i960® Microprocessor CTOOLS Application Development Tools

- **Improved Code Generation for the i960® Rx, Jx and Hx Processor Families**

- **Easy-to-Use Whole-Program and Profile-Driven Optimizations**

- **Debug of Optimized Code Using DWARF 2.0 Symbolic Debug Records**

- **Conformance to the 80960 Tools Consortium's Application Binary Interface (ABI)**

- **PCI Download and PCI Comm on Windows* 95 and Windows* NT 4.0**

- **On-Line HTML**

- **C Compiler Conforms to ANSI Standard X3.159-1989 and Passes Plum Hall Conformance and Perennial Tests**

- **Supports In-Line Assembly Code in C/C++ Source**

- **Includes IEEE-754 Compatible, High-Speed, Accelerated Floating-Point Library for Components Without On-Chip Floating-Point Instructions**

- **Supports Windows 95, Windows NT 4.0 and Selected UNIX Hosts**

- **Source Code Supplied**

PRODUCT OVERVIEW

Intel's CTOOLS provides a complete set of application development tools for developing embedded designs, including advanced optimizing C and C++ compilers, an assembler, a linker, utilities, a GUI based debugger, and a variety of libraries, including floating-point emulation.

Besides operating with the most popular operating systems, CTOOLS also incorporates industry standards in all areas. The C compiler conforms to ANSI Standard X3.159-1989 and passes the Plum Hall conformance and Perennial test suites. CTOOLS also conforms to the 80960 Application Binary Interface (ABI), enabling object code interoperability with third-party tools and debuggers. Compatibility with known standards makes new users productive immediately, and ensures access to existing application code.

CTOOLS can be used across all members of the i960® microprocessor family. Command line switches allow the compiler to take advantage of specific architectural features. For instance, in the case of the i960 Cx and Hx processors, the compiler uses advanced code scheduling algorithms to modify instruction sequences, taking advantage of the processor's parallel execution capability. The generated code is highly efficient, assuring maximum performance for your embedded applications.

PROVEN OPTIMIZATION TECHNIQUES

Advanced optimization techniques are incorporated into Intel's CTOOLS compiler to offer customers superior performance while maintaining robust code. The compiler incorporates local, global, program-wide and profile-driven optimizations.

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- **Constant expression evaluation**
- **Constant propagation**
- **Collapsing of arithmetic and bitwise boolean identities**
- **Common subexpression elimination**
- **Register subsumption or register coalescing**
- **Local variable promotions**
- **Tail-call elimination**

- **Procedure inlining**
- **Branch optimizations**
- **Dead code elimination**
- **Loop invariant code motion**
- **Variable shadowing**
- **Superblock formation**
- **Basic block rearrangement**

PROCESSOR DEPENDENT OPTIMIZATIONS INCLUDING:

- **Specialized instruction selection**
- **An intelligent register manager**
- **Code scheduling**
- **Use of on-chip data RAM for frequently used variables**

- **Efficient use of complex addressing modes**
- **Branch prediction**
- **Generation of leaf procedures**
- **Memory access coalescing**

WHOLE-PROGRAM AND PROFILE-DRIVEN OPTIMIZATIONS

CTOOLS also provides program-level optimizations, which allow optimizations such as function inlining to occur across source files. Changing the optimization level is as simple as changing an argument on the compiler's command line. Restructuring your build environment is no longer needed!

A runtime profile can be used to guide the whole-program optimization decisions. Such profile-driven optimizations combine a global view of the entire program with its typical runtime behavior, to produce highly optimized code.

Collecting a runtime profile is often an expensive procedure. With CTOOLS, once a runtime profile is collected, it can be used to guide optimizations after days, weeks or even months of changes to your source code. The profile is automatically interpolated to match the structure of your program.

COMPRESSION ASSISTED VIRTUAL EXECUTION (CAVE)

By storing non-critical functions in compressed form, CTOOLS can save valuable memory in your ROM-based application. When invoked, such functions are decompressed onto the runtime stack and executed. Upon function return, the stack space is automatically freed.

DEBUGGING OPTIMIZED CODE

The DWARF 2.0 symbolic debug information format supports expression of the complex relationships between your source program and its highly optimized object code. Debugging features such as breakpoints and displaying a variable's value behave more reliably with DWARF than with existing object file formats such as COFF and b.out, when your code is optimized. Optimized code debugging can often eliminate the expensive step of building an unoptimized version of your application for debugging purposes.

ASSEMBLER AND LINKER

The assembler processes assembly code produced by the compiler. The CTOOLS toolset offers other valuable utilities such as:

- **Debugging aids: object file dumper and mapper**
- **An archiver to build libraries**
- **An object file stripper to eliminate debug records from the object module**

- **A COFF to IEEE-695 object file converter**
- **A big-endian to little-endian object file converter**
- **A ROM builder to produce ROMable code**

The linker links together separately compiled modules, performing additional optimizations such as replacing calls by branch-and-link sequences. It reads the contents of a configuration file in order to map the application's code and data sections in memory and then link correct run-time libraries for the application. Linkage may be performed in interactive steps until the final link step, at which time all unresolved externals are satisfied.

DEBUGGER AND MONITOR

The gdb960 symbolic debugger and MON960 monitor are included in CTOOLS. The debugger is a full symbolic debugger, and operates with the MON960 monitor to allow setting of breakpoints, single-stepping, variable tracing, and many other capabilities. The debugger has an easy to use Graphical User Interface (GUI).

LIBRARY SUPPORT

CTOOLS supports three library types:

- **i960® architecture-specific high-level C/C++ libraries**
- **IEEE-754 compatible accelerated floating-point libraries**
- **Low-level libraries supporting i960® processor evaluation boards**

The CTOOLS linker configuration files hide the complexity of linking the correct libraries. All C/C++ libraries have been optimized and generated using the CTOOLS compiler. They are offered in normal code form, in position-independent form for use in applications relocatable at load time, and in big-endian form for applications that use i960 processor big-endian memory regions.

TECHNICAL SUPPORT

Annual software maintenance contracts are available from Intel. Contracts include free production upgrades, 1-800 technical support, FaxBack, BBS and priority bug turnaround (once they have been identified). Intel also offers a 30-day, money-back guarantee to customers who are not satisfied after purchasing any Intel development tool.

HOST SYSTEMS SUPPORTED:

Windows* NT 4.0, Windows* 95, *HP9000/HP-UX, *IBM RS6000/AIX, Sun-4

PROCESSORS SUPPORTED:

i960® Sx, Kx, Cx, Jx, Rx, and Hx Processors

AVAILABILITY:

Now

CONTACT:

Local Distributor, Intel Sales Office or Intel Support at (800) 628-8686.

World Wide: call + 1 (503) 264-7354, 7-5:00, Mon-Wed & Fri; 7-3:00, Thur. All U.S. Pacific time.

WWW: http://www.intel.com

ORDERING INFORMATION:

CTOOLSW95KT	Windows 95 & Windows NT 4.0 — CD-ROM
CTOOLSUNXKT	HP9000/HP-UX — 4mm
	Sun-4/UNIX & IBM RS/6000/AIX — 8mm & QIC-24

i960® Microprocessor Literature

Title	Literature Order #	FaxBack Document #	Title	Literature Order #	FaxBack Document #
PRODUCT INFORMATION			**APPLICATION NOTES/APPLICATION BRIEFS (cont'd)**		
Developers Insight CD-ROM	273000		AP-703 DRAM Controller for the 33-MHz i960® CA/CF Microprocessor	272627	
i960® Processor Product Line Card		2033	AP-704 A Simple DRAM Controller for the i960® Cx Processor Using Flexlogic	272628	
i960® Processor Literature List		2115	AP-706 DRAM Controller for the 40-MHz i960® CA/CF Microprocessor	272655	
FaxBack Document List		2068	AP-712 DRAM Controller for the 33-MHz i960® JA/JF/JD Microprocessor	272674	
i960® CA/CF 32-Bit Superscalar Microprocessor InfoGuide		2705	i960® RP Processor: A Single Chip Intelligent I/O Subsystem	272238	
i960® KA/KB 32-Bit Embedded Microprocessor InfoGuide		2716	**TOOLS**		
i960® HA/HD/HT Superscalar Microprocessor InfoGuide		2730	Technical Assistance (tools)		2544
i960® JX Microprocessor/ The Cobra Series InfoGuide		2731	GNU/960 Software Toolset Fact Sheet	272178	
i960® SA/SB 32-Bit Embedded Microprocessors with 16-Bit Burst Data Bus	272233		i960® Microprocessor Product Line and Support Tools Fact Sheet	272219	
Enhanced PC I/O Performance with i960® RP Processor	272740		EP80960CX Evaluation Platform	272505	
DATA SHEETS			i960® Microprocessor Evaluation Platform/Cyclone EP	272508	
80960JA/JF/JD/JT 3.3V Embedded 32-Bit Microprocessor	273159		Intel's Web Based i960® Processor Remote Evaluation Facility	273127	
80960HA/HD/HT 32-Bit High-Performance Superscalar Processor	272495		Cyclone* Evaluation Platform User's Guide	272577	
80960CA-33,-25,-16 32-Bit High Performance Superscalar Processor	270727		i960® SA/SB Processor Evaluation Board Fact Sheet	272033	
80960CF-33,-25,-16 32-Bit High Performance Superscalar Processor	272187		QT 960 Evaluation and Prototyping Board Fact Sheet	270743	
80960KA Embedded 32-Bit Microprocessor	270775		EV80960SX Evaluation Board User's Manual	270853	
80960KB Embedded 32-Bit Microprocessor with Integrated Floating-Point Unit	270565		EP80960CX Evaluation Platform User's Guide	272456	
80960SA Embedded 32-Bit Microprocessor with 16-Bit Burst Data Bus	272206		82596CA High-Performance 32-Bit Local Area Network Coprocessor	290218	
80960SB Embedded 32-Bit Microprocessor with 16-Bit Burst Data Bus	272207		**MANUALS/DATABOOKS**		
82961KD Printer Coprocessor	272221		i960® Jx Microprocessor User's Manual	272483	
80960 Intelligent I/O Microprocessor	272737		i960® Cx Microprocessor User's Manual	270710	
i960® RP/RD I/O Processor at 3.3 Volts	273001		i960® KB Microprocessor Programmer's Reference Manual	270567	
APPLICATION NOTES/APPLICATION BRIEFS			i960® SA/SB Microprocessor Reference Manual	270929	
i960® Microprocessor Competitive Benchmark Report	272392	2515	82961KD Printer Coprocessor Reference Manual	272280	
Internetworking and the Intel i960® Microprocessor	272601	2359	i960® Extended Architecture Programmer's Reference Manual	271191	
Imaging and the Intel i960® Microprocessor	272602	2360	i960® Processors and Related Products Databook	272084	
AB-42 80960Kx Self-Test	270703		i960® Rx Microprocessor User's Manual	272736	
AP-506 Designing for 80960Cx and 80960Hx Compatibility	272556				

Intel Reference Numbers

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