Software Development Environment

TriMedia SDE

FEATURES

- ANSI-compliant C/C++ compilation system
- Source- and machine-level debugging
- Performance analysis and enhancement tools
- Cycle-accurate machine-level simulator
- TriMedia device and application libraries
- Example programs for application libraries and all on-chip peripherals
- Comprehensive online documentation
- Includes pSOS™ operating systems from Integrated Systems, Inc. (ISI)

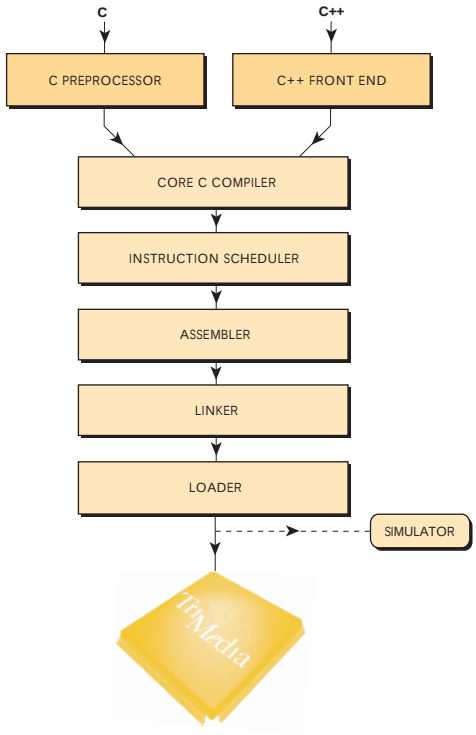
Embedded microprocessor applications are traditionally written in assembly language. This can result in highly efficient code but often at the expense of longer development timelines and code portability. Unlike the development environment of DSPs, the TriMedia™ software development environment (SDE) lets multimedia programmers create highly optimized applications for the TriMedia processor entirely in the C and C++ programming languages.

The TriMedia SDE provides a comprehensive suite of system software tools to compile and debug multimedia applications, analyze and optimize performance, and simulate execution on the TriMedia processor. Comparable to the development environment of general-purpose CPU platforms, the TriMedia SDE helps multimedia developers bring products to market faster and adapt them quickly as markets and technologies change. Together, the TriMedia SDE and programmable TriMedia processors enable the creation of sophisticated multimedia products for the consumer and PC markets.

VLIW COMPILATION SYSTEM

The heart of the SDE is a unique compilation system that leverages the TriMedia processor's very-long instruction word (VLIW) architecture to optimize parallelism at compile time, not during execution. Modular in design, it gives programmers complete control over each step in program compilation, debug, and optimization.

Put simply, the TriMedia compilation system generates an executable program from C or C++ source code. After compiler modules perform C preprocessing or C++ translation, the core C compiler converts the C code into an intermediate representation called decision trees (a single-entry, multiple-exit grouping of one or more basic blocks of code). The instruction scheduler examines the decision trees and generates VLIW instructions for the target processor. During this process, the scheduler adds conditional code to each instruction to enable guarded execution — a technique that can significantly decrease code branching and thus execution time. During the compilation and scheduling stages, the TriMedia compilation system performs many of its automatic optimization and parallelizing functions.



COMPILATION SYSTEM TRAJECTORY

Once acceptable code parallelism is obtained, the scheduled code is assembled and linked with one or more object modules and/or libraries. The executable is then loaded into memory and can be run on a TriMedia processor or simulated using the TriMedia machine-level simulator.

The TriMedia compilation system facilitates system-level programming in the ANSI-standard C and C++ programming languages and includes support for interrupt service routines (handlers) and fine control of data cache. Although most assembly-level instructions are available at the source-code level, a TriMedia assembly language is also available.

SOURCE- AND MACHINE-LEVEL DEBUGGING

The TriMedia SDE supports application debugging at both source-code and machine-instruction levels. The interactive source-level debugger gives the application developer complete control over dynamic execution. It utilizes symbolic debugging information generated by the compiler and enables programmers to inspect stopped programs, view variable and expression values, set breakpoints and watchpoints, and examine and modify registers and memory. While providing similar control and viewing features, machine-level debugging is performed using the TriMedia cycle-accurate simulator and lets programmers step through execution one VLIW instruction at a time.

PERFORMANCE ANALYSIS AND ENHANCEMENT

Developing highly parallel applications code is an iterative process that requires sophisticated tools and programmer skill. Performance of a specific program on the TriMedia fine-grain parallel processor depends on how well the compiler can exploit the program's instruction-level parallelism. To help multimedia developers create highly parallel, high-performance programs, the TriMedia compilation system incorporates many powerful compiler options and code analysis and enhancement features.

Code profiling — Reliable statistics about a program's execution make techniques for increasing its parallelism more effective. When code profiling is enabled, a program's simulated execution produces statistics about the execution of its decision trees and probabilities. The program can then be recompiled using the generated profile information to increase parallelism and decrease the number of branches along critical paths. Profiling can be repeated for functions, modules, or entire programs to fine tune performance.

Decision tree grafting — Grafting increases instruction-level parallelism and provides more useful operations per cycle by reducing branching. In grafting, jumps or exits from a decision tree are replaced with a copy of the destination decision tree. A technique similar to loop unrolling, grafting is performed automatically by the compiler and may be guided by the programmer through profile information and tuning parameters read from a grafting parameters file. These parameters provide control on a per function basis over code density and include minimum probability threshold, maximum code replication factor, minimum execution count threshold, maximum graft depth, and graft enable.

Alias analysis — A key method of improving code parallelism, alias analysis is performed automatically by the compiler to determine if certain optimizations can take place. The compiler examines whether two memory locations are the same or overlap. If neither is true, it attempts to weaken the ordering of memory operations to allow more operations to be executed in parallel. The TriMedia compilation system supports restricted pointers and three levels of alias analysis, differentiated by varying levels of compiler assumptions about program behavior.

Local and global optimization — Four levels of local and global optimization employ techniques such as copy propagation, constant folding, dead code elimination, local common sub-expression elimination, and more to reduce execution time.

Critical path drawing tool — TriMedia compilation system tools can output critical path graphs useful in identifying a program's parallelism. Graph data is output in PostScript format.

Object file utilities — The TriMedia compilation system includes a variety of tools to manipulate, view, and print object files and libraries.

MACHINE-LEVEL SIMULATION

A cycle-accurate, machine-level simulator lets programmers develop and test applications without an actual TriMedia chip. It can execute single, relocated object modules to completion or simulate an entire program with a real-time operating system for a given number of clock cycles. The simulator models behavior of the TriMedia CPU, memory subsystem, and system peripheral units (data coprocessing and acceleration, interrupt control, and PCI interface).

SHARED LIBRARY/DYNAMIC LOAD SUPPORT

The TriMedia compilation system also includes support for a re-entrant ANSI C library, shared libraries, and dynamic linking and loading to reduce executable size and minimize third-party licensing requirements.

POWERFUL, DSP-LIKE SPECIAL OPERATIONS

In addition to standard RISC and 32-bit floating point operations, the TriMedia processor's instruction set includes highly parallelized special DSP operations that accelerate the performance of single instruction, multiple data (SIMD) computations and saturation arithmetic common in multimedia applications. They combine multiple simple operations into a single VLIW operation capable of implementing up to 11 traditional microprocessor operations in a single clock cycle. When incorporated into application source code, special operations dramatically improve performance.

Special operations are invoked with familiar function-call syntax consistent with the C programming language. They are automatically scheduled by the compilation system to take full advantage of the TriMedia processor's highly parallel VLIW implementation. As with all other operations generated by the TriMedia compilation system, the scheduler takes care of register allocation, operation packing, and flow analysis.

TRIMEDIA APPLICATION LIBRARIES

TriMedia application libraries shortcut development of many standards-compliant multimedia applications by providing a variety of algorithms to handle audio, video, graphics, and communications data. Developed by Philips TriMedia and third parties, these libraries of C-callable routines are optimized for top performance on TriMedia architecture. They include such functions as MPEG-1 encode, MPEG-2 decode, Dolby Digital™ AC-3 audio output, 2D graphics, Motion JPEG, and more.

Application libraries for audio and video rendering are included in the SDE. Other libraries are available separately from the TriMedia Business Line and third-party suppliers.

COMPREHENSIVE ONLINE DOCUMENTATION

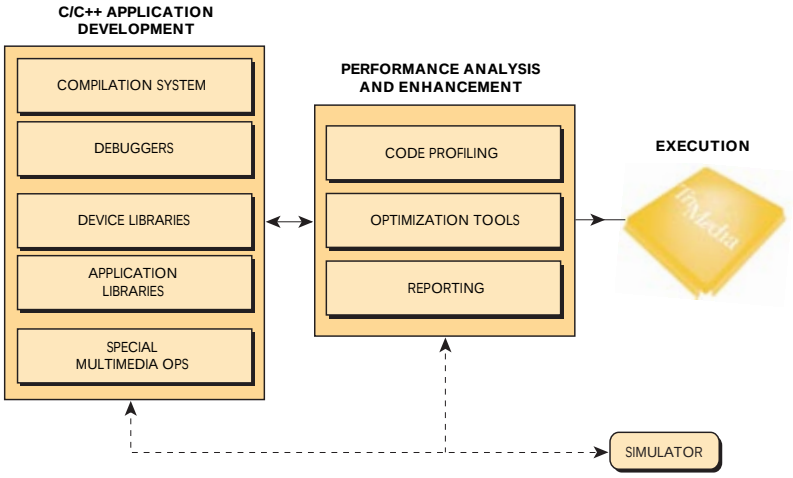
The SDE includes comprehensive technical documentation to guide users through installation and multimedia application development using the SDE tools. Documents are included in Adobe® Acrobat® portable document format (.pdf) for easy online viewing in Acrobat Reader®. A copy of Acrobat Reader is included.

REAL-TIME OPERATING SYSTEM KERNELS

For multimedia applications requiring system resource and task management, TriMedia processors support the pSOS+™ (single processor) or pSOS+m™ (multiprocessor) embedded real-time operating system kernels. Developed by ISI, the pSOS kernels deliver the deterministic response essential for multimedia applications. Both kernels and a license for use on TriMedia processors are included with the SDE.

UPWARD COMPATIBILITY

Upward compatibility for applications developed using the TriMedia SDE is ensured at the source-code level. Only recompilation is required to port existing application code to new TriMedia processors as they become available. Code that activates the new features of the new processors can be developed and easily integrated into existing applications to take advantage of the latest advances in TriMedia processor technology. Source-code compatibility gives Philips the freedom to strike the optimum balance between high performance and low cost for all members of the TriMedia family.



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SDE Specifications

SOFTWARE DEVELOPMENT ENVIRONMENT

Release Version 1.1Y

System Requirements One of the following host configurations:

platform	operating system	disk	RAM
Sun Microsystems	SunOS 4.3.1 or 5.5	200 MB	32 MB
Hewlett-Packard	HP-UX 10.x	200 MB	32 MB
Microsoft	Windows 95 4.00 RS2	80 MB[1]	32 MB
Microsoft	Windows NT 4.0	80 MB[1]	32 MB
Macintosh Power PC	MacOS 7.1 or higher	60 MB	32 MB

Compilation System C/C++ compiler, debugger, linker, loader, simulator, performance analysis and optimization tools

Operating Systems pSOS+ and pSOS+m

Device Libraries Audio I/O, video I/O, synchronous serial interface (SSI), image coprocessor (ICP), I^2C, board support, variable-length decoder (VLD)

Application Libraries Audio renderer, video renderer

Demos & Example Programs MPEG-1 playback demo, MPEG-2 playback demo, AC-3 demo, audio in/out, video in/video out, SSI (telecommunications interface), ICP, I^2C, board support, VLD

Documentation

Online Viewer	Adobe Acrobat Reader, Version 3.01
Online	TriMedia SDE Getting Started TriMedia SDE Cookbook TriMedia SDE Reference Manual TriMedia TM-1000 PCI Media Processor Databook TriMedia Reference Design Board Documentation pSOS Systems Concepts, pSOS Reference (ISI)
Hardcopy	TriMedia SDE Getting Started SDE Release Notes

1 200 MB including documentation

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