

# Intel® Xeon Phi™ Coprocessor Highly-Parallel Processing

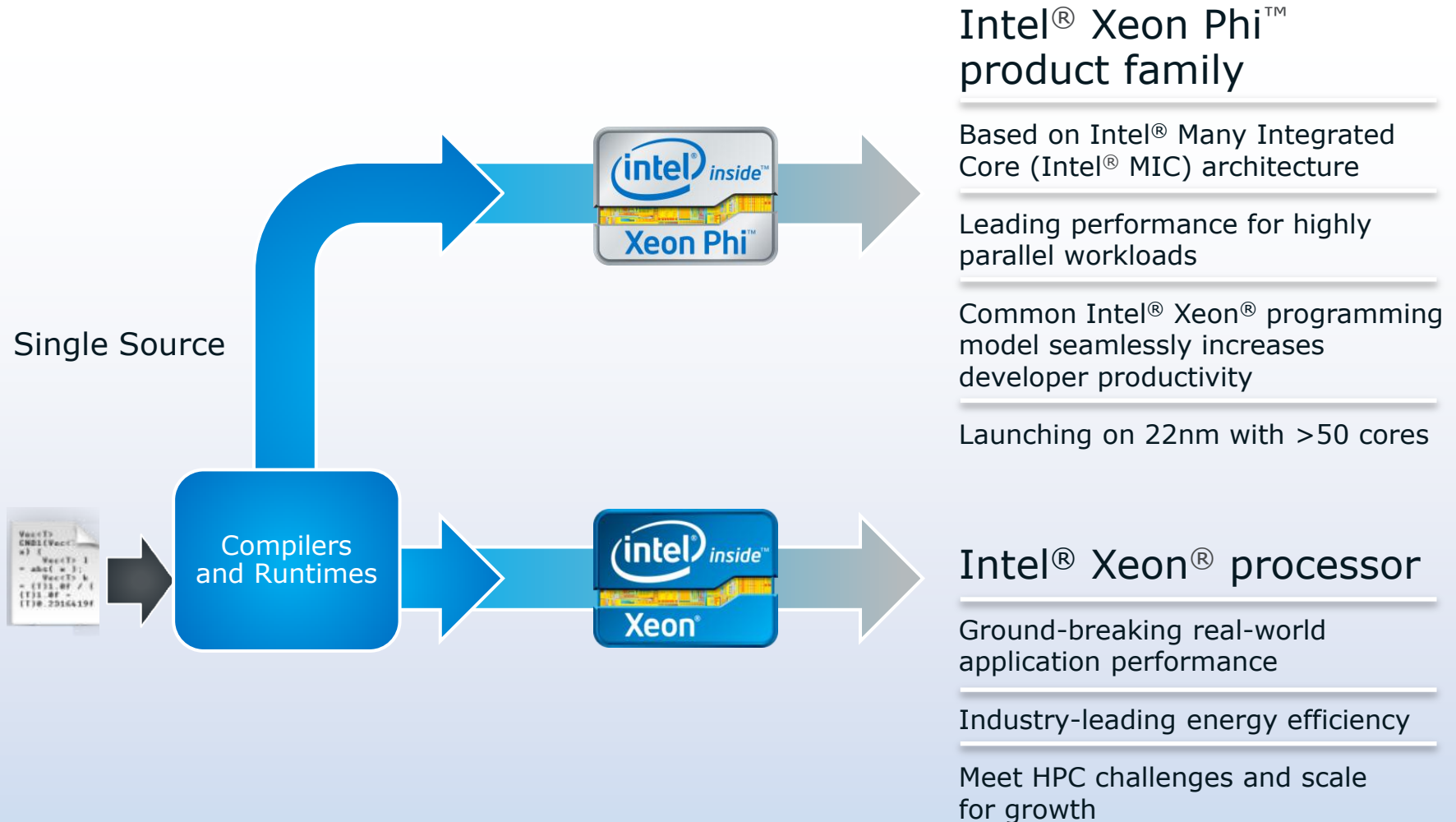
April 2013

Marius Cornea

Intel Corporation

# Highly-Parallel Processing

*Seamlessly solves most important problems of any scale*



# Introducing Intel® Xeon Phi™ Coprocessors

*Highly-parallel Processing for Unparalleled Discovery*

## Groundbreaking Differences

---

Up to 61 IA cores/1.1 GHz/ 244 Threads

---

Up to 8GB memory with up to 352 GB/s bandwidth

---

512-bit SIMD instructions; fma

---

Linux operating system, IP addressable

---

Standard programming languages and tools

## Leading to Groundbreaking Results

---

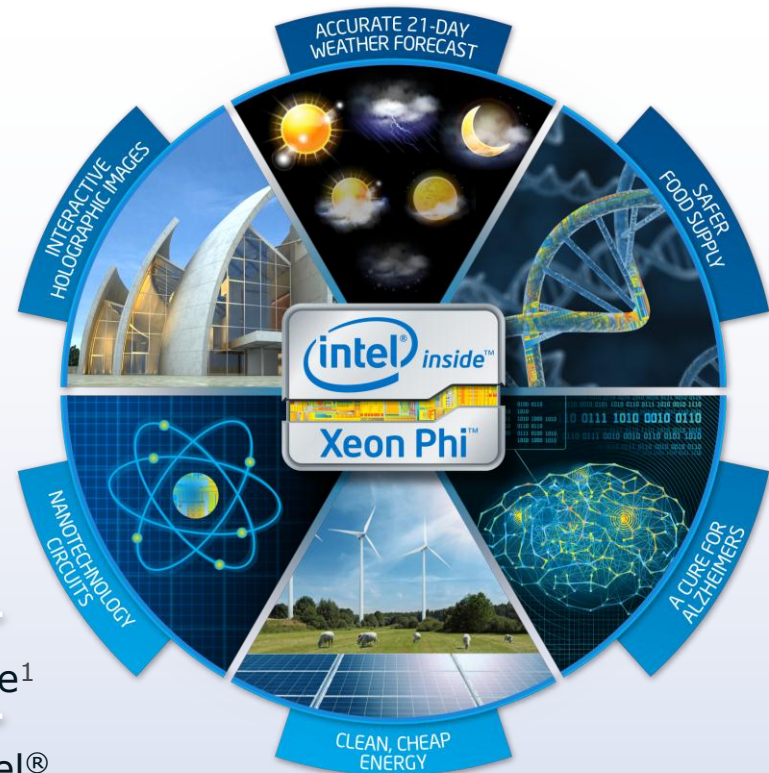
Up to 1 TeraFlop/s double precision peak performance<sup>1</sup>

---

Up to 2.2x higher memory bandwidth than on an Intel® Xeon® processor E5 family-based server.<sup>2</sup>

---

Up to 4x more performance per watt than with an Intel® Xeon® processor E5 family-based server.<sup>3</sup>



# Intel® Xeon Phi™ Coprocessors Much More Than That

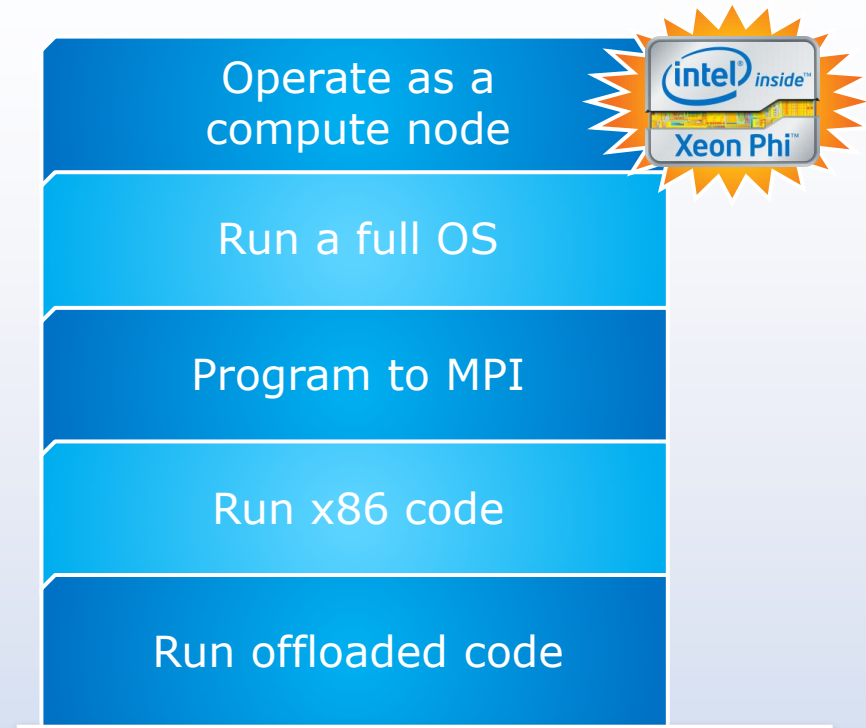
*General purpose IA Hardware leads to less idle time for your investment.*

## Restrictive architectures

## It's a supercomputer on a chip



Custom HW Acceleration



Intel® Xeon Phi™ Coprocessor

Restrictive architectures limit the ability for applications to use arbitrary nested parallelism, functions calls and threading models

# Shipping in 2012

Intel® Xeon Phi™ Coprocessor 5110P

## Performance

Up to 1 TFLOP of double-precision (peak)<sup>1</sup>



8GB GDDR5  
320 GB/s Bandwidth  
Passive form factor at  
225W TDP

## Programmability

C, C++, Fortran  
Intel and 3<sup>rd</sup> party tools



Intel and  
3<sup>rd</sup> party tools

## Applications

Memory Bandwidth /  
Capacity Bound workloads



Ideal for  
Molecular Modeling,  
Digital Content Creation,  
and Energy

# Ideal for memory bandwidth and memory capacity bound workloads

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. For more information go to <http://www.intel.com/performance>. <sup>1</sup>Claim based on calculated theoretical peak double precision performance capability for a single coprocessor. 16 DP FLOPS/clock/core \* 60 cores \* 1.053GHz = 1.0108 TeraFlop/s.

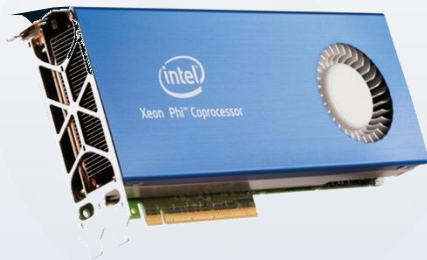


# Shipping in 2013

## Intel® Xeon Phi™ Coprocessor 3100 Product Family

### Performance

Up to 1 TFLOP of double-precision (peak)<sup>1</sup>



6GB GDDR5  
240 GB/s Bandwidth  
Active and passive form factors at 300W TDP

### Programmability

C, C++, Fortran  
Intel and 3<sup>rd</sup> party tools



Intel and 3<sup>rd</sup> party tools

### Applications

Compute Bound workloads



Ideal for MonteCarlo,  
Black-Scholes,  
Life Sciences

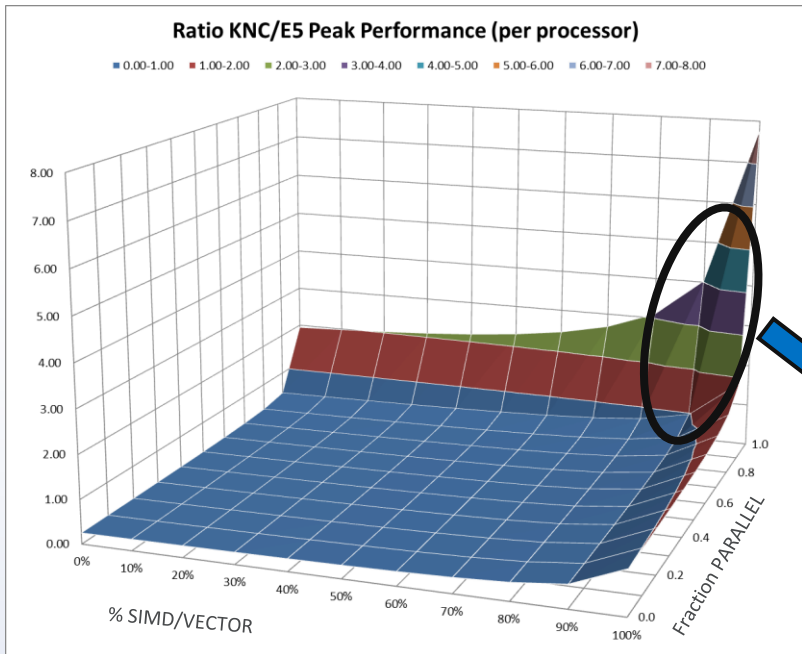
## Ideal for compute bound workloads

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. For more information go to <http://www.intel.com/performance>. <sup>1</sup>Claim based on calculated theoretical peak double precision performance capability for a single 3100 family coprocessor = 1.0032 TeraFlop/s.



# Intel® Xeon Phi™ Coprocessor: Increases Application Performance up to 10x

## Application Performance Examples



Customer	Application	Performance Increase <sup>1</sup> vs. 2S Xeon*
Los Alamos	Molecular Dynamics	Up to 2.52x
Acceleware	8 <sup>th</sup> order isotropic variable velocity	Up to 2.05x
Jefferson Labs	Lattice QCD	Up to 2.27x
Financial Services	BlackScholes SP Monte Carlo SP	Up to 7x Up to 10.75x
Sinopec	Seismic Imaging	Up to 2.53x <sup>2</sup>
Sandia Labs	miniFE (Finite Element Solver)	Up to 2x <sup>3</sup>
Intel Labs	Ray Tracing (incoherent rays)	Up to 1.88x <sup>4</sup>

- Intel® Xeon Phi™ coprocessor accelerates highly parallel & vectorizable applications. (graph above)
- Table provides examples of such applications

\* Xeon = Intel® Xeon® processor;  
\* Xeon Phi = Intel® Xeon Phi™ coprocessor

### Notes:

1. 2S Xeon\* vs. 1 Xeon Phi\* (preproduction HW/SW & Application running 100% on coprocessor unless otherwise noted)
2. 2S Xeon\* vs. 2S Xeon\* + 2 Xeon Phi\* (offload)
3. 8 node cluster, each node with 2S Xeon\* (comparison is cluster performance with and without 1 Xeon Phi\* per node) (Hetero)
4. Intel Measured Oct. 2012

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.

Source: Customer Measured results as of October 22, 2012 Configuration Details: Please reference slide speaker notes.

For more information go to <http://www.intel.com/performance>



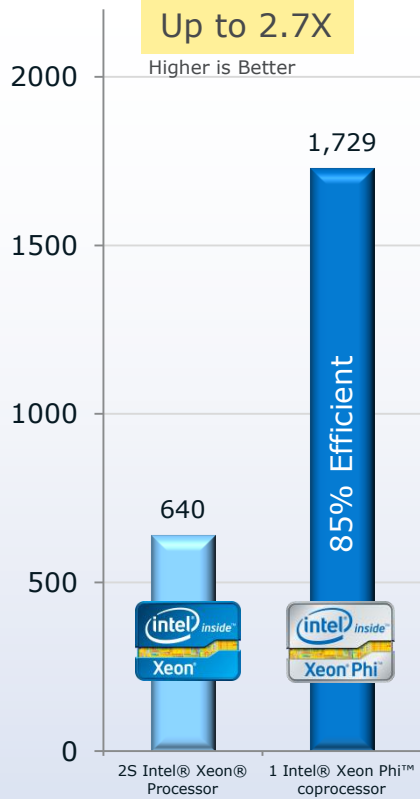


# Synthetic Benchmark Summary (Intel® MKL) (5110P)

## SGEMM (GF/s)

Up to 2.7X

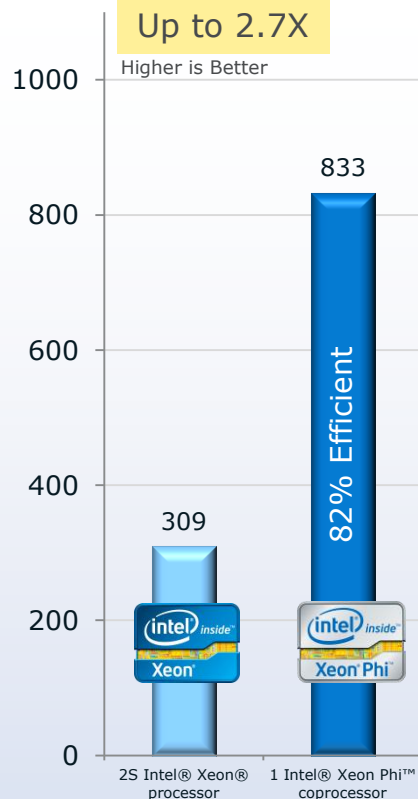
Higher is Better



## DGEMM (GF/s)

Up to 2.7X

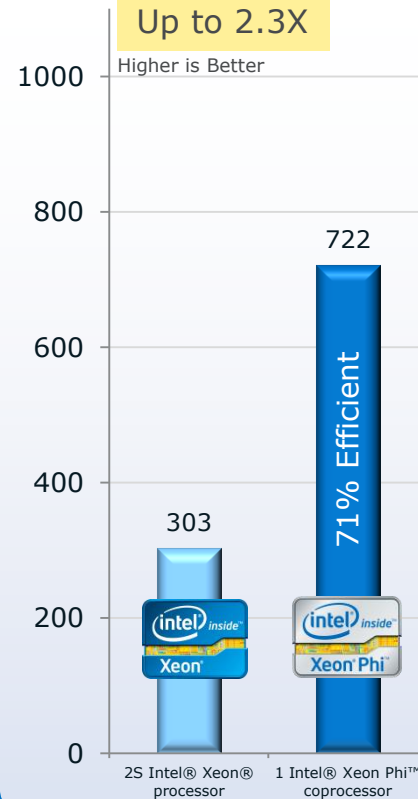
Higher is Better



## SMP Linpack (GF/s)

Up to 2.3X

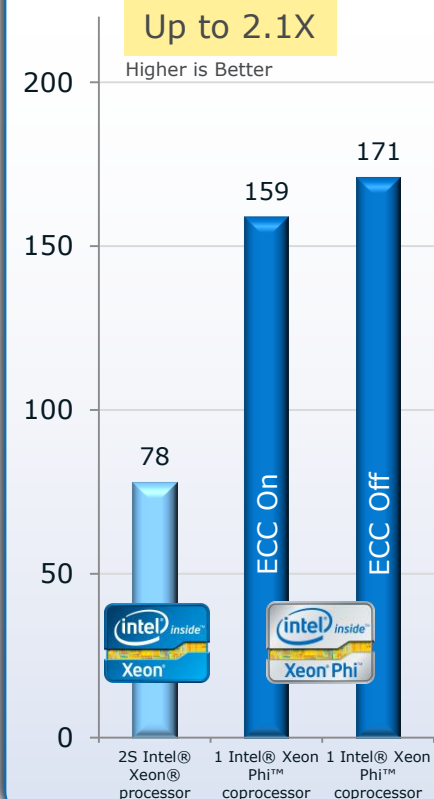
Higher is Better



## STREAM Triad (GB/s)

Up to 2.1X

Higher is Better



Coprocessor results: Benchmark run 100% on coprocessor, no help from Intel® Xeon® processor host (aka native)

### Notes

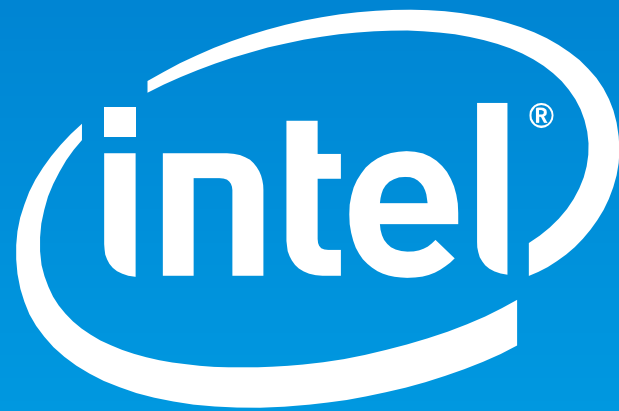
1. Intel® Xeon® Processor E5-2670 used for all SGEMM Matrix = 13824 x 13824, DGEMM Matrix 7936 x 7936, SMP Linpack Matrix 30720 x 30720
2. Intel® Xeon Phi™ coprocessor 5110P (ECC on) with "Gold Release Candidate" SW stack SGEMM Matrix = 11264 x 11264, DGEMM Matrix 7680 x 7680, SMP Linpack Matrix 26872 x 26872

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. Source: Intel Measured results as of October 26, 2012 Configuration Details:

Please reference slide speaker notes. **For more information go to <http://www.intel.com/performance>**







# Notice and Disclaimers

**INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**A "Mission Critical Application" is any application in which failure of the Intel Product could result, directly or indirectly, in personal injury or death. SHOULD YOU PURCHASE OR USE INTEL'S PRODUCTS FOR ANY SUCH MISSION CRITICAL APPLICATION, YOU SHALL INDEMNIFY AND HOLD INTEL AND ITS SUBSIDIARIES, SUBCONTRACTORS AND AFFILIATES, AND THE DIRECTORS, OFFICERS, AND EMPLOYEES OF EACH, HARMLESS AGAINST ALL CLAIMS COSTS, DAMAGES, AND EXPENSES AND REASONABLE ATTORNEYS' FEES ARISING OUT OF, DIRECTLY OR INDIRECTLY, ANY CLAIM OF PRODUCT LIABILITY, PERSONAL INJURY, OR DEATH ARISING IN ANY WAY OUT OF SUCH MISSION CRITICAL APPLICATION, WHETHER OR NOT INTEL OR ITS SUBCONTRACTOR WAS NEGLIGENT IN THE DESIGN, MANUFACTURE, OR WARNING OF THE INTEL PRODUCT OR ANY OF ITS PARTS.**

**Intel may make changes to specifications and product descriptions at any time, without notice. Designers must not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined". Intel reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them. The information here is subject to change without notice. Do not finalize a design with this information.**

**The products described in this document may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.**

**Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.**

**Copies of documents which have an order number and are referenced in this document, or other Intel literature, may be obtained by calling 1-800-548-4725, or go to: <http://www.intel.com/design/literature.htm%20>**

Intel®, Xeon®, Xeon Phi™ and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

Copyright © 2012, Intel Corporation. All rights reserved.

\*Other names and brands may be claimed as the property of others.



# Disclaimers(contintued)

## Usage Guidance

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those 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, go to: [http://www.intel.com/performance/resources/benchmark\\_limitations.htm](http://www.intel.com/performance/resources/benchmark_limitations.htm). Intel does not control or audit the design or implementation of third party benchmarks or web sites referenced in this document. Intel encourages all of its customers to visit the referenced web sites or others where similar performance benchmarks are reported and confirm whether the referenced benchmarks are accurate and reflect performance of systems available for purchase. Relative performance is calculated by assigning a baseline value of 1.0 to one benchmark result, and then dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms, and assigning them a relative performance number that correlates with the performance improvements reported.

SPEC, SPECint, SPECfp, SPECrate, SPECpower, SPECjAppServer, SPECjEnterprise, SPECjbb, SPECcompM, SPECcompL, and SPEC MPI are trademarks of the Standard Performance Evaluation Corporation. See <http://www.spec.org> for more information.

Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor series, not across different processor sequences. See [http://www.intel.com/products/processor\\_number](http://www.intel.com/products/processor_number) for details. Intel products are not intended for use in medical, life saving, life sustaining, critical control or safety systems, or in nuclear facility applications. All dates and products specified are for planning purposes only and are subject to change without notice.

# Disclaimers (continued)

1. Peak DP FLOPS claim based on calculated theoretical peak double precision performance capability for a single coprocessor.  $16 \text{ DP FLOPS/clock/core} * 60 \text{ cores} * 1.053\text{GHz} = 1.0108 \text{ TeraFlop/s}$ .
2. Memory Bandwidth: 2 socket Intel® Xeon® processor E5-2600 product family server vs. Intel® Xeon Phi™ coprocessor (2.2x: Measured by Intel October 2012. 2 socket E5-2670 (8 core, 2.6GHz) vs. 1 Intel® Xeon Phi™ coprocessor SE10P (61 cores, 1.1GHz) on STREAM Triad benchmark 79.5 GB/s vs. 175GB/s ) (TR 2012B)
3. Performance/Watt: 2 socket Intel® Xeon® processor E5-2670 server vs. a single Intel® Xeon Phi™ coprocessor SE10P (Intel Measured DGEMM perf/watt score 309 GF/s @ 335W vs. 829 GF/s @ 195W) (TR 2028B)