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
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

```c
#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**

```c
#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**

```make
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**

  ```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**

```c
#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

```c
#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

```c
#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

![Diagram of the build process showing SPE Source (.c, .cpp) going through SPE Compiler to SPE Objects (.o) and then to Embed SPE Utility, followed by SPE Module, PPE Module, SPE Module, SPE Module, SPE Module, PPE Linker, and finally to Cell Executable.]

- 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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