Introducing the Intel Compiler on Edison

Using the Intel Compiler on Edison and Porting PGI codes from Hopper to Intel on Edison

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Current Edison Programming Environment Status

- The Edison/XC30 Programming Environment is still a work in progress.
- There may be major changes to it by the time Edison is accepted.
- Monitor the www.nersc.gov Edison pages to keep track of the changes.
Introduction

- Similarities and differences between the Edison and the Hopper compiling environments.
- The Edison Intel programming environment.
- Porting from PGI on Hopper to Intel on Edison.
- Preliminary report on Edison performance.
- Your feedback.
Difference Between the Edison and Hopper Compiling Environments

- Edison supports 3 compilers: Intel (default), Cray, and Gnu. PGI and Pathscale are not installed.
- Gnu and Cray use Cray libsci for math library routines, but Intel uses Intel's MKL math library (add "-mkl=cluster" as an LDFLAG).
- Several Cray provided libraries, e.g. netcdf and hdf5, have different names, prefixed with cray-.  
- The Intel OpenMP and hybrid MPI/OpenMP run time environments do not work by default at this time. See below for workarounds.
Edison Math Libraries

- Edison Gnu and Cray math library is the same as on Hopper.
  - Cray libsci
  - no special flags needed at link time.
- Intel uses Intel's MKL math library
  - Add "-mkl=cluster" as a flag at link time to load the MKL library.
  - The libsci library is currently not available for the Intel compiler.
Cray Library Module Name Changes on Edison

- New names for Hopper Cray modules, prefixed with cray-
  - cray-hdf5
  - cray-hdf5-parallel
  - cray-netcdf
  - cray-netcdf-hdf5parallel
  - cray-petsc (not yet available with Intel)
  - cray-trilinos (not yet available with Intel)

The modules also exist currently on Hopper with the new names.
## Converting from PGI to Intel

<table>
<thead>
<tr>
<th>PGI</th>
<th>Intel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-fast</td>
<td>-fast -no-ipo</td>
<td>Produce well optimized code.</td>
</tr>
<tr>
<td>-mp=nonuma</td>
<td>-openmp</td>
<td>Implement OpenMP directives.</td>
</tr>
<tr>
<td>-Mfixed</td>
<td>-fixed</td>
<td>Fortran fixed source form.</td>
</tr>
<tr>
<td>-Mfree</td>
<td>-free</td>
<td>Fortran free source form.</td>
</tr>
<tr>
<td>-byteswapio</td>
<td>-convert big_endian</td>
<td>Read and write Fortran unformatted data files as big endian.</td>
</tr>
<tr>
<td>default</td>
<td>-mkl=cluster</td>
<td>Use math library routines.</td>
</tr>
<tr>
<td>-V</td>
<td>--version</td>
<td>Show Fortran compiler version.</td>
</tr>
</tbody>
</table>
The -fast option to the Intel Compiler

- The Intel and PGI compiler -fast options have different effects.
- PGI
  - "A generally optimal set of options is chosen for targets that support SSE capability."
  - Same as -fastsse.
- Intel
  - Includes interprocedural optimization which can increase compile time by an order of magnitude or cause it to fail.
  - Always turn it off with -no-ipo when using -fast.
  - -fast -no-ipo generally improves performance over the default (no optimization arguments) on Edison.
  - No significant improvement to performance over default on Hopper.
The Intel Hybrid/OpenMP run time environment

- The Cray thread affinity settings and Intel's run time OpenMP environment conflict.
- Intel has an extra thread at run time, so 2 threads are scheduled on the same core and the job takes twice as long as it should.
- Current workaround:
  - OMP_NUM_THREADS \leq 8
    - set KMP_AFFINITY compact
    - aprun -cc numa_node ....
  - OMP_NUM_THREADS >8 and \leq 16
    - set KMP_AFFINITY scatter
    - aprun -cc none ....
Compiler performance on Edison

- Based on a set of NERSC 6 and NPB 3.1.1 benchmarks.
- All compilers produce significantly faster code on Edison compared to Hopper.
- Cray and Intel compilers have comparable performance, Gnu compiled codes run 10% slower on average.
- Recommended optimization arguments:
  - Intel: -fast -no-ipo (different from Hopper).
  - Cray: default, no explicit arguments (same as Hopper).
  - Gnu: -O3 -ffast-math (same as Hopper).
Questions and Comments