

# **Sourcery G++ Lite**

**MIPS GNU/Linux**

**Sourcery G++ Lite 4.4-303**

**Getting Started**



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# **Sourcery G++ Lite: MIPS GNU/Linux: Sourcery G++ Lite 4.4-303: Getting Started**

CodeSourcery, Inc.

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## **Abstract**

This guide explains how to install and build applications with Sourcery G++ Lite, CodeSourcery's customized and validated version of the GNU Toolchain. Sourcery G++ Lite includes everything you need for application development, including C and C++ compilers, assemblers, linkers, and libraries.

When you have finished reading this guide, you will know how to use Sourcery G++ from the command line.

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# Preface

This preface introduces the Sourcery G++ Lite Getting Started guide. It explains the structure of this guide and describes the documentation conventions used.

# 1. Intended Audience

This guide is written for people who will install and/or use Sourcery G++ Lite. This guide provides a step-by-step guide to installing Sourcery G++ Lite and to building simple applications. Parts of this document assume that you have some familiarity with using the command-line interface.

# 2. Organization

This document is organized into the following chapters and appendices:

Chapter 1, “Quick Start”	This chapter includes a brief checklist to follow when installing and using Sourcery G++ Lite for the first time. You may use this chapter as an abbreviated guide to the rest of this manual.
Chapter 2, “Installation and Configuration”	This chapter describes how to download, install and configure Sourcery G++ Lite. This section describes the available installation options and explains how to set up your environment so that you can build applications.
Chapter 3, “Sourcery G++ Lite for MIPS GNU/Linux”	This chapter contains information about using Sourcery G++ Lite that is specific to MIPS GNU/Linux targets. You should read this chapter to learn how to best use Sourcery G++ Lite on your target system.
Chapter 4, “Using Sourcery G++ from the Command Line”	This chapter explains how to build applications with Sourcery G++ Lite using the command line. In the process of reading this chapter, you will build a simple application that you can use as a model for your own programs.
Chapter 5, “Sourcery G++ Debug Sprite”	This chapter describes the use of the Sourcery G++ Debug Sprite for remote debugging. The Sprite is provided for debugging of the Linux kernel on the target board. This chapter includes information about the debugging devices and boards supported by the Sprite for MIPS GNU/Linux.
Chapter 6, “Next Steps with Sourcery G++”	This chapter describes where you can find additional documentation and information about using Sourcery G++ Lite and its components. It also provides information about Sourcery G++ subscriptions. CodeSourcery customers with Sourcery G++ subscriptions receive comprehensive support for Sourcery G++.
Appendix A, “Sourcery G++ Lite Release Notes”	This appendix contains information about changes in this release of Sourcery G++ Lite for MIPS GNU/Linux. You should read through these notes to learn about new features and bug fixes.
Appendix B, “Sourcery G++ Lite Licenses”	This appendix provides information about the software licenses that apply to Sourcery G++ Lite. Read this appendix to understand your legal rights and obligations as a user of Sourcery G++ Lite.

## 3. Typographical Conventions

The following typographical conventions are used in this guide:

<code>&gt; command arg ...</code>	A command, typed by the user, and its output. The “>” character is the command prompt.
<code>command</code>	The name of a program, when used in a sentence, rather than in literal input or output.
<code>literal</code>	Text provided to or received from a computer program.
<code>placeholder</code>	Text that should be replaced with an appropriate value when typing a command.
<code>\</code>	At the end of a line in command or program examples, indicates that a long line of literal input or output continues onto the next line in the document.

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# Chapter 1

## Quick Start

This chapter includes a brief checklist to follow when installing and using Sourcery G++ Lite for the first time. You may use this chapter as an abbreviated guide to the rest of this manual.

Sourcery G++ Lite for MIPS GNU/Linux is intended for developers working on embedded GNU/Linux applications. It may also be used for Linux kernel development and debugging, or to build a GNU/Linux distribution.

Follow the steps given in this chapter to install Sourcery G++ Lite and build and run your first application program. The checklist given here is not a tutorial and does not include detailed instructions for each step; however, it will help guide you to find the instructions and reference information you need to accomplish each step. Note that this checklist is also oriented towards application debugging rather than kernel debugging.

You can find additional details about the components, libraries, and other features included in this version of Sourcery G++ Lite in Chapter 3, “Sourcery G++ Lite for MIPS GNU/Linux”.

## 1.1. Installation and Set-Up

**Install Sourcery G++ Lite on your host computer.** You may download an installer package from the Sourcery G++ web site<sup>1</sup>, or you may have received an installer on CD. The installer is an executable program that pops up a window on your computer and leads you through a series of dialogs to configure your installation. If the installation is successful, it will offer to launch the Getting Started guide. For more information about installing Sourcery G++ Lite, including host system requirements and tips to set up your environment after installation, refer to Chapter 2, “Installation and Configuration”.

## 1.2. Configuring Sourcery G++ Lite for the Target System

**Identify your target libraries.** Sourcery G++ Lite supports libraries optimized for different targets. Libraries are selected automatically by the linker, depending on the processor and other options you have specified. Refer to Section 3.2, “Library Configurations” for details.

**Install runtime libraries on your target machine.** In order to run programs built with the Sourcery G++ runtime libraries on target hardware, you must install these libraries, the Sourcery G++ dynamic linker, and other runtime support files -- collectively referred to as the *sysroot* -- on your GNU/Linux target system. Typically, this involves either using third-party tools to build a complete root filesystem including the Sourcery G++ sysroot, or using special commands when linking or running your program so it can find the sysroot installed in another location on the target. Refer to Section 3.5, “Using Sourcery G++ Lite on GNU/Linux Targets” for full discussion of these options.

## 1.3. Building Your Program

**Build your program with Sourcery G++ command-line tools.** Create a simple test program, and follow the directions in Chapter 4, “Using Sourcery G++ from the Command Line” to compile and link it using Sourcery G++ Lite.

## 1.4. Running and Debugging Your Program

The steps to run or debug your program depend on your target system and how it is configured. Choose the appropriate method for your target.

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<sup>1</sup> [http://www.codesourcery.com/gnu\\_toolchains/](http://www.codesourcery.com/gnu_toolchains/)



**Run your program on the MIPS GNU/Linux target.** To run a program using the included Sourcery G++ libraries, you must install the sysroot on the target, as previously discussed. Copy the executable for your program to the target system. The method you use for launching your program depends on how you have installed the libraries and built your program. In some cases, you may need to invoke the Sourcery G++ dynamic linker explicitly. Refer to Section 3.5, “Using Sourcery G++ Lite on GNU/Linux Targets” for details.

**Debug your program on the target using GDB server.** You can use GDB server on a remote target to debug your program. When debugging a program that uses the included Sourcery G++ libraries, you must use the `gdbserver` executable included in the sysroot, and similar issues with respect to the dynamic linker as discussed previously apply. See Section 3.6, “Using GDB Server for Debugging” for detailed instructions. Once you have started GDB server on the target, you can connect to it from the debugger on your host system. Refer to Section 4.3, “Running Applications from GDB” for instructions on remote debugging from command-line GDB.

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# Chapter 2

## Installation and Configuration

This chapter explains how to install Sourcery G++ Lite. You will learn how to:

1. Verify that you can install Sourcery G++ Lite on your system.
2. Download the appropriate Sourcery G++ Lite installer.
3. Install Sourcery G++ Lite.
4. Configure your environment so that you can use Sourcery G++ Lite.

## 2.1. Terminology

Throughout this document, the term *host system* refers to the system on which you run Sourcery G++ while the term *target system* refers to the system on which the code produced by Sourcery G++ runs. The target system for this version of Sourcery G++ is `mips-linux-gnu`.

If you are developing a workstation or server application to run on the same system that you are using to run Sourcery G++, then the host and target systems are the same. On the other hand, if you are developing an application for an embedded system, then the host and target systems are probably different.

## 2.2. System Requirements

### 2.2.1. Host Operating System Requirements

This version of Sourcery G++ supports the following host operating systems and architectures:

- Microsoft Windows 2000, Windows XP, Windows Vista, and Windows 7 systems using IA32, AMD64, and Intel 64 processors.
- GNU/Linux systems using IA32, AMD64, or Intel 64 processors, including Debian 3.1 (and later), Red Hat Enterprise Linux 3 (and later), and SuSE Enterprise Linux 8 (and later).

Sourcery G++ is built as a 32-bit application. Therefore, even when running on a 64-bit host system, Sourcery G++ requires 32-bit host libraries. If these libraries are not already installed on your system, you must install them before installing and using Sourcery G++ Lite. Consult your operating system documentation for more information about obtaining these libraries.

#### Installing on Ubuntu and Debian GNU/Linux Hosts

The Sourcery G++ graphical installer is incompatible with the `dash` shell, which is the default `/bin/sh` for recent releases of the Ubuntu and Debian GNU/Linux distributions. To install Sourcery G++ Lite on these systems, you must make `/bin/sh` a symbolic link to one of the supported shells: `bash`, `dash`, `tcsh`, `zsh`, or `ksh`.

For example, on Ubuntu systems, the recommended way to do this is:

```
> sudo dpkg-reconfigure -plow dash
Install as /bin/sh? No
```

This is a limitation of the installer and uninstaller only, not of the installed Sourcery G++ Lite toolchain.

### 2.2.2. Host Hardware Requirements

In order to install and use Sourcery G++ Lite, you must have at least 128MB of available memory.

The amount of disk space required for a complete Sourcery G++ Lite installation directory depends on the host operating system and the number of target libraries included. Typically, you should plan on at least 400MB.

In addition, the graphical installer requires a similar amount of temporary space during the installation process. On Microsoft Windows hosts, the installer uses the location specified by the `TEMP` environment variable for these temporary files. If there is not enough free space on that volume, the installer

prompts for an alternate location. On Linux hosts, the installer puts temporary files in the directory specified by the `IATEMPDIR` environment variable, or `/tmp` if that is not set.

### 2.2.3. Target System Requirements

See Chapter 3, “Sourcery G++ Lite for MIPS GNU/Linux” for requirements that apply to the target system.

## 2.3. Downloading an Installer

If you have received Sourcery G++ Lite on a CD, or other physical media, then you do not need to download an installer. You may skip ahead to Section 2.4, “Installing Sourcery G++ Lite”.

You can download Sourcery G++ Lite from the Sourcery G++ web site<sup>1</sup>. This free version of Sourcery G++, which is made available to the general public, does not include all the functionality of CodeSourcery's product releases. If you prefer, you may instead purchase or register for an evaluation of CodeSourcery's product toolchains at the Sourcery G++ Portal<sup>2</sup>.

Once you have navigated to the appropriate web site, download the installer that corresponds to your host operating system. For Microsoft Windows systems, the Sourcery G++ installer is provided as an executable with the `.exe` extension. For GNU/Linux systems Sourcery G++ Lite is provided as an executable installer package with the `.bin` extension. You may also install from a compressed archive with the `.tar.bz2` extension.

On Microsoft Windows systems, save the installer to the desktop. On GNU/Linux systems, save the download package in your home directory.

## 2.4. Installing Sourcery G++ Lite

The method used to install Sourcery G++ Lite depends on your host system and the kind of installation package you have downloaded.

### 2.4.1. Using the Sourcery G++ Lite Installer on Microsoft Windows

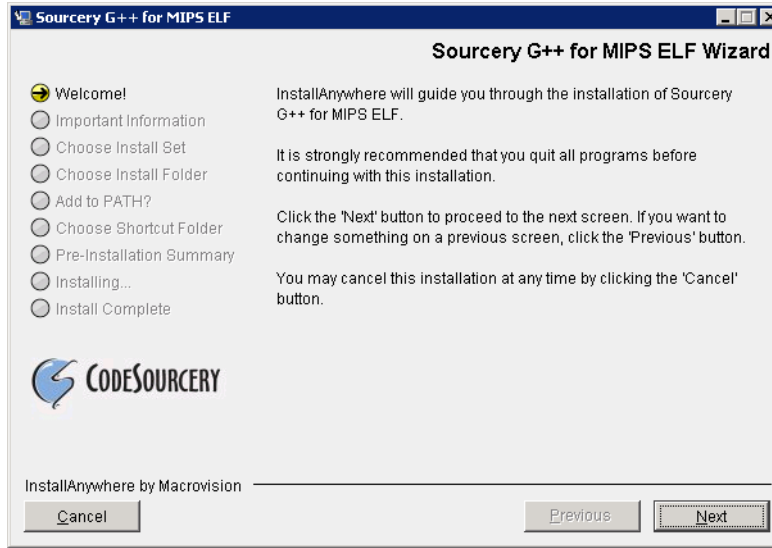
If you have received Sourcery G++ Lite on CD, insert the CD in your computer. On most computers, the installer then starts automatically. If your computer has been configured not to automatically run CDs, open *My Computer*, and double click on the CD. If you downloaded Sourcery G++ Lite, double-click on the installer.

After the installer starts, follow the on-screen dialogs to install Sourcery G++ Lite. The installer is intended to be self-explanatory and on most pages the defaults are appropriate.

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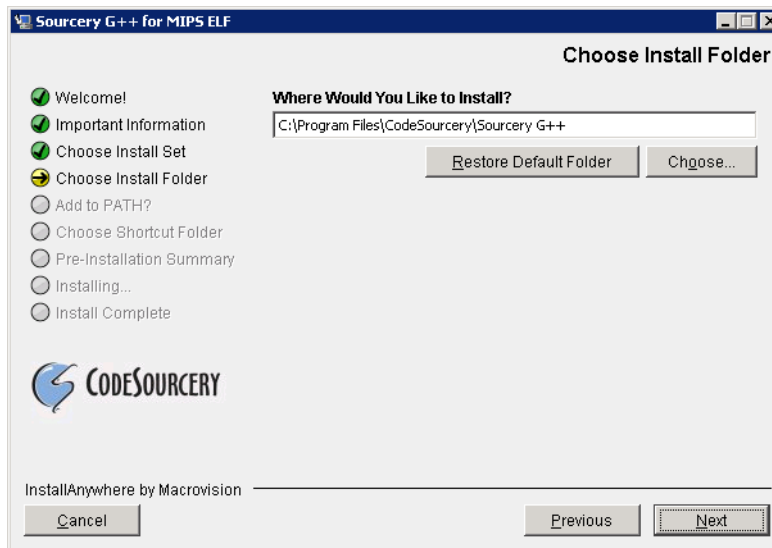
<sup>1</sup> [http://www.codesourcery.com/gnu\\_toolchains/](http://www.codesourcery.com/gnu_toolchains/)

<sup>2</sup> <https://support.codesourcery.com/GNUToolchain/>

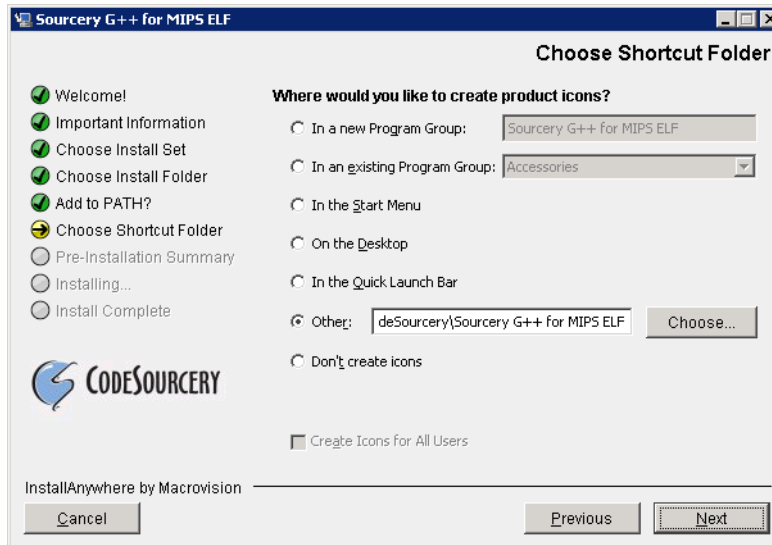


**Running the Installer.** The graphical installer guides you through the steps to install Sourcery G++ Lite.

You may want to change the install directory pathname and customize the shortcut installation.

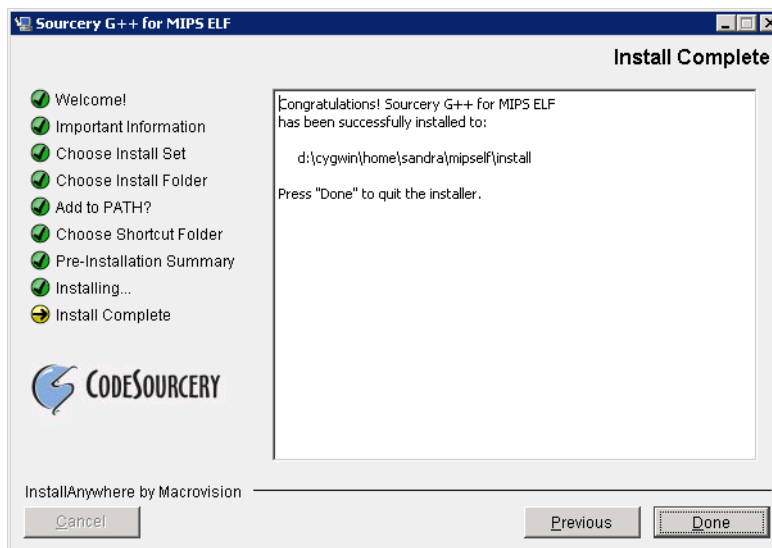


**Choose Install Folder.** Select the pathname to your install directory.



**Choose Shortcut Folder.** You can customize where the installer creates shortcuts for quick access to Sourcery G++ Lite.

When the installer has finished, it asks if you want to launch a viewer for the Getting Started guide. Finally, the installer displays a summary screen to confirm a successful install before it exits.



**Install Complete.** You should see a screen similar to this after a successful install.

If you prefer, you can run the installer in console mode rather than using the graphical interface. To do this, invoke the installer with the `-i console` command-line option. For example:

```
> /path/to/package.exe -i console
```

## 2.4.2. Using the Sourcery G++ Lite Installer on GNU/Linux Hosts

Start the graphical installer by invoking the executable shell script:

```
> /bin/sh ./path/to/package.bin
```

After the installer starts, follow the on-screen dialogs to install Sourcery G++ Lite. For additional details on running the installer, see the discussion and screen shots in the Microsoft Windows section above.

If you prefer, or if your host system does not run the X Window System, you can run the installer in console mode rather than using the graphical interface. To do this, invoke the installer with the `-i console` command-line option. For example:

```
> /bin/sh ./path/to/package.bin -i console
```

### 2.4.3. Installing Sourcery G++ Lite from a Compressed Archive

You do not need to be a system administrator to install Sourcery G++ Lite from a compressed archive. You may install Sourcery G++ Lite using any user account and in any directory to which you have write access. This guide assumes that you have decided to install Sourcery G++ Lite in the `$HOME/CodeSourcery` subdirectory of your home directory and that the filename of the package you have downloaded is `/path/to/package.tar.bz2`. After installation the toolchain will be in `$HOME/CodeSourcery/sourceryg++-4.4`.

First, uncompress the package file:

```
> bunzip2 /path/to/package.tar.bz2
```

Next, create the directory in which you wish to install the package:

```
> mkdir -p $HOME/CodeSourcery
```

Change to the installation directory:

```
> cd $HOME/CodeSourcery
```

Unpack the package:

```
> tar xf /path/to/package.tar
```

## 2.5. Installing Sourcery G++ Lite Updates

If you have already installed an earlier version of Sourcery G++ Lite for MIPS GNU/Linux on your system, it is not necessary to uninstall it before using the installer to unpack a new version in the same location. The installer detects that it is performing an update in that case.

If you are installing an update from a compressed archive, it is recommended that you remove any previous installation in the same location, or install in a different directory.

Note that the names of the Sourcery G++ commands for the MIPS GNU/Linux target all begin with `mips-linux-gnu`. This means that you can install Sourcery G++ for multiple target systems in the same directory without conflicts.

## 2.6. Setting up the Environment

As with the installation process itself, the steps required to set up your environment depend on your host operating system.

## 2.6.1. Setting up the Environment on Microsoft Windows Hosts

### 2.6.1.1. Setting the PATH

In order to use the Sourcery G++ tools from the command line, you should add them to your PATH. You may skip this step if you used the graphical installer, since the installer automatically adds Sourcery G++ to your PATH.

To set the PATH on a Microsoft Windows Vista system, use the following command in a `cmd.exe` shell:

```
> setx PATH "%PATH%;C:\Program Files\Sourcery G++\bin"
```

where `C:\Program Files\Sourcery G++` should be changed to the path of your Sourcery G++ Lite installation.

To set the PATH on a system running a Microsoft Windows version other than Vista, from the desktop bring up the Start menu and right click on My Computer. Select Properties, go to the Advanced tab, then click on the Environment Variables button. Select the PATH variable and click the Edit. Add the string `;C:\Program Files\Sourcery G++\bin` to the end, and click OK. Again, you must adjust the pathname to reflect your installation directory.

You can verify that your PATH is set up correctly by starting a new `cmd.exe` shell and running:

```
> mips-linux-gnu-g++ -v
```

Verify that the last line of the output contains: `Sourcery G++ Lite 4.4-303`.

### 2.6.1.2. Working with Cygwin

Sourcery G++ Lite does not require Cygwin or any other UNIX emulation environment. You can use Sourcery G++ directly from the Windows command shell. You can also use Sourcery G++ from within the Cygwin environment, if you prefer.

The Cygwin emulation environment translates Windows path names into UNIX path names. For example, the Cygwin path `/home/user/hello.c` corresponds to the Windows path `c:\cygwin\home\user\hello.c`. Because Sourcery G++ is not a Cygwin application, it does not, by default, recognize Cygwin paths.

If you are using Sourcery G++ from Cygwin, you should set the `CYGPATH` environment variable. If this environment variable is set, Sourcery G++ Lite automatically translates Cygwin path names into Windows path names. To set this environment variable, type the following command in a Cygwin shell:

```
> export CYGPATH=cygpath
```

To resolve Cygwin path names, Sourcery G++ relies on the `cygpath` utility provided with Cygwin. You must provide Sourcery G++ with the full path to `cygpath` if `cygpath` is not in your PATH. For example:

```
> export CYGPATH=c:/cygwin/bin/cygpath
```

directs Sourcery G++ Lite to use `c:/cygwin/bin/cygpath` as the path conversion utility. The value of `CYGPATH` must be an ordinary Windows path, not a Cygwin path.



## 2.6.2. Setting up the Environment on GNU/Linux Hosts

If you installed Sourcery G++ Lite using the graphical installer then you may skip this step. The installer does this setup for you.

Before using Sourcery G++ Lite you should add it to your `PATH`. The command you must use varies with the particular command shell that you are using. If you are using the C Shell (`csh` or `tcsh`), use the command:

```
> setenv PATH $HOME/CodeSourcery/Sourcery_G++/bin:$PATH
```

If you are using Bourne Shell (`sh`), the Korn Shell (`ksh`), or another shell, use:

```
> PATH=$HOME/CodeSourcery/Sourcery_G++/bin:$PATH
> export PATH
```

If you are not sure which shell you are using, try both commands. In both cases, if you have installed Sourcery G++ Lite in an alternate location, you must replace the directory above with `bin` subdirectory of the directory in which you installed Sourcery G++ Lite.

You may also wish to set the `MANPATH` environment variable so that you can access the Sourcery G++ manual pages, which provide additional information about using Sourcery G++. To set the `MANPATH` environment variable, follow the same steps shown above, replacing `PATH` with `MANPATH`, and `bin` with `share/doc/sourceryg++-mips-linux-gnu/man`.

You can test that your `PATH` is set up correctly by running the following command:

```
> mips-linux-gnu-g++ -v
```

Verify that the last line of the output contains: `Sourcery G++ Lite 4.4-303`.

## 2.7. Uninstalling Sourcery G++ Lite

The method used to uninstall Sourcery G++ Lite depends on the method you originally used to install it. If you have modified any files in the installation it is recommended that you back up these changes. The uninstall procedure may remove the files you have altered. In particular, the `mips-linux-gnu` directory located in the install directory will be removed entirely by the uninstaller.

### 2.7.1. Using the Sourcery G++ Lite Uninstaller on Microsoft Windows

You should use the provided uninstaller to remove a Sourcery G++ Lite installation originally created by the graphical installer. Start the graphical uninstaller by invoking the executable `Uninstall` executable located in your installation directory, or use the `uninstall` shortcut created during installation. After the uninstaller starts, follow the on-screen dialogs to uninstall Sourcery G++ Lite.

You can run the uninstaller in console mode, rather than using the graphical interface, by invoking the `Uninstall` executable found in your Sourcery G++ Lite installation directory with the `-i console` command-line option.

To uninstall third-party drivers bundled with Sourcery G++ Lite, first disconnect the associated hardware device. Then use `Add or Remove Programs (non-Vista)` or `Uninstall a program (Vista)` to remove the drivers separately. Depending on the device, you may need to reboot your computer to complete the driver uninstall.

### **2.7.2. Using the Sourcery G++ Lite Uninstaller on GNU/Linux**

You should use the provided uninstaller to remove a Sourcery G++ Lite installation originally created by the executable installer script. Start the graphical uninstaller by invoking the executable Uninstall shell script located in your installation directory. After the uninstaller starts, follow the on-screen dialogs to uninstall Sourcery G++ Lite.

You can run the uninstaller in console mode, rather than using the graphical interface, by invoking the Uninstall script with the `-i console` command-line option.

### **2.7.3. Uninstalling a Compressed Archive Installation**

If you installed Sourcery G++ Lite from a `.tar.bz2` file, you can uninstall it by manually deleting the installation directory created in the install procedure.

---

# **Chapter 3**

## **Sourcery G++ Lite for MIPS**

### **GNU/Linux**

This chapter contains information about features of Sourcery G++ Lite that are specific to MIPS GNU/Linux targets. You should read this chapter to learn how to best use Sourcery G++ Lite on your target system.

## 3.1. Included Components and Features

This section briefly lists the important components and features included in Sourcery G++ Lite for MIPS GNU/Linux, and tells you where you may find further information about these features.

Component	Version	Notes
<b>GNU programming tools</b>		
GNU Compiler Collection	4.4.1	Separate manual included.
GNU Binary Utilities	2.19.51	Includes assembler, linker, and other utilities. Separate manuals included.
<b>Debugging support and simulators</b>		
GNU Debugger	7.0.50	Separate manual included.
Sourcery G++ Debug Sprite for MIPS	4.4-303	Provided for kernel debugging only. See Chapter 5, “Sourcery G++ Debug Sprite”.
GDB Server	N/A	Included with GDB. See Section 3.6, “Using GDB Server for Debugging”.
<b>Target libraries</b>		
GNU C Library	2.11	Separate manual included.
uClibc C Library	0.9.30	
Linux Kernel Headers	2.6.32	
<b>Other utilities</b>		
GNU Make	N/A	Build support on Windows hosts.
GNU Core Utilities	N/A	Build support on Windows hosts.

## 3.2. Library Configurations

Sourcery G++ Lite for MIPS GNU/Linux includes the following library configuration.

<b>MIPS32 revision 2 - Big-Endian, O32</b>	
Command-line option(s):	default
Sysroot subdirectory:	./
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Little-Endian, O32</b>	
Command-line option(s):	-EL
Sysroot subdirectory:	el/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Big-Endian, Soft-Float, O32</b>	
Command-line option(s):	-msoft-float
Sysroot subdirectory:	soft-float/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Little-Endian, Soft-Float, O32</b>	
Command-line option(s):	-EL -msoft-float
Sysroot subdirectory:	soft-float/el/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Big-Endian, O32, microMIPS</b>	
Command-line option(s):	-mmicromips
Sysroot subdirectory:	micromips/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Little-Endian, O32, microMIPS</b>	
Command-line option(s):	-mmicromips -EL
Sysroot subdirectory:	micromips/el/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Big-Endian, Soft-Float, O32, microMIPS</b>	
Command-line option(s):	-mmicromips -msoft-float
Sysroot subdirectory:	micromips/soft-float/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - Little-Endian, Soft-Float, O32, microMIPS</b>	
Command-line option(s):	-mmicromips -EL -msoft-float
Sysroot subdirectory:	micromips/soft-float/el/
Dynamic linker:	lib/ld.so.1

<b>MIPS32 revision 2 - uClibc, Big-Endian, O32</b>	
Command-line option(s):	-muclibc
Sysroot subdirectory:	uclibc/
Dynamic linker:	lib/ld-uClibc.so.0

<b>MIPS32 revision 2 - uClibc, Little-Endian, O32</b>	
Command-line option(s):	-muclibc -EL
Sysroot subdirectory:	uclibc/el/
Dynamic linker:	lib/ld-uClibc.so.0

<b>MIPS32 revision 2 - uClibc, Big-Endian, Soft-Float, O32</b>	
Command-line option(s):	-muclibc -msoft-float
Sysroot subdirectory:	uclibc/soft-float/
Dynamic linker:	lib/ld-uClibc.so.0

<b>MIPS32 revision 2 - uClibc, Little-Endian, Soft-Float, O32</b>	
Command-line option(s):	<code>-muclibc -EL -msoft-float</code>
Sysroot subdirectory:	<code>uclibc/soft-float/el/</code>
Dynamic linker:	<code>lib/ld-uClibc.so.0</code>

Sourcery G++ includes copies of run-time libraries that have been built with optimizations for different target architecture variants or other sets of build options. Each such set of libraries is referred to as a *multilib*. When you link a target application, Sourcery G++ selects the multilib matching the build options you have selected.

Each multilib corresponds to a *sysroot* directory which contains the files that should be installed on the target system. The sysroot contains the dynamic linker used to run your applications on the target as well as the libraries. Refer to Section 3.5, “Using Sourcery G++ Lite on GNU/Linux Targets” for instructions on how to install and use these support files on your target GNU/Linux system. You can find the sysroot directories provided with Sourcery G++ in the `mips-linux-gnu/libc` directory of your installation. In the tables below, the dynamic linker pathname is given relative to the corresponding sysroot.

### 3.3. Target Architectures

By default, Sourcery G++ Lite for MIPS GNU/Linux generates code for MIPS32r2 processors. If you wish to generate code for another MIPS processor, you must use an appropriate `-march` option when you build your application. Refer to the GCC manual for additional information about supported targets.

### 3.4. Target Kernel Requirements

The GNU C library supplied with this version of Sourcery G++ Lite requires that Linux kernel version 2.6.12 or later be installed on the target in order to run applications.

### 3.5. Using Sourcery G++ Lite on GNU/Linux Targets

In order to run and debug programs produced by Sourcery G++ on a GNU/Linux target, you must install runtime support files on the target. You may also need to set appropriate build options so that your executables can find the correct dynamic linker and libraries at runtime.

The runtime support files, referred to as the *sysroot*, are found in the `mips-linux-gnu/libc` directory of your Sourcery G++ Lite installation. The sysroot consists of the contents of the `etc`, `lib`, `sbin`, and `usr` directories. There may be other directories in `mips-linux-gnu/libc` that contain additional sysroots customized for particular combinations of command-line compiler flags, or *multilibs*. Refer to Section 3.2, “Library Configurations” for a list of the included multilibs in this version of Sourcery G++ Lite, and the corresponding sysroot directory pathnames.

#### Note for Windows Host Users

The sysroots provided in Windows host packages for Sourcery G++ are not directly usable on the GNU/Linux target because of differences between the Windows and GNU/Linux file systems. Some files that are hard links, or copies, in the sysroot as installed on the Windows file system should be symbolic links on the GNU/Linux target. Additionally, some files in the sysroot that should be marked executable on the GNU/Linux target are

not marked executable on Windows. If you intend to use the sysroot provided with Sourcery G++ on a Windows host system as the basis for your GNU/Linux target filesystem, you must correct these issues after copying the sysroot to the target.

You have these choices for installing the sysroot on the target:

- You can install the files in the filesystem root on the target (that is, installing the files directly in `/etc/`, `/lib/`, and so on). All applications on the target then automatically use the Sourcery G++ libraries. This method is primarily useful when you are building a GNU/Linux root filesystem from scratch. If your target board already has a GNU/Linux filesystem installed, overwriting the existing C library files is not recommended, as this may break other applications on your system, or cause it to fail to boot.
- You can install the sysroot in an alternate location and build your application with the `-rpath` and `--dynamic-linker` linker options to specify the sysroot location.
- You can install the sysroot in an alternate location and explicitly invoke your application through the dynamic linker to specify the sysroot location. If you are just getting started with Sourcery G++ Lite, this may be the easiest way to get your application running, but this method does not support use of the debugger. In addition, this method only works with programs linked with the GNU C Library (glibc), not uClibc.

Setting the environment variable `LD_LIBRARY_PATH` on the target is not sufficient, since executables produced by Sourcery G++ depend on the Sourcery G++ dynamic linker included in the sysroot as well as the Sourcery G++ runtime libraries.

### 3.5.1. Installing the Sysroot

If you are modifying an existing system, rather than creating a new system from scratch, you should place the sysroot files in a new directory, rather than in the root directory of your target system.

If you choose to overwrite your existing C library, you may not be able to boot your system. You should back up your existing system before overwriting the C library and ensure that you can restore the backup even with your system offline.

The next step is to identify the correct sysroot subdirectory in the Sourcery G++ Lite install directory on your host system. The sysroot you copy to the target must be the one that corresponds to the linker options you are using to build your applications. The tables in Section 3.2, “Library Configurations” tell you which sysroot subdirectories correspond to which compiler options. If you are unsure what sysroot is being referenced when you build your program, you can identify the sysroot by adding `-v` to your compiler command-line options, and looking at the `--sysroot=` pathname in the compiler output.

The mechanism you use for copying the sysroot to your target board depends on its hardware and software configuration. You may be able to use FTP or SSH with a server already running on your target. If your target board does not have networking configured, you may be able to copy files using an SD card or USB memory stick, or via a file transfer utility over a serial line. The instructions that come with your board may include specific suggestions.

When running Sourcery G++ on a GNU/Linux host, as an alternative to copying files to the target system, you may be able to NFS-mount the Sourcery G++ Lite installation directory from your host system on the target system. It is especially convenient for debugging if you can make the sysroot pathname on the target system be identical to that on the GNU/Linux host system; refer to Section 3.6.3, “Setting the Sysroot in the Debugger” for further discussion of this issue.

Otherwise, you must copy files from the appropriate `sysroot` subdirectory in the `mips-linux-gnu/libc` directory of your Sourcery G++ Lite install to the target system. In many cases, you do not need to copy all of the files in the `sysroot`. For example, the `usr/include` subdirectory contains files that are only needed if you will actually be running the compiler on your target system. You do not need these files for non-native compilers. You also do not need any `.o` or `.a` files; these are used by the compiler when linking programs, but are not needed to run programs. You should definitely copy all `.so` files and the executable files in `usr/bin` and `sbin`.

### 3.5.2. Using Linker Options to Specify the Sysroot Location

If you have installed the `sysroot` on the target in a location other than the file system root, you can use the `-rpath` and `--dynamic-linker` linker options to specify the `sysroot` location.

If you are using Sourcery G++ from the command line, follow these steps:

1. First find the correct `sysroot` directory, dynamic linker, and library subdirectory for your selected multilib. Refer to Section 3.2, “Library Configurations”. In the following steps, `sysroot` is the absolute path to the `sysroot` directory on the target corresponding to your selected multilib. For the default multilib, the dynamic linker path relative to the `sysroot` is `lib/ld.so.1`, and the library subdirectory is `lib`. This is used in the example below.
2. When invoking `mips-linux-gnu-gcc` to link your executable, include the command-line options:

```
-Wl,-rpath=sysroot/lib:sysroot/usr/lib \  
-Wl,--dynamic-linker=sysroot/lib/ld.so.1
```

where `sysroot` is the absolute path to the `sysroot` directory on the target corresponding to your selected multilib.

3. Copy the executable to the target and execute it normally.

Note that if you specify an incorrect path for `--dynamic-linker`, the common failure mode seen when running your application on the target is similar to

```
> ./factorial  
./factorial: No such file or directory
```

or

```
> ./factorial  
./factorial: bad ELF interpreter: No such file or directory
```

This can be quite confusing since it appears from the error message as if it is the `./factorial` executable that is missing rather than the dynamic linker it references.

### 3.5.3. Specifying the Sysroot Location at Runtime

You can invoke the Sourcery G++ dynamic linker on the target to run your application without having to compile it with specific linker options. Note that this method of specifying the `sysroot` is specific to the GNU C Library (glibc) and does not work if you have linked your application with `uClibc` instead.

To do this, follow these steps:



1. Build your application on the host, without any additional linker options, and copy the executable to your target system.
2. Find the correct sysroot directory, dynamic linker, and library subdirectory for your selected multilib. Refer to Section 3.2, “Library Configurations”. In the following steps, *sysroot* is the absolute path to the sysroot directory on the target corresponding to your selected multilib. For the default multilib, the dynamic linker is `lib/ld.so.1`, and the library subdirectory is `lib`. This is used in the example below.
3. On the target system, invoke the dynamic linker with your executable as:

```
> sysroot/lib/ld.so.1 \  
--library-path sysroot/lib:sysroot/usr/lib \  
/path/to/your-executable
```

where *sysroot* is the absolute path to the sysroot directory on the target corresponding to your selected multilib.

Invoking the linker in this manner requires that you provide either an absolute pathname to your executable, or a relative pathname prefixed with `./`. Specifying only the name of a file in the current directory does not work.

## 3.6. Using GDB Server for Debugging

The GDB server utility provided with Sourcery G++ Lite can be used to debug a GNU/Linux application. While Sourcery G++ runs on your host system, `gdbserver` and the target application run on your target system. Even though Sourcery G++ and your application run on different systems, the debugging experience when using `gdbserver` is very similar to debugging a native application.

### 3.6.1. Running GDB Server

The GDB server executables are included in the sysroot in ABI-specific subdirectories of *sysroot/usr*. Use the executable from the sysroot and library subdirectory that match your program. See Section 3.2, “Library Configurations” for details.

You must copy the sysroot to your target system as described in Section 3.5.1, “Installing the Sysroot”. You must also copy the executable you want to debug to your target system.

If you have installed the sysroot in the root directory of the filesystem on the target, you can invoke `gdbserver` as:

```
> gdbserver :10000 program arg1 arg2 ...
```

where *program* is the path to the program you want to debug and *arg1 arg2 ...* are the arguments you want to pass to it. The `:10000` argument indicates that `gdbserver` should listen for connections from GDB on port 10000. You can use a different port, if you prefer.

If you have installed the sysroot in an alternate directory, invoking `gdbserver` becomes more complicated. You must build your application using the link-time options to specify the location of the sysroot, as described in Section 3.5.2, “Using Linker Options to Specify the Sysroot Location”. You must also invoke `gdbserver` itself using the dynamic linker provided in the Sourcery G++ sysroot, as described in Section 3.5.3, “Specifying the Sysroot Location at Runtime”. In other words, the command to invoke `gdbserver` in this case would be similar to:

```
> sysroot/lib/ld.so.1 \  
--library-path sysroot/lib:sysroot/usr/lib \  
sysroot/usr/lib/bin/gdbserver :10000 program arg1 arg2 ...
```

### 3.6.2. Connecting to GDB Server from the Debugger

You can connect to GDB server by using the following command from within GDB:

```
(gdb) target remote target:10000
```

where *target* is the host name or IP address of your target system.

When your program exits, *gdbserver* exits too. If you want to debug the program again, you must restart *gdbserver* on the target. Then, in GDB, reissue the *target* command shown above.

### 3.6.3. Setting the Sysroot in the Debugger

In order to debug shared libraries, GDB needs to map the pathnames of shared libraries on the target to the pathnames of equivalent files on the host system. Debugging of multi-threaded applications also depends on correctly locating copies of the libraries provided in the *sysroot* on the host system.

In some situations, the target pathnames are valid on the host system. Otherwise, you must tell GDB how to map target pathnames onto the equivalent host pathnames.

In the general case, there are two GDB commands required to set up the mapping:

```
(gdb) set sysroot-on-target target-pathname  
(gdb) set sysroot host-pathname
```

This causes GDB to replace all instances of the *target-pathname* prefix in shared library pathnames reported by the target with *host-pathname* to get the location of the equivalent library on the host.

If you have installed the *sysroot* in the root filesystem on the target, you can omit the *set sysroot-on-target* command, and use only *set sysroot* to specify the location on the host system.

Refer to Section 3.5.1, “Installing the Sysroot” for more information about installing the *sysroot* on the target. Note that if you have installed a stripped copy of the provided libraries on the target, you should give GDB the location of an unstripped copy on the host.

---

# **Chapter 4**

## **Using Sourcery G++ from the Command Line**

This chapter demonstrates the use of Sourcery G++ Lite from the command line.

## 4.1. Building an Application

This chapter explains how to build an application with Sourcery G++ Lite using the command line. As elsewhere in this manual, this section assumes that your target system is mips-linux-gnu, as indicated by the `mips-linux-gnu` command prefix.

Using an editor (such as notepad on Microsoft Windows or `vi` on UNIX-like systems), create a file named `main.c` containing the following simple factorial program:

```
#include <stdio.h>

int factorial(int n) {
    if (n == 0)
        return 1;
    return n * factorial (n - 1);
}

int main () {
    int i;
    int n;
    for (i = 0; i < 10; ++i) {
        n = factorial (i);
        printf ("factorial(%d) = %d\n", i, n);
    }
    return 0;
}
```

Compile and link this program using the command:

```
> mips-linux-gnu-gcc -o factorial main.c
```

There should be no output from the compiler. (If you are building a C++ application, instead of a C application, replace `mips-linux-gnu-gcc` with `mips-linux-gnu-g++`.)

## 4.2. Running Applications on the Target System

You may need to install the Sourcery G++ runtime libraries and dynamic linker on the target system before you can run your application. Refer to Chapter 3, “Sourcery G++ Lite for MIPS GNU/Linux” for specific instructions.

To run your program on a GNU/Linux target system, use the command:

```
> factorial
```

You should see:

```
factorial(0) = 1
factorial(1) = 1
factorial(2) = 2
factorial(3) = 6
factorial(4) = 24
factorial(5) = 120
factorial(6) = 720
factorial(7) = 5040
```

```
factorial(8) = 40320  
factorial(9) = 362880
```

## 4.3. Running Applications from GDB

You can run GDB, the GNU Debugger, on your host system to debug programs running remotely on a target board or system.

When starting GDB, give it the pathname to the program you want to debug as a command-line argument. For example, if you have built the factorial program as described in Section 4.1, “Building an Application”, enter:

```
> mips-linux-gnu-gdb factorial
```

While this section explains the alternatives for using GDB to run and debug application programs, explaining the use of the GDB command-line interface is beyond the scope of this document. Please refer to the GDB manual for further instructions.

### 4.3.1. Connecting to the Sourcery G++ Debug Sprite

The Sourcery G++ Debug Sprite is a program that runs on the host system to support hardware debugging devices. You can use the Debug Sprite to run and debug programs on a target board without an operating system, or to debug an operating system kernel. See Chapter 5, “Sourcery G++ Debug Sprite” for detailed information about the supported devices.

You can start the Sprite directly from within GDB:

```
(gdb) target remote | mips-linux-gnu-sprite arguments
```

Refer to Section 5.2, “Invoking Sourcery G++ Debug Sprite” for a full description of the Sprite arguments.

### 4.3.2. Connecting to an External GDB Server

Sourcery G++ Lite includes a program called `gdbserver` that can be used to debug a program running on a remote MIPS GNU/Linux target. Follow the instructions in Chapter 3, “Sourcery G++ Lite for MIPS GNU/Linux” to install and run `gdbserver` on your target system.

From within GDB, you can connect to a running `gdbserver` or other debugging stub that uses the GDB remote protocol using:

```
(gdb) target remote host:port
```

where *host* is the host name or IP address of the machine the stub is running on, and *port* is the port number it is listening on for TCP connections.

---

# Chapter 5

## Sourcery G++ Debug Sprite

This chapter describes the use of the Sourcery G++ Debug Sprite for remote debugging. The Sprite is provided for debugging of the Linux kernel on the target board. This chapter includes information about the debugging devices and boards supported by the Sprite for MIPS GNU/Linux.

Sourcery G++ Lite contains the Sourcery G++ Debug Sprite for MIPS GNU/Linux. This Sprite is provided to allow debugging of programs running on a bare board. You can use the Sprite to debug a program when there is no operating system on the board, or for debugging the operating system itself. If the board is running an operating system, and you wish to debug a program running on that OS, you should use the facilities provided by the OS itself (for instance, using `gdbserver`).

The Sprite acts as an interface between GDB and external debug devices and libraries. Refer to Section 5.2, “Invoking Sourcery G++ Debug Sprite” for information about the specific devices supported by this version of Sourcery G++ Lite.

### Note for Linux users

The Debug Sprite provided with Sourcery G++ Lite allows remote debugging of the Linux kernel running on the target. For remote debugging of application programs, you should use `gdbserver` instead. See Chapter 3, “Sourcery G++ Lite for MIPS GNU/Linux” for details about how to install and run `gdbserver` on the target.

### Important

The Sourcery G++ Debug Sprite is not part of the GNU Debugger and is not free or open-source software. You may use the Sourcery G++ Debug Sprite only with the GNU Debugger. You may not distribute the Sourcery G++ Debug Sprite to any third party.

## 5.1. Probing for Debug Devices

Before running the Sourcery G++ Debug Sprite for the first time, or when attaching new debug devices to your host system, it is helpful to verify that the Sourcery G++ Debug Sprite recognizes your debug hardware. From the command line, invoke the Sprite with the `-i` option:

```
> mips-linux-gnu-sprite -i
```

This prints out a list of supported device types. For devices that can be autodetected, it additionally probes for and prints out a list of attached devices. For instance:

```
CodeSourcery MIPS Debug Sprite (Sourcery G++ Lite 4.4-303)
mdi: [lib=<file>&cfg=<file>&rst=<n>] MDI device
  mdi:/23/1 - 24KE      (Instruction)/24KE LE
  mdi:/23/2 - 24KE      (Instruction)/24KE BE
  mdi:/24/1 - 24KE      (Cycle)/24KE LE
  mdi:/24/2 - 24KE      (Cycle)/24KE BE
  mdi:/$Target/$Device - Generic MDI target/device
```

This shows that MDI (Microprocessor Debug Interface) devices are supported. Four MIPSsim devices have been autodetected. Note that additional configuration steps for the MDI library are required to allow the Sprite to autodetect devices; see Section 5.4, “MDI Devices”.

## 5.2. Invoking Sourcery G++ Debug Sprite

The Debug Sprite is invoked as follows:

```
> mips-linux-gnu-sprite [options] device-url board-file
```

The `device-url` specifies the debug device to use to communicate with the board. It follows the standard format:

```
scheme:scheme-specific-part[?device-options]
```

Most device URL schemes also follow the regular format:

```
scheme:[//hostname:[port]]/path[?device-options]
```

The meanings of *hostname*, *port*, *path* and *device-options* parts depend on the *scheme* and are described below. The following schemes are supported in Sourcery G++ Lite for MIPS GNU/Linux:

**mdi** Use a Microprocessor Debug Interface (MDI) debugging device. Refer to Section 5.4, “MDI Devices”.

The optional *?device-options* portion is allowed in all schemes. These allow additional device-specific options of the form *name=value*. Multiple options are concatenated using *&*.

The *board-file* specifies an XML file that describes how to initialize the target board, as well as other properties of the board used by the debugger. If *board-file* refers to a file (via a relative or absolute pathname), it is read. Otherwise, *board-file* can be a board name, and the toolchain's board directory is searched for a matching file. See Section 5.6, “Supported Board Files” for the list of supported boards, or invoke the Sprite with the *-b* option to list the available board files. You can also write a custom board file; see Section 5.7, “Board File Syntax” for more information about the file format.

Both the *device-url* and *board-file* command-line arguments are required to correctly connect the Sprite to a target board.

## 5.3. Sourcery G++ Debug Sprite Options

The following command-line options are supported by the Sourcery G++ Debug Sprite:

- b** Print a list of *board-file* files in the board config directory.
- h** Print a list of options and their meanings. A list of *device-url* syntaxes is also shown.
- i** Print a list of the accessible devices. If a *device-url* is also specified, only devices for that device type are scanned. Each supported device type is listed along with the options that can be appended to the *device-url*. For each discovered device, the *device-url* is printed along with a description of that device.
- l [host]:port** Specify the host address and port number to listen for a GDB connection. If this option is not given, the Debug Sprite communicates with GDB using *stdin* and *stdout*. If you start the Sprite from within GDB using the *target remote | mips-linux-gnu-sprite ...* command, you do not need this option.
- m** Listen for multiple sequential connections. Normally the Debug Sprite terminates after the first connection from GDB terminates. This option instead makes it listen for a subsequent connection. To terminate the Sprite, open a connection and send the string *END\n*.
- q** Do not print any messages.



`-v` Print additional messages.

If any of `-b`, `-i` or `-h` are given, the Debug Sprite terminates after providing the information rather than waiting for a debugger connection.

## 5.4. MDI Devices

The Sourcery G++ Debug Sprite for MIPS supports MDI (Microprocessor Debug Interface) devices. Each MDI device is identified by a target number and device number; these form the *path* part of the device URL, and the *hostname* and *port* must be empty or omitted. Thus, the *device-url* has the form:

```
mdi:///targetnum/devicenum[?device-options]
```

You can also use the environment variables `GDBMDITARGET` and `GDBMDIDEVICE` to provide defaults for the *targetnum* and *devicenum*.

The following *device-options* are permitted:

`lib=filename` This option specifies the MDI library to load. It is equivalent to setting the `GDBMDILIB` environment variable.

`cfg=filename` Some MDI target libraries, such as MIPSsim, require a configuration file. (This is distinct from the Sprite's own *board-file*.) You can use this option to specify the file. It is equivalent to setting the `GDBMIPSSIMCONFIG` environment variable.

`rst=seconds` This option can be used to specify a delay after the target is reset by the Sprite. If the value of *seconds* is greater than zero, then execution is resumed for the specified number of seconds; this can be used to allow power-on firmware to initialize the memory controller and peripherals. Then the target is halted again and queried for configuration.

If the value of *seconds* is `-1`, then the target is queried immediately without reset. This is the same effect as passing the `-a` command-line option to the Sprite, which allows the Sprite to attach to a running program.

This option is equivalent to setting the `GDBMDICONNRST` environment variable. If neither the option nor the environment variable are provided, the default is to reset the target and query it immediately unless the `-a` option is specified.

`group=/targetn/devicen` This option may be specified multiple times and is cumulative. Each of the specified devices is opened and queried and they are all treated as threads of execution, subject to being enabled or active; if a device is disabled or has no active thread contexts associated with it, it is not visible to GDB but is still under control of the Sprite in case its state changes. This option cannot be used in combination with the `team=` option.

`team=/targetn/devicen` This option may be specified multiple times and is cumulative. The specified devices are not opened, but are associated with the base device by means of the MDI team mechanism for the

purpose of synchronization. The specified devices may still be opened and controlled by another debugger (such as another instance of the Debug Sprite) independently. This option cannot be used in combination with the `group=` option.

Before you can connect to a target using the MDI API, you must tell the Debug Sprite which shared library or DLL to load for your simulator or device. On Linux hosts you should add the directory containing the shared library files to your `LD_LIBRARY_PATH` environment variable. On Windows hosts, add the directory containing the DLLs to your `PATH` environment variable. Then, either set the environment variable `GDBMDILIB` to the base name of the MDI library before starting the Debug Sprite, or use the `lib=` device option to specify the library to load.

Similarly, the `-i` command-line option can only probe for devices if you have set the `PATH` or `LD_LIBRARY_PATH` environment variable appropriately, and specify an MDI library using either the `GDBMDILIB` environment variable or the `lib=` device option. Otherwise, it reports only the generic `device-url` syntax.

For example, to use an FS2 probe on a Windows host to debug a MIPS Malta board, first add the directory containing the MDI DLLs to your `PATH`. Then you can invoke the Sprite from GDB using a command line similar to:

```
(gdb) target remote | mips-linux-gnu-sprite \  
'mdi:/2/2?lib=jnetfs2mdilib.dll&rst=7' malta
```

The quotes are required to prevent special characters in the `device-url` from being interpreted by the shell.

In the above command, the `rst=7` option provides for a sufficient delay for the board's reset code to execute on connection. Since this takes several seconds, GDB may time out waiting for the Sprite to respond. You can prevent this by issuing this command before you connect to the Sprite:

```
(gdb) set remotetimeout 10
```

To use the Sprite with MIPSsim, a configuration file is required. The configuration files provided with the MIPSsim distribution are intended for use with standalone execution from the command line, rather than running the program from the debugger. So, make a copy and comment out the `APP_FILE` setting. It is also recommended that you comment out `TRACE_FILE` as well, since the trace files can be very large.

To connect to MIPSsim using the Sprite on a Linux host, first set your `LD_LIBRARY_PATH` and `GDBMDILIB` as described above. You can run the Sprite from the shell to probe for devices to verify that your setup is correct:

```
> mips-linux-gnu-sprite -i
```

Then, from GDB, use a command similar to:

```
(gdb) target remote | mips-linux-gnu-sprite \  
'mdi:/23/2?cfg=24KE.cfg&rst=-1' mipssim
```

Fill in your target and device numbers as reported by the probe output, and the full pathname to your configuration file. The `rst=-1` option is required, as MIPSsim does not support reset.

This section describes only the basic MDI usage; refer to the documentation for your MDI simulator or debug device for details specific to that target. Note, in particular, that some MDI targets may require you to set up a license in addition to the steps given here.

## 5.5. Debugging a Remote Board

You can run the Sourcery G++ Debug Sprite on a different machine from the one on which GDB is running. For example, if your board is connected to a machine in your lab, you can run the debugger on your laptop and connect to the remote board. The Sourcery G++ Debug Sprite must run on the machine that is connected to the target board. You must have Sourcery G++ installed on both machines.

To use this mode, you must start the Sprite with the `-l` option and specify the port on which you want it to listen. For example:

```
> mips-linux-gnu-sprite -l :10000 device-url board-file
```

starts the Sprite listening on port 10000.

When running GDB from the command line, use the following command to connect GDB to the remote Sprite:

```
(gdb) target remote host:10000
```

where *host* is the name of the remote machine. After this, debugging is just as if you are debugging a target board connected to your host machine.

For more detailed instructions on using the Sourcery G++ Debug Sprite in this way, please refer to the Sourcery G++ Knowledge Base<sup>1</sup>.

## 5.6. Supported Board Files

The Sourcery G++ Debug Sprite for MIPS GNU/Linux includes support for the following target boards. Specify the appropriate *board-file* as an argument when invoking the Sprite from the command line.

Board	Config
MIPS Malta	malta
MIPS SEAD-3 LX110	sead3-lx110
MIPS SEAD-3 LX50	sead3-lx50
MIPSSim	mipssim

## 5.7. Board File Syntax

The *board-file* can be a user-written XML file to describe a non-standard board. The Sourcery G++ Debug Sprite searches for board files in the `mips-linux-gnu/lib/boards` directory in the installation. Refer to the files in that directory for examples.

The file's DTD is:

```
<!-- Board description files
  Copyright (c) 2007-2009 CodeSourcery, Inc.
```

<sup>1</sup> <https://support.codesourcery.com/GNUToolchain/kbentry132>

THIS FILE CONTAINS PROPRIETARY, CONFIDENTIAL, AND TRADE SECRET INFORMATION OF CODESOURCERY AND/OR ITS LICENSORS.

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-->

```

<!ELEMENT board
  (properties?, feature?, initialize?, memory-map?)>

<!ELEMENT properties
  (description?, property*)>

<!ELEMENT initialize
  (write-register | write-memory | delay
   | wait-until-memory-equal | wait-until-memory-not-equal)* >
<!ELEMENT write-register EMPTY>
<!ATTLIST write-register
  address CDATA #REQUIRED
  value CDATA #REQUIRED
  bits CDATA #IMPLIED>
<!ELEMENT write-memory EMPTY>
<!ATTLIST write-memory
  address CDATA #REQUIRED
  value CDATA #REQUIRED
  bits CDATA #IMPLIED>
<!ELEMENT delay EMPTY>
<!ATTLIST delay
  time CDATA #REQUIRED>
<!ELEMENT wait-until-memory-equal EMPTY>
<!ATTLIST wait-until-memory-equal
  address CDATA #REQUIRED
  value CDATA #REQUIRED
  timeout CDATA #IMPLIED
  bits CDATA #IMPLIED>
<!ELEMENT wait-until-memory-not-equal EMPTY>
<!ATTLIST wait-until-memory-not-equal
  address CDATA #REQUIRED
  value CDATA #REQUIRED
  timeout CDATA #IMPLIED
  bits CDATA #IMPLIED>

<!ELEMENT memory-map (memory-device)*>
<!ELEMENT memory-device (property*, description?, sectors*)>
<!ATTLIST memory-device
  address CDATA #REQUIRED
  size CDATA #REQUIRED
  type CDATA #REQUIRED
  device CDATA #IMPLIED>

<!ELEMENT description (#PCDATA)>
<!ELEMENT property (#PCDATA)>

```

```

<!ATTLIST property name CDATA #REQUIRED>
<!ELEMENT sectors EMPTY>
<!ATTLIST sectors
  size CDATA #REQUIRED
  count CDATA #REQUIRED>

<!ENTITY % gdbtarget SYSTEM "gdb-target.dtd">
%gdbtarget;

```

All values can be provided in decimal, hex (with a 0x prefix) or octal (with a 0 prefix). Addresses and memory sizes can use a K, KB, M, MB, G or GB suffix to denote a unit of memory. Times must use a ms or us suffix.

The following elements are available:

<board>	This top-level element encapsulates the entire description of the board. It can contain <properties>, <feature>, <initialize> and <memory-map> elements.
<properties>	The <properties> element specifies specific properties of the target system. This element can occur at most once. It can contain a <description> element.
<initialize>	The <initialize> element defines an initialization sequence for the board, which the Sprite performs before downloading a program. It can contain <write-register>, <write-memory> and <delay> elements.
<feature>	This element is used to inform GDB about additional registers and peripherals available on the board. It is passed directly to GDB; see the GDB manual for further details.
<memory-map>	This element describes the memory map of the target board. It is used by GDB to determine where software breakpoints may be used and when flash programming sequences must be used. This element can occur at most once. It can contain <memory-device> elements.
<memory-device>	This element specifies a region of memory. It has four attributes: <code>address</code> , <code>size</code> , <code>type</code> and <code>device</code> . The <code>address</code> and <code>size</code> attributes specify the location of the memory device. The <code>type</code> attribute specifies that device as <code>ram</code> , <code>rom</code> or <code>flash</code> . The <code>device</code> attribute is required for flash regions; it specifies the flash device type. The <memory-device> element can contain a <description> element.
<write-register>	This element writes a value to a control register. It has three attributes: <code>address</code> , <code>value</code> and <code>bits</code> . The <code>bits</code> attribute, specifying the bit width of the write operation, is optional; it defaults to 32.
<write-memory>	This element writes a value to a memory location. It has three attributes: <code>address</code> , <code>value</code> and <code>bits</code> . The <code>bits</code> attribute is optional and defaults to 32. Bit widths of 8, 16 and 32 bits are supported. The address written to must be naturally aligned for the size of the write being done.
<delay>	This element introduces a delay. It has one attribute, <code>time</code> , which specifies the number of milliseconds, or microseconds to delay by.

`<description>` This element encapsulates a human-readable description of its enclosing element.

`<property>` The `<property>` element allows additional name/value pairs to be specified. The property name is specified in a name attribute. The property value is the body of the `<property>` element.

---

# **Chapter 6**

## **Next Steps with Sourcery G++**

This chapter describes where you can find additional documentation and information about using Sourcery G++ Lite and its components.

## 6.1. Sourcery G++ Knowledge Base

The Sourcery G++ Knowledge Base is available to registered users at the Sourcery G++ Portal<sup>1</sup>. Here you can find solutions to common problems including installing Sourcery G++, making it work with specific targets, and interoperability with third-party libraries. There are also additional example programs and tips for making the most effective use of the toolchain and for solving problems commonly encountered during debugging. The Knowledge Base is updated frequently with additional entries based on inquiries and feedback from customers.

## 6.2. Manuals for GNU Toolchain Components

Sourcery G++ Lite includes the full user manuals for each of the GNU toolchain components, such as the compiler, linker, assembler, and debugger. Most of the manuals include tutorial material for new users as well as serving as a complete reference for command-line options, supported extensions, and the like.

When you install Sourcery G++ Lite, links to both the PDF and HTML versions of the manuals are created in the shortcuts folder you select. If you elected not to create shortcuts when installing Sourcery G++ Lite, the documentation can be found in the `share/doc/sourceryg++-mips-linux-gnu/` subdirectory of your installation directory.

In addition to the detailed reference manuals, Sourcery G++ Lite includes a Unix-style manual page for each toolchain component. You can view these by invoking the `man` command with the pathname of the file you want to view. For example, you can first go to the directory containing the man pages:

```
> cd $INSTALL/share/doc/sourceryg++-mips-linux-gnu/man/man1
```

Then you can invoke `man` as:

```
> man ./mips-linux-gnu-gcc.1
```

Alternatively, if you use `man` regularly, you'll probably find it more convenient to add the directory containing the Sourcery G++ man pages to your `MANPATH` environment variable. This should go in your `.profile` or equivalent shell startup file; see Section 2.6, "Setting up the Environment" for instructions. Then you can invoke `man` with just the command name rather than a pathname.

Finally, note that every command-line utility program included with Sourcery G++ Lite can be invoked with a `--help` option. This prints a brief description of the arguments and options to the program and exits without doing further processing.

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<sup>1</sup> <https://support.codesourcery.com/GNUToolchain/>



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# Appendix A

## Sourcery G++ Lite Release Notes

This appendix contains information about changes in this release of Sourcery G++ Lite for MIPS GNU/Linux. You should read through these notes to learn about new features and bug fixes.

## A.1. Changes in Sourcery G++ Lite for MIPS GNU/Linux

This section documents Sourcery G++ Lite changes for each released revision.

### A.1.1. Changes in Sourcery G++ Lite 4.4-303

**GCC fix for reference to undefined label.** A bug in the optimizer that caused GCC to emit references to undefined labels has been fixed.

**MIPS 34Kn support.** Sourcery G++ now includes support for MIPS 34Kn processors. To compile for these processors, use `-march=34kn`.

**Default setting for MIPS16 interlinking.** MIPS16 interlinking is now disabled by default except when compiling for microMIPS. Interlinking carries a performance penalty and is only required for microMIPS targets.

**Improved code generation for `if` statements.** The compiler can now generate better code for `if` statements when the `then` and `else` clauses contain similar code.

**Fix for invalid code generation bug.** An optimizer bug has been fixed that caused GCC to emit incorrect code for some programs involving casts of a `struct` pointer to a pointer to the structure's first element.

**microMIPS and MIPS16 diagnostic.** The compiler now reports an error if the options `-mmicromips` and `-mips16` are both specified.

**Compiler performance tuning.** Several compiler issues affecting benchmarking performance relative to 4.3-204 have been corrected.

**Array bounds warning bug fix.** An optimizer bug has been fixed that caused GCC to incorrectly report the warning `array subscript is above array bounds`.

**DSPR2 support.** The compiler now automatically enables support for the DSPR2 ASE when the `-march` option is used to specify a core in the 74K family. It is no longer necessary to provide the `-mdspr2` option explicitly.

**Static variables and inlining bug fix.** A bug in GCC that caused miscompilation of functions containing static variables when they were inlined at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fremove-local-statics` command-line option was used.

**Improved linker diagnostic.** The linker now produces a less cryptic error message when a jump instruction that does not support interlinking is used to change modes.

**C++ code bloat with `-g`.** An assembler bug that caused C++ programs that do not use exceptions to include unnecessary library routines when built with debug information enabled has been fixed.

**Strip bug fix.** A bug has been fixed in the `strip` and `objcopy` utilities which caused them to sometimes produce stripped object files that the linker could not recognize.

**Debug Sprite remote reset support.** The Sourcery G++ Debug Sprite now supports resetting the remote target with GDB's `monitor reset` command. Further subcommands are supported – use GDB's `monitor help reset` command for details.

**Debug Sprite single stepping performance improvements.** The Sourcery G++ Debug Sprite has been tuned for better single stepping performance with MT processors, such as the MIPS 34K CPU.

**Debug Sprite MIPSsim profiling support.** The Sourcery G++ Debug Sprite now supports gathering instruction- and cycle-accurate profile information with MIPSsim.

**Debug Sprite initial frame bug fix.** A bug in the Sourcery G++ Debug Sprite has been fixed that caused the debugger to report incorrect call frame information on the initial connection.

### A.1.2. Changes in Sourcery G++ Lite 4.4-203

**Debug Sprite remote command support.** The Sourcery G++ Debug Sprite now supports remote commands with GDB's `monitor mdi` command. Any arguments specified to this command are passed on to the MDI library for interpretation. For more information about commands supported see documentation supplied with the MDI library used.

**Debug Sprite termination behavior.** The Sourcery G++ Debug Sprite has been enhanced to better support GDB's different debugger shutdown modes. The GDB `kill` command now makes the target run from the reset vector, while the `disconnect` command now leaves the target halted at its current location. Formerly, both of these commands incorrectly caused the target to continue running freely from the point where it had been stopped. That behavior is now supported by the Sprite in response to the GDB `detach` command instead.

**Debug Sprite termination bug fix.** A bug in the Sourcery G++ Debug Sprite has been fixed that caused it to crash upon termination if the device being closed reported a fatal condition while shutdown was in progress.

**Incorrect code generation bug fix.** A bug in GCC has been fixed that resulted in incorrect code for some `unsigned short` array accesses when compiling with `-mdsp`.

**Linker bug fix for `--section-start`.** A linker bug that caused `--section-start` to fail to work as documented if the section is defined in multiple object files has been fixed.

**Cavium Octeon disassembly.** GDB now supports disassembling the Cavium Octeon unaligned instructions and the `saa` and `saad` instructions present on some Octeon processors.

**GCC internal compiler error.** A bug has been fixed that caused GCC to crash when compiling some C++ code using templates at `-O2` or `-O3`.

**Debug Sprite performance improvements.** The Sourcery G++ Debug Sprite has been tuned to give better performance when single stepping.

**GCC internal compiler error with `optimize` attribute.** A bug has been fixed that caused the compiler to crash when invoked with the `-O0` or `-O1` option on code using the `optimize` attribute to specify higher optimization levels for individual functions.

### A.1.3. Changes in Sourcery G++ Lite 4.4-160

**GDB update.** The included version of GDB has been updated to 7.0.50.20100218. This update adds numerous bug fixes and new features, including improved C++ language support, automatic caching of stack memory, and Position Independent Executable (PIE) support.

**Static constructor and destructor ordering fixes.** The linker now correctly ensures that static destructors with priorities are executed after destructors without priorities. Another linker bug that

caused incorrect static constructor and destructor ordering with partial linking involved has been fixed.

**GDB asynchronous mode fix.** GDB can now be used from the command line in asynchronous mode with remote targets. Previously, GDB did not accept user input while asynchronous commands (such as `continue &`) were running.

**GDB interrupt handling bug fix.** A bug in GDB has been fixed that caused it to sometimes fail to indicate that the target had stopped after being interrupted. The bug affected clients using GDB's MI front end.

**Function breakpoint bug fix.** A bug in GDB has been fixed that sometimes caused breakpoints on functions without an associated stack frame to be placed at the wrong address.

**GDB MDI target support.** Microprocessor Debug Interface (MDI) protocol support is now provided by the Sourcery G++ Debug Sprite for MIPS. The direct MDI support within GDB, which was deprecated with the introduction of the Sprite in a previous release of Sourcery G++ Lite, has now been removed. This includes GDB commands such as `target mdi`. For information about using the Sprite to debug MDI targets, refer to Chapter 5, "Sourcery G++ Debug Sprite".

**Debug Sprite multiple connections fix.** When started with the `-m` option, the Sourcery G++ Debug Sprite no longer exits if the connection to GDB is lost when sending a response. Instead, it goes back to waiting for another connection.

**MIPS32 revision 2.61 SYNC instruction types.** Binary utilities have been extended to support additional SYNC instruction types introduced with revision 2.61 of the MIPS32 architecture specification.

**GDB and programs linked with the `--gc-sections` linker option.** GDB has been improved to better handle debug information found in programs and libraries linked with the `--gc-sections` option. GDB formerly selected the wrong debug information in some cases, resulting in incorrect behavior when stepping over a function or displaying local variables, for example.

**EGLIBC version 2.11.** Sourcery G++ Lite for MIPS GNU/Linux now includes EGLIBC version 2.11 library which is based on GNU C Library version 2.11. For more information about changes, see [http://www.eglibc.org/news#eglibc\\_2\\_11](http://www.eglibc.org/news#eglibc_2_11).

**GDB memory find bug fix.** A bug in GDB's `find` command has been fixed. The bug caused searches on large memory areas to fail or report matches at incorrect addresses.

**Frame manipulation bug fix.** A bug in GDB has been fixed that caused frame manipulation commands to report an internal error in some cases when used on arbitrary stack frames specified by an address.

**Read watchpoints bug fix.** A GDB bug has been fixed that caused watchpoints set to trigger on memory reads to be silently ignored in some cases.

**Setting thread-specific breakpoints in GDB.** A bug in GDB has been fixed that caused a syntax error for the `break *expression thread threadnum` command.

#### A.1.4. Changes in Sourcery G++ Lite 4.4-158

**microMIPS single stepping bug fix.** A bug in GDB has been fixed that affected single stepping over microMIPS branch instructions. The bug caused GDB to sometimes continue target execution rather than step.

**Debug Sprite device path interpretation bug fix.** A bug in the Sourcery G++ Debug Sprite's interpretation of device paths has been fixed. Target and device numbers are now stable between debug sessions as long as the configuration of the target board or simulator remains the same. Previously the numbers could change in some cases.

**microMIPS breakpoint bug fix.** A bug in GDB has been fixed that, in some cases, caused an incorrect encoding to be chosen for breakpoints while debugging little-endian programs. The bug made such breakpoints never hit and caused unpredictable behavior of the program debugged.

**Debugging preprocessed source code.** A compiler bug has been fixed that caused debug output to erroneously contain the name of the intermediate preprocessed file.

### A.1.5. Changes in Sourcery G++ Lite 4.4-123

**Breakpoint bug fix.** A bug in GDB has been fixed that, in rare circumstances, caused hitting a breakpoint to result in an illegal instruction or segmentation fault in the program being debugged.

**Default generation of JALS instruction.** The compiler now defaults to `-mno-jals`. The microMIPS `JALS` instruction is not compatible with the current implementation of shared library support in the compiler.

**FP condition branch single stepping bug fix.** A bug in GDB has been fixed that affected single stepping over floating point condition branch instructions. The bug caused GDB to sometimes continue target execution rather than step.

**microMIPS debugging.** GDB now supports debugging microMIPS code. Earlier versions of GDB reported the error `software single-stepping unsupported for microMIPS`.

**DSP and MIPS-3D ASE single stepping.** GDB now supports stepping through DSP and MIPS-3D ASE branch instructions. Earlier versions failed to advance execution.

### A.1.6. Changes in Sourcery G++ Lite 4.4-114

**Support for MIPS M14K and M14Kc processors.** Sourcery G++ Lite now supports the MIPS M14K and M14Kc processors. To compile for these targets, use the `-march=m14k -mmicromips` command-line options.

**Support for microMIPS instruction encoding.** Sourcery G++ Lite now supports the microMIPS instruction set architecture. To enable microMIPS code generation, compile and link with `-mmicromips`.

**Code size with `-g`.** A bug that caused binary code size regressions in GCC 4.4 when compiling with `-g` has been fixed.

**Incorrect symbol addresses bug fix.** A bug in the linker that caused it to assign incorrect addresses to symbols has been fixed. The bug occurred when the input objects contained sections not explicitly mentioned in the linker script and was most likely to occur when building the Linux kernel.

**Sourcery G++ Debug Sprite for MIPS.** This release of Sourcery G++ Lite includes the new Sourcery G++ Debug Sprite for MIPS. The Sprite provides similar functionality to the Microprocessor Debug Interface (MDI) protocol support in GDB, but is implemented as an external program which can be run from GDB, rather than in GDB itself. The GDB MDI support is deprecated and will be removed in a future release of Sourcery G++ Lite. For information about using the Sprite, refer to Chapter 5, "Sourcery G++ Debug Sprite".

**Debugging programs built by Green Hills compilers.** GDB has been further extended to accommodate non-standard debug information produced by some Green Hills toolchains.

**Optimizer bug fix.** A bug in GCC that caused internal compiler errors at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fpromote-loop-indices` command-line option was used.

**Static variables and `asm` statements bug fix.** A bug in GCC that caused functions containing static variables and `asm` statements to be miscompiled at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fremove-local-statics` command-line option was used.

**Optimizer bug fix.** A bug in GCC that caused functions with complex loop nests to be miscompiled at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fpromote-loop-indices` command-line option was used.

**Improved assembler error checking.** The assembler has been improved to perform additional checks for invalid inputs.

### A.1.7. Changes in Sourcery G++ Lite 4.4-57

**GDB `finish` internal error.** A bug has been fixed that caused a GDB internal error when using the `finish` command. The bug occurred when debugging optimized code.

**GDB update.** The included version of GDB has been updated to 6.8.50.20090630. This update adds numerous bug fixes and new features, including support for multi-byte and wide character sets and improved C++ template support.

**GDB and third-party compilers.** Some bugs that caused GDB to crash when debugging programs compiled with third-party tools have been fixed. These bugs did not affect programs built with Sourcery G++.

**GDB internal warning fix.** A GDB bug has been fixed that caused warnings of the form `warning: (Internal error: pc address in read in psyntab, but not in symtab.)`.

**@*FILE* fix.** A bug has been fixed in the processing of `@FILE` command-line options by GCC, GDB, and other tools. The bug caused any options in `FILE` following a blank line to be ignored.

**Multi-threaded debugging fix.** A GDB bug has been fixed that caused the `step` command to hang when debugging a multi-threaded program.

**ELF file corruption with `strip`.** A bug that caused `strip` to corrupt unusual ELF files has been fixed.

**GDB support for Cygwin pathnames.** A bug in GDB's translation of Cygwin pathnames has been fixed.

**`gdbserver` multi-threaded debugging fix.** A bug has been fixed that prevented `gdbserver` from exiting after debugging a multi-threaded program.

**Startup code debugging fixes.** Two GDB bugs have been fixed that caused errors when debugging startup code. One bug caused an internal error message; the other caused the error `Cannot find bounds of current function`.

**Debugging programs built by Green Hills compilers.** GDB has been extended to accommodate non-standard debug information produced by some Green Hills toolchains.

**GCC internal compiler error.** A bug has been fixed that caused the compiler to crash when optimizing code that casts between structure types and the type of the first field.

**ELF Program Headers.** The linker now better diagnoses errors in the usage of FILEHDR and PHDRS keywords in PHDRS command of linker scripts. Refer to the linker manual for more information.

**Preprocessor error handling.** The preprocessor now treats failing to find a file referenced via #include as a fatal error.

**Floating-point register display bug fix.** A bug in GDB has been fixed that caused `info reg` to report `internal-error: mips_read_fp_register_double: bad access to odd-numbered FP register.`

### A.1.8. Changes in Sourcery G++ Lite 4.4-20

**Linux kernel headers update.** Linux kernel header files have been updated to version 2.6.30.

**Remote debugging hardware watchpoint bug fix.** A GDB bug has been fixed that caused hardware watchpoint hits to be incorrectly reported in some cases.

**Optimizer improvements.** When optimizing for speed, the compiler now uses improved heuristics to limit certain types of optimizations that may adversely affect both code size and speed. This change also makes it possible to produce better code when optimizing for space rather than speed.

**gdbserver bug fix.** A bug has been fixed that caused `gdbserver` to crash when debugging programs using thread-local storage without other multi-threading features.

**Binutils update.** The `binutils` package has been updated to version 2.19.51.20090709 from the FSF trunk. This update includes numerous bug fixes.

**Support for MIPS 1004K cores.** Sourcery G++ now includes basic compiler and assembler support for MIPS 1004K cores. Use the `-march=1004kc` (integer cores), `-march=1004kf2_1` (half-speed FPU), `-march=1004kf1_1` (full-speed FPU), or `-march=1004kf` (alias for `1004kf2_1`) command-line options.

**GDB backwards compatibility fix.** A bug has been fixed that caused GDB to crash when loading symbols from binaries built by very old versions of GCC.

**Register variable corruption.** A compiler bug has been fixed that caused incorrect code to be generated when the frame pointer or other special-use registers are used as explicit local register variables, introduced via the `asm` keyword on their declarations.

**Stack unwinding termination bug fix.** A bug has been fixed that caused GDB not to detect the outermost frame correctly while doing stack unwinding. The bug sometimes caused the debugger to go into an infinite loop, or other unpredictable behavior.

**-fremove-local-statics optimization.** The `-fremove-local-statics` optimization is now enabled by default at `-O2` and higher optimization levels.

**Elimination of spurious warnings about NULL.** The C++ compiler no longer issues spurious warnings about comparisons between pointers to members and `NULL`.

**Vectorizer improvements.** The compiler now generates improved code for accesses to static nested array variables (e.g. `static int foo[8][8];`).

**EGLIBC version 2.10.** Sourcery G++ Lite for MIPS GNU/Linux now includes EGLIBC version 2.10 library which is based on GNU C Library version 2.10. For more information about changes, see [http://www.eglibc.org/news#eglibc\\_2\\_10](http://www.eglibc.org/news#eglibc_2_10).

**uClibc upgrade.** uClibc has been updated to version 0.9.30 plus additional updates from the [uclibc.org](http://uclibc.org) repository as of June 2009. Programs linked with uClibc shared libraries from a previous version of Sourcery G++ must be recompiled to run with the new version of uClibc.

**GCC version 4.4.1.** Sourcery G++ Lite for MIPS GNU/Linux is now based on GCC version 4.4.1. For more information about changes from GCC version 4.3 that was included in previous releases, see <http://gcc.gnu.org/gcc-4.4/changes.html>.

**Linker map address sorting.** The map generated by the linker `-Map` option now lists symbols sorted by address.

### A.1.9. Changes in Sourcery G++ Lite 4.3-154

**Incorrect code when using `-falign-labels`.** A bug that caused the compiler to generate incorrect code for `switch` statements when the `-falign-labels` option is used has been fixed.

**Reduced compilation time.** Compilation and build times when using Sourcery G++ Lite are now slightly faster. This performance improvement is the result of building the compilers and other host tools with a recent version of Sourcery G++, rather than an older GCC version.

**Loop optimization improvements.** A new option, `-fpromote-loop-indices`, has been added to the compiler. Specifying this option enables an optimization that improves the performance of loops with index variables of integer types narrower than the target machine word size, such as `char` or `short`. This optimization also applies to `int` on 64-bit targets.

**Warnings connecting to `gdbserver`.** A GDB bug has been fixed that caused warnings of the form `Could not load XML document "mips-dsp.xml" to appear when connecting to gdbserver from GDB with target remote`.

**Remote debugging connection auto-retry.** The `target remote` command within GDB now uses a configurable auto-retry timeout when establishing TCP connections. This is useful in avoiding race conditions when the remote GDB stub or GDB server is launched simultaneously with GDB. The auto-retry behavior is enabled by default; refer to the GDB manual for details.

**Extraneous linker error messages.** A linker bug that caused extraneous error messages of the form `Dwarf Error: Offset (507) greater than or equal to .debug_str size (421)` has been corrected. This bug did not affect the correctness of output binaries.

**mips-linux-gnu-objcopy bug fix.** A bug has been fixed that caused `mips-linux-gnu-objcopy` to issue an error when generating output in the Intel HEX format and using `--change-section-lma` to change section addresses.

**Linker script search path.** The bug in the linker has been fixed that caused it not to follow its documented behavior for searching for linker scripts named with the `-T` option. Now scripts are looked up first in the current directory, then in library directories specified with `-L` command-line options, and finally in the default system linker script directory.

**Errors when inserting breakpoints.** A GDB bug has been fixed that caused errors of the form `'function' found in filename psyntab but not in syntab` when setting a



breakpoint on *function*. This error commonly occurred when setting breakpoints on functions provided by the C library.

**Internal compiler error when optimizing.** A bug has been fixed that caused internal compiler error: in `build2_stat` when compiling.

**GDB quit error.** A bug in GDB has been fixed that caused `quit` to report `Quitting: You can't do that without a process to debug.` when debugging a core dump file.

**New assembler option: `-mfix-24k`.** The assembler now accepts the `-mfix-24k` command-line option. The use of this option causes the assembler to work around hardware errata in the `eret` and `deret` instructions on 24K and 24KE cores.

**Corruption of block-scope variables.** A compiler optimization bug that sometimes caused corruption of stack-allocated variables has been fixed. The bug affected variables declared in a local block scope in functions containing multiple non-overlapping lexical block scopes, a technique commonly used by programmers to reduce stack frame size. In some rare cases, other optimizations performed by the compiler were ignoring the local extent of such block-scope variables.

**GDB update.** The included version of GDB has been updated to 6.8.50.20081022. This update includes numerous bug fixes.

### A.1.10. Changes in Sourcery G++ Lite 4.3-114

**GCC version 4.3.3.** Sourcery G++ Lite for MIPS GNU/Linux is now based on GCC version 4.3.3. This is a bug fix update to GCC. For more information about changes from GCC version 4.3.2 that was included in previous releases, see <http://gcc.gnu.org/gcc-4.3/changes.html>.

**Internal compiler error with `-O3` or `-fpredictive-commoning`.** A bug has been fixed that caused internal compiler errors when compiling some code with `-O3` or `-fpredictive-commoning`.

**C++ named operators bug fix.** A bug has been fixed that caused the compiler to crash in some cases when the C++ operators `and_eq`, `bitand`, `bitor`, `compl`, `not_eq`, `or_eq` and `xor_eq` were used in contexts where the preprocessor converts their names to strings.

**Debug information for anonymous structure types.** A GCC bug in the generation of debug information for anonymous structure types in C++ code has been fixed. The bug caused printing the type information for such structures in the debugger (via the `ptype` command) to fail with an error message.

**`timer_delete` bug.** A bug has been fixed that caused some programs to crash or hang after calling `timer_delete`.

**Out-of-range branches.** A bug has been fixed that caused the compiler to emit incorrect branch code in some very large functions when generating position-independent code (`-fpic`) for O32 (`-mabi=32`) or O64 (`-mabi=o64`) ABIs.

**GDB target extended-remote error.** A bug in GDB has been fixed that caused `target extended-remote` to report `Remote failure reply: E01` if no remote program was running.

**uClibc `splice`, `vmsplice` and `tee` functions.** uClibc now provides the functions `splice`, `vmsplice` and `tee`.

**Installer fails during upgrade.** The Sourcery G++ installer for Microsoft Windows hosts could fail during an upgrade while waiting for the previous version to be uninstalled. This bug has been fixed.

**Uninstaller removed by upgrade.** The uninstaller could be incorrectly deleted during an upgrade on Microsoft Windows hosts. This bug has been fixed.

**mips-linux-gnu-objcopy and mips-linux-gnu-strip bug fix.** A bug has been fixed that caused `mips-linux-gnu-objcopy` and `mips-linux-gnu-strip` to corrupt prelinked binaries.

**GDB segment warning.** Some compilers produce binaries including uninitialized data regions, such as the stack and heap. GDB incorrectly displayed the warning `Loadable segment "name" outside of ELF segments` for such binaries; the warning has now been fixed.

**Internal compiler errors when optimizing.** A defect that occasionally caused internal compiler errors when partial redundancy elimination (PRE) optimization was enabled has been corrected.

**Install directory pathnames.** Bugs in the install and uninstall scripts for Linux hosts that caused errors or incorrect behavior when the Sourcery G++ install directory pathname contains whitespace characters have been fixed.

**Temporary files on Microsoft Windows.** On Microsoft Windows hosts, Sourcery G++ Lite now uses the standard Windows algorithm to choose the directory in which to place temporary files. This change eliminates a crash that occurred if none of the `TEMP`, `TMP`, or `TMPDIR` variables were set to a suitable directory.

**Binutils update.** The binutils package has been updated to version 2.19.51.20090205 from the FSF trunk. This update includes numerous bug fixes.

**Internal compiler error with `-fremove-local-statics`.** An internal compiler error that occurred when using the `-fremove-local-statics` option has been fixed. The error occurred when compiling code with function-local `static` array or structure variables.

### A.1.11. Changes in Sourcery G++ Lite 4.3-51

**Setting breakpoints on Windows.** A bug in GDB on Microsoft Windows hosts has been fixed. The bug caused setting breakpoints on a source line by using the file's full path to fail with `No source file named filename`.

**Printing casted values in GDB.** A GDB bug that caused incorrect output for expressions containing casts, such as in the `print *(Type *)ptr` command, has been fixed.

**Bug fix for `objcopy/strip`.** An `objcopy` bug that corrupted `COMDAT` groups when creating new binaries has been fixed. This bug also affected `strip -g`.

**Bug fix for assembly listing.** A bug that caused the assembler to produce corrupted listings (via the `-a` option) on Windows hosts has been fixed.

**GDB update.** The included version of GDB has been updated to 6.8.50.20080821. This update adds numerous bug fixes and new features, including support for decimal floating point, the new `find` command to search memory, the new `/m` (mixed source and assembly) option to the `disassemble` command, and the new `macro define` command to define C preprocessor macros interactively.

**PIE linking fix.** A bug in the GCC `-fpie` and `-fPIE` options has been fixed. The bug caused linker errors referring to `R_MIPS_HI16`.

**Binutils support for DWARF Version 3.** The `addr2line` command now supports binaries containing DWARF 3 debugging information. The `ld` command can display error messages with source locations for input files containing DWARF 3 debugging information.

**GDB display of source.** A bug has been fixed that prevented GDB from locating debug information in some cases. The debugger failed to display source code for or step into the affected functions.

**Connecting to the target using a pipe.** A bug in GDB's `target remote | program` command has been fixed. When launching the specified `program` failed, the bug caused GDB to crash, hang, or give a message `Error: No Error`.

**Remote debugging improvements.** The `gdbserver` utility now supports a more efficient communications protocol that can reduce latency during remote debugging. The protocol optimizations are enabled automatically when `gdbserver` operates over a TCP connection. Refer to the GDB manual for more information.

**PIE support in uClibc.** PIE (Position Independent Executable) support is now enabled in the included uClibc.

**RPC support in uClibc.** RPC (Remote Procedure Call) support is now enabled in the included uClibc. This feature is required to build BusyBox with NFS support.

**Errors after loading the debugged program.** An intermittent GDB bug has been fixed. The bug could cause a GDB internal error after the `load` command.

**Bug fix for objdump on Windows.** An `objdump` bug that caused the `-S` option not to work on Windows in some cases has been fixed.

**Persistent remote server connections.** A GDB bug has been fixed that caused the `target extended-remote` command to fail to tell the remote server to make the connection persistent across program invocations.

### A.1.12. Changes in Sourcery G++ Lite 4.3-7

**FPU defaults.** The `-ffast-math` option now causes subnormal numbers to be immediately flushed to zero. It also sets the rounding mode to `round-to-nearest`.

**DSP support.** The compiler now automatically enables support for the DSP ASE when the `-march` option is used to specify a core in the 24KE, 34K, or 74K families. It is no longer necessary to provide the `-mdsp` option explicitly.

**GCC version 4.3.2.** Sourcery G++ Lite for MIPS GNU/Linux is now based on GCC version 4.3.2. For more information about changes from GCC version 4.2 that was included in previous releases, see <http://gcc.gnu.org/gcc-4.3/changes.html>.

### A.1.13. Changes in Older Releases

For information about changes in older releases of Sourcery G++ Lite for MIPS GNU/Linux, please refer to the Getting Started guide packaged with those releases.

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# Appendix B

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