NERSC: the Mission HPC Facility for DOE Office of Science Research

Largest funder of physical science research in the U.S.

Bio Energy, Environment

Computing

Materials, Chemistry, Geophysics

Particle Physics, Astrophysics

Nuclear Physics

Fusion Energy, Plasma Physics

6,000 users, 700 projects, 700 codes, 48 states, 40 countries, universities & national labs
NERSC supports the broad mission needs of the six DOE Office of Science program offices.

6,000 users and 750 projects

Supercomputing and data users

NERSC science engagement team provides outreach and POCs

2,000 refereed publications in 2016
High Performance Computing (HPC) at NERSC is …

… the application of "supercomputers" and big data systems to computational and data problems that are too large for standard computers, would take them too long, would be too dangerous, or probe inaccessible realms.

- Cheap & Efficient Solar & Wind Energy
- Affordable Water Desalination
- Extreme Climate Events
- Protein structure & function
- New Biofuels
- Better Batteries
- The Universe & Fundamental Laws of Physics
Production High Performance Computing Systems

**Cori**

- 9,300 Intel Xeon Phi “KNL” manycore nodes
- 2,000 Intel Xeon “Haswell” nodes
- 700,000 processor cores, 1.2 PB memory
- Cray XC40 / Aries Dragonfly interconnect
- 30 PB Lustre Cray Sonexion scratch FS
- 1.5 PB Burst Buffer

#6 on list of Top 500 supercomputers in the world

**Edison**

- 5,560 Ivy Bridge Nodes / 24 cores/node
- 133 K cores, 64 GB memory/node
- Cray XC30 / Aries Dragonfly interconnect
- 6 PB Lustre Cray Sonexion scratch FS
A Supercomputer is ...

... not so different from a super high-end desktop computer.

Or rather, a lot of super high-end desktop computers.

Cori has 11,000 “nodes” (each ~a powerful high-end desktop)

700,000 compute cores
~$30 \times 10^{15}$ calculations/second
7 billion people on 4 million Earths doing 1 calculation each second = 1 Cori
Custom Powerful Network

The nodes are all connected to each other with a high speed, low latency network.

This is what allows the nodes to “talk” to each other and work together to solve problems you could never solve on your laptop or even 150,000 laptops.

**Typical point-to-point bandwidth**
Supercomputer: 10 GBytes/sec
Your home: 0.02* GBytes/sec

**Latency**
Supercomputer: 1 µs
Your home computer: 20,000* µs

* If you’re really lucky

Cloud systems have slower networks
How big is 26 PBs?

338 years of HD video

½ the entire written works of mankind ever, in all languages

PBs of fast storage for files and data
Cori: 26 PB
Your laptop: 0.0005 PB
Your iPhone: 0.00005 PB

Write data to permanent storage
Edison: 140 GB/sec
My iMac: 0.01 GB/sec

Cloud systems have slower I/O and less permanent storage

45,000 X

14,000 X

HPSS tape library: 100 PB
NERSC at a Glance

A U.S. Department of Energy Office of Science User Facility
Provides High Performance Computing and Data Systems and Services
Unclassified Basic and Applied Research in Energy-Related Fields
6,000 users, 750 different scientific projects
Located at Lawrence Berkeley National Lab, Berkeley, CA
Permanent Staff of about 70