Hands-on – SPU to SPU DMA Transfer

Cell Programming Workshop
Cell Ecosystem Solutions Enablement
Class Objectives

- Objective: Learn how to do basic DMA transfers
- ‘Hello World’ already uses DMA to send data to an SPU
- We will modify ‘Hello world’ example to:
  - Send data from an SPU back to the PPU
  - Send data between SPUs

/opt/cell_class/Hands-on-30/spu-spu/libspe2
‘Hello World’ Review

- **PPU creates NUM_THREADS threads**
- **Each pthread starts a copy of the SPU program**
- **SPU program does a DMA transfer to receive a string**
- **SPU program prints the string and exits**

```c
/* Here is the actual DMA call */
/* the first parameter is the address in local store to
place the data */
/* the second parameter holds the main memory address */
/* the third parameter holds the number of bytes to DMA */
/* the fourth parameter identifies a "tag" to associate
with this DMA */
/* (this should be a number between 0 and 31, inclusive) */
/* the last two parameters are only useful if you've
implemented your */
/* own cache replacement management policy. Otherwise set
them to 0. */

mfc_get(parameter_area, argp ull, 128, 31, 0, 0);

/* Now, we set the "tag bit" into the correct channel on
the hardware */
/* this is always 1 left-shifted by the tag specified with
the DMA */
/* for whose completion you wish to wait. */

mfc_write_tag_mask(1<<31);

/* Wait for the data array DMA to complete. */

mfc_read_tag_status_all();

printf("SPE: Data received is: %s", parameter_area);
```
Next Step: Data Transfer back to PPU

- DMA Puts look exactly like DMA Gets

...  

mfc_get(parameter_area, argp.ull, 128, 31, 0, 0);

/* Now, we set the "tag bit" into the correct channel on the hardware */
/* this is always 1 left-shifted by the tag specified with the DMA */
/* for whose completion you wish to wait. */
mfc_write_tag_mask(1<<31);

/* Wait for the data array DMA to complete. */
mfc_read_tag_status_all();

printf("SPE: Data received is: %s", parameter_area);

sprintf( parameter_area, "%llx: Back at you\n", speid);

// Now send it back.

mfc_put(parameter_area, argp.ull, 128, 31, 0, 0);
mfc_write_tag_mask(1<<31);
mfc_read_tag_status_all();

...
SPU to SPU Transfer

- Passes data from PPU to SPU, SPU to SPU, then back to the PPU.
- New concepts/constructs:
  - Mailboxes
  - Using SPE local store addresses

PPU Flow
- Receive a mailbox message from each SPU. The message contains an offset into local store where the buffer for the SPU lives.
- Send mailbox messages to SPUs. The message has a control block pointer.
- Send a mailbox message to each SPU to tell them when to execute.

SPU Flow
- Send a mailbox message to the PPU with the offset to the local buffer.
- Read a mailbox to get a control block address.
- Wait on mailbox for a signal to do a data movement to another SPU
PPU Code

```c
#include <stdio.h>
#include <libspe2.h>
#include <libmisc.h>
#include <pthread.h>
#include <string.h>
#include "control.h"

extern spe_program_handle_t hello_spu;
char buffer[128] __attribute__ ((aligned(128)));

#define ACTIVE_SPUS 6

void *ppu_pthread_function(void *arg)
{
    unsigned int entry = SPE_DEFAULT_ENTRY;

    spe_context_run(*((spe_context_ptr_t *)arg), &entry, 0, NULL, NULL, NULL);
    pthread_exit(NULL);
}

int main()
{

    int i;
    spe_context_ptr_t ctxs[ACTIVE_SPUS];
    pthread_t threads[ACTIVE_SPUS];

    control_block * cb = (control_block *)malloc_align(128,7);
    cb->first = 0;
    cb->last = ACTIVE_SPUS - 1;
    cb->memory = buffer;
    strcpy (buffer, "Zao shang hao!");
```

```
control.h

typedef struct {
    char * memory;
    int first;
    int last;
    void * lstore[8];
    char padding[84];
} control_block;
```
for (i=0; i<ACTIVE_SPUS; i++){
    ctxs[i] = spe_context_create (0, NULL);
    spe_program_load (ctxs[i], &hello_spu);
    pthread_create (&threads[i], NULL, &ppu_thread_function, &ctxs[i]);
}

for (i=0; i<ACTIVE_SPUS; i++){
    cb->lstore[i] = spe_ls_area_get(ctxs[i]);
    while (!spe_out_mbox_status(ctxs[i])) {}
    unsigned int temp;
    spe_out_mbox_read(ctxs[i], &temp, 1);
    cb->lstore[i] += temp;
}

for (i=0; i<ACTIVE_SPUS; i++){
    unsigned int data;
    data = (unsigned int)(cb);
    spe_in_mbox_write(ctxs[i], &data, 1, SPE_MBOX_ANY_NONBLOCKING);
}

for (i=0; i<ACTIVE_SPUS; i++){
    spe_in_mbox_write(ctxs[i], (unsigned int *)&i, 1, SPE_MBOX_ANY_NONBLOCKING);
    pthread_join (threads[i], NULL);
}

printf("PPE says %s\n", buffer);
return 0;
SPU Code

```c
#include <stdio.h>
#include <spu_mfcio.h>
#include <malloc_align.h>
#include <string.h>
#include <../control.h>

int main()
{
    int myId;
    char * buffer = malloc_align(128,7);
    control_block * ls_cb = malloc_align(sizeof(control_block),7);
    control_block * cbPtr;

    // Send buffer offset
    spu_write_out_mbox((unsigned int)buffer);

    // Get control block address and transfer it to local storage
    cbPtr = (control_block *) spu_read_in_mbox();
    mfc_get (ls_cb, (unsigned int)cbPtr, sizeof(control_block), 1, 0, 0);
    mfc_write_tag_mask(1<<1);
    mfc_read_tag_status_all();

    // Wait to execute until it is our turn
    myId = spu_read_in_mbox();

    // First SPU in the chain reads from PPU memory
    if (myId == ls_cb->first) {
        mfc_get(buffer, (unsigned int)ls_cb->memory, 128, 1, 0, 0);
        mfc_write_tag_mask(1<<1);
        mfc_read_tag_status_all();
    }

    printf("SPE %d says %s\n", myId, buffer);
```
SPU Code (continued)

```
switch ( myId ) {
  case 0: { strcpy(buffer,"Dobry dien!"); break; }
  case 1: { strcpy(buffer,"Bon giorno!"); break; }
  case 2: { strcpy(buffer,"Buenas dias!"); break; }
  case 3: { strcpy(buffer,"Ohayo gozaimasu!"); break; }
  case 4: { strcpy(buffer,"Boker tov!"); break; }
  case 5: { strcpy(buffer,"Dobre jítro!"); break; }
  case 6: { strcpy(buffer,"Bon jour!"); break; }
  case 7: { strcpy(buffer,"Chao buoi sang!"); break; }
}

// Send message to next SPU (or PPU if we are the last SPU)
if (myId == ls_cb->last) {
  mfc_put(buffer, (unsigned int)ls_cb->memory, 128, 1, 0, 0);
} else {
  mfc_put(buffer, (unsigned int)ls_cb->lstore[myId+1], 128, 1, 0, 0);
}

mfc_write_tag_mask(1<<1);
mfc_read_tag_status_all();

return 0;
```
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