



Systems and Technology Group

Hello World!

Course Code: L2T2H1-10
Cell Ecosystem Solutions Enablement

Course Objectives

- **You will learn how to write, build and run “Hello World!” on the Cell System Simulator.**
- **There are three different versions of “Hello World!” for the PPE only, SPE only and for the Cell BE, i.e. using PPE and SPE.**

How to get “Hello World!”

- **Pre-requisites**
 - Toolchain
 - Compiler
- **Build Process**
- **Source Code**
 - Makefiles
 - Source PPE
 - Source SPE
- **Simulator**
 - Getting the binary into the simulator
 - Running the binary

SDK Installation Requirements

- **Hardware “official” requirements**

- At least 2GHz x86 or x86-64 processor
- At least 1GB RAM
- At least 5GB available space

- **Software “official” requirements**

- Fedora Core 4
 - With TCL/TK
- SDK Installation Files
- Network connectivity to download 2.6.14 kernel (SDK 1.0) or 2.6.15 (SDK 1.0.1)

SDK Installation Files

- **Barcelona Supercomputing Center website**

- GNU x86 toolchain `toolchain-2.3-i686.tar.bz2`
- FC4/PowerPC RPMs `ppc-fc4-rpms-1.0.0-1.i386.rpm`
- Cell Linux kernel patches `cell-linux-patches-1.0.tar.bz2`
- SPE runtime lib source `libspe-1.0.tar.bz2`
- Installation script `install.sh`

- **IBM alpha works (binary / ILA for early release program)**

- System simulator `systemsim-cell-1.0-fc4-x86.tar.bz2`
- XLC `xlc-cell-cmp-1.0-1.i386.rpm`
`xlc-cell-lib-1.0-1.i386.rpm`
- Sample and Library (source / CPL v1.0) `cell-sdk-lib-samples-1.0.tar.bz2`
- SPU instruction timing tool `cell-spu-timing-1.0-fc4-x86.tar.bz2`

Your Virtual Machine

- **Contains an installed Fedora Core 4**
 - including the complete cell sdk
- **You can log in using**
 - User: student
 - Password: go4cellNow
- **Settings for Cell**
 - Alias cdsim → changes directory to the simulator start dir
 - Environment variable \$TOP → CBE home

Compilers

▪ GCC

- GNU public compiler
- x86 toolchain includes PowerPC cross-compiler and SPU-capable cross-compiler
 - /opt/sce/toolchain-2.3/ppu/bin/ppu-gcc
 - /opt/sce/toolchain-2.3/spu/bin/spu-gcc
- Advantages
 - widely available, open source compiler
 - optimizations for POWER platform are improving
- Disadvantages
 - auto vectorization capabilities are limited

▪ XLC

- IBM internal compiler for POWER platform modified to generate SPU object code as well
- Advantages
 - commercial-level compiler dedicated to generating highly-optimized POWER code
 - auto vectorization capabilities originally designed for VMX instruction set have been implemented for SPU
- Disadvantages
 - optimizations are slower to be implemented and released

▪ Octopiler

- A version of XLC that is being developed by IBM Research
- Intended to perform auto vectorization, auto partitioning, and overlay management to standard sequential code
- <http://www.research.ibm.com/journal/sj/451/eichenberger.html>

Build the code

- **TOP set to directory containing make header & footer**
 - make.footer contains all the complicated build rules
- **Place SPU code in a subdirectory of directory containing PPC code**
 - e.g. subdirectory name is 'spu'
- **Makefile for PPC code:**
 - DIRS = spu
 - PROGRAM_ppu = <PPU_executable_name>
 - IMPORTS = <spu_executable-embed.a> -lspe
 - include \$(TOP)/make.footer
- **Makefile for SPU code:**
 - PROGRAM_spu := <SPU_executable_name>
 - LIBRARY_embed = >SPU_executable-embed.a>
 - include \$(TOP)/make.footer

Three Different Versions of “Hello World!”

- **PPU only**
- **SPU only**
- **Synergistic**

“Hello World!” – PPU Only

- **PPC program**

- just like any “Hello World!” program one would write

```
#include <stdio.h>

int main(void)
{
    printf("Hello world!\n");
    return 0;
}
```

- **Makefile**

- make.footer included to set up compiler and compiler flags
- PROGRAM_ppu tells make to use PPC cross-compiler

```
PROGRAM_ppu = hello
include $(SDK_TOP)/make.footer
```

“Hello World!” – SPE Only

- **SPE Program**

```
#include <stdio.h>

int main(unsigned long long speid, unsigned long long argp,
unsigned long long envp)
{
    printf("Hello world!\n");
    return 0;
}
```

- **SPE Makefile**

```
PROGRAMS_spu := hello_spu
IMPORTS       = $(SDKLIB_spu)/libc.a
include $(SDK_TOP)/make.footer
```

“Hello World!” – SPE Only (2)

- **Can only be started directly in the Simulator**
- **Printf()**
 - there is no direct access to linux console by SPE
 - printf() several implementations in different libraries
 - Doing nothing
 - Doing a system call to PPE
 - simulator implements printf() to aid in debugging on simulator console

“Hello World!” – PPU and SPU

- **SPE program**
 - Same as for SPE only
- **SPE Makefile**

```
PROGRAMS_spu    := hello_spu
LIBRARY_embed   := hello_spu.a
IMPORTS         = $(SDKLIB_spu)/libc.a
include $(SDK_TOP)/make.footer
```

“Hello World!” – PPU and SPU (2)

- **PPU program**

```
#include <stdio.h>
#include <libspe.h>
extern spe_program_handle_t hello_spu;
int main(void)
{
    int speid, status;
    speid = spe_create_thread (0, &hello_spu, NULL, NULL, -1, 0);
    spe_wait(speid, &status, 1);
    return 0;
}
```

- **PPU Makefile**

```
PROGRAM_ppu = hello_ppu
IMPORTS = ../spu/hello_spu.a -lspe
include $(SDK_TOP)/make.footer
```

PPE and SPE Synergistic Programming

PPE Code

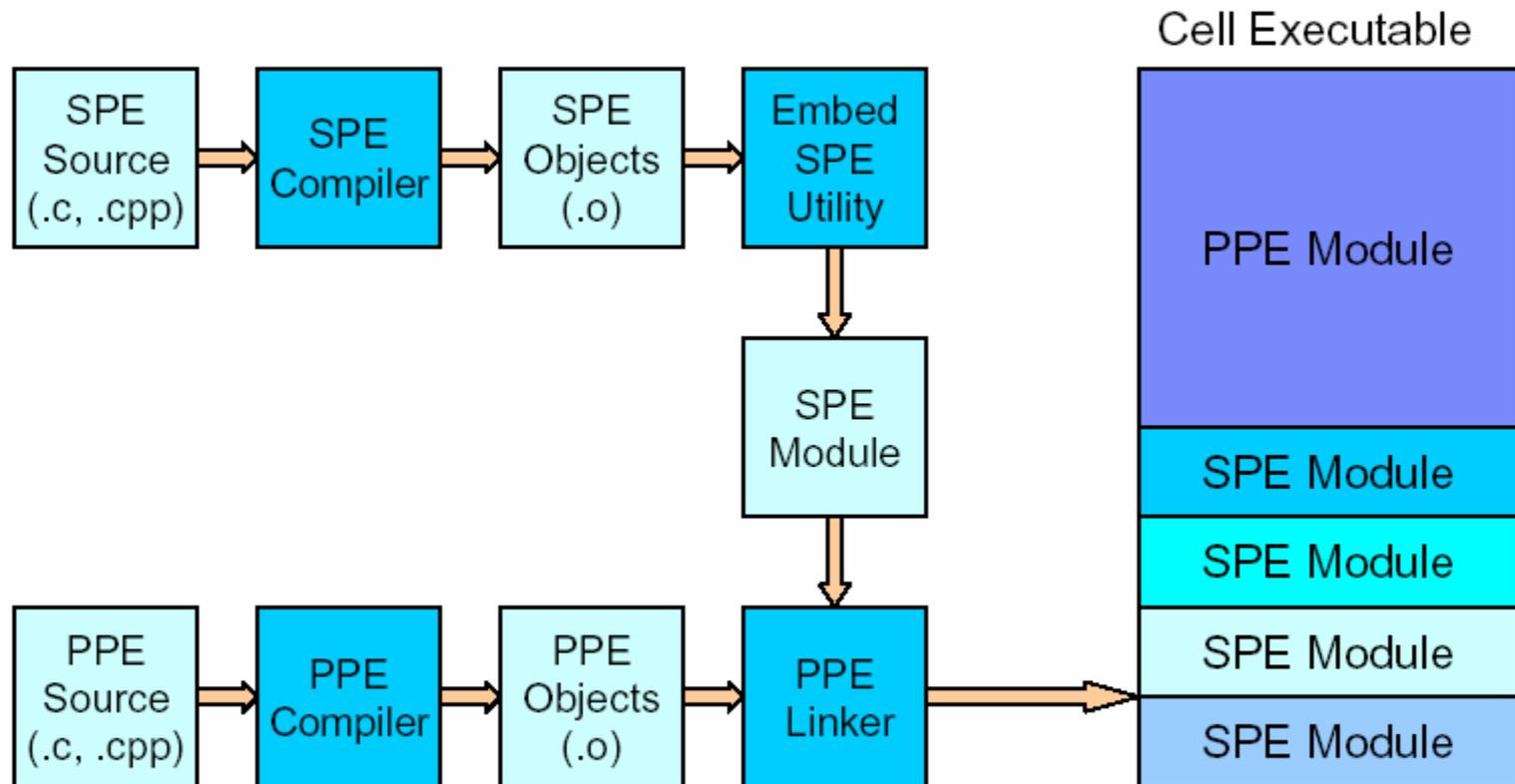
```
#include <stdio.h>
#include <libspe.h>
extern spe_program_handle_t hello_spu;
int main(void)
{
    int speid, status;
    speid = spe_create_thread (0, &hello_spu, NULL, NULL, -1, 0);
    spe_wait(speid, &status, 1);
    return 0;
}
```

SPE Code

```
#include <stdio.h>
#include <cbe_mfc.h>
#include <spu_mfcio.h>

int main(unsigned long long speid, unsigned long long argp,
unsigned long long envp)
{
    printf("Hello world!\n");
    return 0;
}
```

Build Process



✓ Make scripts are available to automate the build process

Two Ways to Exchange Files between Host and Simulator

▪ **RAMDISK**

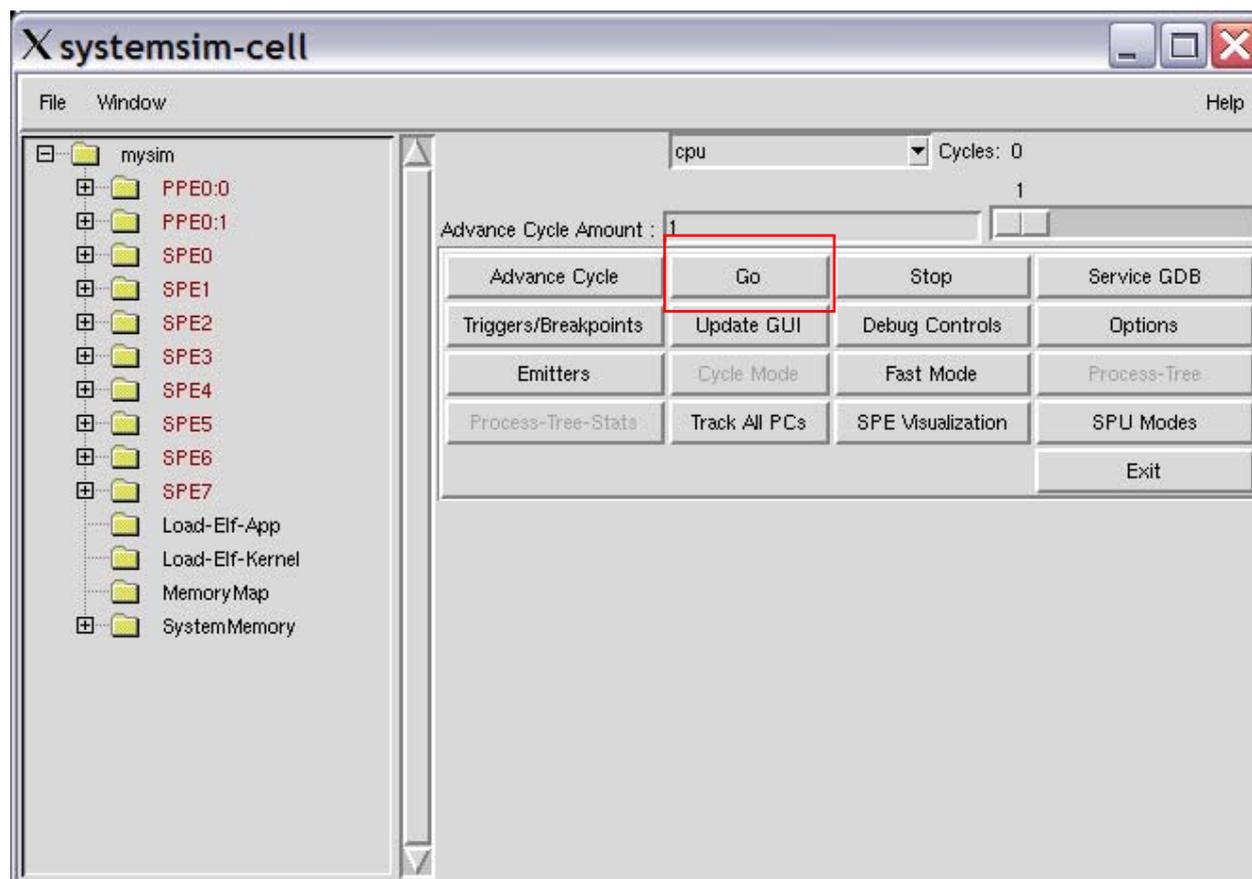
- the Systemsim simulator runs its environment off a ramdisk that is built using “make” in the \$SDK_TOP/ramdisk directory
- files can be inserted into this ramdisk such that when the simulator is started the files will be there already
 - useful for data input files or binaries that are known to work correctly

▪ **Callthru**

- “backdoor” communication mechanism for the simulated environment to communicate with the host environment
- useful for bringing in files to the simulated environment without shutting down and restarting the simulator
- Example: (binary host → simulator)
 - `callthru source /home/systemsim/hello/ppu/hello_ppu > hello_ppu`
 - `chmod 755 hello_spu`
 - `./hello_spu`
- Example (result file simulator → host)
 - `callthru sink /home/systemsim/results/result_file < cat result_file`
 - exporting result files out of the simulated environment for later inspection

Running the Binary

- Start the simulator
 - `# cd systemsim-cell-release/run/cell/linux`
 - `# ./run_gui`
 - Hit **“Go”**



Execute Binary

- Bring executable(s) into the simulator using the callthru utility
 - **callthru source /home/systemsim/hello/ppu/hello_ppu > hello_ppu**
- Execute binary
 - **chmod 755 hello_spu**
 - **./hello_spu**

Tip!

Copy binary to /tmp/<exe> on host to shorten the filename

Directory Structure

- **hello_ppu**
- **hello_be**
 - spu

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