BSC Overview

- World-Leading HPC Center
- MareNostrum ranked top-5 supercomputer in 2005 (Top500 list)
- BSC named 2010 CUDA Research Center
- BSC-Microsoft Research Center
- Funded on January 2008
- BSC Research Interest:
  Computational Sciences (Deep Computing and Computer Architecture), Life Sciences and Earth Sciences
- BSC Director:
  Mateo Valero received Eckert-Mauchly Award in 2007.

BSC Consortium: Spanish Government, Generalitat de Catalunya, UPC

OmpSs Programming Model

- OmpSs is a parallel programming model based on pragmas

- OmpSs can run above:
  OpenCL
  CUDA
  IBM SDK Cell BE
  SGI RascalLib for FPGAs
  Pthreads

- OmpSs integrates:
  - StarSs expressiveness:
    Heterogeneity, Data direction (input/output) hints, Detection of dependences at runtime, Automatic data movement, etc.
  - OpenMP expressiveness:
    Task Level Parallelism, iteration scheduling & tasking
  - OpenCL SIMD notation:
    Explicit Data Level Parallelism

Example: OmpSs with C/OpenCL

```c
#define BS 16384

// pragma omp target device(smp) // For task execution just in the Host
// pragma omp target device(fpga) // For task execution just in the FPGAs

// For execution in both: Host and FPGAs, Runtime decides
pragma omp task input (A0:BS-1, B0:BS-1) output (C0:BS-1)
void processBlock(int BS* A, int BS* B, int BS* C)
{
    for(int i=0; i<BS; i++)
        C[i] = A[i] * B[i];
}

void processData(int BS* A, int BS* B, int BS* C)
{
    for(int i=0; i<BS; i++)
        processBlock(B[i], A[i], C[i]);
}
```

- input/output to indicate data dependencies
- copy_deps to indicate the dependent data has to be copied into the fpga before the execution, and copied out of the fpga after execution
- task, to encapsulate the code/function that should be offloaded into a separate file, and compiled with the compiler for the FPGA

Conclusions

- Transparent and portable FPGA Toolchain for HLL programmer
- Take advantage of the TLP, DLP, etc. on the applications using an OpenMP based parallel programming model (OmpSs)
- Towards a Full Integrated Toolchain for Heterogeneous Systems

References

- Piotr Dziurzanski and Volodymyr Beletskyy. Defining Synthesizable OpenMP Directives and clauses
- Eduard Ayguade et al. Extending the OpenMP Tasking Model to Allow Dependent Tasks
- OmpSs: Toolchain Flow for FPGAs
- Nanos++ Runtime Scheme