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Introduction

This document describes how to install the product, provides a summary of new and changed product features and notes about features and problems not described in the product documentation.

1.1 Change History

This section highlights important changes in product updates. For a list of corrections to reported problems, please read Intel® Professional Edition Compilers 11.1 Fixes List for the compiler and Intel® Math Kernel Library 10.2 Fixes List for the Intel® Math Kernel Library.

Update 5

- Intel® Math Kernel Library updated to 10.2 Update 4
- Corrections to reported problems

Update 4 (11.1.080)

- Intel® Math Kernel Library updated to 10.2 Update 3
- Corrections to reported problems

Update 3 (11.1.076)

- Corrections to reported problems

Update 2 (11.1.067)

- Added mention of new compiler option 
  -mkl
- Mac OS* X 10.6.1 “Snow Leopard” is now supported
- Corrections to reported problems

Update 1 (11.1.058)

- Sources declaring or using derived types containing type-bound procedures must be recompiled
- Note added about change in behavior of 
  -O0
- FORT_BLOCKSIZE and FORT_BUFFERCOUNT environment variables documented
- Corrections to reported problems

1.2 Product Contents

Intel® Fortran Compiler Professional Edition 11.1 for Mac OS* X

Installation Guide and Release Notes
• Intel® Fortran Compilers for building applications that run on Intel-based Mac* systems running the Mac OS* X operating system
• Intel® Debugger
• Intel® Math Kernel Library 10.2 Update 4
• Integration into the Xcode* development environment (Limited Feature)
• On-disk documentation

1.3 System Requirements
• An Intel®-based Apple* Mac* system
• 1GB RAM minimum, 2GB RAM recommended
• 2GB free disk space
• One of the following combinations of Mac OS* X, Xcode* and the Xcode SDK:
  o OS X 10.6.2 with Xcode 3.2.1 and SDK 10.6 or 10.5
  o OS X 10.6 with Xcode 3.2 and SDK 10.6 or 10.5
  o OS X 10.5.8 with Xcode 3.1.4 and SDK 10.5
  o OS X 10.5.6 with Xcode 3.1.2 and SDK 10.5
• gcc* 4

Note: Advanced optimization options or very large programs may require additional resources such as memory or disk space.

1.4 Documentation
Product documentation can be found in the Documentation folder as shown under Installation Folders.

1.5 Technical Support
If you did not register your compiler during installation, please do so at the Intel® Software Development Products Registration Center. Registration entitles you to free technical support, product updates and upgrades for the duration of the support term.

For information about how to find Technical Support, Product Updates, User Forums, FAQs, tips and tricks, and other support information, please visit: http://www.intel.com/software/products/support/

Note: If your distributor provides technical support for this product, please contact them for support rather than Intel.

2 Installation
If you are installing the product for the first time, please be sure to have the product serial number available as you will be asked for it during installation. A valid license is required for installation and use.
If you will be using Xcode*, please make sure that a supported version of Xcode is installed. If you install a new version of Xcode in the future, you must reinstall the Intel Fortran Compiler afterwards.

You will need to have administrative or “sudo” privileges to install, change or uninstall the product.

If you received the compiler product on DVD insert the DVD. Locate the disk image file (m_cprof_p_11.1.xxx.dmg) on the DVD and double-click. If you received the compiler product as a download, double-click the downloaded file, which will have a name of the form m_cprof_p_11.1.xxx.dmg.

Follow the prompts to complete installation.

2.1 Installation Folders
The 11.1 product installs into a different arrangement of folders than in previous versions. The new arrangement is shown in the diagram below. Not all folders will be present in a given installation.

- `<root>/intel/Compiler/11.1/xxx/`
  - `bin`
    - `ia32`
    - `intel64`
  - `include`
    - `ia32`
    - `intel64`
  - `lib`
  - `Frameworks`
    - `mkl`
  - `Documentation`
  - `man`
  - `Samples`

Where `<root>` is `/opt` by default, `xxx` is the three-digit build number and the folders under `bin`, `include` and `lib` are used as follows:

- `ia32`: Compilers that build applications that run on a 32-bit Intel-based Mac OS* X system
- `intel64`: Compilers that build applications that run on a 64-bit Intel-based Mac OS* X system (also referred to as Intel® 64 architecture)

If you have both the Intel C++ and Intel Fortran compilers installed, they will share folders for a given version.
2.2 Relocating Product After Install
If you wish to move the installed product’s command line interface to a different location on disk, you can do so using a supplied script.

1. Open a terminal window
2. Change directory (cd) to the compiler install folder (for example, /opt/intel/Compiler/11.1/xxx)
3. Type the command:
   ./move_cprof.sh <new-install-location>
   where <new-install-location> is the new directory path

This script will move all the files and update symlinks, environment variables and startup scripts as needed. If you have both Intel C++ and Intel Fortran installed in the old path, both products will be moved to the new location.

The Xcode integration is relocatable simply by dragging and dropping the Xcode directory tree to another location. If you wish to use idb from a command prompt using a relocated Xcode directory tree, please see http://software.intel.com/en-us/articles/running-idb-from-command-line-after-relocating-xcode-environment/ for additional steps that are required. Note that idb is not available from within the Xcode IDE.

2.3 Removal/Uninstall
It is not possible to remove the compiler while leaving any of the performance library components installed.

1. Open Terminal and set default (cd) to any folder outside <install-dir>
2. Type the command: <install-dir>/uninstall_cprof.sh
3. Follow the prompts

If you are not currently logged in as root you will be asked for the root password. If you also have the same-numbered version of Intel® C++ Compiler installed, it may also be removed.

3 Intel® Fortran Compiler
This section summarizes changes, new features and late-breaking news about the Intel Fortran Compiler.

3.1 Compatibility
In general, object code and modules compiled with earlier versions of Intel Fortran Compiler for Mac OS® X may be used in a build with version 11. Exceptions include:

- Objects built with the multi-file interprocedural optimization (-ipo) option must be recompiled.
- Objects built for 64-bit systems with the version 9.1 compiler and that use the REAL(16) or REAL*16 datatypes must be recompiled.
• Modules that specified an ATTRIBUTES ALIGN directive and were compiled with versions earlier than 11 must be recompiled. The compiler will notify you if this issue is encountered.

3.1.1 Incorrect Derived Type Layout for Type-Bound Procedures
The initial version 11.1 compiler incorrectly adds unused space to a derived type containing type-bound procedures. This error was corrected in version 11.1 Update 1. All sources declaring or using objects of such type, and which were compiled with the initial 11.1 compiler, must be recompiled with version 11.1 Update 1 or later.

3.2 New and Changed Features

3.2.1 Features from Fortran 2003
• Object-oriented features
  o CLASS declaration
  o SELECT TYPE construct
  o EXTENDS_TYPE_OF and SAME_TYPE_AS intrinsic functions
  o Polymorphic entities
  o Inheritance association
  o Deferred bindings and abstract types
  o Type inquiry intrinsic functions
• Type-bound procedures
  o TYPE CONTAINS declaration
  o ABSTRACT attribute
  o DEFERRED attribute
  o NON_OVERRIDABLE attribute
  o Note: GENERIC attribute and type-bound operators are not supported in this release
• Deferred-length character entities
• PUBLIC types with PRIVATE components and PRIVATE types with PUBLIC components
• NAMELIST I/O is permitted on an internal file
• Restrictions on entities in a NAMELIST group are relaxed
• Changes to how IEEE Infinity and NaN is represented in formatted input and output
• The COUNT_RATE argument to the SYSTEM_CLOCK intrinsic may be a REAL of any kind
• Execution of a STOP statement displays a warning if an IEEE floating point exception is signaling
• MAXLOC or MINLOC of a zero-sized array returns zero if the option --assume noold_maxminloc is specified. Fortran 95 specified that the value was processor-
dependent and Intel Fortran returned 1. Performance will be lower if \texttt{-assume noold_maxminloc} is specified.

### 3.2.2 Other Changes

- When string length checking is in effect (\texttt{-check bounds}), and a character object is passed as an argument, the minimum of the passed length and the declared length in the called procedure is used as an upper limit.
- Input value items in the form of a LOGICAL constant, for example T or .F, are no longer accepted during list-directed or namelist-directed input when the corresponding variable in the I/O list is not LOGICAL. Similarly, when the I/O list variable is of type LOGICAL, the corresponding input value must be in the form of a LOGICAL constant. The new \texttt{-assume old_logical_ldio} option can be used to restore the older behavior.
- Per-compilation control of floating point exception behavior (\texttt{-fpe-all})

### 3.3 New and Changed Compiler Options

Please refer to the compiler documentation for details

- \texttt{-assume [no]old_logical_ldio}
- \texttt{-assume [no]old_maxminloc}
- \texttt{-fpe-all}
- \texttt{-ieee_fpe_flags}
- \texttt{-mk[=lib]}

For a list of deprecated compiler options, see the Compiler Options section of the documentation.

#### 3.3.1 \texttt{-O0} no longer implies \texttt{-mp}

In version 11.1, the \texttt{-O0} option for disabling optimizations no longer implies \texttt{-mp} for maximizing floating-point precision. The \texttt{-mp} switch is deprecated, so we recommend using an explicit \texttt{-fp-model} option for applications that are sensitive to floating-point precision changes.

### 3.4 Other Changes

#### 3.4.1 Optimization Reports Disabled by Default

As of version 11.1, the compiler no longer issues, by default, optimization report messages regarding vectorization, automatic parallelization and OpenMP threaded loops. If you wish to see these messages you must request them by specifying \texttt{-diag-enable vec, -diag-enable par} and/or \texttt{-diag-enable openmp}, or by using \texttt{-vec-report, -par-report} and/or \texttt{-openmp-report}.

Also, as of version 11.1, optimization report messages are sent to stderr and not stdout.

#### 3.4.2 New Environment Variables to Control I/O

Version 11.1 supports two additional environment variables which can be used to affect I/O behavior when an application is run.
FORT_BLOCKSIZE lets you specify the default BLOCKSIZE value to be used when BLOCKSIZE= is omitted on the OPEN statement. Valid sizes are 0 to 2147467264. Sizes will be rounded up to the nearest 512-byte boundary. The default BLOCKSIZE value is now 128KB.

FORT_BUFFERCOUNT lets you specify the default BUFFERCOUNT value to be used when BUFFERCOUNT= is omitted on the OPEN statement. Valid values are 0 to 127. If 0 is specified, the default value of 1 will be used.

3.4.3 Environment Setup Script Changed
The ifortvars.sh (ifortvars.csh) script, used to set up the command-line build environment, changed in version 11.0. In previous versions, you chose the target platform by selecting either the fc or fce directory root. In version 11.x, there is one version of these scripts and they now take an argument to select the target platform.

The command takes the form:

```
source /opt/intel/Compiler/11.1/xxx/bin/ifortvars.sh argument
```

Where xxx is the package identifier and argument is either ia32 or intel64 as described above under Installation Folders. If you have installed the compiler into a different path, make the appropriate adjustments in the command. Establishing the compiler environment also establishes the Intel® Debugger (idb) environment.

3.5 Known Issues

3.5.1 Limited Support for Empty Derived Types
Fortran 2003 adds the ability to declare a derived type with no data components. The Intel compiler has limited support for these in the current release. These limitations will be lifted in a future release of the compiler. The limitations are as follows:

- When an object of derived type is declared, the type must have at least one data component. Extending an empty type is supported. For example:

```
type t
end type

type, extends (t) :: t1
end type

type, extends (t1) :: t2
  integer i
end type

type, extends (t2) :: t3
end type

type (t) :: recl ! Not supported, type t is empty
```
type (t1) :: rec2 ! Not supported, type t1 is empty
type (t2) :: rec3 ! Supported, type t2 is not empty
type (t3) :: rec4 ! Supported, type t3 is not empty

An exception is that it is supported to declare a class object with an empty type, for example:

    class(t1) :: rec5

If an unsupported use of an empty type is seen, the compiler will issue the diagnostic:

Declaring an object with no data component fields is not yet supported

- Referencing a component that is an empty type is not supported. For example, assuming the declarations above, in:

    call sub(rec4%t3, rec4%t1, rec3%t)
    print *, rec3%t1, rec4%t
    call sub2(rec3%t2, rec4%t2)

the references to rec4%t3, rec4%t1, rec4%t, rec3%t, and rec3%t are not supported. References to rec3%t2 and rec4%t2 will be supported. If an unsupported reference is seen, the compiler will issue the diagnostic:

Accessing an empty type is not yet supported

- A type constructor for an empty type is not supported. Again assuming the declarations above, the type constructor t() is not supported. If an unsupported constructor is seen, the compiler will issue the diagnostic:

A type constructor for an empty type is not yet supported

3.6 Fortran 2003 Feature Summary

The Intel Fortran Compiler supports many features that are new to the latest revision of the Fortran standard, Fortran 2003. Additional Fortran 2003 features will appear in future versions. Fortran 2003 features supported by the current compiler include:

- The Fortran character set has been extended to contain the 8-bit ASCII characters ~ \ [ ] ` ^ { } | # @
- Names of length up to 63 characters
- Statements of up to 256 lines
- Square brackets [ ] are permitted to delimit array constructors instead of (/ /)
- Structure constructors with component names and default initialization
- Array constructors with type and character length specifications
- A named PARAMETER constant may be part of a complex constant
- Enumerators
Allocatable components of derived types
Allocatable scalar variables
Deferred-length character entities
PUBLIC types with PRIVATE components and PRIVATE types with PUBLIC components
ERRMSG keyword for ALLOCATE and DEALLOCATE
SOURCE= keyword for ALLOCATE
Type extension
CLASS declaration
Polymorphic entities
Inheritance association
Deferred bindings and abstract types
Type-bound procedures
TYPE CONTAINS declaration
ABSTRACT attribute
DEFERRED attribute
NON_OVERRIDABLE attribute
ASYNCHRONOUS attribute and statement
BIND(C) attribute and statement
PROTECTED attribute and statement
VALUE attribute and statement
VOLATILE attribute and statement
INTENT attribute for pointer objects
Reallocation of allocatable variables on the left hand side of an assignment statement when the right hand side differs in shape or length (requires option "assume realloc_lhs")
ASSOCIATE construct
SELECT TYPE construct
In all I/O statements, the following numeric values can be of any kind: UNIT=, IOSTAT=
NAMELIST I/O is permitted on an internal file
Restrictions on entities in a NAMELIST group are relaxed
Changes to how IEEE Infinity and NaN is represented in formatted input and output
FLUSH statement
WAIT statement
ACCESS='STREAM' keyword for OPEN
ASYNCHRONOUS keyword for OPEN and data transfer statements
ID keyword for INQUIRE and data transfer statements
POS keyword for data transfer statements
PENDING keyword for INQUIRE
The following OPEN numeric values can be of any kind: RECL=
The following READ and WRITE numeric values can be of any kind: REC=, SIZE=
The following INQUIRE numeric values can be of any kind: NEXTREC=, NUMBER=, RECL=, SIZE=
- Recursive I/O is allowed in the case where the new I/O being started is internal I/O that does not modify any internal file other than its own
- IEEE Infinites and NaNs are displayed by formatted output as specified by Fortran 2003
- BLANK, DECIMAL, DELIM, ENCODING, IOMSG, PAD, ROUND, SIGN, SIZE I/O keywords
- DC, DP, RD, RC, RN, RP, RU, RZ format edit descriptors
- In an I/O format, the comma after a P edit descriptor is optional when followed by a repeat specifier
- Rename of user-defined operators in USE
- INTRINSIC and NON_INTRINSIC keywords in USE
- IMPORT statement
- Allocatable dummy arguments
- Allocatable function results
- PROCEDURE declaration
- Procedure pointers
- ABSTRACT INTERFACE
- PASS and NOPASS attributes
- The COUNT_RATE argument to the SYSTEM_CLOCK intrinsic may be a REAL of any kind
- Execution of a STOP statement displays a warning if an IEEE floating point exception is signaling
- MAXLOC or MINLOC of a zero-sized array returns zero if the option –assume noold_maxminloc is specified.
- Type inquiry intrinsic functions
  - COMMAND_ARGUMENT_COUNT intrinsic
  - EXTENDS_TYPE_OF and SAME_TYPE_AS intrinsic functions
  - GET_COMMAND intrinsic
  - GET_COMMAND_ARGUMENT intrinsic
  - GET_ENVIRONMENT_VARIABLE intrinsic
  - IS_IOSTAT_END intrinsic
  - IS_IOSTAT_EOR intrinsic
  - MAX/MIN/MAXVAL/MINVAL/MAXLOC/MINLOC intrinsics allow CHARACTER arguments
  - MOVE_ALLOC intrinsic
  - NEW_LINE intrinsic
  - SELECTED_CHAR_KIND intrinsic
  - The following intrinsics take an optional KIND= argument: ACHAR, COUNT, IACHAR, ICHAR, INDEX, LBOUND, LEN, LEN_TRIM, MAXLOC, MINLOC, SCAN, SHAPE, SIZE, UBOUND, VERIFY
  - ISO_C_BINDING intrinsic module
  - IEEE_EXCEPTIONS, IEEE_ARITHMETIC and IEEE_FEATURES intrinsic modules
  - ISO_FORTRAN_ENV intrinsic module
Fortran 2003 features not yet supported include:

- Type-bound operators and the GENERIC binding for type-bound procedures
- User-defined derived type I/O
- Parameterized derived types

4 Intel® Debugger (IDB)

4.1 Known Problems

4.1.1 Dwarf vs. Stabs Debug Formats
The debugger only supports debugging of executables whose debug information is in Dwarf format, and does not support the Stabs debug format. Use the -gdwarf-2 flag on the compile command to have gcc and g++ generate Dwarf output. The Intel compilers (icc and ifort) produce Dwarf debug format with the -g flag.

4.1.2 Compilation Requirements
Starting with Xcode 2.3, the Dwarf debugging information is stored in the object (.o) files. These object files are accessed by the debugger to obtain information related to the application being debugged and thus must be available for symbolic debugging.

In cases where a program is compiled and linked in one command, such as:

    ifort -g -o hello.exe hello.f90

the object files are generated by the compiler but deleted before the command completes. The binary file produced by this command will have no debugging information. To make such an application debuggable users have two options.

Users may build the application in two steps, explicitly producing a .o file:

    ifort -c -g -o hello.o hello.f90
    ifort -g -o hello.exe hello.o

Alternatively, users may use the compiler switch -save-temps to prevent the compiler from deleting the .o files it generates:

    ifort -g -save-temps -o hello.exe hello.f90

The debugger does not use the output of the “dsymutil” utility.

4.1.3 Non-local Binary and Source File Access
The debugger cannot access binary files from a network-mounted file system (such as NFS). The error message will look like this:

    Internal error: cannot create absolute path for: /home/me/hello
You cannot debug "/home/me/hello" because its type is "unknown".

The debugger cannot access source files from a network-mounted file system (such as NFS). The error message will look like this:

Source file not found or not readable, tried...

./hello.f90

/auto/mount/site/foo/usr1/user_me/f_code/hello.f90

(Cannot find source file hello.f90)

The file-path specified will be correct.

The workaround in both cases is to copy the files to a local file system (i.e., one which is not mounted over the network).

4.1.4   Local variables may not be visible
The linker on Mac OS X 10.5.4 (and subsequent versions) does not always issue definitions of local variables into the debug information in the executable. We do not have a characterization of when this occurs. The end result is that the variable is not visible or is visible but incorrectly evaluated.

The instances we have seen have involved local arrays in Fortran programs which were allocated in the .bss segment by the compiler. A work-around is to change the source to make the variable be global rather than local. In Fortran this is most easily done by putting the variable into a module or common block. Intel and Apple are working together to resolve this issue.

4.1.5   Printing Fortran REAL*16 variables
The debugger does not print the correct value for Fortran REAL*16 variables.

4.1.6   Debugging applications that fork
Debugging the child process of an application that calls fork is not yet supported.

4.1.7   Debugging applications that exec
The $catchexecs control variable is not supported.

4.1.8   Fortran alternate entry points
Formal parameters of alternate entry points are not visible from within the debugger if they are not also formal parameters of the main entry point .

4.1.9   Snapshots
Snapshots are not yet supported as described in the manual.
4.1.10 Debugging optimized code
Debugging optimized code is not yet fully supported. The debugger may not be able to see
some function names, parameters, variables, or the contents of the parameters and variables
when code is compiled with optimizations turned on.

4.1.11 Watchpoints
Watchpoints that are created to detect write access don’t trigger when a value identical to the
original has been written. These restrictions are due to a limitation in the Mac OS* X operating
system.

Because the SIGBUS signal rather than the SIGSEGV signal is used by the debugger to
implement watchpoints, you cannot create a signal detector which will catch a SIGBUS signal.

4.1.12 Fortran modules and commons
A globally defined Fortran module should be rescoped with a double percent (%%) when
referred to. For example, to set a breakpoint in the subroutine bar contained in a globally
defined module foo, do

(idb) stop in foo%%bar

Please refer to the following section in the manual for the rescoping syntax:

Looking Around the Code, the Data and Other Process Information >

Looking at the Data >

The print Command

If you try to access (print, etc.) a Fortran module or common using the name in the source code,
the debugger may not be able to find it. As a workaround, the you can try prepending '_' to the
name. For example, in the source code, if you have a common called "com":

(idb) print _com

4.1.13 Graphical User Interface (GUI)
This version of the debugger does not support the GUI

4.1.14 MPP Debugging Restrictions
MPP debugging is not supported as described in the manual.

4.1.15 Function Breakpoints
Debugger breakpoints set in functions (using the "stop in" command) may not halt user program
execution at the first statement. This is due to insufficient information regarding the function
prologue in the generated Dwarf debug information. As a work-around, use the "stop at"
command to set a breakpoint on the desired statement.
The compiler generates a call to "__dyld_func_lookup" as part of the prologue for some functions. If you set a breakpoint on this function the debugger will stop there, but local variable values may not be valid. The work-around is to set a breakpoint on the first statement inside the function.

4.1.16 Core File Debugging
Debugging core files is not yet supported.

4.1.17 Universal Binary Support
Debugging of universal binaries is supported. The debugger supports debugging the IA-32 Dwarf sections of binaries on IA-32 and either the IA-32 or the Intel® 64 sections on Intel® 64.

4.1.18 Debugger variable $threadlevel
The manual's discussion of the debugger variable "$threadlevel" says "On Mac OS* X, the debugger supports POSIX threads, also known as pthreads." This sentence might be read as implying that other kinds of threads might be supported. This is not true; only POSIX threads are supported on Mac OS* X.

4.1.19 Open File Descriptors Limitation
Because the debugger opens the .o files of a debuggee to read debug information, you should raise the open file limit.

Mac OS* limits the number of open file descriptors to 256. You can increase this limit as follows:

ulimit -n 2000

Please use this command to increase the number of open descriptors before starting the debugger.

This is a workaround until the debugger can better share a limited number of open file descriptors over many files.

4.1.20 $cdir, $cwd Directories
$cdir is the compilation directory (if recorded). This is supported in that the directory is set; but $cdir is not itself supported as a symbol.

$cwd is the current working directory. Neither the semantics nor the symbol are supported.

The difference between $cwd and '.' is that $cwd tracks the current working directory as it changes during a debug session. '.' is immediately expanded to the current directory at the time an entry to the source path is added.

4.1.21 info stack Usage
The debugger command "info stack" does not currently support negative frame counts in the optional syntax below:

    info stack [num]
A positive frame count num will print the innermost num frames. A negative or zero count will print no frames rather than the outermost num frames.

4.1.22 $\text{stepg0} \text{ Default Value Changed}$
The debugger has changed the default value of the debugger variable $\text{stepg0}$ from 1 to 0. With the value "0" the debugger will step over code without debug information if you do a "step" command. Set the debugger variable to 1 to have compatibility with previous debugger versions as follows:

(idb) set $\text{stepg0} = 1$

5 Intel® Math Kernel Library
This section summarizes changes, new features and late-breaking news about Intel® Math Kernel Library (Intel® MKL) as part of Intel® Fortran Compiler Professional Edition.

5.1 Changes in This Version
For further information on improvements in this and previous releases, see

5.1.1 Intel® Math Kernel Library 10.2 Update 4

New Features

- Introduced the single precision complex absolute value function $\text{SCABS1}$
- Introduced the solver $\text{?DTSVB}$ for diagonally dominant tri-diagonal systems which is up to 2x faster than the general solver with partial pivoting ($\text{?GTSV}$)
- Added routines for factorization ($\text{?DTTRFB}$) and the forward/backward substitution ($\text{?DTTRSB}$) of the diagonally dominant tri-diagonal systems

Performance improvements

- FFTs
  - Enhanced performance for transforms which are a multiple of 8 or 13
  - Optimized 1D complex cluster FFTs for non-power-of-2 vector lengths
- VSL
  - Convolution and Correlation computations that require decimation show significant improvements (re-link required, see Known Issues)

5.1.2 Intel® Math Kernel Library 10.2 Update 3

Performance Improvements

- BLAS
  - Threaded the 32-bit OS versions of the following BLAS Level 1 and 2 functions for Intel® Core™ i7 processors and Intel® Xeon® processor 5300, 5400, and 5500 series: $\text{(D,S,C,Z)COPY, (D,S,C,Z)SWAP, (D,S,C,Z)AXPY, (S,C)ROT,}$
(S,C)DOT, CDOTC, (D,S,C,Z)GEMV, (D,S,C,Z)TRMV, (S,C)SYMV, (S,C)SYR, (S,C)SYR2

- Improved 32-bit and 64-bit OS versions of the following BLAS level 1 functions for Intel® Xeon® processors 5300, 5400, 5500: ZAXPY, ZSCAL, ZDOT(U,C), and (D,S)ROT
- Improved DGEMM threading efficiency for matrices with many more rows than columns for Intel® Xeon® processor 5300

- LAPACK

- FFTs
  - Updated underlying kernels to provide widespread performance improvements in FFTs
  - Improved threading of 3D FFTs when a small number of transforms are calculated with a single function call
  - Extended threading to small size multidimensional transforms

- VML
  - Further optimization for these VML functions on Intel® Xeon® processor 5500 series: v(s,d)Asin, v(s,d)Acos, v(s,d)Ln, v(s,d)Log10, vsLog1p, v[d]Hypot

- VSL
  - Improved performance of viRngPoisson and viRngPoissonV random number generators

Usability and Interface Improvements

- Improved example programs for uBLAS, Java, FFTW3, LAPACK95, and BLAS95
- Some examples in the reference manual were removed where identical examples in source code form also appeared in the examples directory
- New 64-bit integer (ILP64) fftw_mpi interfaces for cluster FFTs

5.1.3 Intel® Math Kernel Library 10.2 Update 2

New Features

- LAPACK 3.2
  - 238 new LAPACK functions
  - Extra Precise Iterative Refinement
  - Non-Negative Diagonals from Householder QR factorization
  - High Performance QR and Householder Reflections on Low-Profile Matrices
  - New fast and accurate Jacobi SVD
  - Routines for Rectangular Full Packed format
  - Pivoted Cholesky
  - Mixed precision iterative refinement (Cholesky)
More robust DQDS algorithm

- Introduced implementation of the DZGEMM Extended BLAS function (as described at http://www.netlib.org/blas/blast-forum/). See the description of the \*gemm family of functions in the BLAS section of the reference manual.
- PARDISO now supports real and complex, single precision data

**Usability/Interface improvements**

- Sparse matrix format conversion routines which convert between the following formats:
  - CSR (3-array variation) ↔ CSC (3-array variation)
  - CSR (3-array variation) ↔ diagonal format
  - CSR (3-array variation) ↔ skyline
- Fortran95 BLAS and LAPACK compiled module files (.mod) are now included
  - Modules are pre-built with the Intel Fortran Compiler and are located in the include directory (see Intel® MKL User’s Guide for full path)
  - Source is still available for use with other compilers
  - Documentation for these interfaces can be found in the Intel® MKL User’s Guide
- The FFTW3 interface is now integrated directly into the main libraries
  - Source code is still available to create wrappers for use with compilers not compatible with the default Intel® Fortran compiler convention for name decoration
  - See Appendix G of the Reference Manual for information
- DFTI_DESCRIPTOR_HANDLE now represents a true type name and can now be referenced as a type in user programs
- Added parameter to Jacobi matrix calculation routine in the optimization solver domain to allow access to user data (see the description of the djacobix function in the reference manual for more information)
- Added an interface mapping calls to single precision BLAS functions in Intel® MKL (functions with “s” or “c” initial letter) to 64-bit floating point precision functions has been added on 64-bit architectures (See “sp2dp” in the Intel® MKL User Guide for more information)
- Compatibility libraries (also known as “dummy” libraries) have been removed from this version of the library

**Performance improvements**

- Further threading in BLAS level 1 and 2 functions for Intel® 64 architecture
  - Level 1 functions (vector-vector): (CS,ZD,S,D)ROT, (C,Z,S,D)COPY, and (C,Z,S,D)SWAP
    - Increase in performance by up to 1.7-4.7 times over version 10.1 Update 1 on 4-core Intel® Core™ i7 processor depending on data location in cache
- Increase in performance by up to 14-130 times over version 10.1 Update 1 on 24-core Intel® Xeon® processor 7400 series system, depending on data location in cache
  - Level 2 functions (matrix-vector): (C,Z,S,D)TRMV, (S,D)SYMV, (S,D)SYR, and (S,D)SYR2
    - Increase in performance by up to 1.9-2.9 times over version 10.1 Update 1 on 4-core Intel® Core™ i7 processor, depending on data location in cache
    - Increase in performance by up to 16-40 times over version 10.1 Update 1 on 24-core Intel® Xeon® processor 7400 series system, depending on data location in cache

- Introduced recursive algorithm in 32-bit sequential version of DSYRK for up to 20% performance improvement on Intel® Core™ i7 processors and Intel® Xeon® processors in 5300, 5400, and 7400 series.
- Improved LU factorization (DGETRF) by 25% over Intel MKL 10.1 Update 1 for large sizes on the Intel® Xeon® 7460 Processor; small sizes are also dramatically improved
- BLAS *TBMV/*TBSV functions now use level 1 BLAS functions to improve performance by up to 3% on Intel® Core™ i7 processors and up to 10% on Intel® Core™2 processor 5300 and 5400 series.
- Improved threading algorithms to increase DGEMM performance
  - up to 7% improvement on 8 threads and up to 50% on 3,5,7 threads on the Intel® Core™ i7 processor
  - up to 50% improvement on 3 threads on Intel® Xeon® processor 7400 series.
- Threaded 1D complex-to-complex FFTs for non-prime sizes
- New algorithms for 3D complex-to-complex transforms deliver better performance for small sizes (up to 64x64x64) on 1 or 2 threads
- Implemented high-level parallelization of out-of-core (OOC) PARDISO when operating on symmetric positive definite matrices.
- Reduced memory use by PARDISO for both in-core and out-of-core on all matrix types
- PARDISO OOC now uses less than half the memory previously used in Intel MKL 10.1 for real symmetric, complex Hermitian, or complex symmetric matrices
- Parallelized Reordering and Symbolic factorization stage in PARDISO/DSS
- Up to 2 times better performance (30% improvement on average) on Intel® Core® i7 and Intel® Core™2 processors for the following VML functions: v(s,d)Round, v(s,d)Inv, v(s,d)Div, v(s,d)Sqrt, v(s,d)Exp, v(s,d)Ln, v(s,d)Atan, v(s,d)Atan2
- Optimized versions of the following functions available for Intel® Advanced Vector Extensions (Intel® AVX)
  - BLAS: DGEMM
  - FFTs
  - VML: exp, log, and pow
  - See important information in the Intel® MKL User’s Guide regarding the mkl_enable_instructions() function for access to these functions
5.2 Known Issues
A full list of the known limitations of this release can be found in the Knowledge Base for the Intel® MKL at http://software.intel.com/en-us/articles/known-limitations-in-intel-mkl-10-2

5.3 Notices
The following change is planned for future versions of Intel MKL. Please contact Technical Support if you have concerns:

- Content in the libraries containing solver in the filenames will be moved to the core library in a future version of Intel MKL. These solver libraries will then be removed.

5.4 Attributions
As referenced in the End User License Agreement, attribution requires, at a minimum, prominently displaying the full Intel product name (e.g. "Intel® Math Kernel Library") and providing a link/URL to the Intel® MKL homepage (www.intel.com/software/products/mkl) in both the product documentation and website.

The original versions of the BLAS from which that part of Intel® MKL was derived can be obtained from http://www.netlib.org/blas/index.html.

The original versions of LAPACK from which that part of Intel® MKL was derived can be obtained from http://www.netlib.org/lapack/index.html. The authors of LAPACK are E. Anderson, Z. Bai, C. Bischof, S. Blackford, J. Demmel, J. Dongarra, J. Du Croz, A. Greenbaum, S. Hammarling, A. McKenney, and D. Sorensen. Our FORTRAN 90/95 interfaces to LAPACK are similar to those in the LAPACK95 package at http://www.netlib.org/lapack95/index.html. All interfaces are provided for pure procedures.

The original versions of ScaLAPACK from which that part of Intel® MKL was derived can be obtained from http://www.netlib.org/scalapack/index.html. The authors of ScaLAPACK are L. S. Blackford, J. Choi, A. Cleary, E. D’Azevedo, J. Demmel, I. Dhillon, J. Dongarra, S. Hammarling, G. Henry, A. Petitet, K. Stanley, D. Walker, and R. C. Whaley.

PARDISO in Intel® MKL is compliant with the 3.2 release of PARDISO that is freely distributed by the University of Basel. It can be obtained at http://www.pardiso-project.org.

Some FFT functions in this release of Intel® MKL have been generated by the SPIRAL software generation system (http://www.spiral.net/) under license from Carnegie Mellon University. Some FFT functions in this release of the Intel® MKL DFTI have been generated by the UHFFT software generation system under license from University of Houston. The Authors of SPIRAL are Markus Puschel, Jose Moura, Jeremy Johnson, David Padua, Manuela Veloso, Bryan Singer, Jianxin Xiong, Franz Franchetti, Aca Gacic, Yevgen Voronenko, Kang Chen, Robert W. Johnson, and Nick Rizzolo.
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