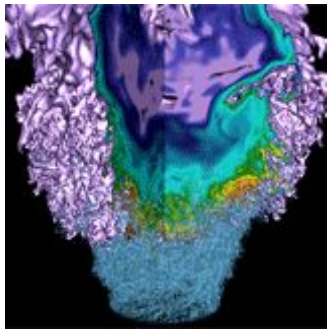
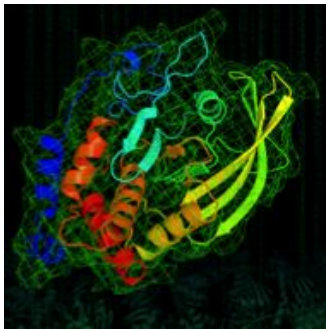
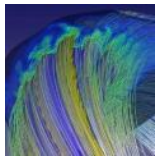
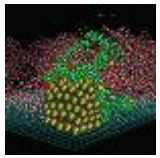
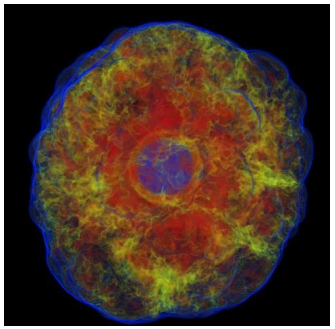
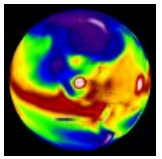
NERSC Users Group Monthly Webinar 12/08/2016

Announcements

Agenda

- Cori status and plans for user access
- Allocations and usage update; plans for charging in 2017
- Intel Xeon Phi (KNL) overview and modes of operation
- Shifter overview and hands-on demo

Cori update and user access plans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Dec 8, 2016

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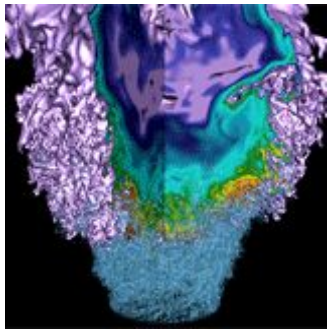
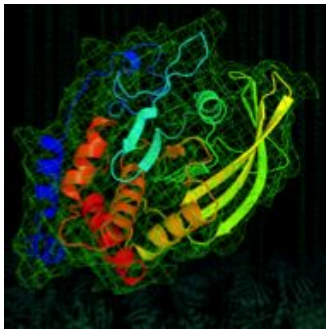
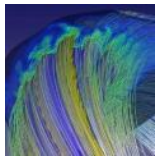
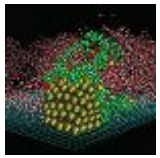
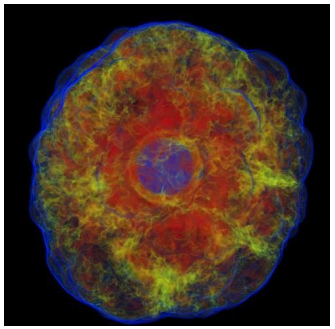
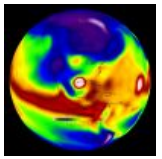
Cori Update

- **Cori Haswell and Xeon Phi (KNL) nodes have been fully integrated into a single system**
- **Haswell nodes are in full production since Oct. 31**
- **NESAP teams are on KNL nodes, testing codes and identifying system issues**
- **KNL nodes testing, debugging is ongoing**
  - 1st of a kind processor and network scale pose complex challenges
  - NERSC and Cray staff working with few breaks while creating innovative solutions on a daily basis. Strong support from Intel and SchedMD (SLURM)
  - Connecting 9,300 KNL nodes to network has caused disruptions that also affect Haswell nodes

Cori KNL: Things Look Good!

- **System is almost in a steady enough state for use by general NERSC users**
- **Users will be added in waves to Cori KNL debug queues to start testing codes**
  - This will likely start within the next few weeks
- **Access to full KNL system will still be restricted to NESAP teams for a number of weeks**
- **Performance on NESAP codes at small scale is exceeding our expectations**
  - Not enough experience yet at large scale to comment

Allocations and usage update; charging plans for 2017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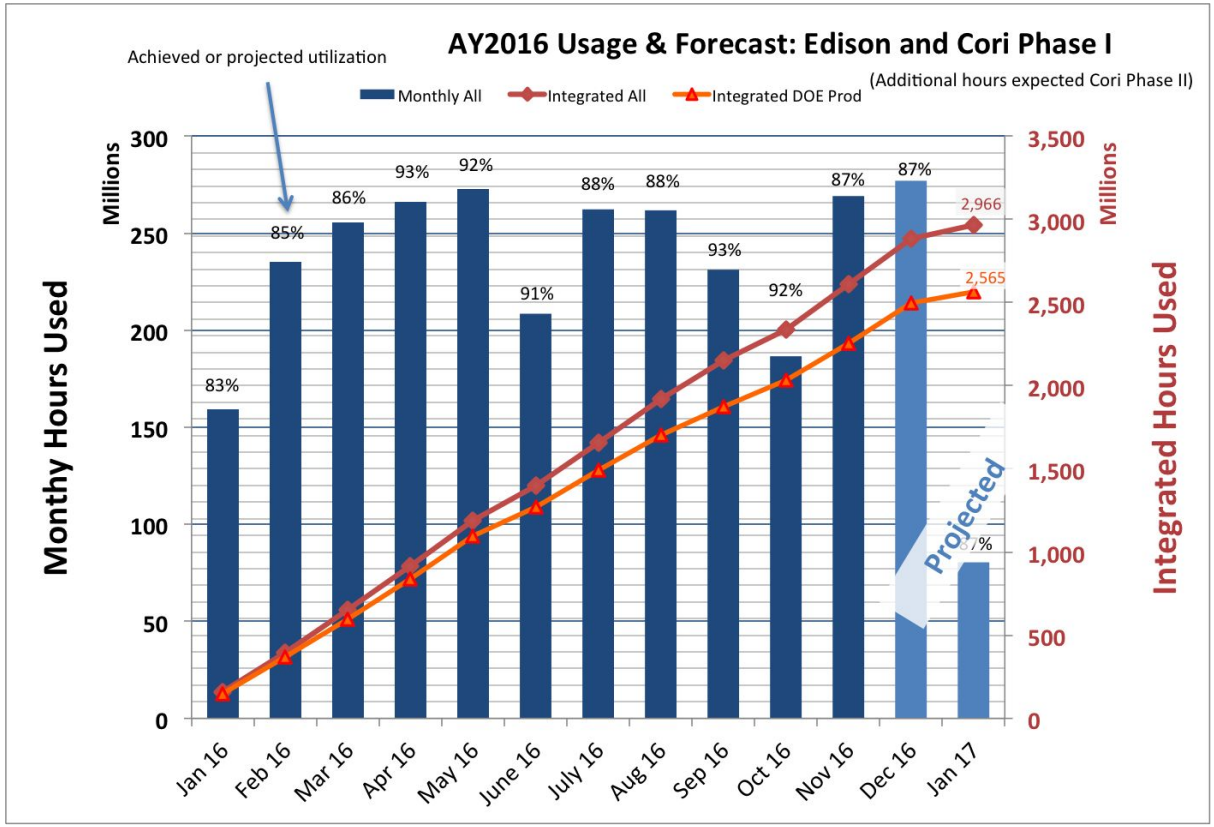
2016 Allocations and Usage

NERSC will once again overdeliver on compute hour commitments to DOE Production and ALCC

DOE Production
Target: 2,477 M Hrs
Pace: 2,565 M Hrs

ALCC
Target: 223 M Hrs
Delivered: 249 M Hrs

Scavenger
Delivered: 78 M Hrs
(3% of total)



We know there is queue pain

Edison

Oct. avg wait: 112 hours

Nov. avg wait: 39 hours

‘Typical’ wait: ~12-18 hours

Cori Haswell

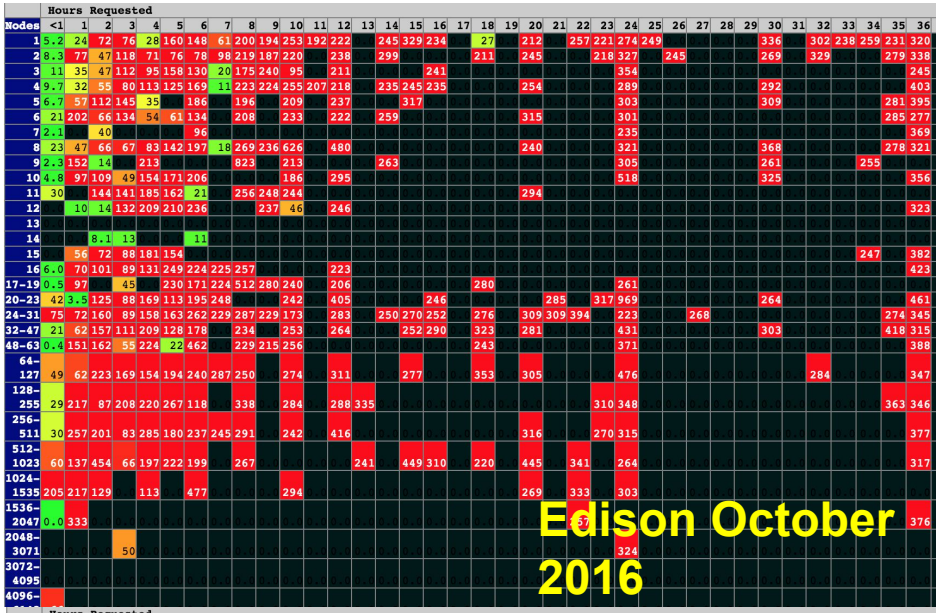
Oct. availability: ~0%

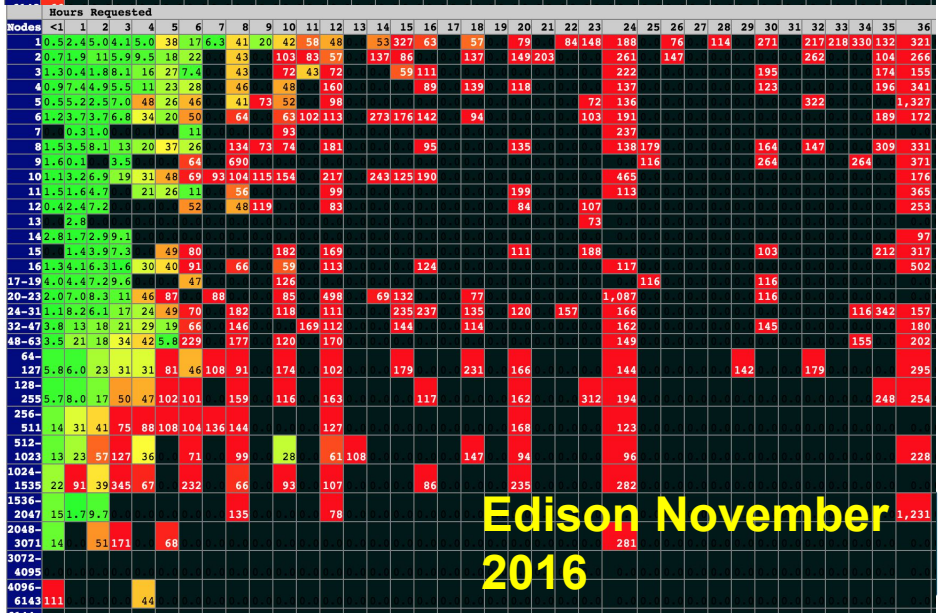
Nov. availability: 84%

Target: 90%

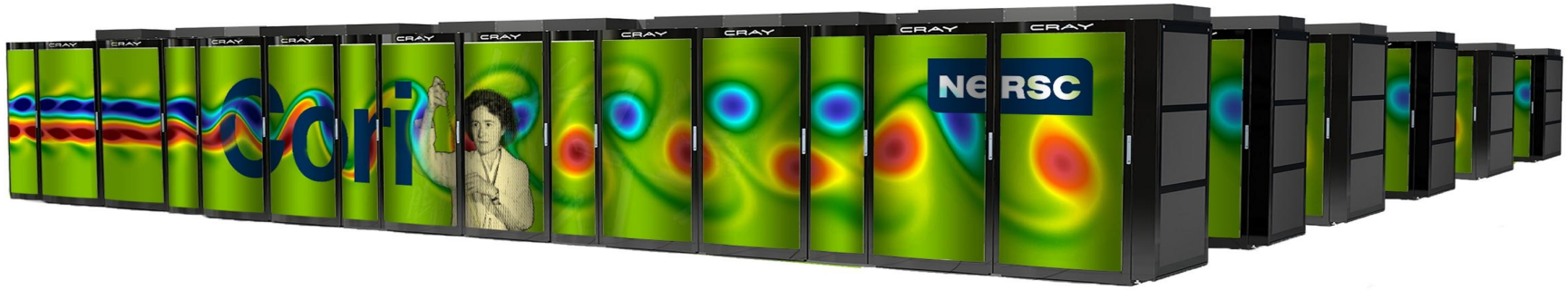
NERSC ‘typical’: 96-99.5%

Queue wait time “heat maps” where each cell is color coded by the average wait time. Hours requested increases across columns and nodes requested increases down rows. Red color indicates a wait time of greater than 36 hours.





NERSC's Response to Demand for Hours



In addition to enabling science at unprecedented scale

- Cori KNL nodes will provide an estimated 4.8 B DOE Prod NERSC Hrs/year
- 2X that provided by Edison and Cori Haswell combined
- 3X overall increase in NERSC hours

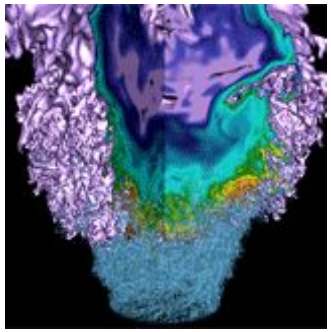
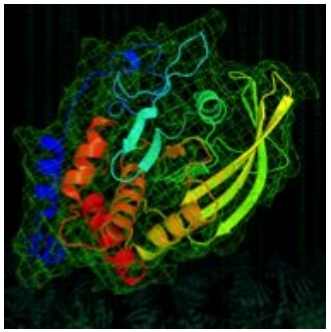
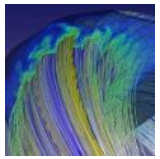
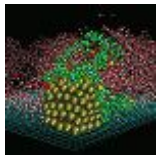
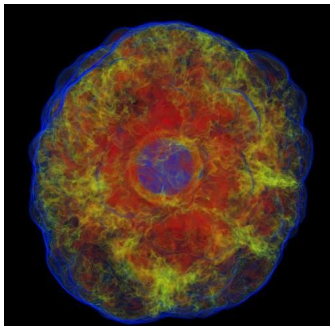
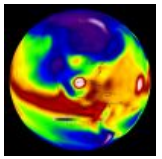
KNL nodes will be "free" through June 30, 2017!

Edison and Cori Haswell will continue to be in full production mode for all of NERSC AY2017.

2017 Allocation Plans

- **2017 allocation decision announcements from DOE program managers scheduled for Friday, Dec. 9**
  - May be delayed if not all received and processed on time
- **2.4 B NERSC hours to be distributed on Dec. 9 for use in AY 2017 (starts Jan. 10, 2017)**
  - Minus reserves held by program managers
- **Additional 2.4 B hours for use on KNL will be distributed in spring 2017**
  - For use in 2017 after KNL charging begins on July 1, 2017
  - DOE program manager decisions will be based on applications' readiness for KNL
  - NERSC will provide process for demonstrating readiness

Preparing for Cori KNL access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Topics

- **How is KNL different to Haswell?**
  - Faster and slower
  - MCDRAM and clustering modes
- **How to compile for KNL**
- **How to submit to KNL nodes**

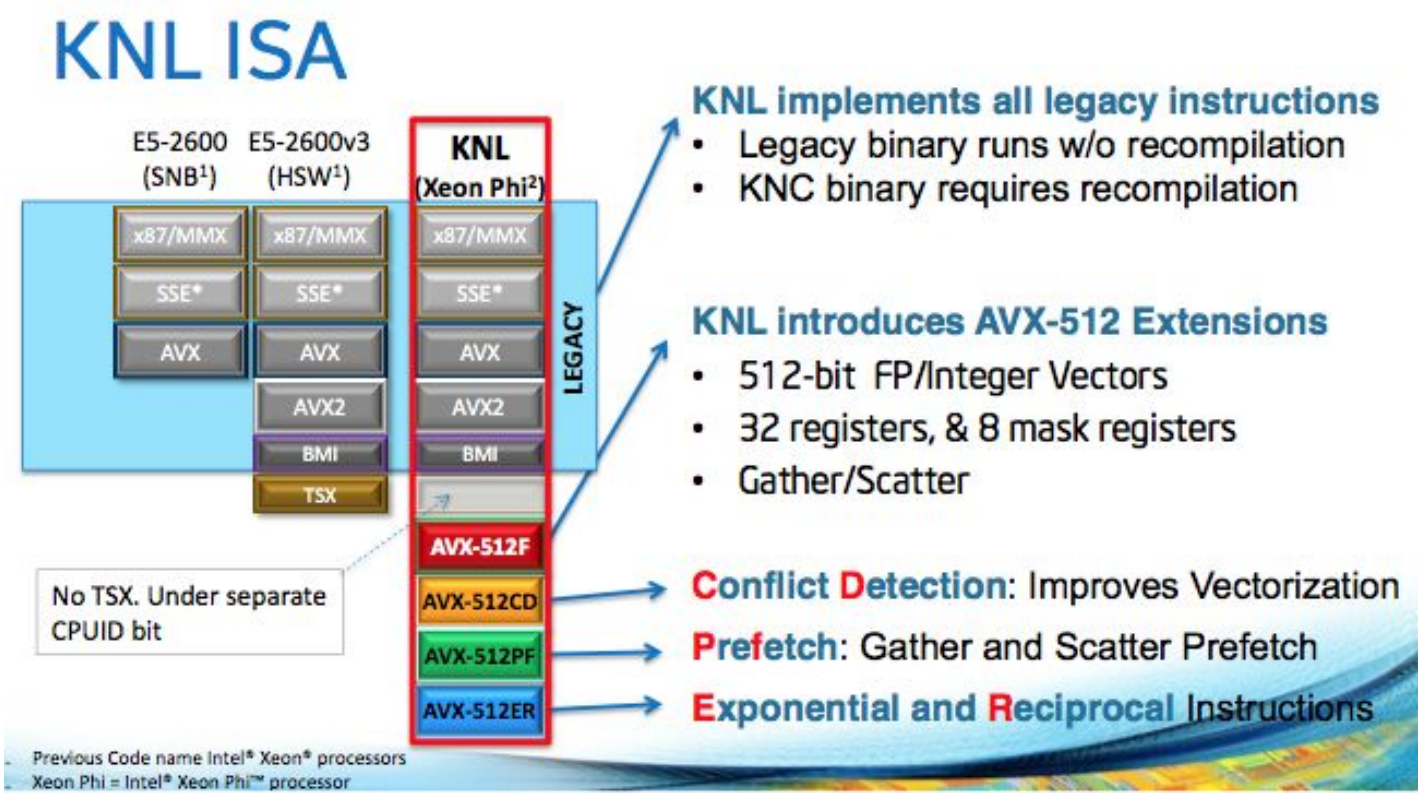
Key Messages

- **Don't Panic!**
  - Using KNL is *mostly* the same as you already use Cori
- **Recompile**
  - `module swap craype-haswell craype-mic-knl`
- **Submit with:**
  - `#SBATCH -C knl,cache,flat`

- **See notes (downloads) at:**
  - http://www.nersc.gov/users/training/events/2016-nesap-workshop-and-hack-a-thon/

KNL vs Haswell

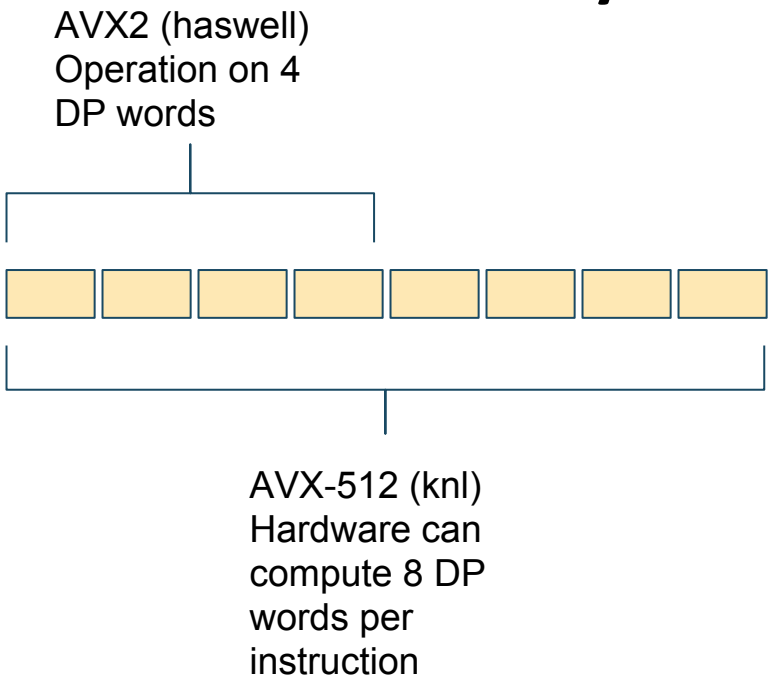
- **KNL can run Haswell executables**



KNL vs Haswell

But ..

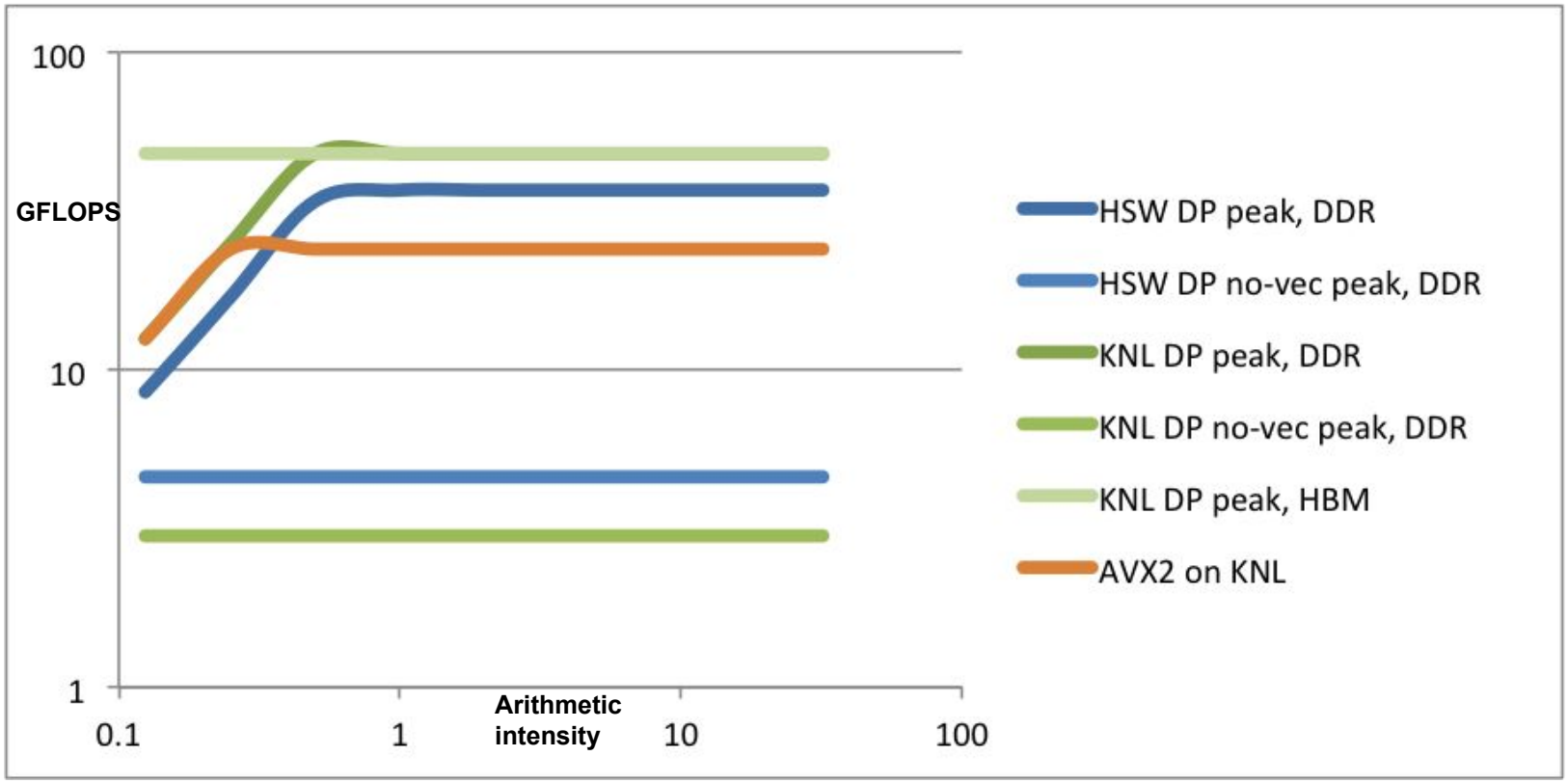
- **Haswell Executables can't fully use KNL hardware**



KNL vs Haswell

And ..

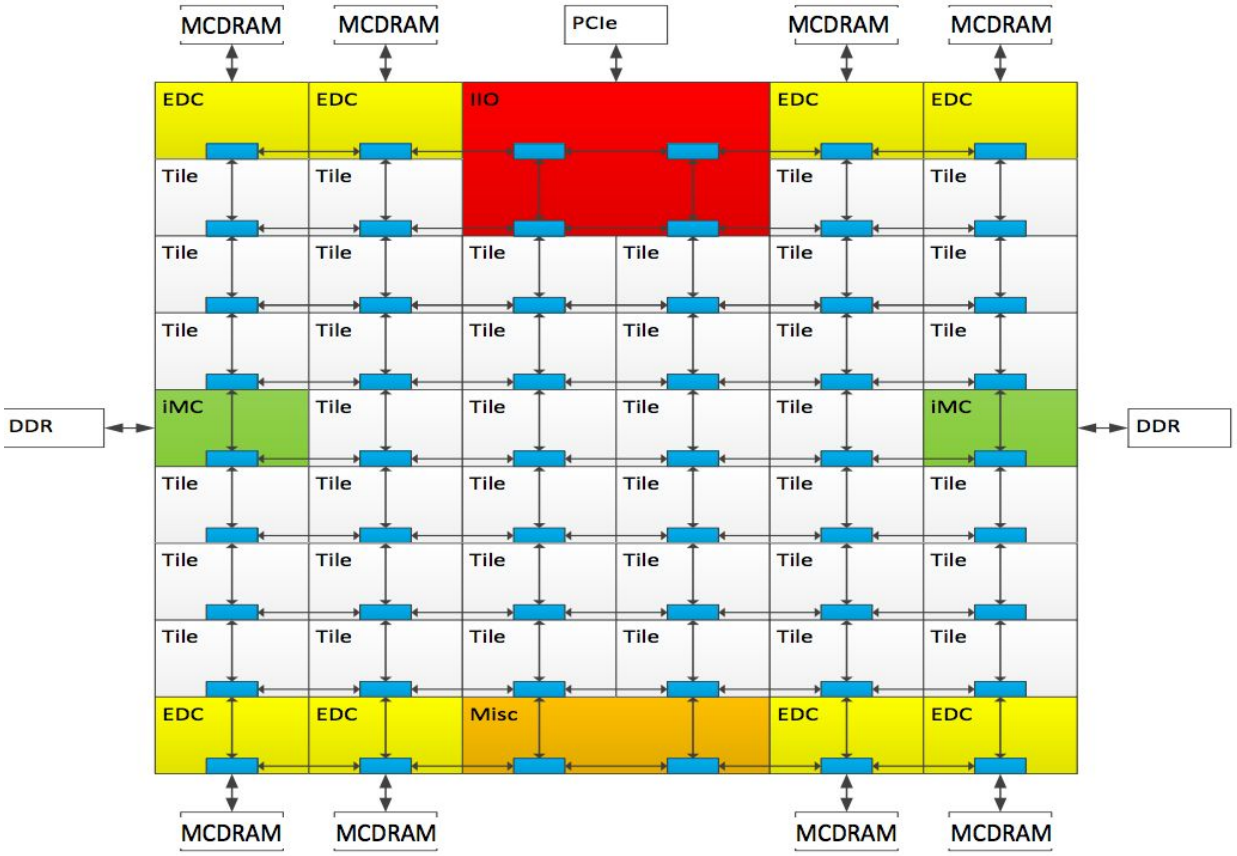
- KNL relies more on vectorization for performance



KNL vs Haswell

And ..

- KNL has a lot more cores (and even more hyperthreads)

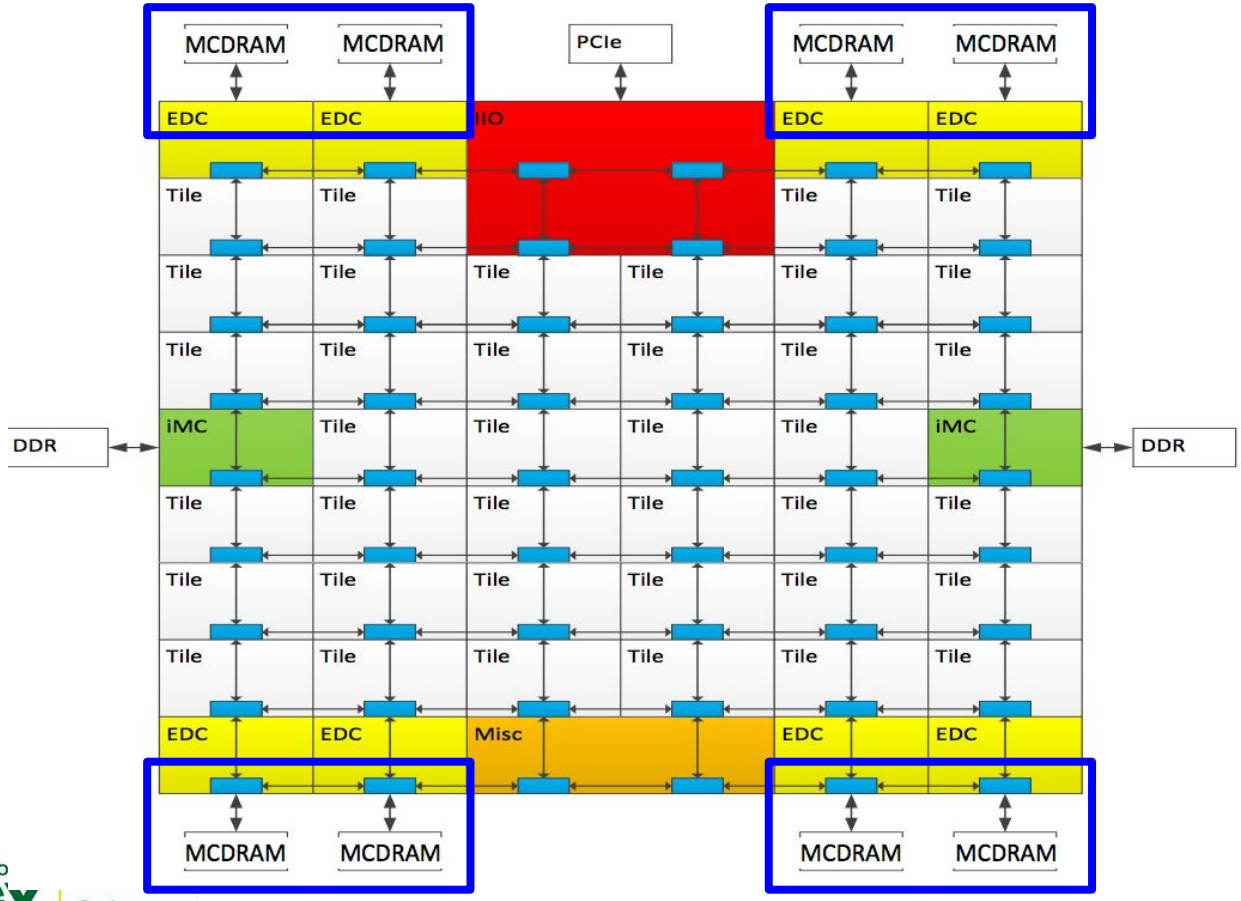


68 cores (2 per tile)
4 threads / core
= 272 threads

KNL vs Haswell

And ..

- **KNL has MCDRAM**



MCDRAM/Clustering Modes

You'll hear a lot about these …

- **Quad, flat, cache, snc, a2a, …**

2 "knobs" to turn

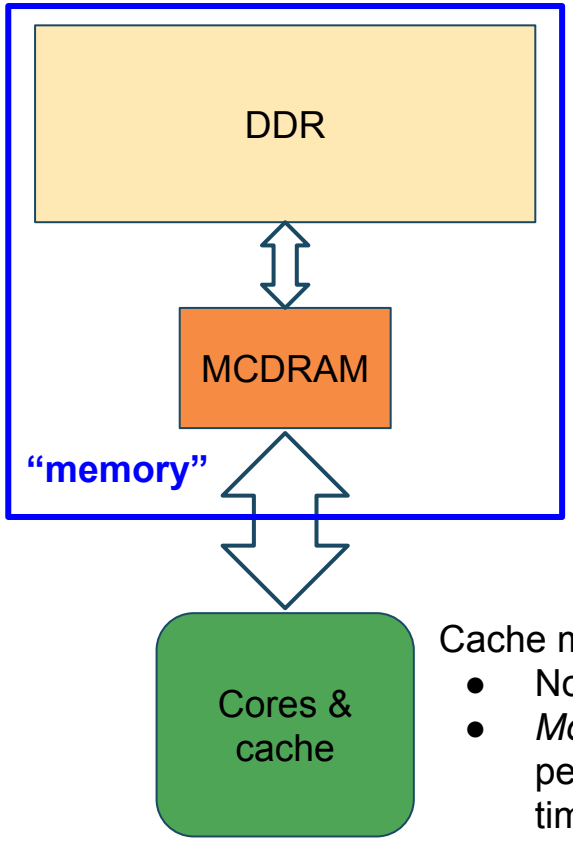
- **MCDRAM mode: "cache", "flat", "hybrid"**
- **Clustering mode: "quad", "snc4", "snc2", …**

MCDRAM in a nutshell

- **16GB on-chip memory**
  - cf 96GB off-chip DDR (Cori)
- **Not (exactly) a cache**
  - Latency similar to DDR
- **But very high bandwidth**
  - ~5x DDR
- **2 ways to use it:**
  - "Cache" mode: invisible to OS, memory pages are cached in MCDRAM (cache-line granularity)
  - "Flat" mode: appears to OS as separate NUMA node, with no local CPUs. Accessible via numactl, libnuma (page granularity)

MCDRAM modes

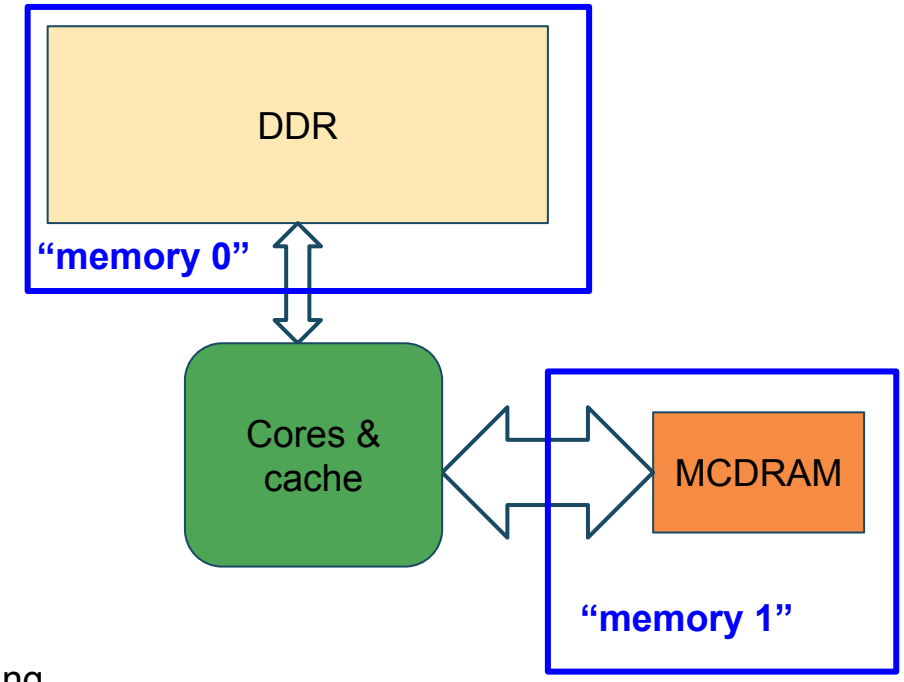
Cache mode



Cache mode:

- No need to do anything
- *Most* of the flat-mode performance, *most* of the time

Flat mode



Flat mode: better achievable performance

- Which memory do I want to use?
- For which arrays?

Hybrid mode: a bit of each

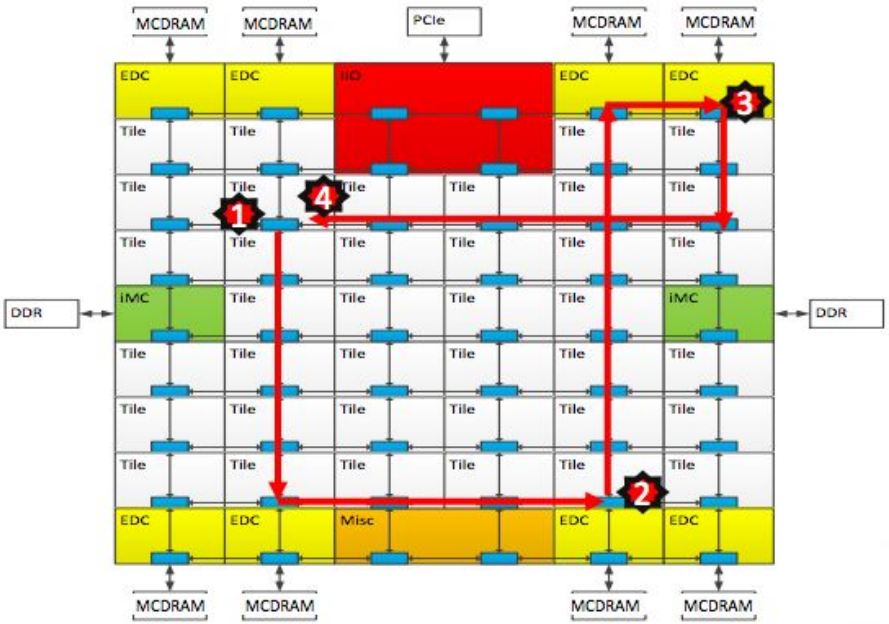
Clustering Modes

Cache coherency

- does another cache hold this memory address?

"Tag directory"

- list of address:cache-id
- Distributed tag directory, each looks after part of the address

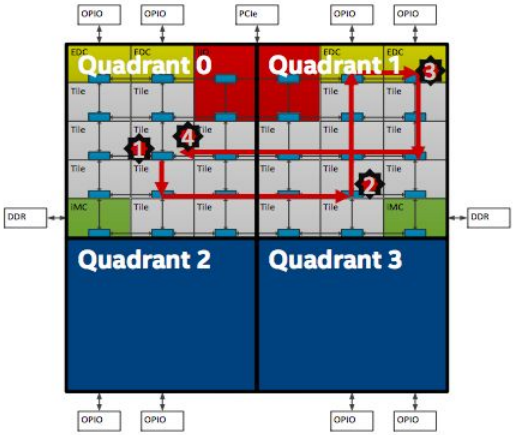


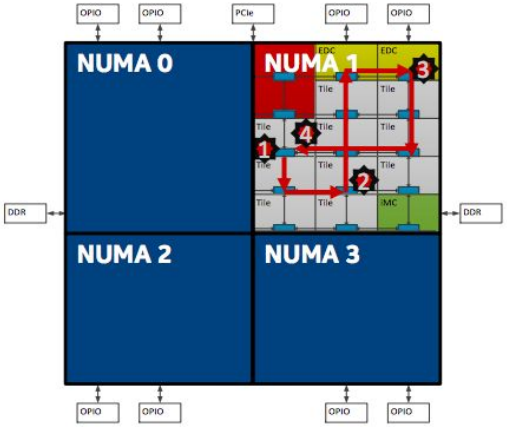
On local cache miss:

- Check tag-directory-part for other-cache-id
- Fetch from other-cache (or memory)
- Takes time! (latency)

Clustering modes

- **Quadrant (“quad”)**
  - distribute tag directories so each manages only memory nearby
  - Invisible to user, but improves memory access latency
- **Sub-NUMA-clustering (“snc4”)**
  - Expose each quadrant and it’s managed memory as a NUMA node
  - Even lower latency, but less flexible
- **We recommend quadrant mode for most users**





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How to compile

Best: Use Cray compiler wrappers

```
module swap craype-haswell craype-mic-knl
```

- **The loaded craype-* module sets the target that the compiler wrappers (cc, CC, ftn) build for**
  - Eg `-mknl` (GNU compiler), `-hmic-knl` (Cray compiler)
- **craype-haswell is default on login nodes**
- **craype-mic-knl is for KNL nodes**

```
10:51 sleak@cori11:~$ module list
Currently Loaded Modulefiles:
  1) modules/3.2.6.7                13) xpmem/0.1-4.5
  2) nsg/1.2.0                      14) job/1.5.5-3.58
  3) modules/3.2.10.4               15) dvs/2.7_0.9.0-2.201
  4) intel/16.0.3.210               16) alps/6.1.3-17.12
  5) craype-network-aries           17) rca/1.0.0-6.21
  6) craype/2.5.5                   18) atp/2.0.2
  7) cray-libsci/16.06.1            19) PrgEnv-intel/6.0.3
  8) udreg/2.3.2-4.6                20) craype-haswell
  9) ugni/6.0.12-2.1                21) cray-shmem/7.4.0
 10) pmi/5.0.10-1.0000.11050.0.0.ari 22) cray-mpich/7.4.0
 11) dmapp/7.1.0-12.37              23) altd/2.0
 12) gni-headers/5.0.7-3.1
```

```
10:51 sleak@cori11:~$ module avail craype

----------------------- /opt/cray/pe/craype/2.5.5/modulefiles ----
craype-accel-host      craype-hugepages256M  craype-intel-knc
craype-accel-nvidia20  craype-hugepages2M    craype-ivybridge
craype-accel-nvidia35  craype-hugepages32M   craype-mic-knl
craype-broadwell       craype-hugepages4M    craype-network-aries
craype-haswell         craype-hugepages512M  craype-network-none
craype-hugepages128M   craype-hugepages64M   craype-sandybridge
craype-hugepages16M    craype-hugepages8M
```

Topics

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How to run on KNL

#SBATCH -C knl,quad,cache

- **Tells Slurm you want to run on this type of node**
- **If insufficient nodes in that configuration, will reboot some to change mode**
  - This takes time!
- **Which modes are there now?**
- **`sinfo -p knl --format="%15b %8D %A"`**
- **See notes (doanloads) at:**
  - http://www.nersc.gov/users/training/events/2016-nesap-workshop-and-hack-a-thon/
  - (affinity etc)

Key Messages

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  - Using KNL is *mostly* the same as you already use Cori
- **Recompile**
  - `module swap craype-haswell craype-mic-knl`
- **Submit with:**
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