second Step:** The user can run multiple processes or threads on multiple tiles to exploit data parallelism. Tilera provides application libraries to abstract the work required to run the application in parallel. The libraries include:

- Network I/O library (NetI/O), which provides a configurable packet load-balancing function to distribute the traffic across multiple cores
- Standard Linux libraries running processes or threads on multiple tiles
- iLib library providing process management and communication mechanisms

**Third Step:** Users can tune applications using tools designed specifically for multicore, including:

- Parallel debugger and profiler for analysis and optimization of applications
- Multiple compiler optimization levels
- Acceleration instructions accessible through compiler intrinsics

## Immediate Results and Incremental Efforts to Increase Performance

## Tilera's Run-time Software Environment

Tilera's standard Linux-based programming environment gives users the freedom to run their existing applications and integrate third-party applications and libraries. The runtime software environment consists of three layers:

- Hypervisor: a hardware abstraction layer for operating systems
- Supervisor: one or multiple operating systems
- User Space: user libraries and applications

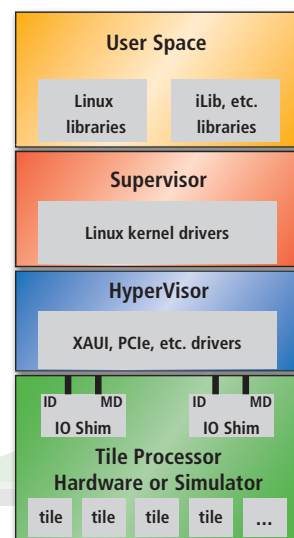
### Hypervisor

The hypervisor's abstraction layer gives users tremendous freedom in running operating systems on the TILE64. The hypervisor lets users run a single operating system on the entire chip, or multiple operating systems on multiple cores. At the same time, it protects applications from interfering with each other and provides additional functions, such as:

- Booting processor
- Managing low-level virtual memory
- Interfacing to performance counters
- Configuring memory
- Interfacing to Input/Output devices

### Supervisor: Linux SMP 2.6

By running the standard Linux environment, Tilera offers users a tremendous ease-of-use advantage. Linux enables users to reuse code, scale performance, use their existing programming skills, and take advantage of the many available Linux-based applications and libraries ecosystem. The Linux environment also enables users to easily run their existing code, unmodified, on the Tile processor. Finally, the 64-way SMP Linux multi-threaded and multi-process approach lets users scale their applications' performance, running 64 threads or processes in parallel.



## iLib™ Process Management and Communication Library

To ensure efficient and scalable inter-process communication and process management in a multicore environment, Tiler provides a standards-based iLib Communication Library. The process management library enables users to run applications in parallel in a matter of minutes, using standard process calls and leveraging the highly parallel architecture of the Tile processors. iLib also uses several standard communication protocols, including socket-like streaming channels, message passing, and shared memory. The communication libraries utilize the iMesh™ network and are optimized for low overhead and maximum bandwidth.

## Development Tools

Tiler provides familiar, industry-standard development tools, as well as new tools developed specifically for the multicore environment.

### Standard C/C++ Compiler

The C/C++ compiler is based on SGI's highly regarded MIPSpro compiler, was specifically designed for parallel processing, making it an ideal choice for multicore development. The compiler's strong support for VLIW machines enables it to deliver maximum instruction-level parallelism in both looping and straight-line code. The compiler supports:

- Full ANSI C and C++ support
- GNU extensions
- State-of-the-art optimizations, including automatic function inlining and software pipelining
- SIMD intrinsics to enable fine-grain parallelism
- Customized compilation for maximum performance based on profile-guided optimization
- Three levels of user-specified optimizations

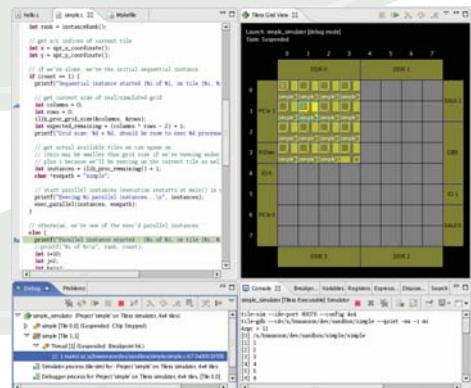
### Parallel Debugger

Tiler's parallel debugger was designed specifically for multicore applications and can debug all 64 tiles at once. The debugger can present a "whole-application" view of the processor, while also identifying application-level symptoms and examining the state of any individual process to determine the cause of an issue. The MDE offers both a port of the standard GDB debugger, and a parallel debug view in the IDE, simplifying the parallel debug task by providing a visual representation of the state of all cores. The debugger can also:

- Debug all or a subset of the cores
- Add/remove and enable/disable breakpoints
- Resume, suspend, or terminate an application
- Step into, step over, and step out of source code
- Display and control variable and register values

## Leveraging Your Existing Software Investment

## Collective View of the Whole Application & Detailed Presentation for Processes Debugging

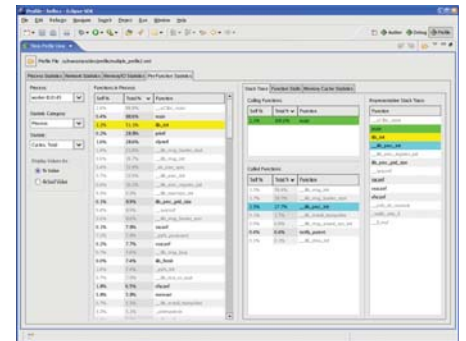


## Development Tools – continued

### Parallel Profiler

The parallel profiler enables users to analyze performance at the whole-application level as well as the functional level. The profiler offers trace charts, scatter plots, and network animation views as well as hardware and software statistics of run-time performance. The developer can also access views dynamically to zero in on run-time performance bottlenecks. The data offered by the profiler includes:

- Execution utilization: process paths, stalls, cache hits
- Memory utilization: data flow, cycles, latency
- I/O utilization: data flow, data rates, packet sizes
- Function behaviors: per-function statistics within any executable



## Hardware Platform and System Simulation

Tilera offers users both a simulator and a hardware platform to test, run, and prototype their applications. The MDE simulator:

- Is timing-accurate, providing very high visibility and control into the processor and applications.
- Runs a complete OS stack on the processor
- Runs a full system simulations including cores, I/O, memory, and iMesh

Users also have the option of using the Tilera TILExpress-64 PCIe card to test, run and prototype their applications. The TILExpress-64 card integrates the tile processors, providing access to all the TILE64 interfaces, expandable memory, and the customizable mezzanine card.

## Timing Accurate Simulator for Visibility and a Complete Hardware Platform for Prototyping



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