BCC - Bare-C Cross-Compiler User's Manual

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1 Introduction

1.1 Scope

BCC is a cross-compiler for LEON2 and LEON3 processors. It is based one the GNU compiler tools and the Newlib standalone C-library. The cross-compiler system allows compilation of both tasking and non-tasking C and C++ applications. It supports hard and soft floating-point operations, as well as SPARC V8 multiply and divide instructions. BCC can also be used to compile the eCos kernel.

BCC consists of the following packages:

- GNU GCC C/C++ compiler v3.4.4, v4.4.2
- Newlib C-library v 1.13.1
- Low-level I/O routines for LEON2 and LEON3, including interrupt support
- uIP light-weight TCP/IP stack
- GDB debugger v6.4 with DDD and Insight Graphical front-end
- Mkprom prom-builder for LEON2/3
- Linux and Windows/Cygwin hosts

1.2 Installation

1.2.1 Linux / Cygwin

BCC is provided as a bzipped tar-file. It should be unpacked in the /opt directory of the host:

```
mkdir /opt
tar -C /opt -xjf sparc-elf-<version-number>.tar.bz2
```

After installation, add /opt/sparc-elf-<gcc-version-number>/bin to the PATH variable. This should be done by adding the following line to the file .profile in the home directory:

```
export PATH=/opt/sparc-elf-<gcc-version-number>/bin:$PATH
```

On Cygwin hosts, all installation steps should be done in a cygwin shell window.

See http://www.cygwin.com/ for information on Cygwin.

1.2.2 Windows

BCC for Windows is provided for native Windows (MinGW) and for the Cygwin environment. For the Cygwin version see previous section. The native version will not require any additional packages and can be run from a standard Command Prompt.

The native Windows version of BCC is packaged with zip. Use a tool like WinZip to uncompress it to a directory, e.g., C:\opt. Note: The directory should not contain spaces (or any other non-ASCII characters) as this will confuse the compiler.

To use the compiler the bin subdirectory, e.g., C:\opt\bin, must be added to the PATH environment variable. This can be done from the Control Panel:

```
System -> Advanced -> Environment Variables...
```

Se http://www.mingw.org/ for more information on MinGW and the optional MSYS environment.

1.3 Building from source

The source code for BCC is available from the Gaisler homepage www.gaisler.com. To build BCC from source you should:

- untar the source archive to <dir>
- issue "*cd <dir>;make download*". This will download the original gcc, binutils and newlibc sources.
- issue "*cd <dir>; make install*". This will untar all the downloaded original archives over the current sourcetree, preserving the LEON sprecific files.

- issue “*cd <dir>; make all*”. This will build the 4.4.2 and 3.4.4 toolchains. The default prefix is /opt.

1.4 Technical support

Technical support for BCC can be obtained from Aeroflex Gaisler AB by purchasing a technical support contract. Please contact sales@gaisler.com for details.

2 General development flow

2.1 Overview

Compilation and debugging of applications is typically done in the following steps:

1. Compile and link program with gcc
2. Debug program on a simulator or remote target
3. Create boot-prom for a standalone application

BCC supports both tasking and non-tasking C/C++ programs. Compiling and linking is done in the same manner as with a host-based gcc, and will not be explained here. The produced binaries will run on both LEON2 and LEON3 systems, without requiring any switches during compilation.

2.2 Gcc options

All gcc options are described in detail in the gcc manual. Some useful options are:

- -g generate debugging information - must be used for debugging with gdb
- -msoft-float emulate floating-point - must be used if no FPU exists in the system
- -mcpu=v8 generate SPARC V8 mul/div instructions - needs hardware multiply and divide
- -O2 or -O3 optimise code maximum performance and minimal code size
- -qsvt use the single-vector trap model
- -mtune=ut699 sets UT699 specific parameters (gcc-3.4.4 and gcc-4.4.2)
- -mfix-ut699 sets UT699 specific parameters (gcc-4.6.0 upward)

Note that in GCC version 3.4.4 -mcpu=v8 was called -mv8 and -mflat was present:

- -mv8 generate SPARC V8 mul/div instructions - needs hardware multiply and divide
- -mflat do not use register windows (i.e. no save/restore instructions). This options is only available in gcc-3.4.4.

Ordinary C programs can be compiled without any particular switches to the compiler driver:

```
sparc-elf-gcc -msoft-float -g -O2 hello.c -o hello.exe
```

The default link address is start of RAM, i.e. 0x40000000 for LEON. Other link addresses can be specified through the -Ttext option (see gcc manual).

2.3 Floating-point considerations

If the targeted LEON processor has no floating-point hardware, then all applications must be compiled (and linked) with the -msoft-float option to enable floating-point emulation. When running the program on the TSIM simulator, the simulator should be started with the -nfp option (no floating-point) to disable the FPU.

2.4 LEON SPARC V8 instructions

Both LEON2 and LEON3 processors can be configured to implement the SPARC V8 multiply and divide instructions. The BCC compiler does by default not issue those instructions, but emulates them trough a library. To enable generation of mul/div instruction, use the -mcpu=v8 switch during both compilation and linking. The v8 switch improves performance on compute-intensive applications and floating-point emulation.

LEON2 and LEON3 also supports multiply and accumulate (MAC). The compiler will never issue those instructions, they have to be coded in assembly. Note that the BCC assembler and other util-

ities are based on a modified version of GNU binutils-2.15 that supports the LEON MAC instructions.

2.5 Alternate register windows organization (only for GCC 3.X)

The compiler normally produces binaries that assumes that the target processor has 8 register windows. However, by compiling and linking with the **-mflat** switch, it is possible to produce binaries that will run on processors with only 2 register windows.

-mflat affect performance and code size. Using -mflat, the code size will increase with ~ 10%, and the performance will decrease with the same amount. When creating boot proms (see below), it is essential that the same **-mflat** parameter is given to sparc-elf-mkprom, as was used when the binary was compiled. Any miss-match will produce a faulty prom image.

2.6 Single vector trapping

When the vhdl model is configured to support single vector trapping (svt) the -qsvt switch can be used with the linker to build an image that uses a dispatcher rather than a static trap table. The saving amounts to ~4k for the trap table, however trap handling will be slower. The image will try to enable svt on boot using %asr17.

2.7 Memory organization

The resulting executables are in elf format and have three main segments; text, data and bss. The text segment is by default at address 0x40000000 for LEON2 and LEON3, followed immediately by the data and bss segments. The stack starts at top-of-ram and extends downwards. The area between the end of bss and the bottom of the stack is used for the heap.

2.8 Making LEON boot-proms

To make a boot-prom that will run from the prom on a standalone LEON2 or LEON3 target, use the sparc-elf-mkprom utility. It will create a compressed boot image that will load the application to the RAM, initiate various LEON registers, and finally start the application. sparc-elf-mkprom will set all target dependent parameters, such as memory sizes, waitstates, baudrate, and system clock. The applications compiled with sparc-elf-gcc do not set these parameters themselves, and thus do not need to be re-linked for different board architectures.

The example below creates a boot-prom for a system with 1 Mbyte RAM, one RAM waitstate, 3 waitstates for ROM access, and 25 MHz system clock. For more details see the mkprom manual.

```
sparc-elf-mkprom -ramsize 1024 -ramws 1 -romws 3 -freq 25 hello.exe -msoft-float
```

Note that sparc-elf-mkprom creates ELF files. To create an SRECORD file for a prom programmer, use objcopy:

```
sparc-elf-objcopy -O srec hello.prom hello.srec
```

Note: it is essential that the same -mflat, -qsvt and -msoft-float parameters are given to sparc-elf-mkprom, as was used when the binary was compiled. Any miss-match will produce a faulty PROM image.

2.9 Creating applications that run in prom

BCC supports applications that run in PROM, but have data and stack in ram. A PROM application is created in two steps:

1. Compile the application into on or more object files, but do not link:

```
sparc-elf-gcc -msoft-float -c -g -O2 hello.c
```

2. Create final prom image with mkprom, listing all object files on the command line :

```
sparc-elf-mkprom -freq 40 -rmw hello.o -msoft-float
```

A PROM application has it code (.text segment) in prom, and data (.data & .bss) in RAM. At start-up, the .data segment is copied from the prom to the ram, and the .bss segment is cleared. A prom application is linked to start from address 0x0. The data segment is by default linked to 0x40000000, but can be changed by giving the -Tdata=<address> option of gcc to mkprom. Note that if no FPU is present, the -msoft-float option must also be given to mkprom in this case since it is needed during the final linking. When debugging prom applications with GRMON or gdb, only hardware breakpoints (hbreak command) can be used.

2.10 NGMP, RAM applications located at address 0 and multibus systems

To create an application that is located at address 0, like when runing on a NGMP system, the option *-Wl,-msparcleon0* can be given to *gcc* or *-msparcleon0* to *ld*. (Until bcc 1.0.40: On systems with multiple busses *-qambapp* can be given to *gcc* in the final link, this activates theAMBA PnP scan. From 1.0.41 onward AMBA scanning is default).

2.11 Simple examples

Following example compiles the famous ‘hello world’ program and creates a boot-prom in SRECORD format:

```
$ sparc-elf-gcc -g -O2 hello.c -o hello -msoft-float
$ sparc-elf-mkprom hello -o hello.exe -msoft-float

MKPROM boot-prom builder v1.0

section: .text at 0x4000000, size 31040 bytes
section: .data at 0x4007940, size 1904 bytes

$ sparc-elf-objcopy -O srec hello.exe hello.srec
```

Several example C programs can be found in *src/examples*.

2.12 Newlib C-library

2.12.1 Stdio

BCC applications uses Newlib, which is a posix compatible C-library with full math support. However, no file or other I/O related functions will work, with the exception of I/O to stdin/stdout. Stdin/stdout are mapped on UART A, accessible via the usual stdio functions.

2.12.2 Time functions

The LEON timers are used to generate the system time. The function clock() will return the time expired in microseconds. The gettimeofday(), time() and times() can also be used to get the time. Before the time functions can be used, leonbare_init_ticks() should be called to start the LEON timers and install the timer interrupt handler:

```
#include <asm-leon/timer.h>
void leonbare_init_ticks();
```

This will initialize Timer1 and Timer2. Timer1 is used to generate ticks at 100Hz while Timer2 is used to create high resolution timer events. Timer1 ticks can be used by installing a ticker callback at

```
tickerhandler ticker_callback;
```

Timer2 timer events can be generated by initializing a struct timerevent structure and calling

```
#include <asm-leon/timer.h>
int addtimer(struct timerevent *e);
```

struct timerevent 'expire' field is the timeposition at which the event should be triggered. The current time can be retrieved using int gettimeofday(struct timeval *tv, struct timezone *tz);

2.12.3 Task switching

Task switching is supported by the functions:

```
#include <contextswitch.h>
int thread_setjmp(threadctx_t env, int val);
void thread_longjmp(threadctx_t env, int val);
```

thread_longjmp() will save the current register windows to the stack and jump to the stack previously saved by thread_setjmp() similar to clib's setjmp and longjmp construct. You can create your own scheduler by using a construct like:

```
void sched() {
  ...
  thread_longjmp(next());
}
...
  if (!thread_setjmp(self()))
    sched();
...
```

2.12.4 Interrupt handling

Installing an interrupt handle is done by initializing member *handler* of a global variable *struct irqaction* and calling:

```
#include <asm-leon/irq.h>
void chained_catch_interrupt (int irq, struct irqaction *a );
```

where irq is the irq number (1 - 15). The supplied struct irqaction will be inserted in a list and therefore should be global.

The simple void *catch_interrupt(void func(int irq), int irq); is also supported which uses chained_catch_interrupt internally.

The source code for libgloss (libleonbare.a) can be found in the *src/libgloss* directory.

For systems using the extended LEON3 interrupt controller with support for up to 31 interrupts it is possible to use irq 1-31 with catch_interrupt() and chained_catch_interrupt().

An example for how to install interrupt handler is supplied withthe **src/examples/c-irq.c** example of the BCC distribution.

Low-level interrupt processing takes around 40 instructions to setting up the C enviroment for the interrupt handler, and another ~25 instruction to dispatch irq to the associated handler. If very fast processing is required, a custom lolevel assemler irqroutine can be installed using:

```
#include <asm-leon/leon.h>
void lolevelirqinstall(int irqnr,void (*handler)());
```

This will write instructions:

```
sethi    %hi(handler), %l4;
jmpl    %l4 + %lo(handler), %g0;
 nop
```

at address traptable+0x100+(irqnr*16). The callers low-level interrupt routine has to ensure proper enviroment setup before calling a C routine. This includes saving volatile register,

checking for invalid windows and avoiding nested irqs. An appropriate routine would be written in assembler.

In case of single (-qsvt) vector trap shemes you have to use he following funtion to insert a irq handler:

```
int svtlolevelirqinstall(int trap,void (*handler)())
```

In case of -qsvt a table is used to dispatch the traps:

```
struct svt_trap_entry {
int start,end;
void (*func)(void);
};
extern struct svt_trap_entry trap_table[28];
```

Where *start* and *end* specify the range of traps that handler *func* should process. The last entry in the table should be {0,0,0}. You can modify the table by hand or use svtlolevelirqinstall to install a interrupt handler for you. Note that the irq number is trap number + 0x10. The symbol *svt_trap_table_ext_end* marks the end of the trap dispatch table. To insert a trap handler in -qsvt mode you can use the function

```
int svtloleveltrapinstall(int trap,void (*handler)());
```

svtlolevelirqinstall(irq,handler) is equivalent to svtloleveltrapinstall(irq+0x10,handler).

```
     Trap pre-amble
     --------------
     1572  400001a0  ae10200a  mov      10, %l7
     1579  400001a4  a1480000  mov      %psr, %l0
     1580  400001a8  108022fc  ba       0x40008d98
     1581  400001ac  a7500000  mov      %wim, %l3

     1582  40008d98  2d000004  sethi    %hi(0x1000), %l6
     1587  40008d9c  a02c0016  andn     %l0, %l6, %l0
     1588  40008da0  2d100023  sethi    %hi(0x40008c00), %l6
     1595  40008da4  ac15a1a8  or       %l6, 0x1a8, %l6
     1596  40008da8  29100025  sethi    %hi(0x40009400), %l4

     etraps.s save state
     -------
     1597  40008dac  81c52170  jmp      %l4 + 0x170
     1599  40008db0  932de008  sll      %l7, 8, %o1
     1606  40009570  aa27a138  sub      %fp, 312, %l5
     1613  40009574  c2256074  st       %g1, [%l5 + 0x74]
     1616  40009578  c43d6078  std      %g2, [%l5 + 0x78]
     1620  4000957c  c83d6080  std      %g4, [%l5 + 0x80]
     1624  40009580  cc3d6088  std      %g6, [%l5 + 0x88]
     1634  40009584  15100029  sethi    %hi(0x4000a400), %o2
     1635  40009588  d602a050  ld       [%o2 + 0x50], %o3
     1639  4000958c  d6256134  st       %o3, [%l5 + 0x134]
     1644  40009590  960560b0  add      %l5, 176, %o3
     1651  40009594  d622a050  st       %o3, [%o2 + 0x50]

check for invalid window:

     1654  40009598  a8102001  mov      1, %l4
     1655  4000959c  a92d0010  sll      %l4, %l0, %l4
     1656  400095a0  808d0013  andcc    %l4, %l3, %g0
     1663  400095a4  02800013  be       0x400095f0
     1664  400095a8  01000000  nop
     1665  400095f0  81c5a008  jmp      %l6 + 0x8
     1673  400095f4  9c100015  mov      %l5, %sp

back in irqtrap_fast.s:
check for nested_irq flag + set pil

     1674  40008db0  932de008  sll      %l7, 8, %o1
     1675  40008db4  92140009  or       %l0, %o1, %o1
     1676  40008db8  11100029  sethi    %hi(0x4000a400), %o0
     1677  40008dbc  90122054  or       %o0, 0x54, %o0
     1678  40008dc0  d0020000  ld       [%o0], %o0
```

```
     1688  40008dc4  80a00008  cmp      %o0
     1691  40008dc8  22800002  be,a     0x40008dd0
     1692  40008dcc  92126f00  or       %o1, 0xf00, %o1
     1693  40008dd0  818a6020  mov      %o1, 0x20, %psr
     1700  40008dd4  01000000  nop
     1701  40008dd8  01000000  nop
     1702  40008ddc  01000000  nop


  ------------------------------------------------------------


  call routine catch_interrupt.c: handler_irq():

     1703  40008de0  90100017  mov      %l7, %o0
     1710  40008de4  40000028  call     0x40008e84
     1711  40008de8  9203a0f0  add      %sp, 240, %o1
     1712  40008e84  9de3bf98  save     %sp, -104, %sp
     1713  40008e88  03100029  sethi    %hi(0x4000a400), %g1
     1714  40008e8c  9b2e2002  sll      %i0, 2, %o5
     1715  40008e90  82106228  or       %g1, 0x228, %g1
     1722  40008e94  e000400d  ld       [%g1 + %o5], %l0
     1723  40008e98  80a42000  cmp      %l0
     1726  40008e9c  02800018  be       0x40008efc
     1727  40008ea0  a4102001  mov      1, %l2
     1734  40008ea4  10800007  ba       0x40008ec0
     1735  40008ea8  da040000  ld       [%l0], %o5
     1739  40008ec0  80a36000  cmp      %o5
     1748  40008ec4  02bffffa  be       0x40008eac
     1749  40008ec8  23100029  sethi    %hi(0x4000a400), %l1
     1750  40008ecc  c2046124  ld       [%l1 + 0x124], %g1
     1754  40008ed0  90100018  mov      %i0, %o0
     1761  40008ed4  80a06000  cmp      %g1
     1762  40008ed8  12bffff5  bne      0x40008eac
     1764  40008edc  94100019  mov      %i1, %o2
     1765  40008ee0  d2042008  ld       [%l0 + 0x8], %o1
     1775  40008ee4  9fc34000  call     %o5
     1777  40008ee8  e4246124  st       %l2, [%l1 + 0x124]

     -- installed irq handler
     1780  40001260  9de3bf98  save     %sp, -104, %sp
```

2.12.5 Extended IrqCtrl

The extended irq functionality is activated by the following code (the extended irq number is 13 for this example):

```
#include <asm-leon/irq.h>
extern struct irqmp_type irqmp;
...
irqmp.addr = 0x80000200;
irqmp.eirq = 13;
enable_irq(13);
...
```

irqmp.addr is the address of the irq controller, *irqmp.eirq* is the extended irq number. Having initialized the application like this you can register an irq handler for an irq > 15 using *catch_interrupt()*. Note that the extended irq number's interrupt handler itself is not called but the handler of the irq indicated by the extended irq ctrl's extended irq acknowledge register. Another possibility is of course to implement the extended irq handling yourself.

2.12.6 Interrupt nesting

The variable

```
 extern unsigned int nestedirq;
```

can be set to 1 if irq nesteing is desired.By default it is set to 0. In case of 0 the PSR's PIL will be set to 15 (highest) to keep the irq processing uninterrupted. If nestedirq is set to 1 the PSR's PIL will be set to the incoming irq's level, therefore causing higher level irq's to interrupt the current irq processing.

2.12.7 Small binary

Newlib atexit() introduces a dependency to malloc() which will add ~10k extra code. If you want to avoid this you can link against libsmall.a (**-lsmall**). libsmall.a's atexit() supports only a static 32 exit-function entries. The c library newlib atexit() function is declared weak and can be overridden.

- **-lsmall** remove reference to malloc() by override Newlibc atexit().
-

2.12.8 Amba PLUG and PLAY

Until BCC 1.0.40: The options *-qambapp* can be given to enable PLUG and PLAY scanning for UART, timer and irq-ctrl across AHB2AHB bridges. The default setup ony scanns the main BUS's configuration area at 0xfff00000.
From BCC 1.0.41 upward: recursive scanning is set as default, *-qnoambapp* can be given to disable recursive scaning.

2.13 FreeRtos

The simple sheduling library FreeRtos (www.freertos.org) is included in the distribution. Please refer to the FreeRtos documentation on the website for information on how to use the FreeRtos API. The precompiled library libfreertos.a was compiled using the configuration file supplied in <installdir>/sparc-elf/include/freertos/FreeRTOSConfig.h. To recompile it with another configuration goto <installdir>/src/freertos/, change FreeRTOSConfig.h and type

```
$make recompile
```

You might also want to add more sources to $(LIBOBJ).

3 Execution and debugging

3.1 TSIM simulator and GRMON debug monitor

LEON applications can be debugged on either the TSIM simulator or real target hardware through the use of the GRMON debug monitor. Both TSIM and GRMON can be connected to the GNU debugger (sparc-elf-gdb) to perform source-level symbolic debugging.

3.1.1 Running on the TSIM simulator

To execute an application in the TSIM LEON simulator, use the load command to load the binary, and the go command to execute the application:

```
$ tsim-leon3

  TSIM LEON SPARC simulator, version 2.0.3 (professional version)

Copyright (C) 2001, Gaisler Research - all rights reserved.
using 64-bit time
serial port A on stdin/stdout
allocated 4096 K RAM memory, in 1 bank(s)
allocated 2048 K ROM memory
icache: 1 * 4 kbytes, 16 bytes/line (4 kbytes total)
dcache: 1 * 4 kbytes, 16 bytes/line (4 kbytes total)

tsim> load hello.exe

section: .text at 0x40000000, size 35120 bytes
section: .data at 0x40008930, size 2080 bytes
section: .jcr at 0x400091b4, size 4 bytes

tsim> go

resuming at 0x40000000
Hello world!

Program exited normally.
grmon[sim]>
```

3.2 Debugging with GDB

To debug an application with gdb, start grmon with the -gdb option (or issue the gdb command inside grmon). Note that GRMON listens on port 2222 for a gdb connection. This can be changed to any port using the grmon -port switch at start-up.

```
$ tsim-leon3 -gdb

TSIM LEON SPARC simulator, version 2.0.3 (professional version)

Copyright (C) 2001, Gaisler Research - all rights reserved.
using 64-bit time
serial port A on stdin/stdout
allocated 4096 K RAM memory, in 1 bank(s)
allocated 2048 K ROM memory
icache: 1 * 4 kbytes, 16 bytes/line (4 kbytes total)
dcache: 1 * 4 kbytes, 16 bytes/line (4 kbytes total)
gdb interface: using port 1234
```

Then, start gdb in a separate shell, load the application to the target, add optional breakpoints, and finally execute the application using the gdb run command:

```
$ sparc-elf-gdb hello.exe
GNU gdb 5.3
Copyright 2002 Free Software Foundation, Inc.
```

```
GDB is free software, covered by the GNU General Public License, and you are
welcome to change it and/or distribute copies of it under certain conditions.
Type "show copying" to see the conditions.
There is absolutely no warranty for GDB.  Type "show warranty" for details.
This GDB was configured as "--host=i686-pc-linux-gnu --target=sparc-tsim-elf"...
(gdb) tar extended-remote localhost:1234
Remote debugging using localhost:1234
0x00000000 in ?? ()
(gdb) load
Loading section .text, size 0x8930 lma 0x40000000
Loading section .data, size 0x820 lma 0x40008930
Loading section .jcr, size 0x4 lma 0x400091b4
Start address 0x40000000, load size 37204
Transfer rate: 297632 bits in <1 sec, 275 bytes/write.
(gdb) break main
Breakpoint 1 at 0x40001384: file hello.c, line 4.
(gdb) run
The program being debugged has been started already.
Start it from the beginning? (y or n) y
Starting program: /home/jiri/samples/hello.exe

Breakpoint 1, main () at hello.c:4
4               printf("Hello world!\n");
(gdb)
```

To re-execute the application, first re-load it to the target using the gdb **load** command and the issue run again.

3.3 Debugging on target hardware

To connect GRMON to a LEON system, start GRMON on the command line in a shell window. By default, GRMON will connect to the processor debug support unit (DSU) using a serial port of the host (ttyS0 or com1). See the GRMON manual for how to connect via JTAG, PCI, ethernet or Spacewire. Once connected, the application can be downloaded and executed using the same procedure as when the simulator is used:

```
$ grmon -u

 GRMON - The LEON multi purpose monitor v1.0.7

 Copyright (C) 2004, Gaisler Research - all rights reserved.
 For latest updates, go to http://www.gaisler.com/
 Comments or bug-reports to grmon@gaisler.com

 using port /dev/ttyS0 @ 115200 baud

 initialising .........

 Component                            Vendor
 Leon3 SPARC V8 Processor             Gaisler Research
 AHB Debug UART                       Gaisler Research
 Ethernet DSU interface               Gaisler Research
 LEON2 Memory Controller              European Space Agency
 AHB/APB Bridge                       Gaisler Research
 Leon3 Debug Support Unit             Gaisler Research
 Generic APB UART                     Gaisler Research
 Multi-processor Interrupt Ctrl       Gaisler Research
 Modular Timer Unit                   Gaisler Research

 Use command 'info sys' to print a detailed report of attached cores

grmon[grlib]> load hello.exe
section: .text at 0x40000000, size 35120 bytes
section: .data at 0x40008930, size 2080 bytes
section: .jcr at 0x400091b4, size 4 bytes
total size: 37204 bytes (99.4 kbit/s)
read 110 symbols
```

```
entry point: 0x40000000

grmon[grlib]> run
Hello world!

Program exited normally.
grmon[grlib]>
```

Connecting GDB to GRMON when attached to a real LEON target is done in the same way as when using the simulator. Note that GRMON uses port 2222 to communicate with gdb, while TSIM uses port 1234.

3.4 Using the DDD graphical front-end to GDB

DDD is a graphical front-end to gdb, and can be used regardless of target. DDD must be started with the --debugger switch to select the sparc debugger, rather than the native gdb:

```
ddd --debugger sparc-elf-gdb --attach-window
```

For further details on DDD operation, see the DDD home page:

http://www.gnu.org/software/ddd/

DDD has also a built-in manual under the HELP menu in the main window.

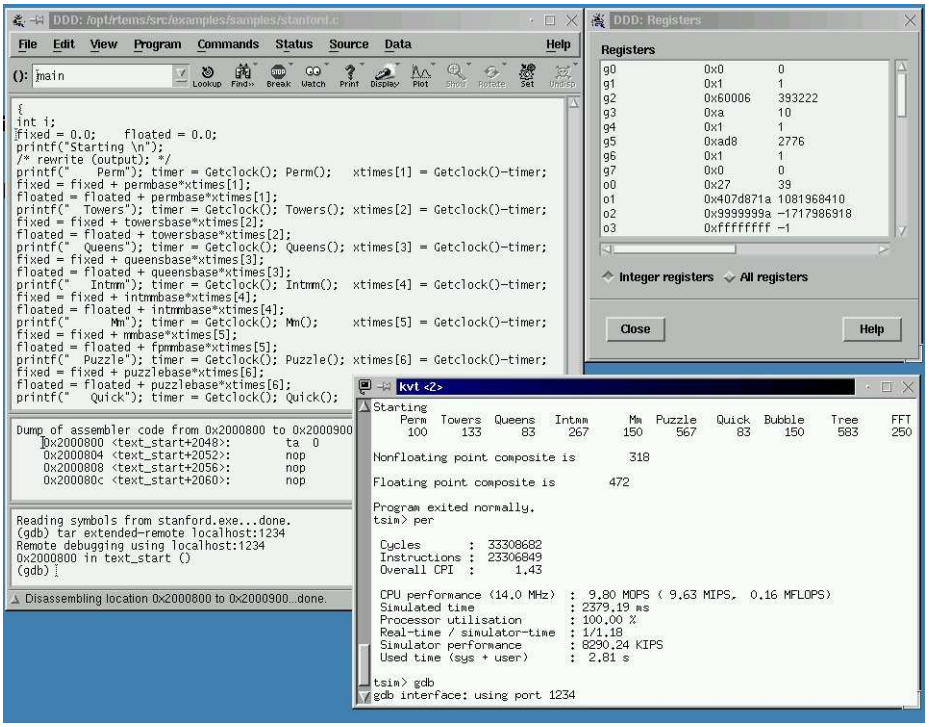


Figure 1. DDD with TSIM

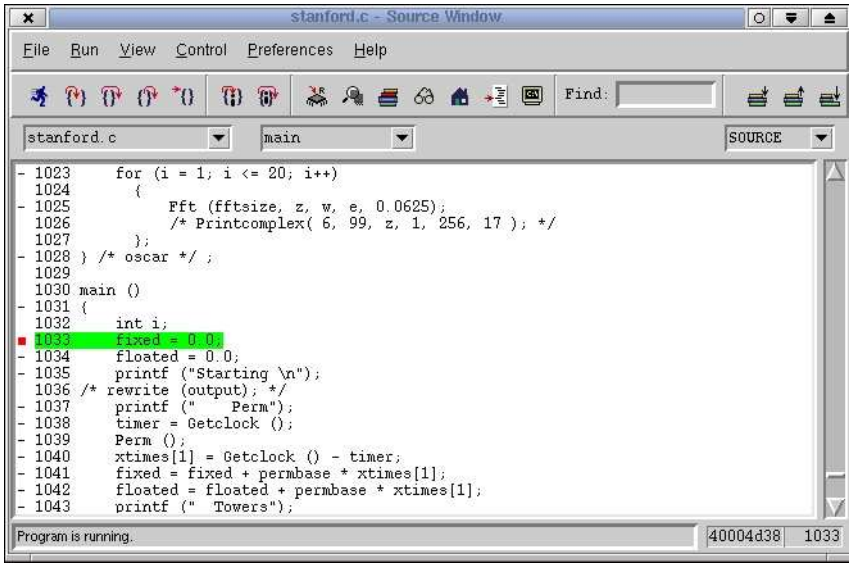
Attaching to TSIM of GRMON is done in the same manner as when using sparc-elf-gdb without DDD. The gdb commands are entered in the bottom command window. Remember to **load** the application first, before issuing a **run** command. On cygwin hosts, the cygwin X-server must first be started by issuing **startx** in a cygwin terminal. This will open an Xterm window, from which DDD should be started with the options mentioned above.

3.5 Using the Insight debugger

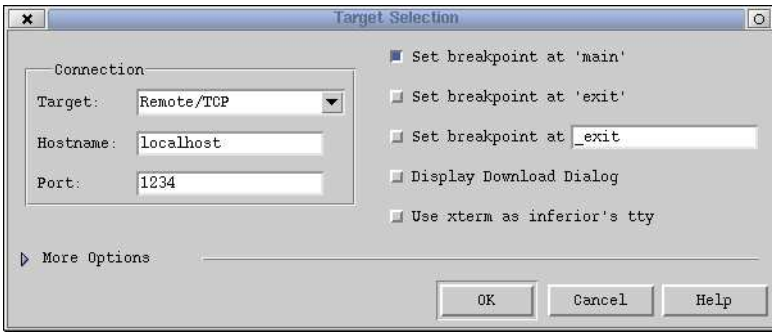
The Insight debugger is based on GDB-6.4 with an TCL/TK based graphical front-end. It can be used on both linux and cygwin hosts. The debugger is started with:

```
sparc-elf-insight app.exe
```

This will create the Insight main window:



Clicking on the RUN button (or selecting Run->Connect) will open the ‘Connect to target’ menu:



To connect to TSIM, select Remote/TCP and port 1234. To connect to GRMON, select port 2222. Enable the breakpoint on ‘main’, but disable the breakpoint on ‘exit’. Before clicking on OK, make sure that you have started TSIM or GRMON is a separate window, and entered gdb mode.

Insight automatically downloads the application to the target when needed, so the load command does not have to be issued manually. To restart the application, just click on the RUN button again.

NOTE: Insight can only be used with TSIM-2.0.5 and GRMON-1.1.12, or later versions.

4 MKPROM boot-prom builder

4.1 Introduction

(The successor of sparc-elf-mkprom is *mkprom2* that can be downloaded from the Aeroflex Gaisler homepage).

sparc-elf-mkprom is a utility program to create boot-images for programs compiled with the BCC cross-compiler. It encapsulates the application in a loader suitable to be placed in a boot PROM. The application is compressed with a modified LZSS algorithm, typically achieving a compression factor of 2. The boot loader operates in the following steps:

1. The register files of IU and FPU (if present) are initialized.
2. The memory controller, UARTs and timer unit are initialized according to the specified options.
3. The application is decompressed and copied into RAM
4. Finally, the application is started, setting the stack pointer to the top of ram.