University of Tsukuba | Center for Computational Sciences

Omni Compiler

Omni XcalableMP Compiler

- XcalableMP (XMP) is a PGAS language for distributed memory system, which is a directive-based language extension of C and Fortran
- XMP supports typical parallelization under global-view programming model
  - 》XMP global-view model enables parallelizing the original sequential code using minimal modification with simple directives, like OpenMP
  - 》The directives can describe data mapping, work mapping, and inter-node communication
  - 》Many ideas on global-view programming are inherited from High Performance Fortran
- XMP includes Coarray Fortran syntax as local-view programming model

Example of the HIMENO Benchmark in XMP/Fortran

```
real p(mimax, mjmax, mkmax)
!$xmp nodes n(2, 2)
!$xmp template t(mimax, mjmax, mkmax)
!$xmp distribute t(*, block, block) onto n
!$xmp align (*,j, k) with t(*,j, k) :: p
!$xmp shadow p(0, 1, 1)
  :
!$xmp reflect (p)
!$xmp loop (J, K) on t(*, J, K) reduction (+:GOSA)
do K = 2, kmax−1
  do J = 2, jmax−1
    do I = 2, imax−1
      S0 = p(I+1, J, K) * ...
      SS = ... - p(I, J, K) * ...
      GOSA = GOSA + SS * SS
        :
    enddo
  enddo
enddo
```

Definition of data mapping

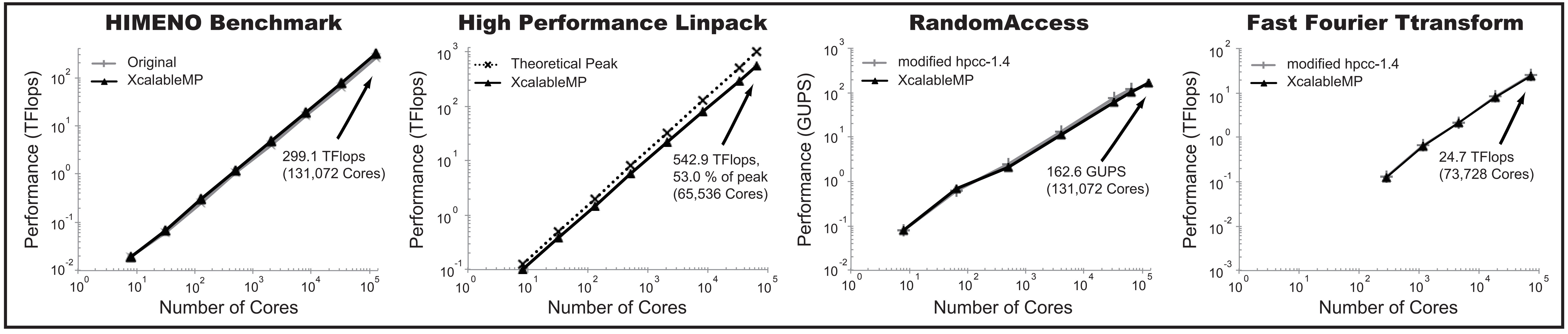
Definition & data sync. of shadow area

Parallelization for loop statement

Access to shadow area

Note : The HIMENO Benchmark is a typical stencil benchmark.

Performances of the HIMENO Benchmark & the HPC Challenge Benchmarks on the K computer

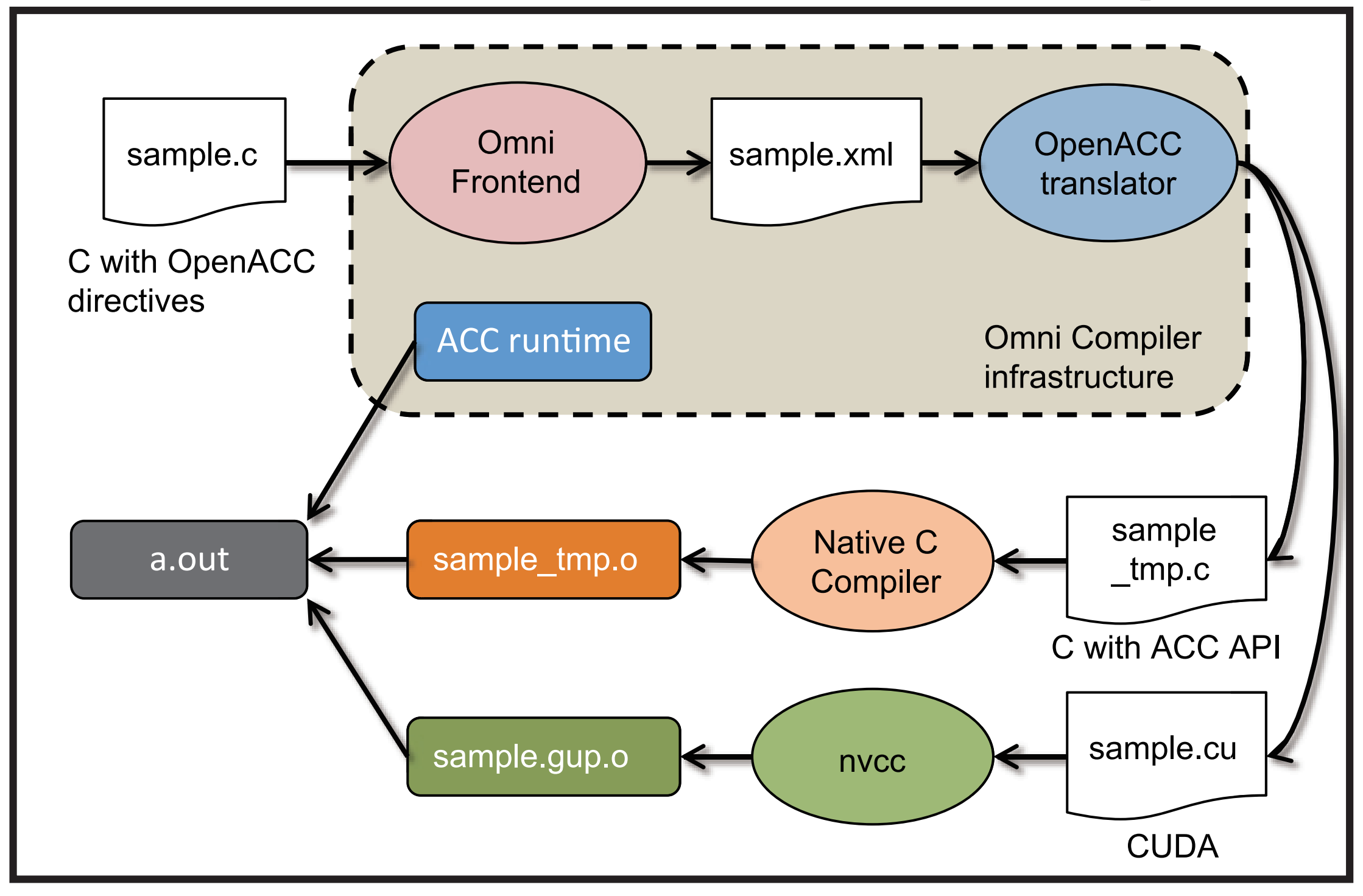


Reference: Masahiro Nakao, Hitoshi Murai, Takenori Shimosaka, Mitsuhisa Sato. "Productivity and Performance of the HPC Challenge Benchmarks", PGAS2013

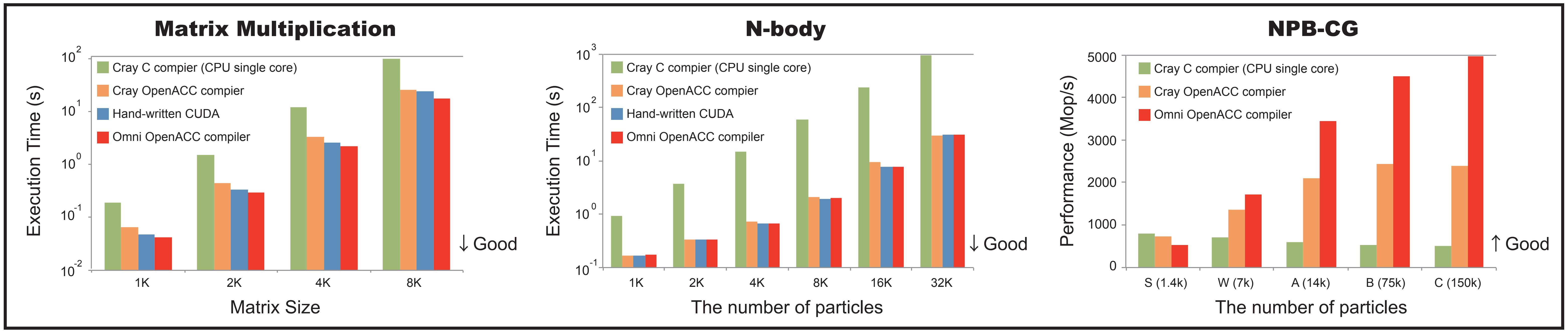
Omni OpenACC Compiler

- OpenACC is a directive-based programming model for accelerators
- We have been designing and implementing an open source OpenACC compiler
  - 》To implement our OpenACC compiler, we use the Omni compiler-infrastructure of C source code analysis and translations
  - 》Target language is C language
  - 》Target accelerator is NVIDIA GPUs
  - 》The proposed compiler is a source-to-source compiler that translates an OpenACC program into a C program with CUDA library calls
  - 》This approach enables to leave detailed machine-specific code optimization to the mature CUDA compiler by NVIDIA

Flow of Compilation



Performances on Cray XK6m-200 (AMD Opteron 6277 2.1GHz, NVIDIA X2090(MatMul, N-body), K20(NPB CG))



Reference: Akihiro Tabuchi, Masahiro Nakao, Mitsuhisa Sato. "A Source-to-Source OpenACC compiler for CUDA ", HeteroPar'2013

These compilers are free. You can download them from http://www.hpcs.cs.tsukuba.ac.jp/omni-compiler/