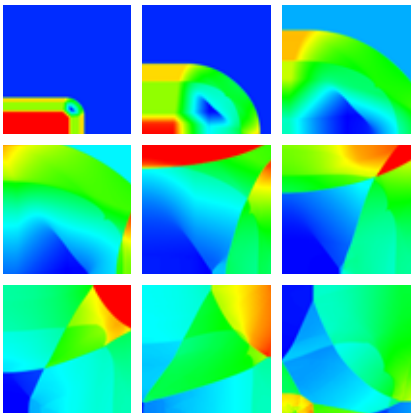
CASE STUDY
Intel® Software Development Tools
Intel® C /C++ Compiler, Intel® Fortran Compiler,
Intel® MPI Library, Intel® Xeon Phi™ coprocessor

AWE's HPC Research Applications Get Performance Boost with the Intel® Xeon Phi™ Coprocessor

Sophisticated hydrodynamics software leverages the value of advanced Intel® tools



CloverLeaf* app tracks shock waves

"Utilizing Intel® Xeon Phi™ enabled AWE to produce a highly optimised code that gave the correct results and was not only portable across Intel® platforms, but also helped form the basis for other software models and technologies tested. AWE achieved portability, while retaining performance."

OVERVIEW

As a cornerstone of nuclear deterrence and national defence in the United Kingdom, AWE is a centre of scientific and technological excellence, with some of the most advanced research, design, and production facilities in the world. Precision, performance, and reliability are mission critical capabilities for AWE in its high performance computing research and development.

The company rigorously tests software products to ensure it has the best possible development tools. Criteria include performance, power use, ease of use, portability, and open standard vs. vendor-specific tools.

THE CHALLENGE

As computing hardware evolves to multicore chips and wider functional units, the impact on key software algorithmic schemas can be uncertain. Through the use of a lightweight mini-application, AWE wanted to understand key performance characteristics of real applications across a spectrum of the latest computing architectures, including the Intel® Xeon Phi™ coprocessor.

AWE utilised a 2-D, structured hydrodynamic CloverLeaf* "mini-app"—an explicit solution to compressible Euler equations. The app uses a finite volume predictor/corrector Lagrangian step, followed by an advective remap that is used to benchmark hardware platforms and software methods. It allows the tracking of shock waves and the bulk flow of gas through a compressible medium. The app provides a tool to investigate the software methodologies required to efficiently use exascale platforms to meet significant scientific challenges.

THE SOLUTION

AWE took advantage of early access to experimental and prerelease hardware for Intel Xeon Phi, as well as the latest Intel® compilers and drivers. Intel experts worked closely with AWE engineers to optimise the company's software. AWE examined "every technology we could get access to, including Intel® Xeon®, GPUs, APUs, and other CPU architectures. We also tested OpenCL, CUDA, OpenACC, PGAS, and offload." The Intel Xeon Phi coprocessor allowed AWE to realise significant performance gains.

Key Findings	
Performance	Refactored code ran 25 times faster on the Intel® Xeon Phi™ coprocessor
Productivity	Performance gains will allow an increased amount of research and greater fidelity of research, if the refactoring is applied to production codes. The payoff for the effort involved in refractoring is that the code will scale as the architecture evolves.
Forward-Scaling/ Cross-Platform	The same version of code (hybrid OpenMP/MPI*) runs on Intel® Xeon® and Intel Xeon Phi with no changes, other than choosing the optimal balance of MPI tasks and OpenMP* threads at runtime.
Extendable Improvements	Once optimised on the Intel® Xeon Phi™ coprocessor, running the application on a purely Intel® Xeon® E5 cluster achieved significant gains due to improved threading, vectorization, and memory locality, as well as a performance boost.

RESULTS

Utilizing Intel Xeon Phi enabled AWE to produce a highly optimised code that gave the correct results and was not only portable across Intel® platforms, but also helped form the basis for other software models and technologies tested. AWE achieved portability, while retaining performance.

From an original benchmark code, AWE optimised the Intel Xeon Phi code by a factor of eight through the refactoring needed to produce a performing OpenMP* version. This version then ran more than 3X faster on the Intel Xeon Phi coprocessor compared to the runtime on the Intel® Xeon® dual-socket E5 2687W 3.1 GHz processor alone. Intel® VTune™ Amplifier XE was used to optimise threading and vectorization.

Conclusion

AWE realised significant performance gains on its software when using the Intel Xeon Phi coprocessor. The combination of Intel® software tools and standardised, scalable manycore architecture with AWE's engineering expertise and advanced HPC software enables scale-forward applications with the high levels of accuracy and reliability required by AWE's customers.

For AWE, the Intel Xeon Phi coprocessor is instrumental in reducing costs and the time required to carry out research in computational physics; reducing time lost in porting to new platforms; and increasing its knowledge base on harnessing the power of new technologies.

Learn more about Intel® software development tools at **http://software.intel.com/en-us/intel-sdp-home/**.

ABOUT AWE

AWE plays a crucial role in the defence of the United Kingdom. AWE is the home of the UK's nuclear deterrent, where it builds and maintains warheads for Trident, a submarine-launched ballistic missile. The company has been at the forefront of the UK nuclear deterrence programme for more than 60 years, delivering to the UK Government, providing innovative solutions to national nuclear security, and supporting the Continuous at Sea Deterrence (CASD).

To learn more about AWE please visit **http://www.awe.co.uk/**

About Intel® Software Development Tools

Intel has been providing standards-driven tools for developers in the high performance computing industry for more than 25 years. Its industry-leading tools include Fortran, C, and C++ Compilers, as well as performance profiling and analysis tools such as Intel® VTune™ Amplifier XE, Intel® Inspector XE, and Intel® Trace Analyzer and Collector. Performance libraries and programming models such as Intel® MPI library, Intel® Math Kernel Library, Intel® Cilk™ Plus, and Intel® Threading Building Blocks provide developers the tools needed to build applications for today and scale forward to tomorrow.

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