



IBM Systems & Technology Group
Cell/Quasar Ecosystem & Solutions Enablement

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

```

. . .
/* 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.u11, 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.u11, 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.u11, 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

```
#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_thread_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;
```

PPU Code (continued)

```
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

```
#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 jitra!"); 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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