

# Games Console Development

## Lecture I

Topics covered this week:

- Module Overview
- Intro to PS3 / Cell architecture and development

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## Module Overview

### Contacts

- Module Co-ordinator
  - Dr Richard Beeby (E360)
  - [Richard.Beeby@uws.ac.uk](mailto:Richard.Beeby@uws.ac.uk)
- Module Deliverer
  - Derek Stobbs (E260)
  - [Derek.Stobbs@uws.ac.uk](mailto:Derek.Stobbs@uws.ac.uk)
  - 07725 266 901 *in emergency*

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## Module Overview

### Notes, etc.

- Lecture slides, practical exercises, assessments etc.
  - Home - <http://www.wosgamers.co.uk/projects/show/gcd>
  - Wiki - <http://www.wosgamers.co.uk/wiki/gcd>
- Last years notes
  - <http://blackboard.uws.ac.uk>
  - Will be uploaded to the Wiki for reference
- West of Scotland Gamers social networking site
  - <http://wosgamers.ning.com>

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## Module Overview Effort expected

- Each 20 point module requires about 200 hours of effort, including the allocated contact hours; for this module ...
  - 12 Lectures [24 hours]
  - 12 Practical sessions [24 hours]
  - Examination [2 hours]
  - Coursework [40 Hours]
  - Independent study and revision [110 hours]
- This equates to about 40 hours total per week for the 3 modules or 13.33 hours per module per week (over 15 weeks)

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## Module Overview Rules

- Attendance will be monitored!
  - You must attend all lectures
  - You must attend all practical sessions
  - Failure to do so (without good reason) will first result in a warning being given, and may result in you being removed from module registration!!
- If you don't want to listen, don't disrupt others!

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## Module Overview Assessment Schedule

- Exam – 40%
  - Lecture material
  - Own research on topic
- Coursework – 60%
  - Specification to be handed out week 4 (probably)
  - Will likely involve porting an application from Windows and optimising for the PS3 architecture

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## Module Overview Marking Scheme

Grade	Score	Criteria
A	70% – 100%	Commercial quality
B1	60% – 69%	What was asked for
B2	50% – 59%	A few flaws
C	40% – 49%	Acceptable
D	30% – 39%	Needs more work
E	20% – 29%	Needs restarted
F	0 – 19%	No significant effort

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## Module Overview Course Texts

- Programming the Cell Processor: For Games, Graphics, and Computation (Hardcover) by Matthew Scarpino - <http://www.amazon.co.uk/dp/0136008860/>
- CBE Resource Center - <http://www.ibm.com/developerworks/power/cell/>
- As always, Google and Wikipedia are your friends ... but don't trust everything you read!

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## Module Overview What, where, why, when, who?

- As you may have guessed ...
- PS3 Low-level programming
- Discussions about current generation consoles, and some previous generation added into the mix
- Lots of work, coding, blood, sweat, tears ...

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## PlayStation 3

- Supports High-Definition television (HDTV) with a resolution of 1920x1080
- Uses Blu-ray discs (54GB)
- IEEE 802.11gWi-Fi, Bluetooth 2.0, USB 2.0
- Processor: "The Cell"
- Graphics: NVidia RSX

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## The hype: On Moore's Law...

"We are working for the third-generation (PlayStation) with this very aggressive and crazy goal. Moore's Law is too slow for us. We can't wait 20 years to achieve a 1,000-fold increase in PlayStation performance."

Shin'ichi Okamoto  
Chief Technical Officer, SCEI

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## The Cell

- The Cell has been developed by SCEI, Toshiba and IBM.
- Claims have been made that it is one of the most significant developments in popular computing since the PC.
- Used in the PlayStation 3 and also many other devices. Toshiba are planning a high-spec television that uses the Cell
- May offer serious competition to Intel & AMD
- Offers cheap (so-called) "supercomputing" capability.
- Reported capability of over 256 GFLOPS (billions of Floating Point Operation per Second) – theoretical maximum.

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## Cell Architecture

- Most microcomputer processors use a JIT (just in time) abstraction layer: Assembly language is written for a virtual machine implemented in a processor's microcode.
- The cell does not have this layer of abstraction – the programmer has direct access to the hardware.
- The architecture is unlike any microcomputer processor – it is more similar to Cray designs.
- Marketing speak describes the chip as a "supercomputer". However, it remains significantly slower than the slowest computer on the list of the world's top 500 supercomputers. <http://www.top500.org>

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## Cell Architecture

- Designed for high-performance distributed computing
- Comprised of hardware & software cells.
- SW cells (a.k.a. "apulets") are units containing programs and data. These are sent to the hardware cells, which execute the programs and return, or pass on the results.
- SW cells can be sent to any cell processor, even in different hosts.
- SW cells contain source, destination and reply address fields, which may contain network addresses.

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## Cell Architecture

- Ad hoc configurations are possible – processors can be added and removed to distributed systems with ease.
- If you need more processing, simply add more cells, or connect to more!

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## Cell Architecture

- The Cell processor contains:
  - A power processing element (PPE): a conventional microprocessor: "Power Architecture" CPU with 512k cache. Can execute PowerPC binaries, although it is distinct from Mac G5/G6 processors.
  - Dual IO controllers (providing 76.8 Gb/sec)
  - Dual memory controllers (providing 25.6 Gb/sec) to up to 256 MB
  - 8 Synergistic Processing Elements (SPEs) – very high performance vector processors. (only 7 SPEs are present in PS3)
  - Element Interconnect Bus (EIB): A bus connecting it all together (1024-bit) may be clocked at 3.2GHz, supporting 204.8Gb / sec (theoretical)
  - A DMA controller. Apulets and control data will be passed to the SPEs by the PPE via DMA.

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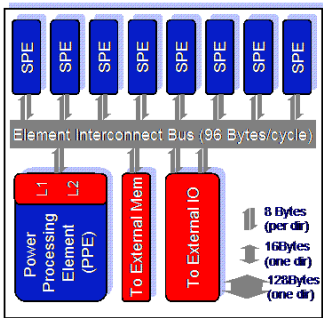
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## Cell Processor




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## SPE Architecture

- Each Attached Processing Unit is a self-contained processor.
- Single Instruction Multiple Data (SIMD) design
- They contain:
  - 128 128-bit four-field single precision float registers
  - 4 floating point ALUs
  - 4 integer ALUs
  - 256k local memory

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## SPE Architecture

- IBM claim that a single SPE can perform as well as a current top end single core desktop CPU, given the right task.
- One SPE can deliver a theoretic maximum of 32 GFLOPS
- (Was formerly called APU)

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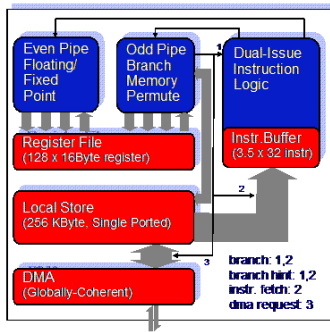


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## Synergistic Processing Element




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## Stream processing

- SPEs may be chained together in an arbitrary way to process data in a stream.
- An SPE will perform a task, and send the resulting data to another SPE, which will perform another task, and so on...
- Chains may include SPEs in different cell processors.
- The PS3 has one Cell processor

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## Programming the Cell

- The PPE manages a job (apulet) queue. Scheduling of jobs to the SPEs can be done automatically by the PPE.
- Writing Cell applications requires parallel software engineering principles.
- Development tools currently in production (some in use) to ease development of parallelised jobs.
- Any PowerPC distribution of Linux can be run on the retail PS3. However, indie developers do not have full access to the hardware.
- Some have expressed concerns about the cost and expertise required to program the Cell, due to the degree of parallelism. (These skills are scarce!)

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## Graphics

- Custom RSX, or "Reality Synthesiser" co-developed by NVidia & Sony
- Clocked at 550 MHz / 1.8 TFLOPS
- Programmable parallel floating point shader pipelines (136 shader operations per clock)
- 128-bit pixel precision for high dynamic range imaging (HDR) (advanced lighting)
- 512MB VRAM
- Programmable by OpenGL ES (Embedded Systems)

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## Summary

- One cell can theoretically perform at 250 GFlops
- A 3GHz P4 has a theoretical maximum of 6 GFlops. The GeForce 6800 Ultra has been observed to achieved 40 GFlops.
- It is claimed that 6 hours of processing on a modern intel CPU can be done in 5 minutes on a PS3.
- Only true if the processing could be parallelized with no redundancy - impossible in practice.
- The new processor offers extensive parallel features well in excess of any current mini or micro-computer technology.

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## Summary

- The first processor aimed at the consumer market to significantly violate Moore's law.
- Has the potential to revolutionise personal computing.
- May present serious challenges to developers : full exploitation of the hardware requires optimal use of parallelism.

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## How to get started in development

- Practical session next week will get you started in your development on the PS3s
- Write your code on the PC using your favourite editor (VC, Eclipse, Notepad++)
- Copy files to PS3 using WinSCP or FileZilla
- Login to PS3 linux shell using PuTTY SSH
- Compile and run at the command line ... no Graphics!

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## For next week

- Order the course book (highly recommended)
- Join the WosGamers Projects site, and the GCD project
- Keep an eye on the Wiki page, I intend to post the practical session for next week up over the weekend
- Make sure your C++ skills are up to scratch
- Answer these questions:
  - How can we get around the "No graphics" problem?
  - What would you consider a reasonable coursework?

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