Getting Started with the i960® Processor Development Tools

Revision	Revision History	Date
-001	Original issue for CTOOLS960 R4.5 and GNU/960 R2.4.	05/94
-002	Original issue for CTOOLS960 & GNU/960 R4.6, and MON R2.1.	12/94
-003	Revision for CTOOLS (formerly CTOOLS960 & GNU/960) R5.0.	02/96
-004	Revision for CTOOLS R5.1.	01/97
-005	Revision for CTOOLS R6.0	12/97
-006	Revision for CTOOLS R6.5	12/98

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Intel Corporation
Literature Sales
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Denver, CO 80217-9808

Or you can call the following toll-free number:

1-800-548-4725

In locations outside the United States, contact your local Intel sales office.

Contents

The CTOOLS Software Development Toolset

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This chapter introduces you to the CTOOLS software development toolset and this manual. Topics include:

* An overview of the toolset

* How to use the printed and online documentation

The CTOOLS Toolset

CTOOLS is a complete C/C++-language software-development toolset for developing embedded applications to run on i960® processors. It contains a C/C++ compiler, the gcc960 and ic960 compiler driver programs, an assembler, runtime libraries, a collection of software-development tools and utilities, and printed and on-line documentation. Figure 1-1 shows the various tools and the flow of information among them. Table 1-1 tells you where to find information on each of the CTOOLS programs.

NOTE. *CTOOLS was called CTOOLS960 and GNU/960 in release 5.0 and earlier. Release 6.5 of CTOOLS is the current upgrade of these products. You can install the gcc960 interface to CTOOLS for compatibility with GNU/960, or the ic960 interface for compatibility with CTOOLS960. You also can install both interfaces, one after the other.*

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Figure 1-1   CTOOLS Overview
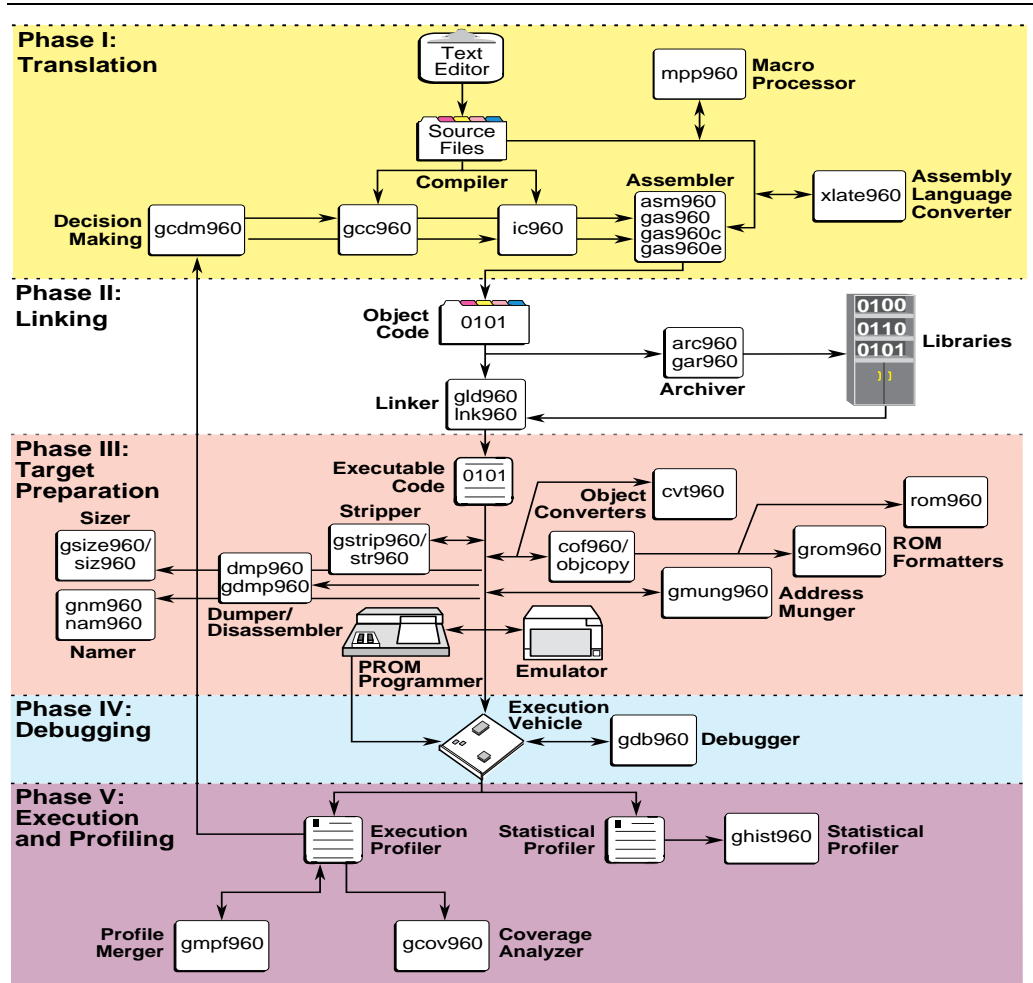
Table 1-1   Where to Find Information on CTOOLS Software

Program Function	Name	Title	Number
archiver	arc960, gar960	*i960 Processor Software Utilities User's Guide*	485277
assembler	asm960, gas960	*i960 Processor Assembler User's Guide*	485276
compiler	gcc960, ic960	*i960 Processor Compiler User's Guide*	651230
converters	cof960/objcopy, cvt960, xlate960	*i960 Processor Software Utilities User's Guide*	485277
coverage analyzer	gcov960	*i960 Processor Software Utilities User's Guide*	485277
debugger	gdb960, gdb960v	*gdb960 User's Manual*	485546
dumper/ disassembler	dmp960, gdmp960	*i960 Processor Software Utilities User's Guide*	485277
installer	install	*Getting Started with the i960 Processor Development Tools* (this manual)	485544
libraries	libc, libm, libh, libfp, libq/libqf, libll, libmon, libhis	*i960 Processor Library Supplement*	651231
linker	gld960, lnk960	*i960 Processor Software Utilities User's Guide*	485277
macro processor	mpp960	*i960 Processor Software Utilities User's Guide*	485277
munger	gmung960	*i960 Processor Software Utilities User's Guide*	485277
name lister	gnm960, nam960	*i960 Processor Software Utilities User's Guide*	485277
ROM image builders	rom960, grom960	*i960 Processor Software Utilities User's Guide*	485277
section size printer	size960, gsize960	*i960 Processor Software Utilities User's Guide*	485277
statistical profiler	ghist960	*i960 Processor Software Utilities User's Guide*	485277
stripper	gstrip960, str960	*i960 Processor Software Utilities User's Guide*	485277

What's New In CTOOLS

- Release 6.5 supports the *long long* type in the C/C++ compilers. The *long long* type is represented as a 64-bit integer. All arithmetic operations are supported for the *long long* type. New routines have been added to the libraries to provide support for the *long long* type.

- The CTOOLS debugger (gdb960) supports debugging via the SPI610 JTAG Scanner* from Spectrum Digital Inc. This provides a non-intrusive but low cost debugging environment.

- Many enhancements have been made to the compiler for better code generation. New pragmas have been added for better control of the code generated by the compiler.

- CTOOLS 6.5 includes support for the i960® RN , RM and VH processors. All tools support code generation for these new i960 processor family members.

- Special libraries have been inlcuded for use with various CTOOLS performance analyis and profiling tools in conjunction with Tornado for I^{2}O*.

About the Documentation

The CTOOLS documentation is designed for use with either the gcc960 interface or the ic960 interface, on any supported host. You receive the same set of manuals, the same release notes, and the same online documentation, irrespective of your order code.

Tables 1-2 lists the titles, order numbers and brief descriptions of the CTOOLS manuals. For information on ordering these and other Intel publications, write to:

Intel Corporation
PO Box 5937
Denver, CO 80217-9808

You can also order manuals by phone by calling 1-800-548-4725. (International customers should contact their local Intel sales office.) Customers can also request the Customer Literature Guide, order number 210620, for complete information about Intel product literature. Complete CTOOLS manual sets are available. Contact your local Intel sales office or distributor (use order code CTOOLSDOC).

Online Hypertext Documentation

In addition to the printed documentation, a HyperText Markup Language (HTML) hypertext containing the command-line information previously delivered in UNIX*-style manpages is automatically installed in a directory named `html`. This hypertext can be displayed and printed with any HTML-compatible browser, such as Microsoft Internet Explorer* or Netscape Navigator*. To use the hypertext, open the file named `start.htm` in the `html/tools` directory or open `whats new.htm` in the `html` directory. (**Hint:** in your browser, bookmark this location.)

Table 1-2   Manuals

Title	Number	Contents
Getting Started with the i960 Processor Development Tools (this manual)	485544	Describes installation, environment variables, documentation, and customer service.
i960 Processor Compiler User's Guide	651230	Describes the compiler and two-pass optimization tools.
i960 Processor Library Supplement	651231	Describes the supplied libraries and provides other library information (e.g., all library file names).
i960 Processor Assembler User's Guide	485276	Describes the assembler and assembly language.
i960 Processor Software Utilities User's Guide	485277	Describes the archiver, converters, coverage analyzer, dumper/disassembler, ghist960 profiler, linker, macro processor, namer, rommer, stripper.
gdb960 User's Manual	485546	Describes the gdb960 debugger.
i960 Processor Tools License Guide	614851	Describes CTOOLS licensing and copyrights.
Intel 80960 Embedded Application Binary Specification	631999	Provides a description of ELF.

Installation 2

This chapter provides detailed steps for installing CTOOLS on your host system.

Table 2-1 lists the host and operating systems for which CTOOLS R6.5 is available and the media type(s) supplied for each order code. For a list of product contents, see the Release Notes supplied with your toolset. For a list of the manuals supplied with your toolset, see Chapter 1. For information about customer support and product service, see Chapter 3.

Table 2-1   Product Codes, Hosts, Operating Systems, and Media

Product Code	Host System	OS Version	Media
CTOOLSW95R6.0	Intel486™, Pentium®, or Pentium Pro processor-based PC	Windows 95 or Windows NT 4.0	CD-ROM
CTOOLSUNXR6.0	HP9000/700 workstation	HP-UX 10.20	4 mm & 8 mm DAT tapes; CD-ROM
	IBM RS/6000 workstation	AIX 4.1	
	Sun/4 workstation	Solaris 5.6	

NOTE. *SUN OS 4.1.x, Solaris version 5.5.x and HP-VX 10.1 are not supported in this release. CD-ROM supplied for UNIX and Windows. QIC 24 tape is not provided.*

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Host System Requirements

The amount of disk space required to install CTOOLS depends on which product components you install. You can save a significant amount of disk space by not installing source code for the tools and libraries. Refer to Table 2-2 for a listing of disk space requirements.

Table 2-2   Installation Disk Space Requirements

Operating System	With RTL and Binary Source Code	Without Source Code
UNIX	90 megabytes	28 megabytes
Windows 95/NT	83 megabytes	21 megabytes

Installing CTOOLS

The following sections describe installing the tools on host systems.

Preparing for Installation on UNIX

1. Back up any previously installed versions of the i960 processor language tools.
2. Determine the directory in which to install the tools. Make sure that you have write permission on this directory.
   — If you want to install the new tools in an existing `intel960` directory, you must first remove the tools in this directory.
   — If you want to keep a previous version of the tools, either move them to another directory or choose another location in which to install the new tools.
3. Determine your interrupt key sequence (usually Ctrl-C) by using `stty`.
4. Determine the name of your system's tape device if you are using a tape to install the tools. Determine the name of the directory where your CD-Rom device has been mounted if you are using a CD-Rom to install the tools.

5. Place the installation tape in the tape device or the cd-rom in the cd-rom drive.
6. Decide if you need to install source code for the tools. The installation script prompts you to enter this information. Having source code for the tools allows you to modify and build the tools, and to receive fixes in the form of source patches.

Installing on UNIX Hosts Using a Tape

1. Change directory (`cd`) to an empty or temporary directory.
2. Extract the installation script from the tape device, using the tape device name you determined in step 4 in *Preparing for Installation on UNIX* (above).

   To install the ic960 interface to CTOOLS, enter:

   tar xvf *tape_device* install.ic

   To install the gcc960 interface to CTOOLS, enter:

   tar xvf *tape_device* install.gnu

3. To save time during tape scanning, watch for the messages:

   ```
   x install.ic, num bytes, num tape/media blocks
   ```

   or

   ```
   x install.gnu, num bytes, num tape/media blocks
   ```

   After you see this message, you may optionally enter your interrupt key sequence, using the sequence you determined in step 3 (above) and continue to the next step.

4. Execute the installation program.

   To install the ic960 interface to CTOOLS, enter:

   ./install.ic

   To install the gcc960 interface to CTOOLS, enter:

   ./install.gnu

5. When prompted for the installation directory, specify the directory in which to install the tools. Entering a carriage return specifies the default `/usr/local/intel960`. You can also specify a full path name to install the tools in a custom location (e.g., `/usr/projects/p1/ctools`).

6. If the directory you specify has files in it, a warning similar to the following appears:

    ```
    WARNING: Directory dirname is not empty.
    Installation may corrupt existing files.

    Do you wish to proceed (y/n)?
    Default is [n]
    ```

    Entering `y` may overwrite or remove the old files in the directory and may cause an installation failure. If you enter `n`, the installation script terminates.

    The installation script continues, prompting you for the following information:

    — Tape device (default provided)
    — Host and operating system (table provided)
    — Whether or not to install source code for the tools (default and table provided)
    — Whether or not to install source code for the hdil and hdilcomm components (these are required if you plan to rebuild the tools)

    The installation program invokes `tar` to install the tools. If the installation begins, a message similar to the following displays:

    ```
    Invoking tar for ...
    ```

    If `tar` fails, the following message appears:

    ```
    Tar exited with 1; enter 'abort' or 'retry'.
    ```

    Entering `abort` causes the installation program to terminate. Entering `retry` causes the installation program to try `tar` again.

During installation, the system displays several progress indicator messages related to the renaming of files. No action is required in response to these messages. A message notifies you when the installation is complete.

If you want the tools to be owned by `root` with a Group ID of `bin`, have your system administrator make this change now.

Installing on UNIX Hosts Using a CD-ROM

1. Change directory (`cd`) to the mount directory of the cd-rom device that you determined in step 4 in *Preparing for Installation on UNIX* (above). Change directory (`cd`) to **ctoolsunix**.

2. Execute the installation program.
    To install the ic960 interface to CTOOLS, enter:

    sh ./install.ic_cd

    To install the gcc960 interface to CTOOLS, enter:

    sh ./install.gnu_cd

3. When prompted for the installation directory, specify the directory in which to install the tools. Entering a carriage return specifies the default `/usr/local/intel960`. You can also specify a full path name to install the tools in a custom location (e.g., `/usr/projects/p1/ctools`).

4. If the directory you specify has files in it, a warning similar to the following appears:

    ```
    WARNING: Directory dirname is not empty.
    Installation may corrupt existing files.

    Do you wish to proceed (y/n)?
    Default is [n]
    ```

    Entering `y` may overwrite or remove the old files in the directory and may cause an installation failure. If you enter `n`, the installation script terminates.

    The installation script continues, prompting you for the following information:

    — The directory where you have the cd-rom device mounted
    — Host and operating system (table provided)
    — Whether or not to install source code for the tools (default and table provided)
    — Whether or not to install source code for the run-time libraries and other components (defaults or tables provided)
    — Whether or not to install source code for the hdil and hdilcomm components (these are required if you plan to rebuild the tools)

    The installation program invokes `tar` to install the tools. If the installation begins, a message similar to the following displays:

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```
Invoking tar for ...
```
If `tar` fails, the following message appears:
```
Tar exited with 1; enter 'abort' or 'retry'.
```
Entering `abort` causes the installation program to terminate. Entering `retry` causes the installation program to try `tar` again.

During installation, the system displays several progress indicator messages related to the renaming of files. No action is required in response to these messages. A message notifies you when the installation is complete.

If you want the tools to be owned by `root` with a Group ID of `bin`, have your system administrator make this change now.

Preparing for Installation on Windows 95/NT

1. Determine the directory in which to install the tools. The installation program places the toolset in `C:\INTEL960`, unless you specify otherwise when the installation program prompts you. (If you want to save a previous version of the tools, you must copy them to a different directory, or specify a different installation directory for the new tools.)
2. You can save disk space by not installing the source code for the runtime libraries.
3. Binary versions of the tools and a UNIX compressed (`.tar`) file of the source code are included on the CD-ROM. You need the following development tools to build the binaries of CTOOLS from source code:
   — UNIX system to modify the filenames to an 8.3 character format
   — Microsoft* Visual* C++ compiler 5.0
   — OPUS Make Version 6.06a for NT or later
   — Thompson Toolkit Version 4.1d or later

NOTE. *Note that you can re-run the installation program later if you need components of the tools that you omit during the initial installation.*

Installing on Windows 95/NT Hosts

To install the tools on a Windows host insert the CD-ROM into your drive and enter *drive*:\ctools\setup. Respond to the prompts as appropriate for your installation.

The installation program modifies your autoexec.bat and saves a copy of the previous version under the name autoexec.bak. You must re-boot your system for these settings to take effect.

Preparing to Use the Tools

In order to use the tools, you must set certain environment variables and ensure that certain directories are in your path. The variables that you set vary depending on the interface you selected during installation. The tables below describe the variables that must be set for the GNU/960 and CTOOLS960 interfaces.

Table 2-3   GNU/960 Environment Variables

Variable	Purpose
G960BASE	specifies base directory for invoking the CTOOLS programs such as gcc960 and gld960. In Windows, this variable is set by winstall during installation.
G960ARCH	specifies the target-architecture libraries.
G960LIB	specifies an additional directory for the invocation library and directive-file search path.
G960LLIB	library and directive-file search path.

Table 2-4   CTOOLS960 Environment Variables

Variable	Purpose
I960BASE	specifies base directory for invoking the CTOOLS programs such as ic960 or lnk960. In Windows, this variable is set by winstall during installation.
I960ARCH	specifies the target-architecture libraries.
I960LIB	specifies additional directories for the invocation library and directive-file search path.
I960LLIB	library and directive-file search path.

Setting Environment Variables

In UNIX you must set the G960BASE or I960BASE for the tools to function correctly. These variables are set during the Windows installaiton. The others described in Tables 2-3 and 2-4 are optional and are provided for your convenience. For example, if you don't set the I960ARCH or G960ARCH variable, you must specify the target architecture on the program command lines with the -A*arch* option. To set the environment variables:

- Windows users must use the set command on the command line or in a batch file such as autoexec.bat. For example, to set the default installation directory:

  ```
  set G960BASE = C:\intel\g960
  ```

- UNIX users must use the set or setenv command in script files, or in a bootup file such as .cshrc, .login, or .profile. You must also specify the host-specific directory under the installation directory. For example, if you installed the toolset in /usr/local/intel on an HP9000/700 workstation, you would use the command:

  ```
  setenv G960BASE = /usr/local/intel/hp700.
  ```

The *i960 Processor Compiler User's Guide* provides a complete list of the environment variables that can be used to alter the default behavior of the tools when using the ic960 or gcc960 interface.

Adjusting Your Path

The directory `I960BASE/bin` (ic960) or `G960BASE/bin` (gcc960) must be in your path. In Windows, this modification is made by winstall during the installation process. UNIX users must change their path accordingly.

Customer Support Services 3

Customer Support Services

The Intel Customer Support organization currently provides the following services to i960 processor development tools customers:

- two types of support contracts
- a World-Wide Web site
- an anonymous FTP server

These services are described in the following sections. Following the description of these support services, this chapter also provides a list of frequently asked questions and information on reporting problems with the software.

Support Contracts

There are two types of support contracts available for customers: Software Assistance and Software Support. Each level of support is available for one-year periods, which can be renewed.

Some highlights of the support contracts are summarized below. However, the contents and details of the contracts are subject to change.

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Software Assistance Contracts (DT80960SAC)

Software Assistance Contract customers must return the registration card to activate their support. Software Assistance includes:

Hotline Assistance: Our telephone hotline, 1-800-628-8686, is open from 7:00 a.m. to 5:00 p.m. Pacific time. Calling the hotline connects you to support engineers who specialize in supporting CTOOLS.

Toll Free Phone Number: 1-800-628-8686

Electronic Mail: 960tools@intel.com

If calling is not convenient, you may send an email to this address and a support engineer will respond to you quickly.

The Intel World-Wide Web site described in the next section is also available.

Multiple user support   Software support is provided for up to nine users of your product. You may add users to this support contract by purchasing a *medium* to *large* support contract, listed in Table 3-1.

Free release upgrades   Once you register CTOOLS**,** or renew your support contract, you are automatically updated for any new release during the 12-month period of your support contract. (Of course, we automatically update you ONLY if you register.)

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[1] U.S. Phone number. Please use the correct prefix for your country to dial this number.

Software Support Contracts (DT80960SSC)

Software Support Contract customers also receive:

Priority bug fixes/ workarounds	Software Support customers receive a fix or work-around to all critical problems, once they can be duplicated at Intel's development facility. These critical problems are placed on a high priority status and receive immediate engineering attention.
Inter-release fixes	Software Support customers who report a problem receive a fix. (Information on submitting a problem report is included in this manual.) If a fix benefits other Software Support customers, we also send each of them the inter-release fix.

A one-year Software Assistance Contract (DT80960SAC) is provided to customers with the purchase of CTOOLS. To order additional support services (DT80960SSC) or renew your existing contract, contact your local Intel representative or distributor and ask for order code DT80960SSC (Software Support Contract) or DT80960SAC (Software Assistance Contract). Note: 90 days of free software assistance is included with CTOOLS upon purchasing any of our QUICKval evaluation kits.

If you do not wish to purchase an additional contract upon expiration of your 12 month free support, you may receive support by using our Pay Per Incident (PPI) plan.

Pay Per Incident (PPI)

This is a pay-per-incident plan whereby you will be charged a flat rate of $25.00 for your call. Payment is to be made via credit card (MasterCard, AmericanExpress or Visa) prior to being transferred to a technical engineer.

Callers reporting a problem in the software kit will initially be charged a $25 flat fee. The contact name and information will be entered into a

tracking system. Problems verified by Intel to be caused by a software anomaly will result in a $25 refund to the customer who made the report. Whenever possible, a fix will be made available free of charge and is obtainable by contacting the Hotline Assistance number.

The following table lists annual support contract options.

Table 3-1   Annual Support Contracts

Contract	Price*	Number of Users Supported
DT80960SAC		
small	$2,500	1-9
medium	$4,500	10-19
large	$6,500	20-50
DT80960SSC		
small	$6,000	1-9
medium	$11,000	10-19
large	$15,000	20-50

For contracts to support users in excess of 50, please contact your local Intel Distributor or Customer Support for more information.

*Subject to change.

World-Wide Web Site

The web site provides two areas designed to help CTOOLS customers:

- The i960(R) Processors-Software Support page
  `http://www.intel.com/design/i960/swsup/`

- The Intel 80960 Software Tools Patches Page
  `http://www.intel.com/design/i960/patches/`

The software support page provides:

- Software code examples

- Drivers

- Executables

- Other miscellaneous software

The patches page provides:

- Windows 95/NT patched executables

- UNIX patched executables

- UNIX source code

- MON960/MONDB source code

Web site patches provide updated executables and an automated installation process. The Windows 95/NT patch files are self-exploding compressed files. The UNIX binaries include patched executables in compressed tar format. The UNIX source patch files contain updated C code files in UNIX tar format. The source files can be used to rebuild modified tools. UNIX patch files include an automated installation script `ubins`.

Rebuilt or patched tools have a version number of Major.Minor.Fix where:

- Major = 6

- Minor = 5

- Fix = the applied patch release number

For example: 6.5.001.

Note that releases are cumulative, that is, each successive patch release contains all of the previous software updates.

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Anonymous FTP

You can retrieve the same software patches described in the previous
section via anonymous ftp. To access the ftp system, ftp onto Intel's
`ftp.intel.com` machine (the IP address is `134.134.214.7`):

```
$   ftp intel.com
login: anonymous
passwd: use your email address
```

To get the patches for the current release, retrieve the latest readme (`.rm`)
file, which describes the software changes. Use the commands:

```
cd /pub/i960/gnu/6.5_patches
binary
get PWyymmdd.rm
```

where "`yymmdd`" represents the name of the readme file associated with the
latest patch. If you have any questions, send electronic mail to Customer
Support at `960tools@intel.com`

Frequently Asked Questions

Q. How do I receive future releases?

A. Currently, new releases are automatically shipped to existing
    customers provided that they have returned the *REGISTRATION
    CARD* and they have purchased CTOOLS within past the 12 months
    and an upgrade has been created within that time. Additionally, you
    may purchase one of the two support contracts we provided at the end
    of your initial 12 month period.

**Q. I received CTOOLS as part of a QUICKval Evaluation kit. What
    kind of software support comes with that?**

A. QUICKval is an evaluation kit, so the software support is for 90-days.
    Should a software release be made during your 90-day period, a free
    copy would be shipped to you automatically.

Q. Can I make copies of the software and documentation for distribution to my group?

A. Please refer to the *i960 Processor Tools License Guide* that ships in the CTOOLS kit for this information. You will see that certain modules within the kit can be copied as long as you adhere to the license terms that are applicable to that module. However, some modules are controlled by licenses that do not allow for any copying.

Q. Can I install onto a network or onto multiple systems?

A. Yes, you are authorized to do so provided you comply with all applicable license guidelines.

Q. When I purchase one seat of CTOOLS and I receive a Software Assistance Support that supports from 1-9 users. Does that mean I can copy the software that number of times?

A. The support contract is for users of the software, whereby the one seat you purchased resides in a central location and up to nine users have access to that system. You may only make copies if the applicable license permits it. Please refer to the *i960 Processor Tools License Guide*.

Q. How can I obtain a patch for a problem in this version after I have already received the software?

A. Patches for known problems found in our software can be downloaded from the following location on the World-Wide Web:
`http://developer.intel.com/design/i960/patches/`

Q. If I have a QUICKval kit and the software that was included, am I going to receive 12 months of support?

A. Development tools that are included in the i960 QUICKval kits are
    supported for a 90 day period, at which point you need to purchase
    CTOOLSW95KT or CTOOLSUNXKT to receive 12 months of
    support or you may use the PPI support. However, any releases that
    may occur within the 90 days of your QUICKval purchase will be
    shipped to you free of charge and upon receipt of the registration card.

Fixes

In an effort to keep CTOOLS reliable, Intel attempts to fix reported
problems. However, unless you have a support contract, we cannot accept
problem reports by telephone. The best way to report problems is via
electronic mail. For a list of addresses, see the How to Report problems
section that follows.

If you do report a problem to us, please include a return United States
Postal Service address and a phone number, so that we can let you know
promptly when we create a fix.

Some of the tools in CTOOLS are based on source code from the Free
Software Foundation (FSF). Please note that not all of the tools present in
CTOOLS are supported by the FSF, and all of the tools have been
extensively modified by Intel, so the FSF may or may not be able to help.

Your problem reports play an important role in making these tools reliable.
In order for a problem report to serve its purpose, you must include
information we need to fix the problem.

If you are not sure whether you have found a problem, here are some
guidelines:

*   If any of the tools gets a fatal signal for any valid input, that is usually
    a problem.
*   If the compiler produces invalid assembly code, for any input whatever
    (except an `asm` statement), that is usually a problem, unless the
    compiler reports errors (not just warnings) that would ordinarily
    prevent the assembler from being run.

- If the compiler produces valid assembly code that does not correctly execute the input source code, that is usually a compiler problem. However, you must double-check to make sure, because you may have run into an incompatibility between versions of C.

  You may have a program whose behavior is undefined, which happened by chance to give the desired results with another C compiler.

  For example, in many nonoptimizing compilers, you can write `x;` at the end of a function instead of `return x;`, with the same results. But the value of the function is undefined if `return` is omitted; it is not a problem when the compiler produces different results.

  Problems often result from expressions with two increment operators, as in `f(*p++, *p++)`. Your previous compiler might have interpreted that expression the way you intended; the compiler might interpret it another way. Neither compiler is wrong. The problem is in your code.

  After you have localized the error to a single source line, it should be easy to check for these details. If your program is correct and well defined, you have found a compiler problem.

  Remember, however, that the definition in C of correct behavior is sometimes quite broad, especially when it concerns program behavior that is not portable between machines, such as:

  a. variables that should be and are not marked volatile;
  b. default alignment of structure elements;
  c. treatment of character variables, signed or unsigned; and
  d. undefined behavior surrounding a machine's subroutine calling sequence.
- If a tool produces an error message for valid input, that is a problem. The following is not valid input, and the error message for it is not a problem:

```
int foo (char);

int
foo (x)
```

```
        char x;
{ ... }
```
The prototype says to pass a `char`, while the definition says to pass an
`int` and treat the value as a `char`. This is what the ANSI standard
requires.

- If the compiler does not produce an error message for invalid input,
  that is a compiler problem. However, your idea of "invalid input"
  might be someone else's idea of "an extension" or "support for
  traditional practice."

- If you are an experienced user of C compilers, your suggestions for
  improvement of the compiler are welcome in any case, though they are
  usually lower priority than fixing actual problems.

How to Report Problems

Send problem reports via any of the methods listed in this section. The
preferred methods of contact are electronic mail or telephone. Regardless
of the method that you use, please include your electronic mail address,
phone number, and FAX number with your report.

Via electronic mail:

`960tools@intel.com`

Via FAX:

80960 Development Tool Problem Report: (916) 356-2892

Via telephone:

Customers with either support contract in force may call our support
engineers at our HOTLINE at 1-800-628-8686.

The fundamental principle of reporting problems usefully is this: *report all
the facts*. If you are not sure whether to state a fact or leave it out, state it!

To enable us to fix the problem, you should include all these things:

- The version of the tool containing the problem. You can get this by
  running the tool with the `-v` and `-v960` options. ic960 and gcc960

also place relevant version number information in comments at the beginning of each generated assembler file.

* A complete input file that reproduces the problem. If the problem is in the C preprocessor, send a source file and any header files that it requires. If the problem is in the compiler, run your source file through the C preprocessor by doing:

```
ic960 -P sourcefile.c -o outfile.i
```

or

```
gcc960 -E sourcefile.c > outfile.i
```

and include the contents of `outfile.i` in the problem report. (Any `-I`, `-D` or `-U` options that you used in actual compilation should also be used when doing this.)

A single statement is not enough of an example. In order to compile it, it must be embedded in a function definition; and the problem might depend on the details of how this is done.

* The command arguments you gave to the tool to observe the problem. To guarantee you won't omit something important, list them all.

* The type of machine you are using, and the operating system name and version number.

* A description of what behavior you observe that you believe is incorrect. For example, "It gets a fatal signal," or, "There is an incorrect assembler instruction in the output."

* If you send examples of assembler output from the compiler, please use `-g` when you make them. The debugging information includes source line numbers that are essential for correlating the output with the input. Embedded comments that highlight the problem are also extremely useful.

If you wish to suggest changes to the compiler source, please send context diffs. If you even discuss something in the compiler source, refer to it by context, not by line number. The line numbers in Intel's development source may not match those in your sources.

License and Warranty

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This appendix indicates where license information is provided, and summarizes the CTOOLS warranty.

License Guide

To make appropriate use of your Intel i960 processor tools, it is important that you know your rights and responsibilities. We urge you to read the *i960 Processor Tools License Guide*, which describes the licensing terms for CTOOLS.

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Warranty and Maintenance

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