Carleton University Cell BE Programming Workshop

Registration at the Architecture Building (AA on the campus map) between 7:30 – 8:00 AM on May 15th, 2008

Course Description

The Cell BE (Cell) architecture incorporates several interesting features which enable Cell to support highly parallel, compute intensive codes. The first implementation of the architecture results a single chip of heterogeneous processors, including a POWER processing element PPE with two levels of cache and eight synergistic processing elements SPEs with their own local memories and globally consistent DMA engines. In addition to processor-level parallelism, each processing element has Single Instruction Multiple Data (SIMD) units that can each process from 4 words up to 16 chars per processing cycle. Such design allows Cell to support a wide variety of high performance workloads across a number of industries including digital media, medical imaging, aerospace, defense and communications, and financial services. While PlayStation 3 is the first major piece of hardware to use Cell in the gaming industry, the Roadrunner project scheduled to be deployed at Los Alamos National Laboratory sometime in 2008 will be the first large-scale heterogeneous supercomputer system deployment containing 16,000 Cell processors hybridizing with 16,000 Opteron X64 delivering 1.6 petaflops. Programming techniques which harness the power of Cell are key to attaining the high compute performance of which it is capable, but such techniques may require some different programming concepts.

The first day of this two-day Cell BE programming workshop is designed for beginners and provides a technical overview of the Cell architecture, programming models, and software development environment. It will also cover the IBM SDK (Software Development Toolkit) for Multicore Acceleration Version 3.0 plus hands-on exercise to give participants a jump start opportunity to practice Cell programming. There will be a poster session (wine & cheese served) on the evening of the first day. Posters are welcome from researchers and graduate students on any Cell BE related topic; include early stage project proposal type posters. Please let James Green (jrgreen@sce.carleton.ca) know if you will be able to provide a poster. The research questions arising from the poster session will be addressed in the two discussion sessions on the second day of the workshop.

The second day of the course is primarily designed for the more advanced students who have some programming experience with the SDK and the Cell BE Simulator (these students are strongly recommended to join the first day class to re-familiar themselves with the fundamentals). The first half of the second day will be used to cover advanced programming topics including two application sessions presented by guest speakers from EL TE University in Hungary and Simon Fraser University in British Columbia . The second half of the day will be used for scientific case studies (presented by instructors on their research projects) and for discussion of student projects presented in the poster session on the first day. In the discussion sessions, instructors will interact with the student and suggest ways to address their problems such as what were the performance bottlenecks in their Cell program? how should the bottlenecks be handled? how should the students SIMDize their code? how should they parallelize it? how the codes be synchronized? and processes be communicated? Any unexpected problems the students encountered that yet to be resolved? .....

Class agenda

(Instructors: CA – Christopher Anand, MP – Michael Perrone and RE – Robert Enenkel)

Day 1: Beginner Course (classroom in the 508 Architecture Building)

Session	Minutes	From-To	Subject
01	10	08:00-08:10	Welcoming session
02	50	08:10-09:00	Introduction – processor, Architecture & Cell SDK 3.0 (Instructor: MP)
03	10	09:10-9:20	Basic Programming Concepts (instructor: MP)
04	30	9:20-9:50	Hands-on System Check & System Exploration (Instructor Lead: MP)
05	10	9:50-10:00	Cell BE Simulator (SPU Dynamic Profiling) (Instructor: CA)
06	30	10:00-10:30	Hands-on – SPU Dynamic Profiling (Instructor Lead: CA)
	10	10:30-10:40	Break
07	40	10:40-11:20	Developing Code for Cell – SIMD (Instructor: CA)
08	30	11:20-11:50	Hands-on Hello World Program PPE vs SPE (Instructor Lead: MP)
		11:50-12:50	Lunch
09	40	12:50-13:30	Developing code for Cell – GCC & XLC (Instructor: RE)
10	20	13:30-13:50	Performance Tools (Instructor: RE)
11	40	14:20-15:00	Developing code for Cell – DMA and mailbox (Instructor: RE)
		15:00-15:10	Break
12	40	15:10-15:50	Hands-on SIMD with Practical Examples (Instructor Lead: CA)
13	70	15:50- 17:00	Hands-on_Async-Multithread
14			Hands-on_DMA_get_buffer
15			Hands-on_DMA_get&put_buffer
16			Hands-on_DMA_ControlBlock
17			Hands-on_DMA_SPU-to-SPU (Instructors: CA, MP & RE)
18	90	17:00-18:30	Poster Session : **University Centre Galleria (Wine & Cheese Reception)**

Day 2: Advanced Course (Classroom in 208 Tory Building)

Session	Minutes	From-To	Subject
01	20	09:00-09:20	PPU / SPU MASS library (Instructor: MP & RE)
02	20	09:20-09:40	SPU Floating Point (Instructors: MP & RE)
03	20	09:40-10:10	Optimizing a Computation for SPU (Instructor: CA)
04	30	10:10-10:40	Introduction to Coconut (Instructor: CA)
		10:40-11:00	Break
05	40	11:00-11:40	Special Guest: Primality Testing on Cell (Instuctor: Zoltan Jarai, **Eötvös Loránd** University, Budapest, Hungary)
06	40	11:40-12:20	Special Guest: XML on Cell (Instructor: Rob Cameron, (Simon Fraser University, BC)
	60	12:20-13:20	Lunch
07	25	13:20-13:45	Scientific Computing – Seismic Signal Processing (Instructor: MP)
08	25	13:45-14:10	Scientific Computing - Bioinformatics (Instructor: MP)
09	25	14:10-14:35	Scientific Computing – Medical Image Processing (Instructor: CA)
	10	14:35-14:45	Break
10	45	14:45-15:30	Discussion 1 (Student Projects – Poster)
11	45	15:30-16:15	Discussion 2 (Student Projects – Poster)
12	45	16:15-17:00	Closing session