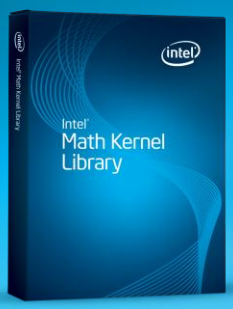


INDUSTRY-LEADING HIGH PERFORMANCE MATH LIBRARY

Intel® Math Kernel Library 11.1

Product Brief

Top Features

- Vectorized and threaded for highest performance on all Intel and compatible processors
- Compatible with all C/C++ and Fortran compilers
- Royalty-free, per developer licensing for low cost deployment

Available in the following suites or standalone:

- Intel® Parallel Studio XE
- Intel® C++ Studio XE
- Intel® Fortran Studio XE
- Intel® Cluster Studio XE
- Intel® Composer XE
- Intel® C++ Composer XE
- Intel® Fortran Composer XE

OS Support:

- Windows*
- Linux*
- OS X*

"Intel MKL is indispensable for any high-performance computer user on x86 platforms."

Prof. Jack Dongarra, Innovative Computing Lab, University of Tennessee, Knoxville

Follow us on Twitter

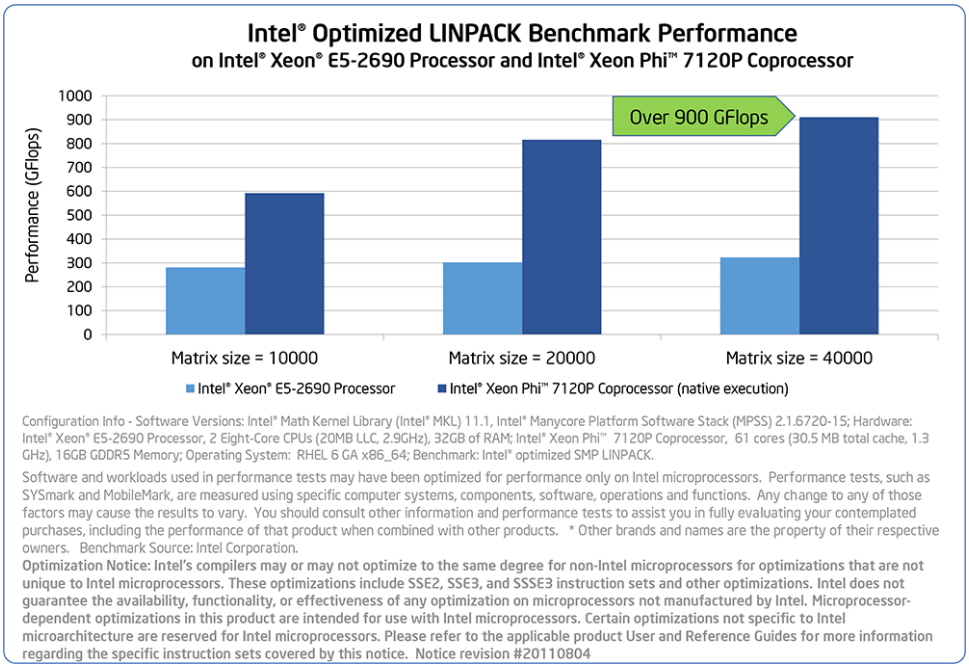
@IntelMKL

Performance: Ready to Use

Intel® Math Kernel Library v11.1 (Intel® MKL) includes a wealth of routines to accelerate application performance and reduce development time. Today's processors have increasing core counts, wider vector units and more varied architectures. The easiest way to take advantage of all of that processing power is to use a carefully optimized library designed to harness that potential. Even the best compiler can't compete with the level of performance possible from a hand-optimized library.

Because Intel has done the engineering on these ready-to-use, royalty-free functions, you'll not only have more time to develop new features for your application, but in the long run you'll also save development, debug and maintenance time while knowing that the code you write today will run optimally on future generations of Intel processors.

Intel MKL includes highly vectorized and threaded Linear Algebra, Fast Fourier Transforms (FFT), Vector Math and Statistics functions. Through a single C or Fortran API call, these functions automatically scale across previous, current and future processor architectures by selecting the best code path for each.



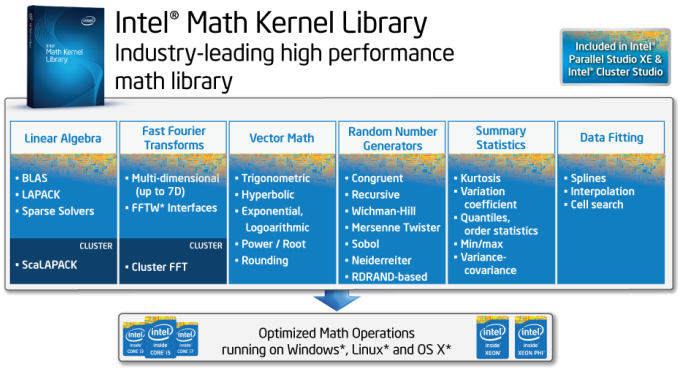
Configuration Info - Software Versions: Intel® Math Kernel Library (Intel® MKL) 11.1, Intel® Manycore Platform Software Stack (MPSS) 2.1.6720-15; Hardware: Intel® Xeon® E5-2690 Processor, 2 Eight-Core CPUs (20MB LLC, 2.9GHz), 32GB of RAM; Intel® Xeon Phi™ 7120P Coprocessor, 61 cores (30.5 MB total cache, 1.3 GHz), 16GB GDDR5 Memory; Operating System: RHEL 6 GA x86_64; Benchmark: Intel® optimized SMP LINPACK.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, 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 contemplated purchases, including the performance of that product when combined with other products. * Other brands and names are the property of their respective owners. Benchmark Source: Intel Corporation.

Optimization Notice: Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice. Notice revision #20110804

Intel MKL's industry-leading LINPACK benchmark performance makes it the math library of choice for many of the world's fastest supercomputers.

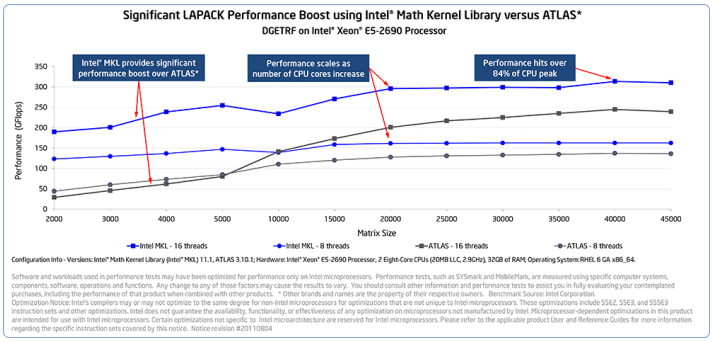
Top Features



Comprehensive Math Functionality – Covers Range of Application Needs

Intel® Math Kernel Library (Intel® MKL) contains a wealth of threaded and vectorized complex math functions to accelerate a wide variety of software applications. Why write these functions yourself when Intel has already done the work for you?

Major functional categories include Linear Algebra, Fast Fourier Transforms (FFT), Vector Math and Statistics. Cluster-based versions of LAPACK and FFT are also included to support MPI-based distributed memory computing.

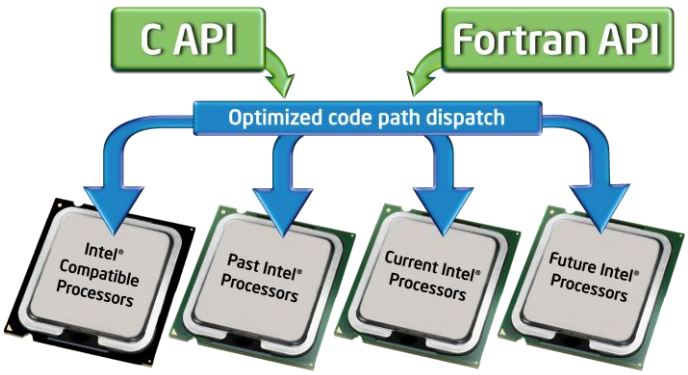


Standard APIs – For Immediate Performance Results

Wherever available, Intel MKL uses de facto industry standard APIs so that minimal code changes are required to switch from another library. This makes it quick and easy to improve your application performance through simple function substitutions or relinking.

Simply substituting Intel MKL's LAPACK (Linear Algebra PACKage), for example, can yield 500% or higher performance improvement (benchmark left.)

In addition to the industry-standard BLAS and LAPACK linear algebra APIs, Intel MKL also supports MIT's FFTW C interface for Fast Fourier Transforms.

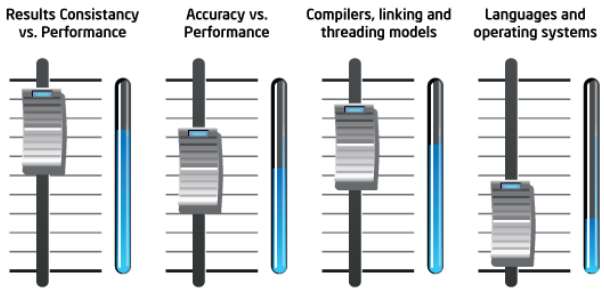


Highest Performance and Scalability across Past, Present & Future Processors – Easily and Automatically

Behind a single C or Fortran API, Intel MKL includes multiple code paths -- each optimized for specific generations of Intel and compatible processors. With no code-branching required by application developers, Intel MKL utilizes the best code path for maximum performance.

Even before future processors are released, new code paths are added under these same APIs. Developers just link to the newest version of Intel MKL and their applications are ready to take full advantage of the newest processor architectures.

In the case of the new Intel® Xeon Phi™ coprocessors, in addition to full native optimization support, Intel MKL can also automatically determine the best load balancing between the host CPU and the Intel Xeon Phi coprocessors.



Flexibility to Meet Developer Requirements

Developers have many requirements to meet. Sometimes these requirements conflict and need to be balanced. Need consistent floating point results with the best application performance possible? Want faster vector math performance and don't need maximum accuracy? Intel MKL gives you control over the necessary tradeoffs.

Intel MKL is also compatible with your choice of compilers, languages, operating systems, linking and threading models. One library solution across multiple environments means only one library to learn and manage.

Details

Linear Algebra

Intel® Math Kernel Library (Intel® MKL) BLAS provides optimized vector-vector (Level 1), matrix-vector (Level 2) and matrix-matrix (Level 3) operations for single and double precision real and complex types. Level 1 BLAS routines operate on individual vectors, e.g., compute scalar product, norm, or the sum of vectors. Level 2 BLAS routines provide matrix-vector products, rank 1 and 2 updates of a matrix, and triangular system solvers. Level 3 BLAS level 3 routines include matrix-matrix products, rank k matrix updates, and triangular solvers with multiple right-hand sides.

Intel MKL LAPACK provides extremely well-tuned LU, Cholesky, and QR factorization and driver routines that can be used to solve linear systems of equations. Eigenvalue and least-squares solvers are also included, as are the latest LAPACK 3.3.1 interfaces and enhancements.

If your application already relies on the BLAS or LAPACK functionality, simply re-link with Intel MKL to get better performance on Intel and compatible architectures.

Fast Fourier Transforms

Intel MKL FFTs include many optimizations and should provide significant performance gains over other libraries for medium and large transform sizes. The library supports a broad variety of FFTs, from single and double precision 1D to multi-dimensional, complex-to-complex, real-to-complex, and real-to-real transforms of arbitrary length. Support for both FFTW* interfaces simplifies the porting of your FFTW-based applications.

Vector Math

Intel MKL provides optimized vector implementations of computationally intensive core mathematical operations and functions for single and double precision real and complex types. The basic vector arithmetic operations include element-by-element summation, subtraction, multiplication, division, and conjugation as well as rounding operations such as floor, ceil, and round to the nearest integer. Additional functions include power, square root, inverse, logarithm, trigonometric, hyperbolic, (inverse) error and cumulative normal distribution, and pack/unpack. Enhanced capabilities include accuracy, denormalized number handling, and error mode controls, allowing users to customize the behavior to meet their individual needs.

Statistics

Intel MKL includes random number generators and probability distributions that can deliver significant application performance. The functions provide the user the ability to pair Random-Number Generators such as Mersenne Twister and Niederreiter with a variety of Probability Distributions including Uniform, Gaussian and Exponential.

Intel MKL also provides computationally intensive core/building blocks for statistical analysis both in and out-of-core. This enables users to compute basic statistics, estimation of dependencies, data outlier detection, and missing value replacements. These features can be used to speed-up applications in computational finance, life sciences, engineering/simulations, databases, and other areas.

Data Fitting

Intel MKL includes a rich set of splines functions for 1-dimensional interpolation. These are useful in a variety of application domains including data analytics (e.g. histograms), geometric modeling and surface approximation. Splines included are linear, quadratic, cubic, look-up, stepwise constant and user-defined.

What's New

Feature	Benefit
Conditional Numerical Reproducibility	Overcome the inherently non-associativity characteristics of floating-point arithmetic results with new support in the Intel MKL. New in this release is the ability to achieve reproducibility without memory alignment.
New and improved optimizations for Haswell Intel® Core™, Ivy Bridge Intel® Xeon, future Broadwell processors and Intel® Xeon Phi™ coprocessors	Intel MKL is optimized for the latest and upcoming processor architectures to deliver the best performance in the industry. For example, new optimizations for the fusedmultiply-add (FMA) instruction set introduced in Haswell Core processors deliver up to 2x performance improvement for floating point calculations.
Automatic offload and compute load balancing between Intel Xeon processors and Intel Xeon Phi coprocessors – Now for Windows*	For selected linear algebra functions, Intel MKL can automatically determine the best way to utilize a system containing one or more Intel Xeon Phi coprocessors. The developer simply calls the MKL function and it will take advantage of the coprocessor if present on the system. New functions added for this release plus Windows OS support.
Extended Eigensolver Routines based on the FEAST algorithm	New sparse matrix Eigensolver routines handle larger problem sizes and use less memory. API-compatibility with the open source FEAST Eigenvalue Solver makes it easy to switch to the highly optimized Intel MKL implementation.

Purchase Options: Language Specific Suites

Several suites are available combining the tools to build, verify and tune your application. The product covered in this product brief is highlighted in blue. Named-user 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, O	W, L, O

Note: [1] Operating System: W=Windows*, L= Linux*, O= 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: Intel® Xeon™ Processor, Intel® Core™ processor family and Intel® Atom™ processor family.
Operating Systems	Use the same API for application development on multiple operating systems: Windows*, Linux* and OS X*.
Development Tools and Environments	Compatible with compilers from vendors that follow platform standards (e.g., Microsoft*, GCC, Intel). Can be integrated with Microsoft Visual Studio* 2008, 2010 and 2012.
Programming Languages	Natively supports C++ and Fortran development. Cross-language compatible with Java*, C#, Python* and other languages.
System Requirements	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.
Community	Share experiences with other users of Intel® TBB and other parallel programming tools at the Intel moderated forum: http://software.intel.com/en-us/forums/

Learn more about Intel Math Kernel Library

- Click or enter the link below: http://intel.ly/intel-mkl
- 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 'Compilers and Libraries' link

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