# What's New in Intel® Fortran? Intel Fortran Composer 2011 XE Webinar

December 14th, 2010

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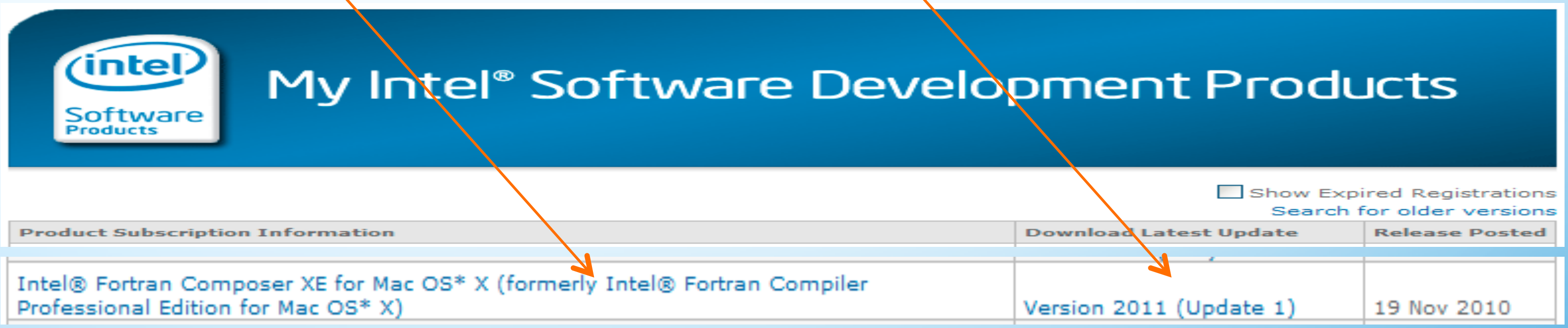
# Agenda

- What’s in a name? Changes in naming
- New utilities, new options, new installation dirs
- What’s New in Fortran standards features?
- A simple and quick look at using the Intel Fortran compiler’s Coarray Fortran (CAF) feature
- Question and Answer session

# An Obvious Change: Naming

- New names:
  - Intel® Visual Fortran Composer XE 2011 (Windows*)
  - Intel® Fortran Composer XE 2011 (Linux* and Mac OS* X)
- Replaces older "…Compiler Pro " naming
- Composer XE 2011 is our next major release ( 12.0 )
- Registration Center: Version numbers not as prominent – using "Update x"



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|---|---|---|
| Intel® Fortran Composer XE for Mac OS* X (formerly Intel® Fortran Compiler Professional Edition for Mac OS* X) | Version 2011 (Update 1) | 19 Nov 2010 |

# Licensing

- Existing, CURRENT licenses for Compiler Pro will work for Intel Fortran Composer products
- Registration Center will offer to “upgrade” your existing licenses – this is FREE
- Intel C/C++ licenses MUST BE UPGRADED for Intel C/C++ Composer XE 2011 – upgrade is free
- All renewals will get upgraded licenses to Composer XE 2011 products

- Optional: Compiler customers can move to new “Intel® Parallel Studio XE 2011” products. These contain the Intel Fortran compiler, C++ compiler, libraries, AND new checking and performance tools

# Poll Question #1

# What’s ~~New~~ OLD in Intel Fortran: listing file

Back by popular demand: DEC Fortran style cross referenced listing file:

-list[=*filename*]  or   /list[:*filename*]

where *filename* is the name of the output file

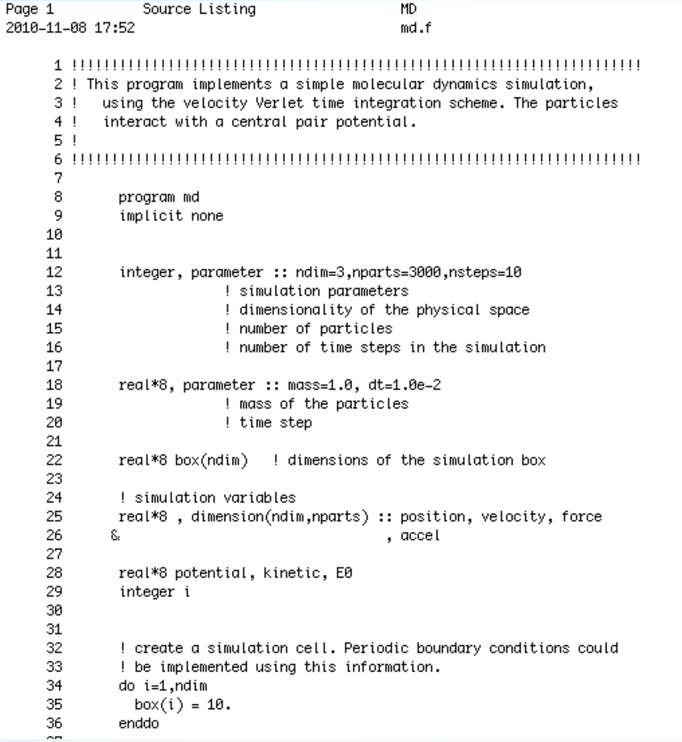
- if filename is not specified, the listing is saved in the name of the source file with extension .lst

default is –no-list  or /list-

The listing contains the following:

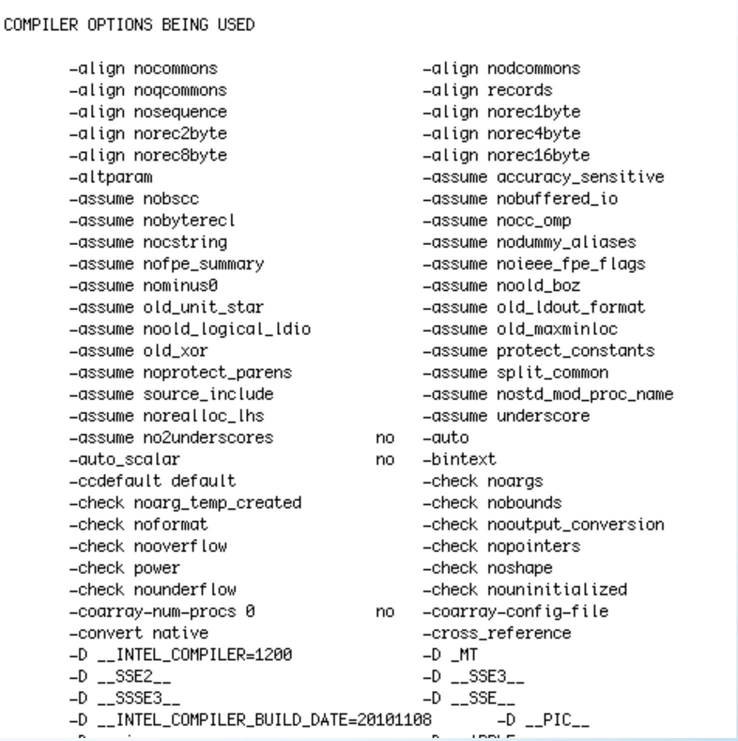
- The contents of files, including contents with INCLUDE statements, with line numbers
- A symbol list with a line number cross-reference for each
- A list of compiler options used for the current compilation
- list-line-len and list-page-len options for further control

# What’s ~~New~~ OLD in Intel Fortran: listing file



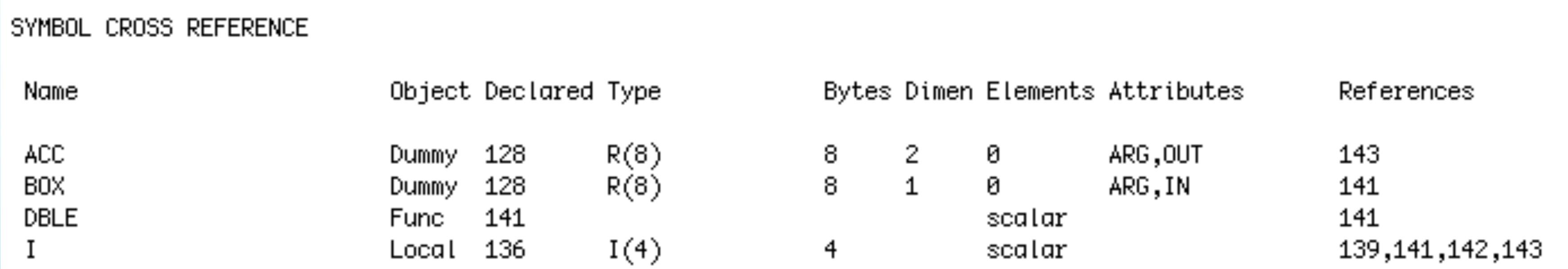
```
Page 1             Source Listing                    MD
2010-11-08 17:52                                     md.f

     1 !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
     2 ! This program implements a simple molecular dynamics simulation,
     3 !   using the velocity Verlet time integration scheme. The particles
     4 !   interact with a central pair potential.
     5 !
     6 !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
     7
     8       program md
     9       implicit none
    10
    11
    12       integer, parameter :: ndim=3,nparts=3000,nsteps=10
    13                    ! simulation parameters
    14                    ! dimensionality of the physical space
    15                    ! number of particles
    16                    ! number of time steps in the simulation
    17
    18       real*8, parameter :: mass=1.0, dt=1.0e-2
    19                    ! mass of the particles
    20                    ! time step
    21
    22       real*8 box(ndim)   ! dimensions of the simulation box
    23
    24       ! simulation variables
    25       real*8 , dimension(ndim,nparts) :: position, velocity, force
    26      &                                 , accel
    27
    28       real*8 potential, kinetic, E0
    29       integer i
    30
    31
    32       ! create a simulation cell. Periodic boundary conditions could
    33       ! be implemented using this information.
    34       do i=1,ndim
    35         box(i) = 10.
    36       enddo
```



```
COMPILER OPTIONS BEING USED

       -align nocommons                      -align nodcommons
       -align noqcommons                     -align records
       -align nosequence                     -align norec1byte
       -align norec2byte                     -align norec4byte
       -align norec8byte                     -align norec16byte
       -altparam                             -assume accuracy_sensitive
       -assume nobscc                        -assume nobuffered_io
       -assume nobyterecl                    -assume nocc_omp
       -assume nocstring                     -assume nodummy_aliases
       -assume nofpe_summary                 -assume noieee_fpe_flags
       -assume nominus0                      -assume noold_boz
       -assume old_unit_star                 -assume old_ldout_format
       -assume noold_logical_ldio            -assume old_maxminloc
       -assume old_xor                       -assume protect_constants
       -assume noprotect_parens              -assume split_common
       -assume source_include                -assume nostd_mod_proc_name
       -assume norealloc_lhs                 -assume underscore
       -assume no2underscores             no -auto
       -auto_scalar                       no -bintext
       -ccdefault default                    -check noargs
       -check noarg_temp_created             -check nobounds
       -check noformat                       -check nooutput_conversion
       -check nooverflow                     -check nopointers
       -check power                          -check noshape
       -check nounderflow                    -check nouninitialized
       -coarray-num-procs 0               no -coarray-config-file
       -convert native                       -cross_reference
       -D __INTEL_COMPILER=1200              -D _MT
       -D __SSE2__                           -D __SSE3__
       -D __SSSE3__                          -D __SSE__
       -D __INTEL_COMPILER_BUILD_DATE=20101108       -D __PIC__
```



```
SYMBOL CROSS REFERENCE

 Name                    Object Declared Type          Bytes Dimen Elements Attributes     References

 ACC                     Dummy  128      R(8)          8     2     0        ARG,OUT        143
 BOX                     Dummy  128      R(8)          8     1     0        ARG,IN         141
 DBLE                    Func   141                                scalar                  141
 I                       Local  136      I(4)          4           scalar                  139,141,142,143
```

# GAP – Guided Automatic Parallelization

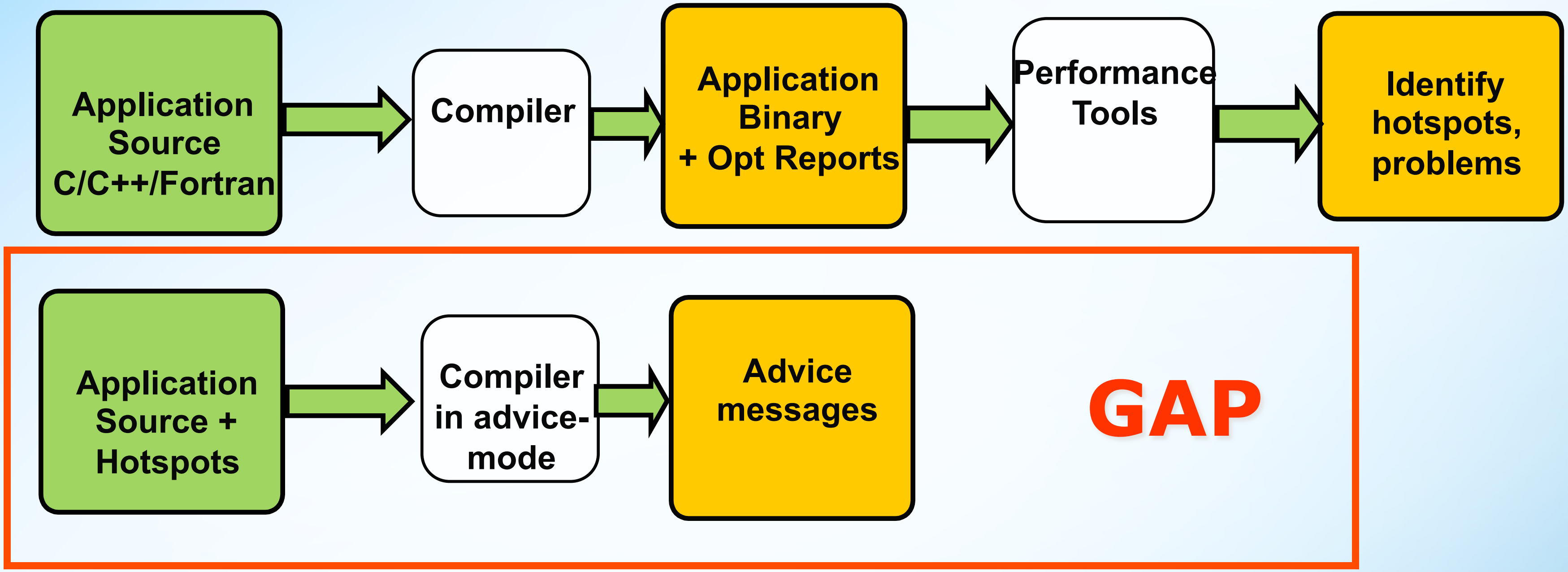
## Key design ideas:

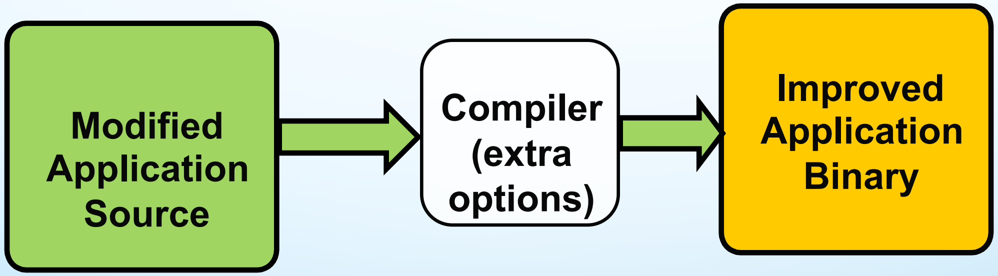
- Use compiler to help detect what is blocking optimizations – in particular vectorization, parallelization and data transformations – gives advice on how to change code, add directives, add compiler options
  - Extend diagnostic message for failed vectorization and parallelization by specific hints to fix problem
- Not a separate tool, part of the compiler

## It is not:

- Automatic vectorizer or parallelizer
  - in fact, no code is generated to accelerate analysis
- GAP does not ask the programmer to change algorithms, transformation ordering or internal heuristics of compiler
  - It is restricted to changes applied to the program to be compiled

# Workflow with Compiler as a Tool


Application Source C/C++/Fortran
Compiler
Application Binary + Opt Reports
Performance Tools
Identify hotspots, problems
Application Source + Hotspots
Compiler in advice-mode
Advice messages
GAP



***Simplifies programmer effort in application tuning***

# GAP – How it Works (linux)

## Selection of most Relevant Switches

**Multiple compiler switches to activate and fine-tune guidance analysis**

- **Activate messages individually for vectorization, parallelization, data transformations or all three**

```
-guide[=level]
-guide-vec[=level]
-guide-par[=level]
-guide-data-trans[=level]
```

**Optional argument level=1,2,3,4 controls extend of analysis**

- **Control the source code part for which analysis is done**

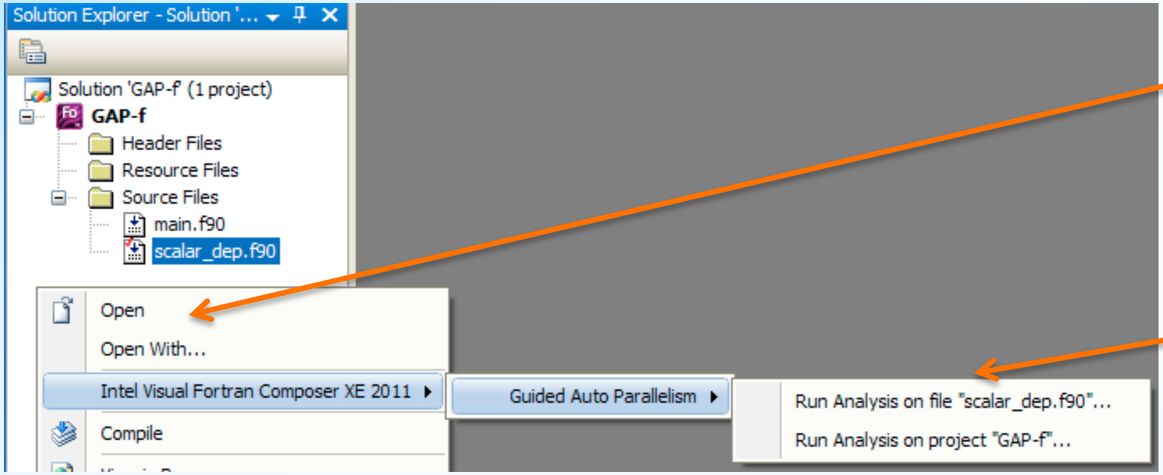
```
-guide-opts=<arg>
Samples:
-guide-opts="bar.f90,'module_1::func_solve`“
```

- **Control where the message are going**

```
-guide-file=<file_name>
```

# GAP – How it Works (Windows)

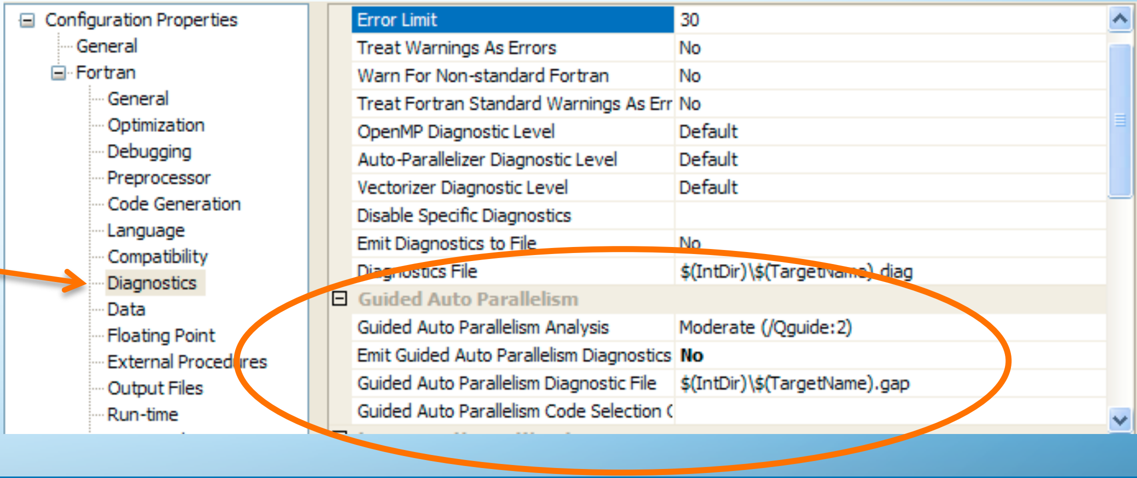
- Windows – right-click or Project Properties
  - GAP analysis appears in Output window


Solution Explorer - Solution '...
Solution 'GAP-f' (1 project)
GAP-f
Header Files
Resource Files
Source Files
main.f90
scalar_dep.f90
Open
Open With...
Intel Visual Fortran Composer XE 2011
Compile
Guided Auto Parallelism
Run Analysis on file "scalar_dep.f90"...
Run Analysis on project "GAP-f"...

Right-click file or project, Fortran Composer pop-up

Choose single-file or whole project

OR you can use the Project Properties, Fortran, Diagnostics property page



| | |
|---|---|
| Error Limit | 30 |
| Treat Warnings As Errors | No |
| Warn For Non-standard Fortran | No |
| Treat Fortran Standard Warnings As Err | No |
| OpenMP Diagnostic Level | Default |
| Auto-Parallelizer Diagnostic Level | Default |
| Vectorizer Diagnostic Level | Default |
| Disable Specific Diagnostics | |
| Emit Diagnostics to File | No |
| Diagnostics File | $(IntDir)\$(TargetName).diag |
| **Guided Auto Parallelism** | |
| Guided Auto Parallelism Analysis | Moderate (/Qguide:2) |
| Emit Guided Auto Parallelism Diagnostics | **No** |
| Guided Auto Parallelism Diagnostic File | $(IntDir)\$(TargetName).gap |
| Guided Auto Parallelism Code Selection ( | |

# GAP Sample Messages

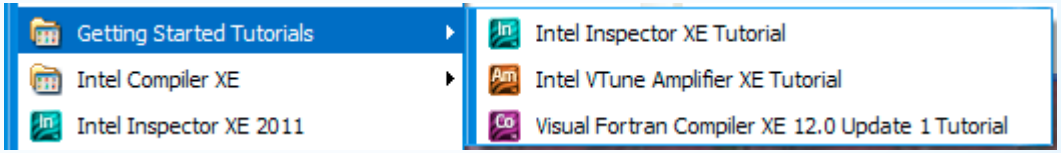
```
 GAP REPORT LOG OPENED ON Thu May 20 15:22:14 2010

C:\scalar_dep.f90(66): remark #30525: (PAR) If the trip count of the
  loop at line 66 is greater than 36, then use "!dir$ loop count min
  (36)" to parallelize this loop.
  [VERIFY]  Make sure that the loop has a minimum of 36 iterations.


C:\scalar_dep.f90(66): remark #30515: (VECT) Loop at line 66 cannot
  be vectorized due to
     conditional assignment(s) into the following variable(s): T.
  This loop will be vectorized
     if the variable(s) become unconditionally initialized at the top
  of every iteration.
      [VERIFY] Make sure that the value(s) of the variable(s) read in
  any iteration of the loop
     must have been written earlier in the same iteration.
```

# Also New: Tutorials and Samples, New Directory Structure

- Greatly enhanced and updated samples included in Composer XE
- Tutorials to help introduce new features ( GAP, for example )


Getting Started Tutorials
Intel Compiler XE
Intel Inspector XE 2011
Intel Inspector XE Tutorial
Intel VTune Amplifier XE Tutorial
Visual Fortran Compiler XE 12.0 Update 1 Tutorial

- New directory paths on Linux, Windows, Mac OS X
- Better integration of libraries
- Linux and Mac OS X: side-by-side installation of multiple versions BUT symbolic links give a 'default' path to tools that is not version dependent

# Also New Features in Both Intel Fortran and Intel C/C++

- Enhanced vectorization
  - Loops with mixed data types, conditionals
  - Support AVX instruction set (-[a]xAVX  or /Q[a]xAVX)
- SIMD directives
  - For example, require compiler to vectorize a loop
- Math library options (-fimf-precision /Qimf-precision)
  - High/low accuracy options   (tradeoff against performance)
  - Require consistent results on all processor types
- Matrix multiply idiom recognition   (-opt-matmul)
  - Replace by high performance library call

# Poll Question #2

# Fortran Language Features – What's New?

# What’s New in Intel Fortran

## Fortran 2003 implementation mostly complete

- Added in 12.0 ( not in 11.1 )
  - Complete type-bound procedures (GENERIC, OPERATOR,..)
  - FINAL procedures
- Remaining major features of F2003 not implemented:
  - User-defined derived type I/O
  - Parameterized derived types

## Fortran 2008 features

- Coarrays
- DO CONCURRENT
- CONTIGUOUS
- I/O enhancements
- New constants in ISO_FORTRAN_ENV
- New intrinsic functions
- Increase maximum rank from 7 to 31
  - F2008 requires only 15

# Fortran 2003 Pointer Bounds Specification and Remapping List on Pointer Assignment

- Fortran 2003 features
- Pointer assignment for arrays extended to allow specification of lower bounds:

```
real :: myarray(1:100,1:100)
real, pointer :: ptr(:,:)
ptr(0:,0:) => myarray
```

- Remapping of a rank-one array
  - ptr(1:n,1:n) => 1D_Array(1:n*n)

# Fortran 2003 FINALizers

- A derived type with ‘FINAL’ subroutines bound to it
- The FINAL subroutine(s) perform ‘clean-up’ when the object ceases to exist

```
module M
  type mytype
    : !declaration of mytype components
  contains
    FINAL :: mycleanup
  end type mytype
contains
  subroutine mycleanup(x)
  type(mytype) :: x
   !...deallocate data in object X
  end subroutine mycleanup
end module M
```

Note: Fortran 2003 does not have the equivalent to C++ constructor functions

# F2008 DO CONCURRENT

## A new Parallel Loop Construct

- Syntax uses elements of Fortran 90 FORALL

```
DO [,] CONCURRENT <forall-header>
```

- Semantically there is a key difference to FORALL however :
  - No dependencies between the iterations of the loop body are permitted ( no “loop carried dependencies”)
- The semantics of DO CONCURRENT make it easier to parallelize
- Use option –parallel (/Qparallel) to get parallelization
- No requirement or guarantees that the loop will be parallelized
- Our implementation will execute the iterations in parallel using OpenMP*

# F2008 DO CONCURRENT

Example:

```
DO CONCURRENT (i=1:m)
    a(k+i) = a(k+i) + factor*a(l+i)
END DO
```

Different from FORALL, using DO CONCURRENT, the programmer guarantees, that the values of `m`, `k` and `l` will never cause `a(l+i)` to reference an element of the array defined on the LHS

in other words: the array sections `a(l+1:l+m)` and `a(k+1:k+m)` do not overlap

This allows compiler to generate very efficient parallel code.

# Fortran 2008 CONTIGUOUS Attribute

- An array attribute that tells the compiler that the data occupies a contiguous block
  - Allows compiler to make optimizations
  - Pointers and assumed-shaped arrays: useful to remove ambiguity when the compiler cannot determine if the object is contiguous or non-contiguous

```
real, pointer, contiguous :: ptr(:)
real, contiguous :: arrayarg(:,:)
```

- The POINTER target must be contiguous
- The actual argument corresponding to the assumed-shape array must be contiguous
- F08 intrinsic, logical return: `is_contiguous()`

```
IF ( is_contiguous(thisarray) ) THEN
   ptr => thisarray
```

# Fortran 2008 MOLD keyword for ALLOCATE

- ALLOCATE statement can give a polymorphic variable the type and shape of another object without copying the other object's values.

```
allocate ( polymorphvar, mold=srcvar )
```

Variable `polymorphvar` is allocated with the type and shape of `srcvar.` `polymorphvar` does not receive the values in the components of srcvar.

Also,  SOURCE= with polymorphic source not yet supported in ALLOCATE

# Fortran 2008 IO Additions

- NEWUNIT=<integer> keyword in OPEN finds a unit number that is not being used.  Simplifies bookkeeping of unit numbers

```
OPEN( NEWUNIT=iun, file=‘foo’, … )
```

!assigns an unused number to `iun`

- G0 and G0.d edit descriptors.  Can be used with multiple data types:
  - real or complex: acts like `esw.de`
    - e format with values w, d and e chosen by the processor
  - Integers, acts like `I0`
  - Logicals, acts like `L1`
  - Character, acts like `A`

# Fortran 2008 IO Additions
# Unlimited format item repeat count

- Asterisk preceding a list of edit descriptors
- Repeats the list indefinitely

```
real :: myarray(50) = 42.0
write(42, ‘( “myarray =“, *( g0, :, “,”))’) myarray
```

```
myarray=42.00000,42.00000,42.00000,42.00000,42.00000,4
  2.00000,42.00000,42.00000,42.00000,42.00000,42.00000
  ,42.00000,42.00000,…etc…
```

- This example writes 1 record, comma separated values
- This can be used with G0 edit descriptor to write output with various data types present

# F2008 Intrinsics

- Bessel, first kind
- Bessel, second kind
- Error functions
- GAMMA
- Euclidean distance
- Bit-wise comparisons
- Integer bit-wise shifts
- Bit masks
- Merge bits with mask
- Population count: return the number of 1 bits
- Parity of population
- Bit-wise exclusive-or (XOR) on array elements
- Bitwise reductions on array elements using AND or OR
- Number of leading or trailing 0 bits
- Storage size in bits

# Fortran 2008 Additions to ISO_FORTRAN_ENV

- CHARACTER_KINDS
  - Default integer array with the kind values supported for variables of type character
  - Size equals the number of kinds supported

- INTEGER_KINDS, REAL_KINDS
  - Similar to CHARACTER_KINDS, arrays of kind values for INTEGER and REAL data types

# Fortran 2008 Additions to ISO_FORTRAN_ENV

- INT8, INT16, INT32, and INT64
  - Default integer scalars, kind values for integers of storage size 8, 16, 32, and 64 bits
  - If there is no such type, -2 is return if there is a type of larger storage size or -1 otherwise

- REAL32, REAL64, and REAL128
  - Default integer scalars, the kind values for reals of storage size 32, 64, and 128 bits
  - If there is no such type, -2 is return if there is a type of larger storage size or -1 otherwise

# Poll Question #3

# Coarray Fortran Fundamentals

- Simple extension to Fortran to make Fortran into a robust and efficient parallel programming language
- Single-Program, Multiple-Data programming model
  - Single program is replicated a fixed number of times
  - Each program instance has it's own set of data objects – called an "IMAGE"
  - Each image executes asynchronously
  - Extensions to normal Fortran array syntax to allow images to reference data in other image(s)
- Part of the Fortran 2008 standard
- Shared-memory in Fortran Composer XE for Windows* and Linux*
- Distributed-memory supported in Linux only, Intel® Cluster Tools product line

# Compilation

- `ifort –coarray      !Linux*`
- `ifort /Qcoarray     !Windows*`

  along with other options. Enables compiling for CAF.  By default, executable will use as many cores (real and hyperthreaded) as are available.

```
ifort –coarray -coarray-num-images=x
ifort /Qcoarray /Qcoarray-num-images=x
```

along with other options.  Sets number of images to “x”.

# Running (linux)

- Simple hello world:

```
program hello_image
   write(*,*) "Hello from image ", this_image(), &
     "out of ", num_images()," total images“
end program hello_image
```

```
ifort –coarray –o hello_image hello_image.f90
./hello_image
 Hello from image           1 out of            4  total images
 Hello from image           4 out of            4  total images
 Hello from image           2 out of            4  total images
 Hello from image           3 out of            4  total images
```

# Controlling the Number of Images, env var: FOR_COARRAY_NUM_IMAGES

- Environment variable can set number of images
- Environment variable overrides –coarray-num-images compiler option

```
Linux host>  export FOR_COARRAY_NUM_IMAGES=2
./hello_image
Window host> set FOR_COARRAY_NUM_IMAGES=2
hello_image.exe
 Hello from image 1 out of 2  total images
 Hello from image 2 out of 2  total images
```

# CAF Fundamentals:  Determining Number of Images, num_images()

- Intrinsic function num_images() returns an integer result, the total number of images in the CAF program:

```
$> cat hello_num_images.f90
program hello_num_images
  write(*,*) "Hello there are ", num_images()," total images"
end program hello_num_images

> ifort -coarray -coarray-num-procs=4 hello_num_images.f90
$> ./a.out
 Hello there are            4  total images
 Hello there are            4  total images
 Hello there are            4  total images
 Hello there are            4  total images
```

# Coarray Fundamentals:  this_image()

- Images have a logical ordering from 1 to N
- Integer function this_image() without an argument returns unique logical ordering from 1 to N
  - More complex image mappings possible: 2D, 3D, etc with arguments (topic discussed later)

```
$> cat hello_this.f90
program hello_this_image
  write(*,*) "Hello from image ", this_image()
end program hello_this_image
$> ifort -coarray -coarray-num-procs=4 hello_this.f90
$> ./a.out
Hello from image            1
Hello from image            3
Hello from image            2
Hello from image            4
```

- Remember, the images are inherently asynchronous

# CAF Fundamentals – Codimensions Declaration, A Simple Scalar Example

- A variable can be declared with a CODIMENSION

```
real, codimension[*] :: x
real :: y[*]
```

- X, Y are real scalar variables, codimension can be used to reference copies of X & Y on remote images
- Similar to assumed size array syntax, "[*]" means as many copies as there are images, one copy per image
  - "*" can ONLY be used on last codimension for the object
    - Ex:  [*,2] is illegal, but [2,*] is valid: means a 2D ordering of images. 20 images would have object with [2,10] codimension. 30 images would have object with [2,15] codimensions

# CAF Fundamentals – Codimensions Declaration, Coarray Examples

```
real ::  myarray(100)[*]
```

- A program with N images will have N copies of `myarray`, 1 per image
- Extent of `myarray` is 100, lower bound 1, upper bound 100 on each image
- Coarrays can have normal F08 attributes: ALLOCATABLE, POINTER, have multiple dimensions, be part of a derived type, etc.

```
real, allocatable :: a(:)[*], b(:)[*]

allocate( b(100)[*], b(100)[0:*] )

   **note that the brackets and cobounds are
  needed
```

# Some Advice Before Some Examples

- CAF behavior rule of thumb: when questioning the behavior of CAF ask “what would the Fortran semantics imply here” – follow Fortran rules
- The “[]” codimension syntax is a visual clue to where communication to remote images is performed (implies OVERHEAD, implies possible performance drops)
- There are many restrictions to where coarrays can be used: Simply put: any attempt to alias a coarray with a non-coarray object are prohibited:
  - Pointers that are not coarrays
  - Non-coarray dummy args passed coarrays
  - Passing coarray object to C or another language
  - COMMON, EQUIVALENCE, etc

# CAF Fundamentals – Codimensions Reference, A Simple Scalar Example

- Without specifying codimension, usual Fortran semantics:  X is the local image instance for X

```
x = 42.0   !refers to the local image’s variable instance
```

If you specify the codimension, it references a specific image’s copy of the variable:

```
x[3] = 42.0  !sets X on image 3 to 42.0
x = x[1]    !local X gets value of X from image 1
X[i] = x[j]  !image I’s value of X set to value from image J
```

- Objects referenced with square brackets “coindexed object”

# CAF Fundamentals - Codimensions

- Codimensions follow similar syntax and semantics as Fortran 90 array dimension syntax

[1:N]   codimensions 1 to N

[ -1:99, 0:100, -100:-1 ]  upper and lower bounds need not start at 1, can be negative, etc.

- Restriction:  Total number of dimensions PLUS codimensions <= 15

- Similar to array syntax, objects can have:
  - corank, cobounds, coextents

# CAF Fundamentals - Codimensions

- Intrinsic functions `lcobound()` and `ucobound()` return lower and upper cobounds
- UCOBOUND( coarray [,DIM, KIND] ) !upper
- LCOBOUND( coarray [,DIM, KIND] ) !lower

```
real, allocatable :: A[:,:,:]
integer :: lcb(3), ucb(3)
allocate( A[3:4,-1:6,*] )  !..assume 30 images

lcb = lcobound(A)
!...if images=30, lcb = (/ 3, -1, 1 /)
ucb = ucobound(A)
!...if images=30, ucb = (/ 4, 6, 2 /)
lcobound(A,DIM=2) == -1
```

# CAF Fundamentals - Codimensions

- Mapping of objects with codimensions: 2D

```
real, codimension[2,*] :: x
```

- Mapping of X if program run with 6 images:

| | | |
|---|---|---|
| Image 1<br>X[1,1] | Image 3<br>X[1,2] | Image 5<br>X[1,3] |
| Image 2<br>X[2,1] | Image 4<br>X[2,2] | Image 6<br>X[2,3] |

Mapping of X if program run with 9 images

| | | | | |
|---|---|---|---|---|
| Image 1<br>X[1,1] | Image 3<br>X[1,2] | Image 5<br>X[1,3] | Image 7<br>X[1,4] | Image 9<br>X[1,5] |
| Image 2<br>X[2,1] | Image 4<br>X[2,2] | Image 6<br>X[2,3] | Image 8<br>X[2,4] | |

# CAF Fundamentals: Global Barrier Synchronization

- SYNC ALL statement global barrier: requires all images to join the synchronization point
- sync images( ) allows synchronization with a subset of images. The image set is an integer scalar holding an image index, an integer array of rank 1 holding distinct image indices, or an asterisk to indicate all images,
- Critical sections can be created, bounded by **`CRITICAL ; END CRITICAL`**
- SYNC MEMORY ensures any changed data that is held in temporary storage ( cache, registers ) or in transit between images is made visible to the other image

# Additional Synchronization

- LOCK and UNLOCK statements provide fine-grained control
- ERROR STOP stops execution on all images immediately with error code
- Implicit global synchronization at ALLOCATE, DEALLOCATE of coarrays
  - When coarray is allocated on one image, wait until all images allocate their copy.  Otherwise, one image could attempt to access unallocated coarray data on another image
  - Similar on DEALLOCATE:  Wait to remove the coarray data until all images synch and deallocate: otherwise, other images could try to access deallocated coarray data

# CAF Fundamentals - Input/Output

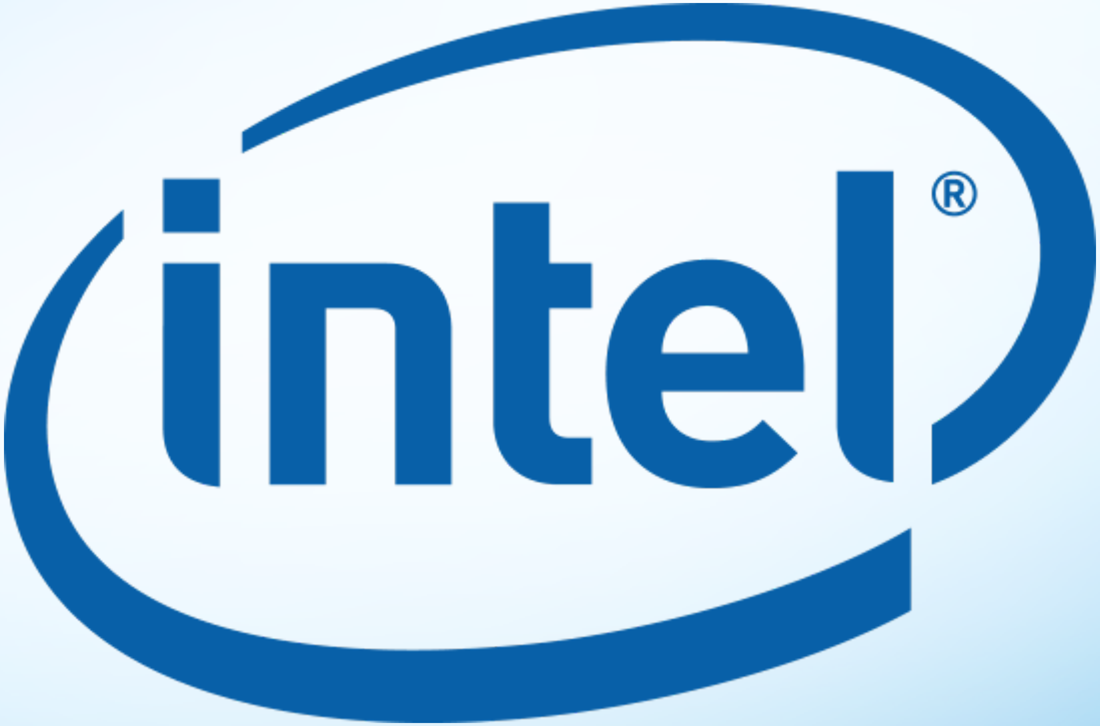
- Each image has its own set of connected units
- Default output unit is preconnected on all images
  - Assumption is that processor will merge the streams
- Default input unit is preconnected on image 1 only

# Further Reading

- Coarrays in the next Fortran Standard
  - ftp://ftp.nag.co.uk/sc22wg5/N1801-N1850/N1824.pdf
- The New Features of Fortran 2008
  - ftp://ftp.nag.co.uk/sc22wg5/N1801-N1850/N1828.pdf
- Fortran 2008 Standard (current draft)
  - http://j3-fortran.org/doc/standing/links/007.pdf

# Poll Question #4

# Questions and Answers Session



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## Optimization Notice

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