

HIGH PERFORMANCE MPI HYBRID DEVELOPMENT SUITE



Intel® Cluster Studio XE 2013

Product Brief

Top Features

- Integrated Tool Suite for HPC Application Development
- High Performance MPI Library
- High Performance C++, Fortran Compilers & Powerful Parallel Models for Multicore and Many-core
- Correctness Analysis & Profiling Tools for Shared, Distributed, and Hybrid Applications

Flow-3D's unique advantage is its ability for modeling complex fluid flows. As such, it is difficult to enable the parallel performance demanded by our customers. To meet the demand, we actively use the full functionality of Intel Cluster Studio XE to reduce and find previously undetectable shared and distributed memory errors, improve the overall performance and scaling of our software on the different multicore architecture systems used by our customers. In addition to the development benefits, the Cluster Studio XE tools help us to solve unreproducible issues that occur at customer sites." Dr. Anup Gokarn, Senior Developer, Flow Science, Inc.

Interoperable Products

- Intel® OpenCL*

Available in other configuration(s):

- Intel® Cluster Studio

OS Support:

- Windows*
- Linux*

Scale Forward, Scale Faster

The evolution of HPC architectures with more cores and wider vectors on more nodes challenges developers in writing applications that leverage these architectural advancements while accommodating result deadlines. The Intel® Cluster Studio XE suite provides a comprehensive set of parallel programming standards driven by C/C++ and Fortran development tools and programming models which enable software developers to efficiently develop, analyze, and optimize HPC applications to scale forward, scale faster, and boost performance for IA-compatible processors, including the Intel® Xeon Phi™ Coprocessor.

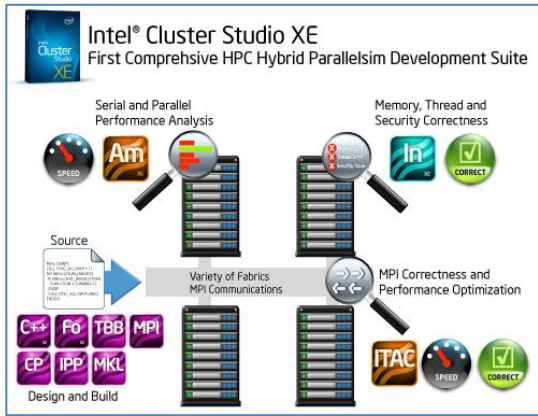
Intel® Cluster Studio XE includes the next-generation software development tools:

- **Intel® MPI Library** - Highly scalable and interconnect independent low latency MPI library
- **Intel® Trace Analyzer and Collector** - MPI communications performance profiler
- **Intel® C, C++ and Fortran Compilers** - Industry-leading compilers
- **Intel® MKL and Intel® IPP** - Performance libraries for math and multimedia
- **Intel® Threading Building Blocks and Intel® Cilk™ Plus** - Parallel programming models based on threading
- **Intel® Advisor XE** - Threading assistant for C/C++, C#, and Fortran applications using thread-based parallelism on the master node of a cluster
- **Intel® VTune™ Amplifier XE** - Performance & thread profiler is MPI enabled on every node
- **Intel® Inspector XE** - Memory and thread checker is MPI enabled on every node
- **Static Analysis** - Locate difficult to find defects
- **Intel® MPI Benchmarks** - An open source set of MPI and cluster benchmark kernels



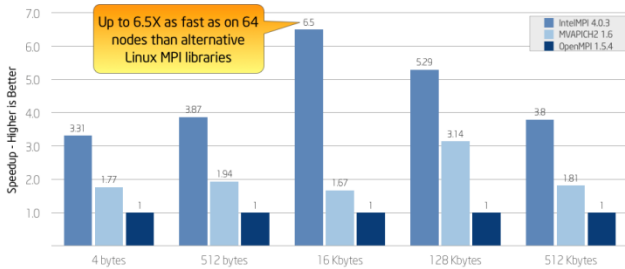
Flow Science Inc. Flow-3D application used Intel® Cluster Studio XE to improve application performance. Image shows simulation results of a launch vehicle draining an oxidizer tank

Top Features



Industry Leading Performance with Intel® MPI Library 4.0

Relative (Geomean) MPI Latency Benchmarks on Linux* 64 (Higher is Better)
768 processes on 64 nodes (InfiniBand + shared memory)



Configuration Info: SW Versions: C/C++ version 12.1 update 6, Intel® MPI Library 4.0 Update 3, MPIHC2 1.6, Open MPI 1.5.4, Intel® MPI Benchmarks 3.2.3; Hardware: Intel® Xeon® CPU X5670 @ 2.93GHz, 24x20GB RAM, 24GB In-memory, InfiniBand, ConnectX adapters, QDR, Operating System: RHEL Server 6.1; Notes: 768 Processes on 64 nodes (InfiniBand + shared memory). All Intel MPI Libraries were built with the Intel® C++ Compiler 12.0 US for Linux*. Benchmark Source: Intel Corp.
Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by these tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, refer to www.intel.com/performance/benchmarks/mpi/mpi_benchmarks.htm. * Other brands and names are the property of their respective owners.
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Integrated Tool Suite for HPC Development

Superior shared, distributed, or hybrid application performance through industry leading Intel compilers, parallel models and libraries with advanced performance optimizations for today's multicore and tomorrow's many-core processors in HPC clusters.

Industry Leading MPI Library

Intel MPI Library provides new levels of performance, scalability and flexibility for applications that execute on clusters of Intel® platforms.

- Scaling Up To 120K Processes
- High Performance Low Latency implementation
- Interconnect Independence
- Runtime Fabric Selection
- Application and Cluster Tuning Capability
- Multirail InfiniBand Support
- Berkeley Labs Checkpoint Restart (BLCR) Support

Additional information: <http://intel.ly/intel-mpi>

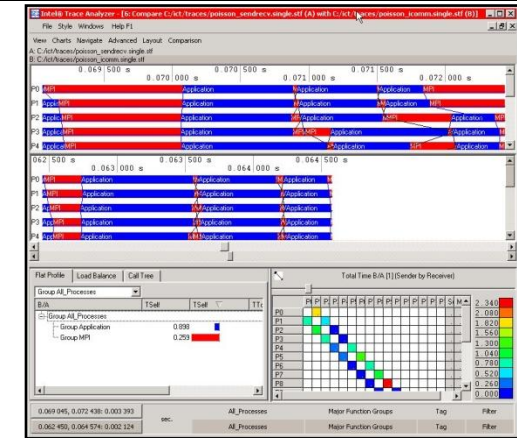
Note: Updated Intel MPI Library 4.1 benchmarks will be available when the product ships in Q4'2012

Intel Trace Analyzer and Collector

Intel Trace Analyzer and Collector is a powerful tool for understanding MPI application correctness and behavior.

- Visualize and understand parallel applications behavior
- Evaluate profiling statistics and load balancing
- Analyze performance of subroutines or code blocks
- Learn communications patterns and identify hotspots
- Decrease time to workload

Additional information: <http://intel.ly/traceanalyzer-collector>



Industry Leading Performance using the Intel® C/C++ and Fortran Compilers

Higher is Better



Windows Configuration Info: SW Versions: Intel® C/C++ 13.0, Microsoft Visual C++ 2010 R2, Intel® Fortran Compiler 13.0, GCC 4.7.1, Absolt 11.5; Hardware: HP ProLiant DL380 Gen2, 2 x Intel® Xeon® processor E5-2670 (2.93GHz, 30MB/30K L3), 12GB RAM, SAS, Operating System: Windows 7 Enterprise SP1, Polyhedron benchmark (www.polyhedron.com) performed by Intel Corp on August 22, 2012.
Linux Configuration Info: SW Versions: Intel® C/C++ 13.0, GCC 4.7.1, Absolt 11.5; Hardware: HP ProLiant DL380 Gen2, 2 x Intel® Xeon® processor E5-2670 (2.93GHz, 30MB/30K L3), 12GB RAM, SAS, Operating System: Red Hat Enterprise Linux Server release 6.2 (Satellite), Kernel 2.6.32-220.el6.x86_64, Polyhedron benchmark (www.polyhedron.com) performed by Intel Corp on August 22, 2012.
Solutions and optimization techniques may have been optimized for performance only on Intel microprocessors. Performance tests, such as SPECint and SPECfp, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your computing environment, including the performance of that product when combined with other products. * Other brands and names are the property of their respective owners.
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High Performance C/C++, Fortran Compilers & Libraries

Intel® C/C++ and Fortran compilers have built-in optimization technologies and multithreading support that help create code that runs best on the latest Intel® multicore and many-core architectures.

- Multicore and Many-core Optimizations
- Support for distributed memory CAF (Co-Array Fortran)
- Advanced optimization, multithreading, and processor support
- Support for hybrid models of parallelism with MPI and threading models like OpenMP, Intel Cilk Plus, and Intel TBB methods to boost application performance on clusters
- Industry-leading Intel® MKL and Intel® IPP include a wealth of routines to improve performance and cut development time.

Additional information: <http://intel.ly/composer-xe>

Details

Intel Cluster Studio XE meets the challenges facing HPC developers by providing, for the first time, a comprehensive suite of tools that enables developers to boost HPC application performance and reliability. It combines Intel's proven cluster tools with Intel's advanced threading/memory correctness analysis and performance profiling tools to enable scaling application development for today's and tomorrow's HPC cluster systems.

Scale Performance

Superior shared, distributed, or hybrid application performance through industry leading Intel compilers, parallel models and libraries with advanced performance optimizations for today's multicore and tomorrow's many-core processors in HPC clusters.

- **MPI Latency** - Intel® MPI Library is up to 6.5X as fast as alternative MPI libraries
- **Compiler Performance** - Industry leading Intel C, C++ & Fortran compilers
- **Profiling & Tuning** - In addition to native MPI profiling using the Intel® Trace Analyzer and Collector, Intel® VTune™ Amplifier XE is now MPI enabled for every node

Scale Forward

Intel Cluster Studio XE provides the tools, programming models, and performance libraries that enable developers to develop code that scales on Intel® Xeon® Processors today while easily extending to the Intel® Xeon Phi™ Coprocessor.

- **MPI Capacity** - Intel® MPI Library scales beyond 120k processes
- **Parallel Programming Models** - Commercially supported Intel versions of open source Intel® Threading Building Blocks and Intel® Cilk™ Plus for threading parallelism

Scale Efficiency

The impact of budget and schedule pressure makes it crucial to have the right tools and programming models to rapidly develop and deploy reliable HPC applications. Intel Cluster Studio XE delivers powerful threading and correctness tools for hybrid applications development and parallel programming models that are simple to adopt.

- **Thread & Memory Correctness** - Intel® Inspector XE is MPI enabled for every node
- **MPI Correctness** - Increased productivity in finding MPI errors
- **Rapid Performance Profiling** - Intel® VTune Amplifier can identify hotspots 10x faster*
- **Parallel Programming Models** - Parallelize code using three keywords with Intel® Cilk™ Plus
- **Innovative Threading Assistant** - Intel® Advisor XE analyses code to identify regions for parallelization potential to improve performance on shared memory code.

What's New

Feature	Benefit
Increased MPI Scalability	Intel® MPI Library now scales up to 120K processes and Intel® Trace Analyzer and Collector now scales up to 6K processes to support application development and deployment for continued capacity growth of HPC systems
MPI Standards Support & Reliability	Intel® MPI Library now supports the MPI standard version 2.2. Berkeley Labs Checkpoint Restart (BLCR) support has been implemented to improve reliability of long running cluster based applications in case of failure recovery, scheduling, and process migration.
Latest Processor Support Haswell, Ivy Bridge, Intel® Xeon Phi™ Coprocessor	Intel consistently offers the first set of tools to take advantage of the latest performance enhancements in the newest Intel product, while preserving compatibility with older Intel and compatible processors. New support includes AVX2, TSX and FMA3.
Conditional Numerical Reproducibility	Overcome the inherently non-associativity characteristics of floating-point arithmetic results with new support in the Intel® Math Kernel Library, along with special Intel support for OpenMP and Intel® Threading Building Blocks.
New Threading Assistant, Intel® Advisor XE	Add parallelism to a threaded or a non-threaded application on the master node of a cluster. Evaluate alternatives before investing in implementation. Intel® Advisor XE can assist developers in producing scalable, maintainable C, C++, C# and Fortran code.
C++ Performance Guide	If you're not a performance expert, you will love the new C++ Performance Guide. Easy, quick 5 step process for more performance.
Fortran and C++ Standards Support	Intel Fortran supports widely used features of the F2003 standard and key parts of the 2008 standard, including co-arrays. Intel demonstrates its commitment to the C++11 standard support in this release.
Find and Eliminate More Errors with Intel® Inspector XE	Intel® Inspector XE is an efficient way to increase your application reliability to ensure performance in C, C++, C#, Fortran, Java and MPI applications. The new heap growth analysis feature is another way to look for memory leaks.
Additional Profiling Data while Easier to Use	Intel® VTune™ Amplifier XE is now easier to use and provides additional profiling data. Its powerful bandwidth and memory access analysis means spending less time puzzling over cryptic performance data and more time developing.
Pointer Checker	This new, compiler-based diagnostic tool helps you find code that accesses memory addresses beyond the allocated addresses. This helps with 'security hardening' and finding difficult memory corruption type bugs.

Purchase Options

Intel Cluster Studio XE combines all Intel development tools in one suite. It is highlighted in blue below. Single or multi-user licenses along with volume, academic, and student discounts are available.

Suites >>		Intel® Cluster Studio XE	Intel® Parallel Studio XE	Intel® C++ Studio XE	Intel® Fortran Studio XE	Intel® Composer XE	Intel® C++ Composer XE	Intel® Fortran Composer XE
Components	Intel® C / C++ Compiler	●	●	●		●	●	
	Intel® Fortran Compiler	●	●		●	●		●
	Intel® Integrated Performance Primitives ³	●	●	●		●	●	
	Intel® Math Kernel Library ³	●	●	●	●	●	●	●
	Intel® Cilk™ Plus	●	●	●		●	●	
	Intel® Threading Building Blocks	●	●	●		●	●	
	Intel® Inspector XE	●	●	●	●			
	Intel® VTune™ Amplifier XE	●	●	●	●			
	Intel® Advisor XE	●	●	●	●			
	Static Analysis	●	●	●	●			
	Intel® MPI Library	●						
	Intel® Trace Analyzer & Collector	●						
	Rogue Wave IMSL* Library ²							●
Operating System ¹	W, L	W, L	W, L	W, L	W, L	W, L	W, L, O	W, L, O

Note: ¹ Operating System: W=Windows, L= Linux, M= OS X*. ² Available in Intel® Visual Fortran Composer XE for Windows with IMSL*

³ Not available individually on OS X, it is included in Intel® C++ & Fortran Composer XE suites for OS X

Technical Specifications

Specs at a Glance	
Processor support	Validated for use with multiple generations of Intel® and compatible processors including but not limited to: 2nd Generation Intel® Core™2 processor, Intel® Core™ 2 processor, Intel® Core™ processor, Intel® Xeon™ processor, and Intel® Xeon Phi™ Coprocessor.
Operating systems	Windows* and Linux*
Programming languages	Natively supports C, C++ and Fortran development
System requirements	Please refer to www.intel.com/software/products/systemrequirements/ for details on hardware and software requirements.
Support	All product updates, Intel® Premier Support services and Intel® Support Forums are included for one year. Intel Premier Support gives you secure, web-based, engineer-to-engineer support..



Learn more about Intel Cluster Studio XE

- Click or enter the link below:
<http://intel.ly/cluster-studio-xe>
- Or scan the QR code on the left



Download a free 30-day evaluation

- Click or enter the link below:
<http://intel.ly/sw-tools-eval>
- Click on 'Cluster Tools' link

Optimization Notice

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