Argonne NATIONAL LABORATORY

Distributed Science, Data Deluge, and SaaS

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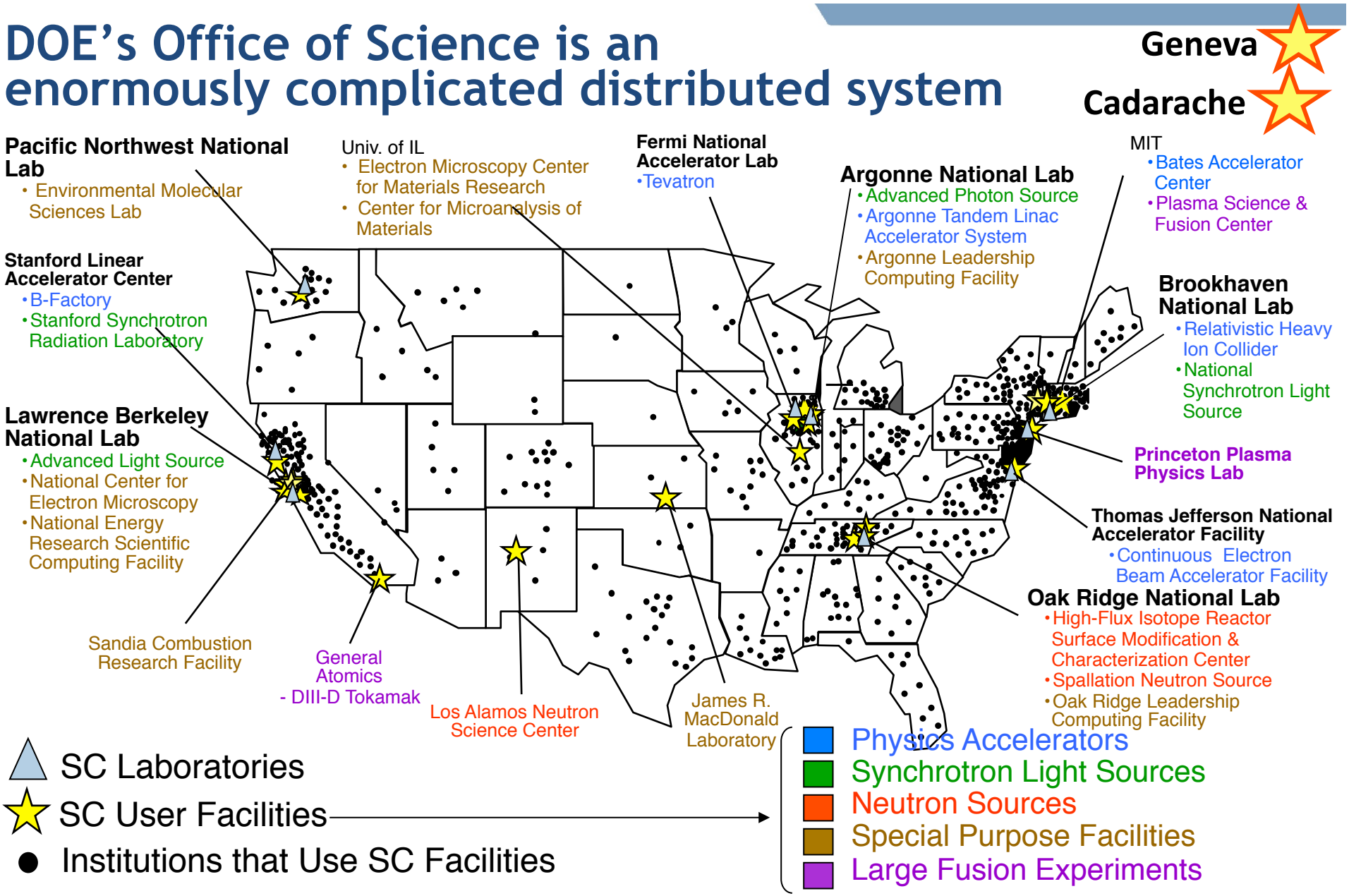
U.S. DEPARTMENT OF ENERGY

DOE's Office of Science is an enormously complicated distributed system

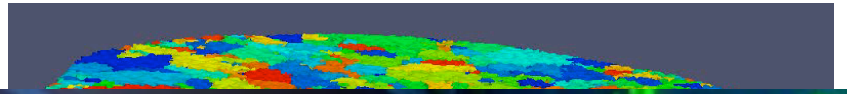


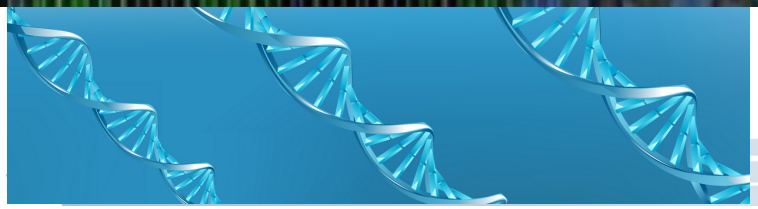
$5B/yr supports **26,000** investigators at **300** academic institutions and all DOE laboratories; **27,000** researchers use scientific user facilities

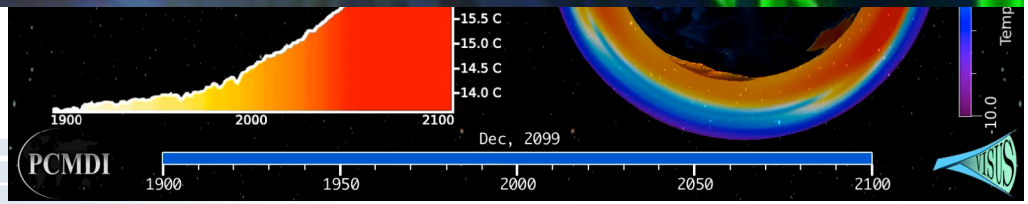
Data Deluge

Cosmology

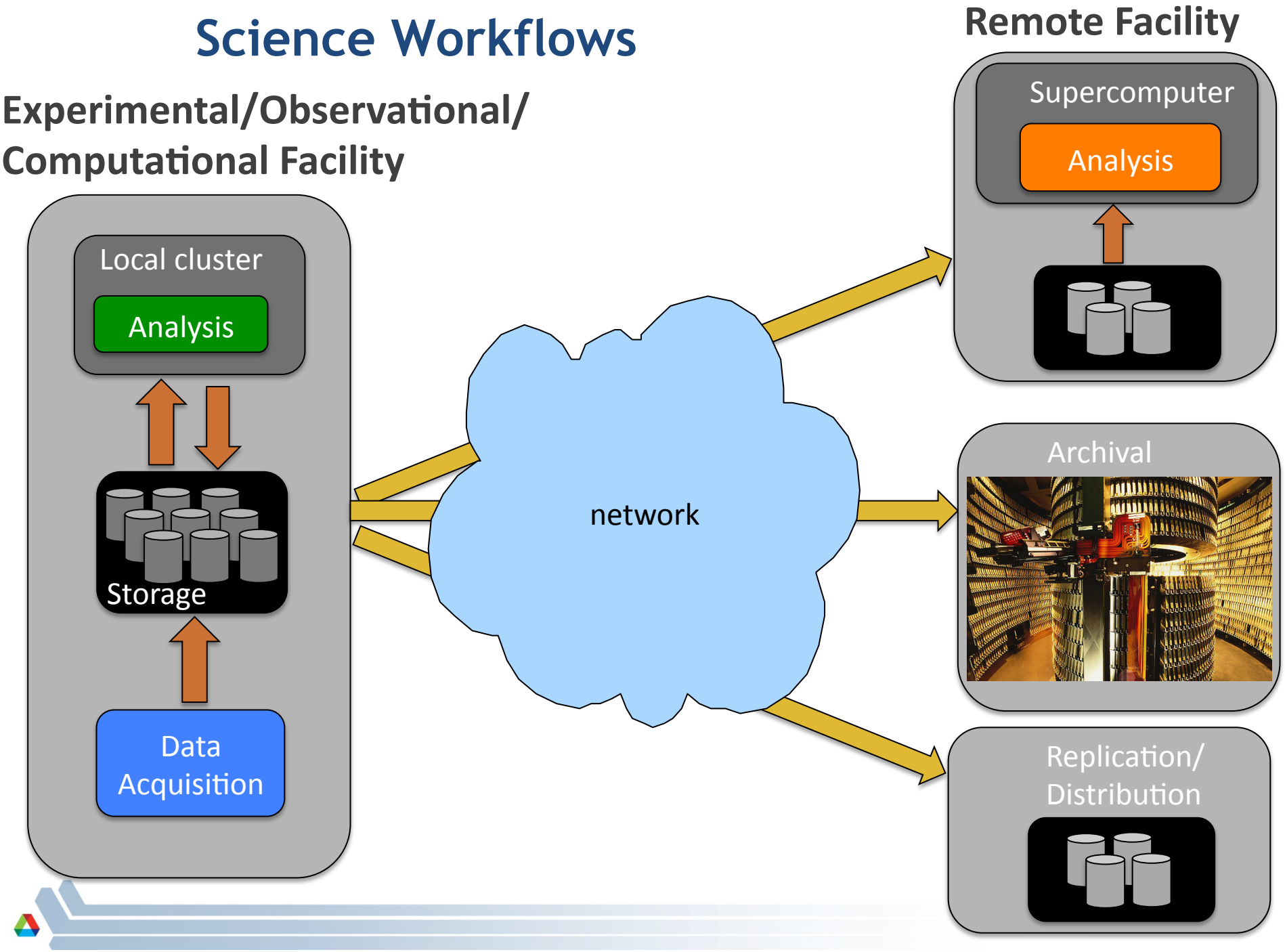
Light Source Facilities



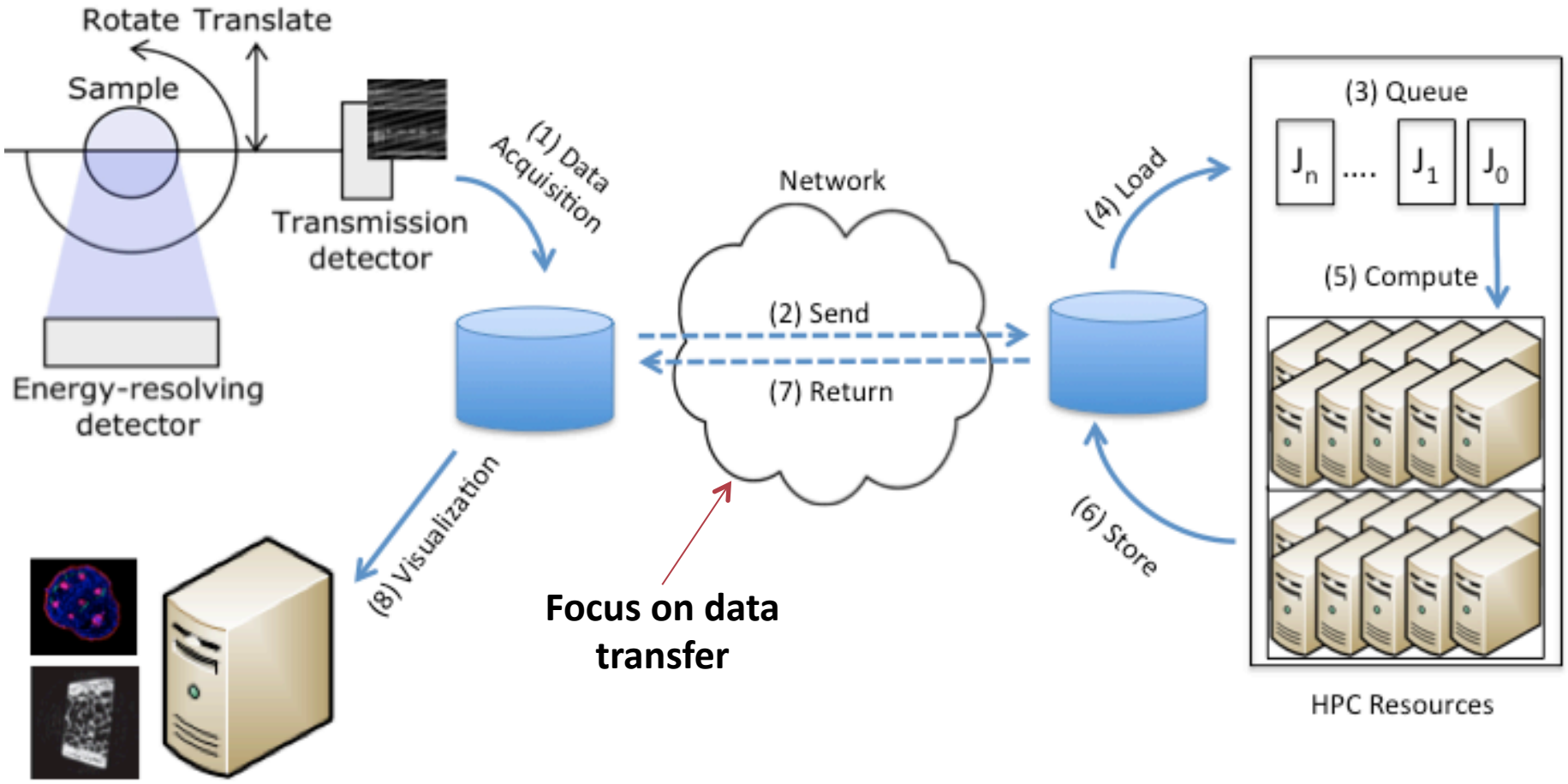




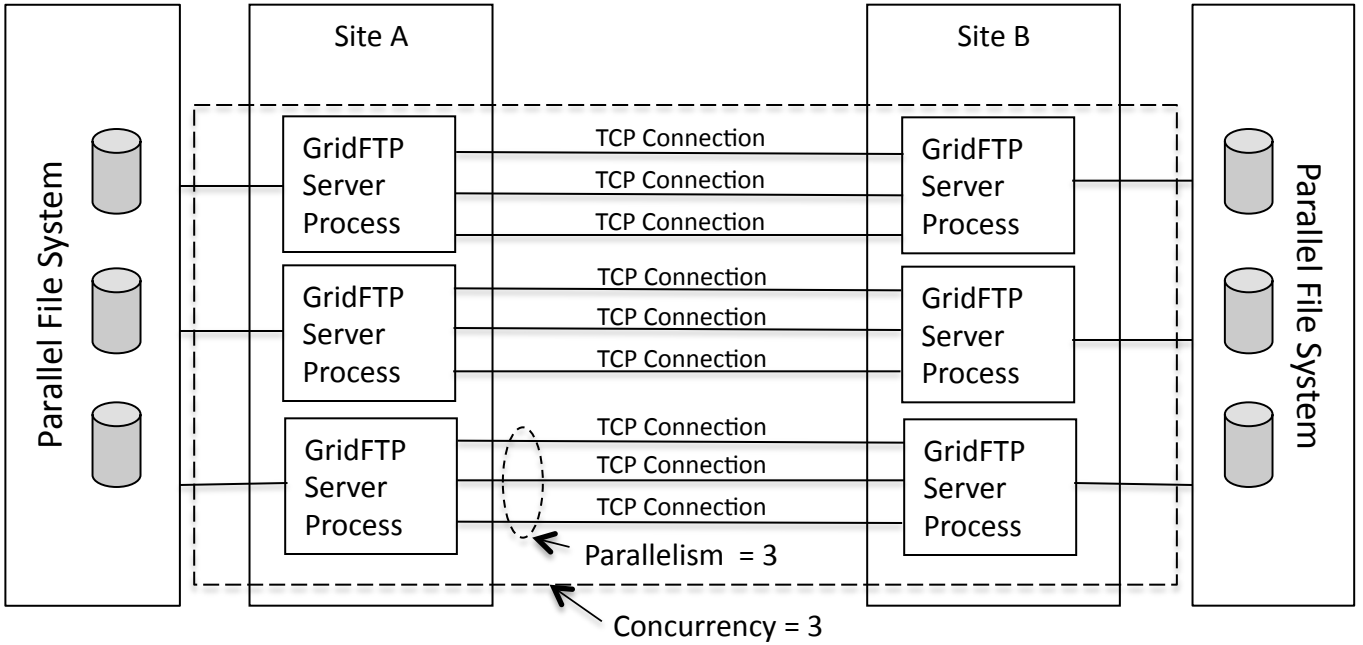
Science Workflows



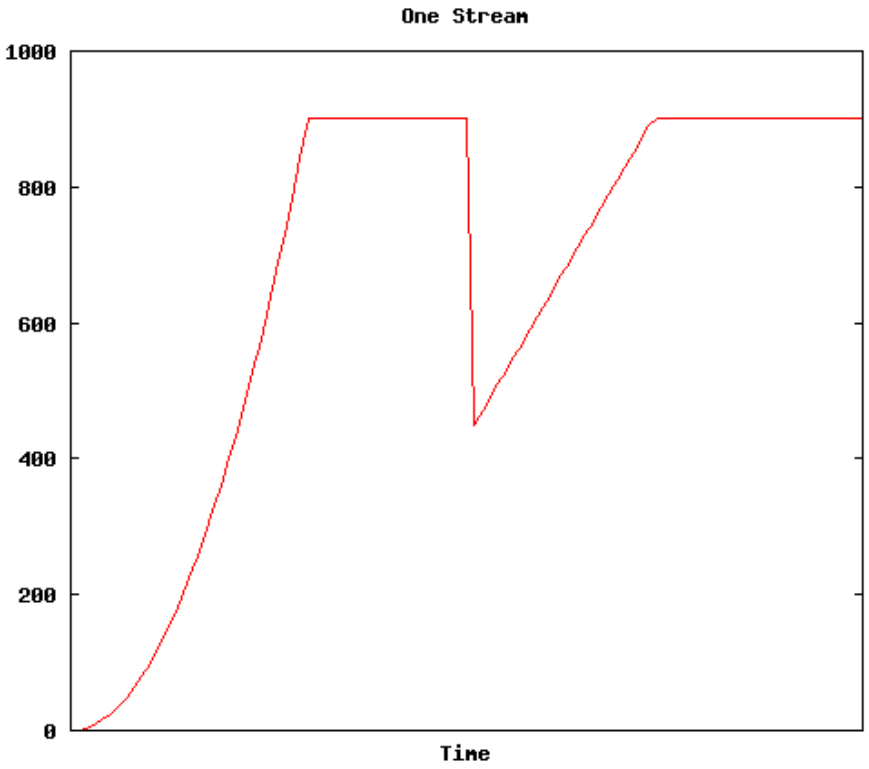
Science workflow - current

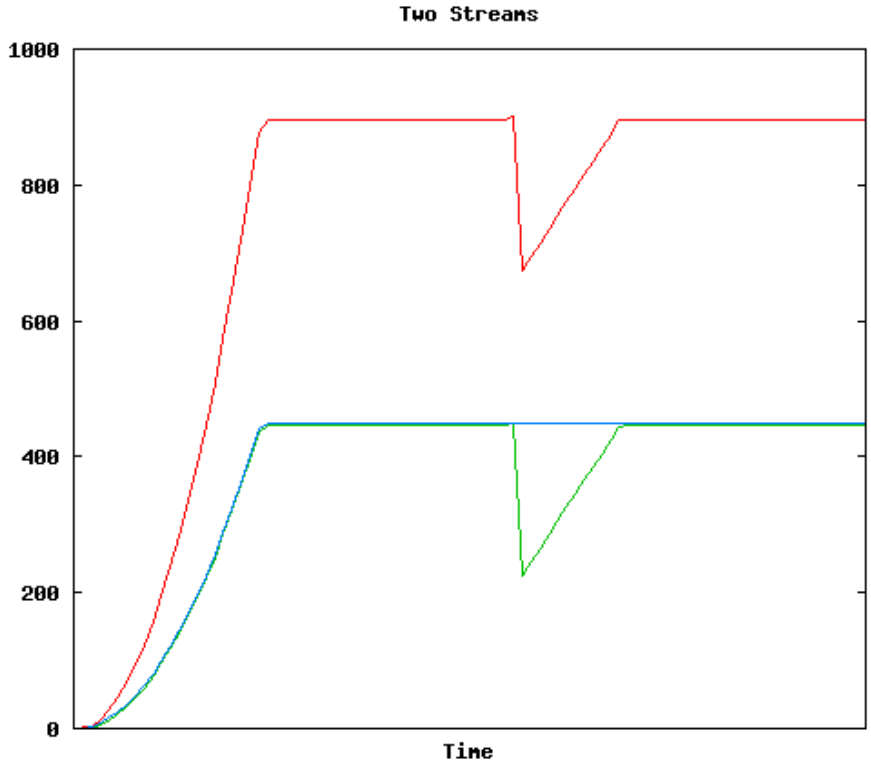


GridFTP – parallelism, concurrency, and multi-node data movement

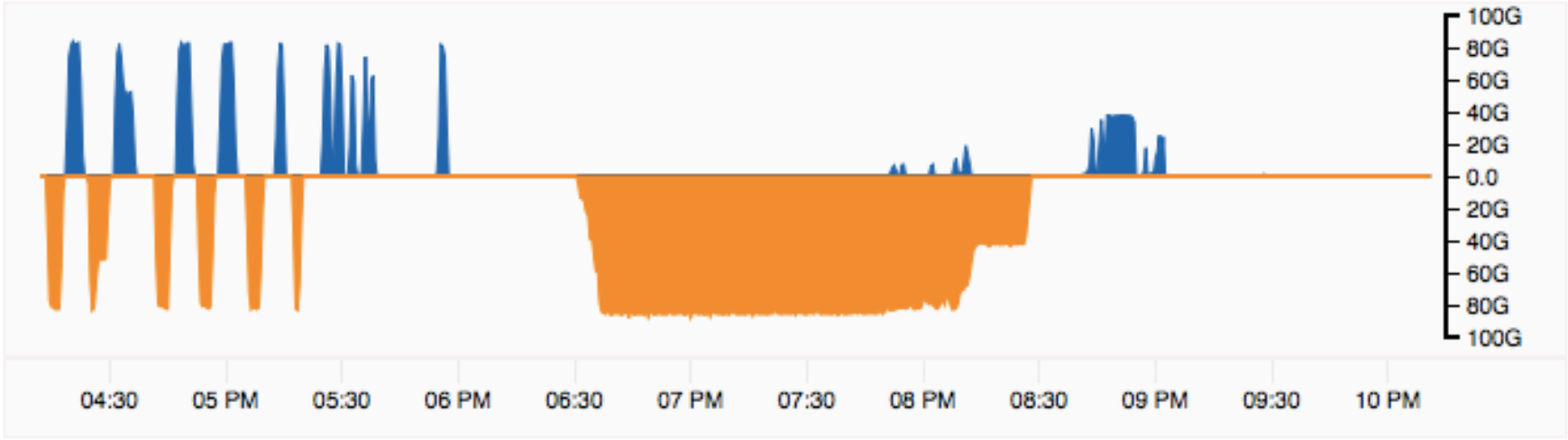


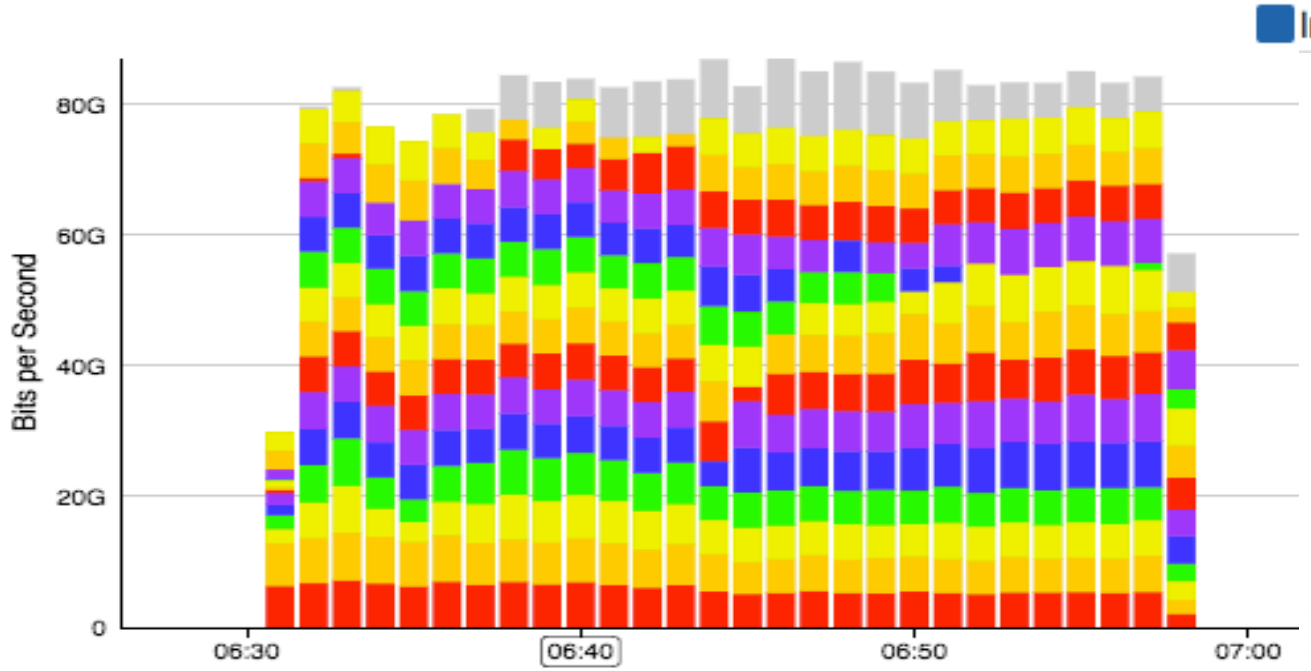
Parallel TCP streams





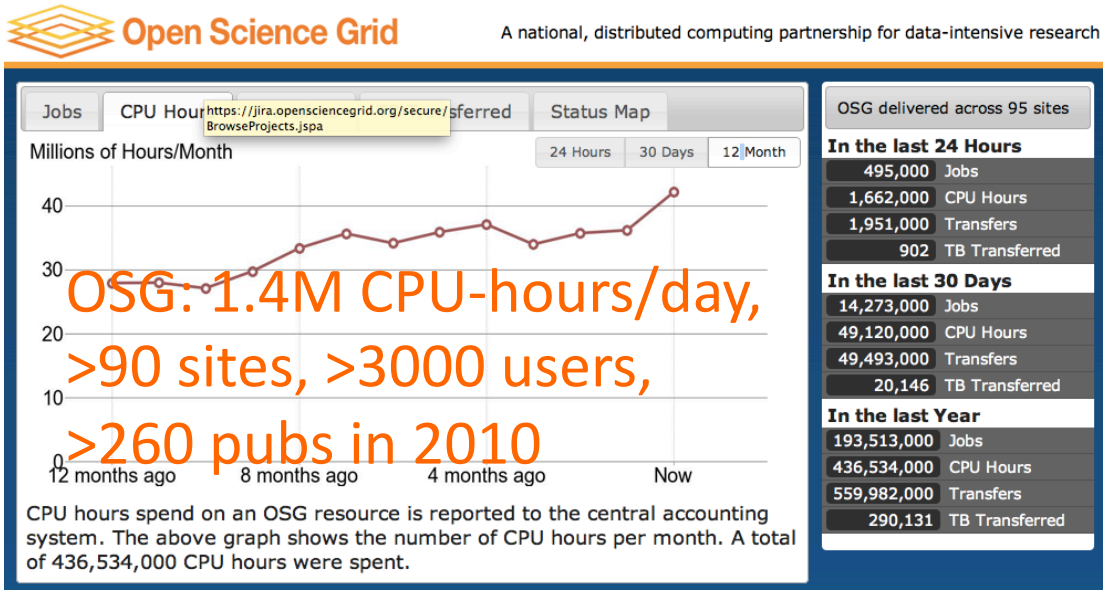
85 Gbps Sustained Disk-to-Disk over 100 Gbps Network, Ottawa—New Orleans





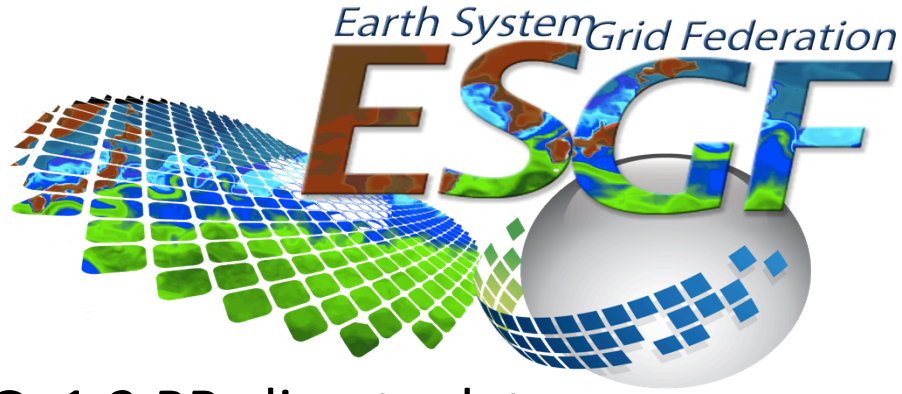
GridFTP underpins many science projects & facilities

LIGO: 1 PB data in last science run, distributed worldwide



OSG: 1.4M CPU-hours/day, >90 sites, >3000 users, >260 pubs in 2010

Robust production solutions
Substantial teams and expense
Sustained, multi-year effort
Application-specific solutions, built on common technology



ESG: 1.2 PB climate data delivered to 23,000 users; 600+ pubs

All build on GridFTP and other Globus Toolkit software

Small science struggling

More data, more complex data

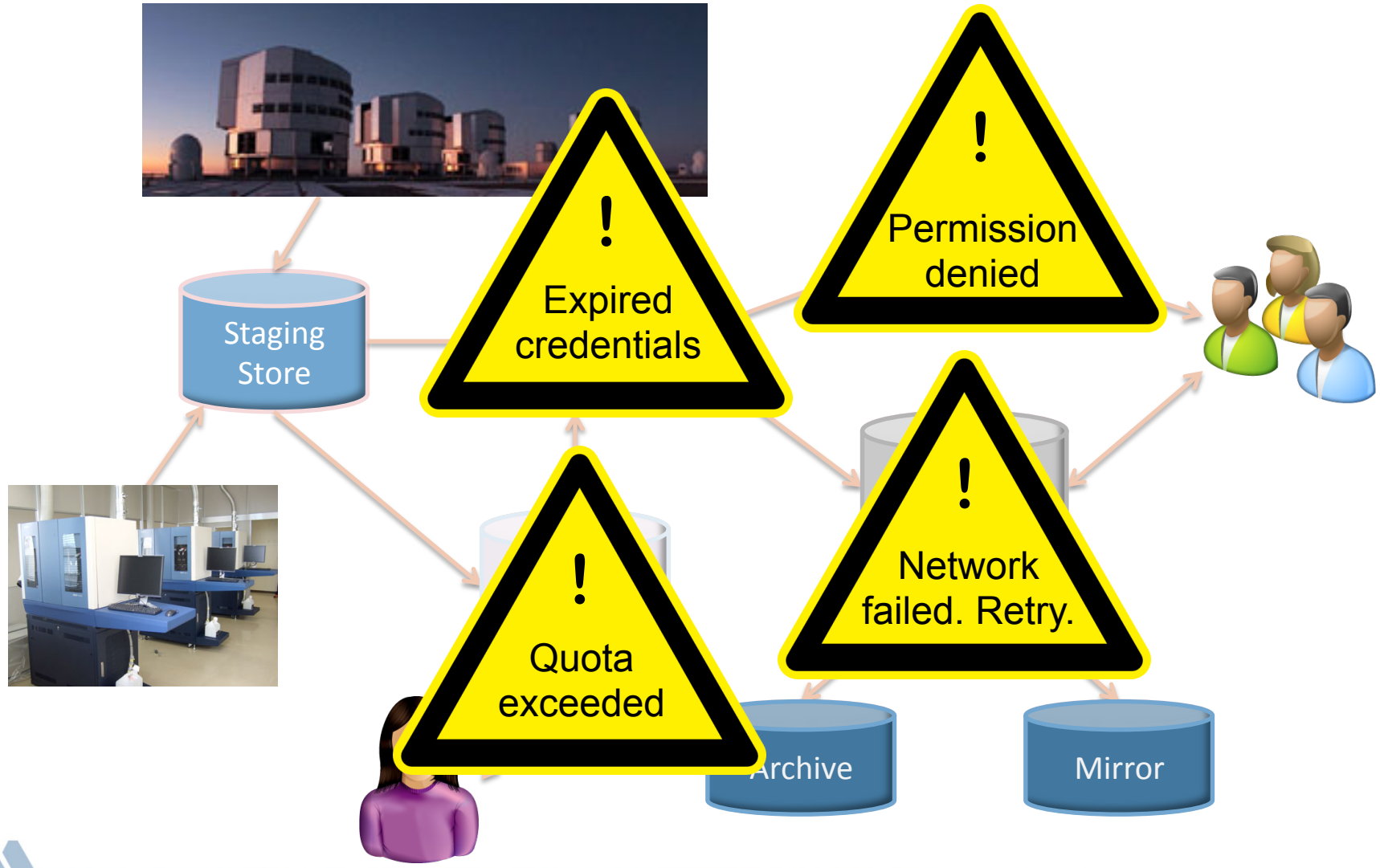
Ad-hoc solutions

Inadequate software, hardware

Poor performance

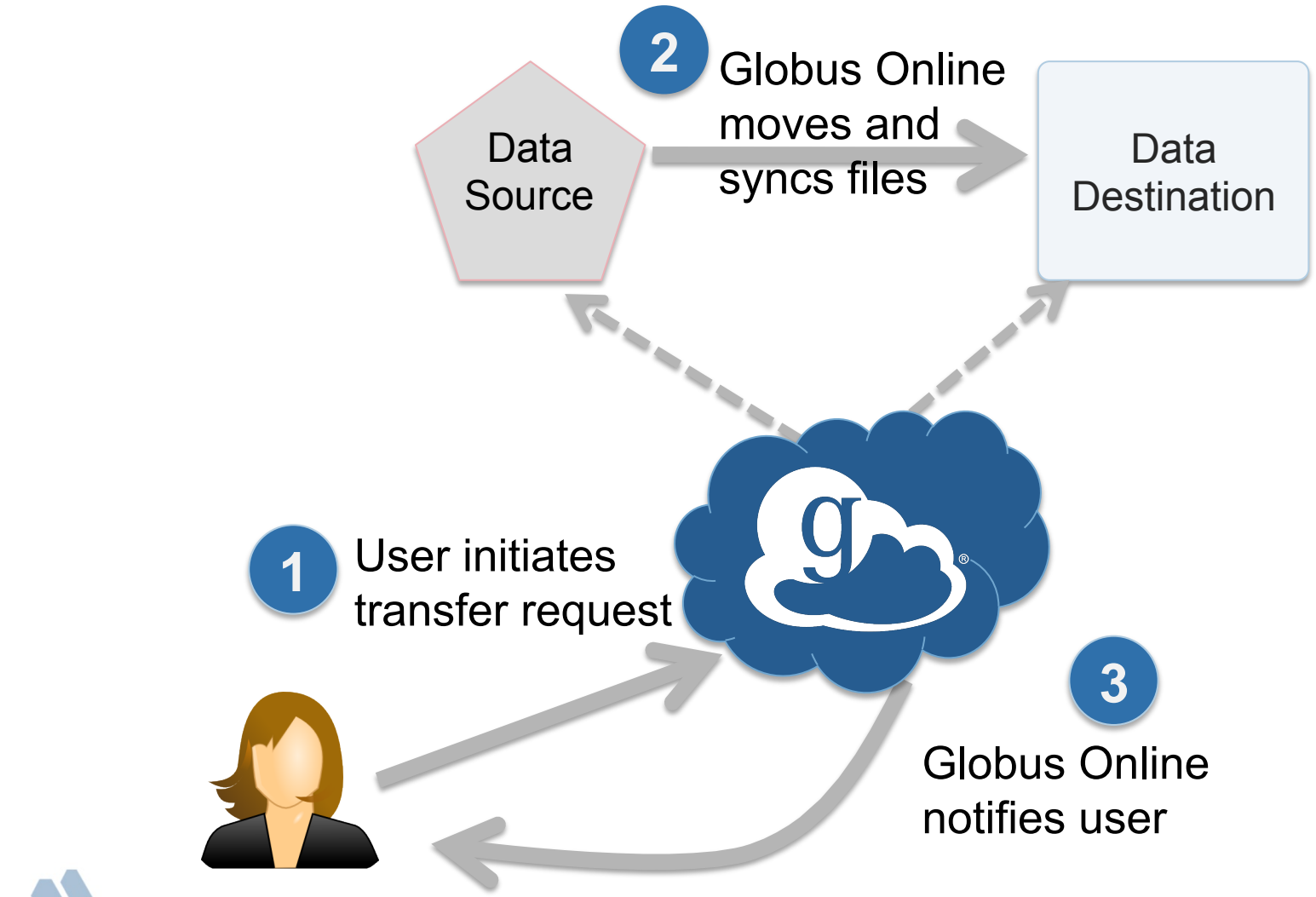
Moving data should be easy …

…but it's hard and frustrating



SaaS

Globus Online



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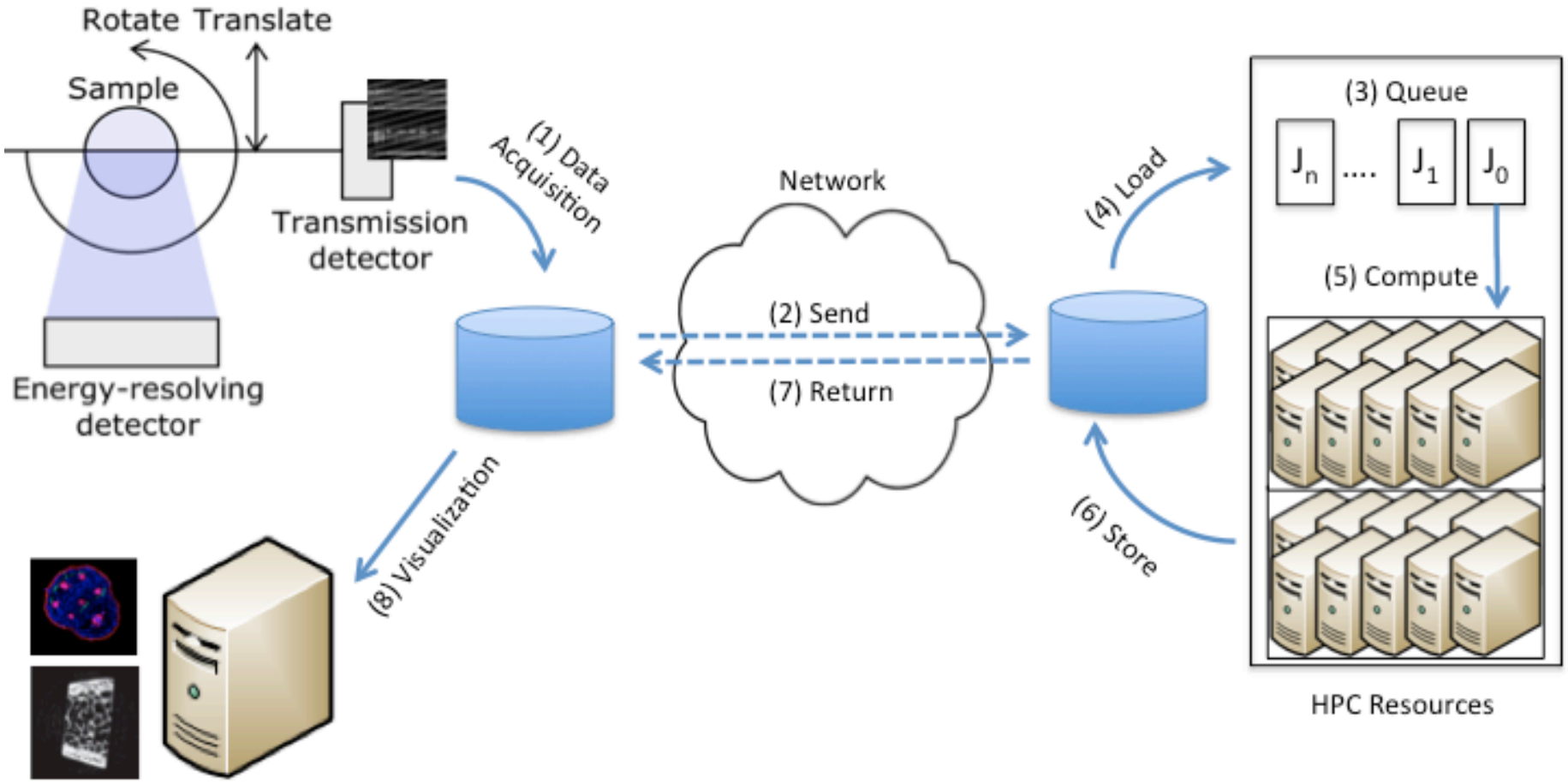
Globus by the numbers

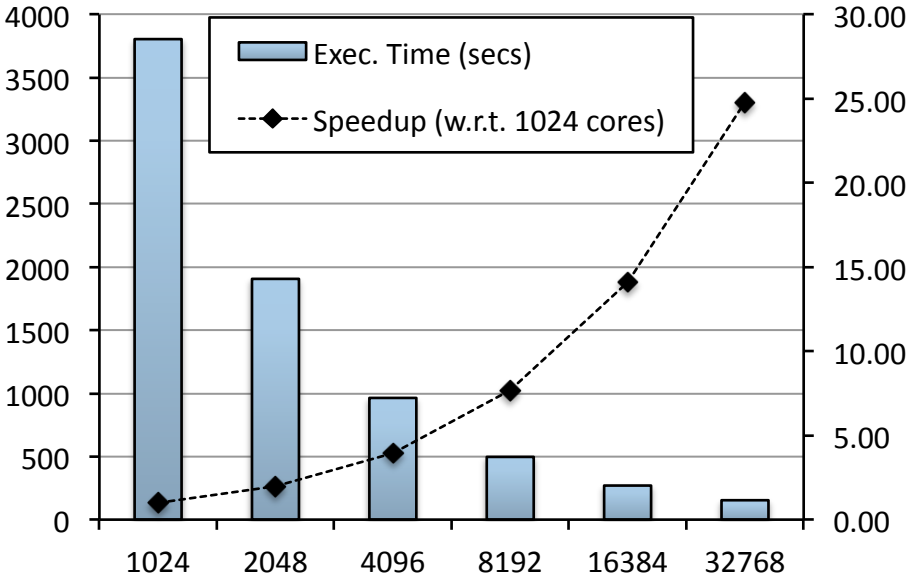
4 major services	**175 PB** transferred	**30 billion** files processed	**43,000** registered users
13 national labs use Globus	**2,500** active endpoints	**450+** active daily users	**99.9%** uptime
35+ institutional subscribers	**1 PB** largest single transfer to date	**3 months** longest continuously managed transfer	**130** federated campus identities

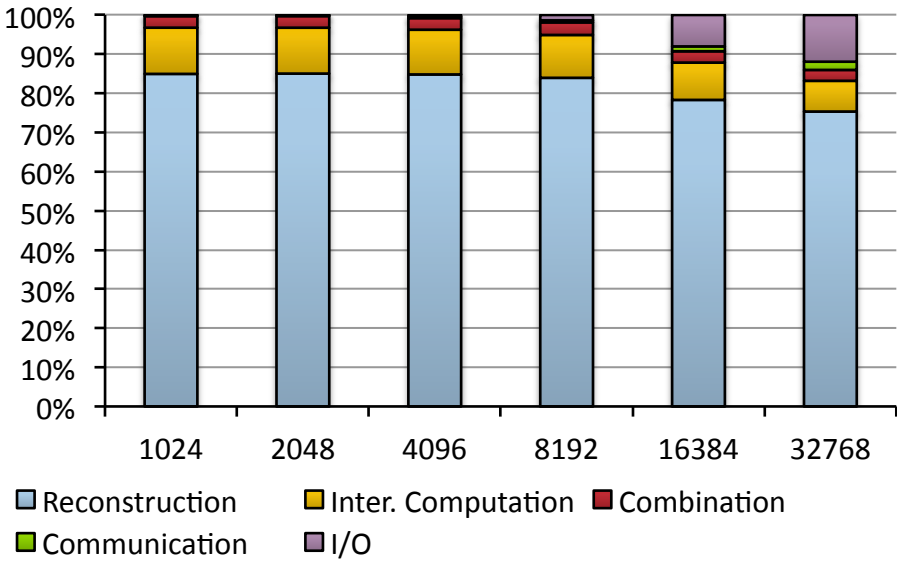
Research challenges

Science workflow - current

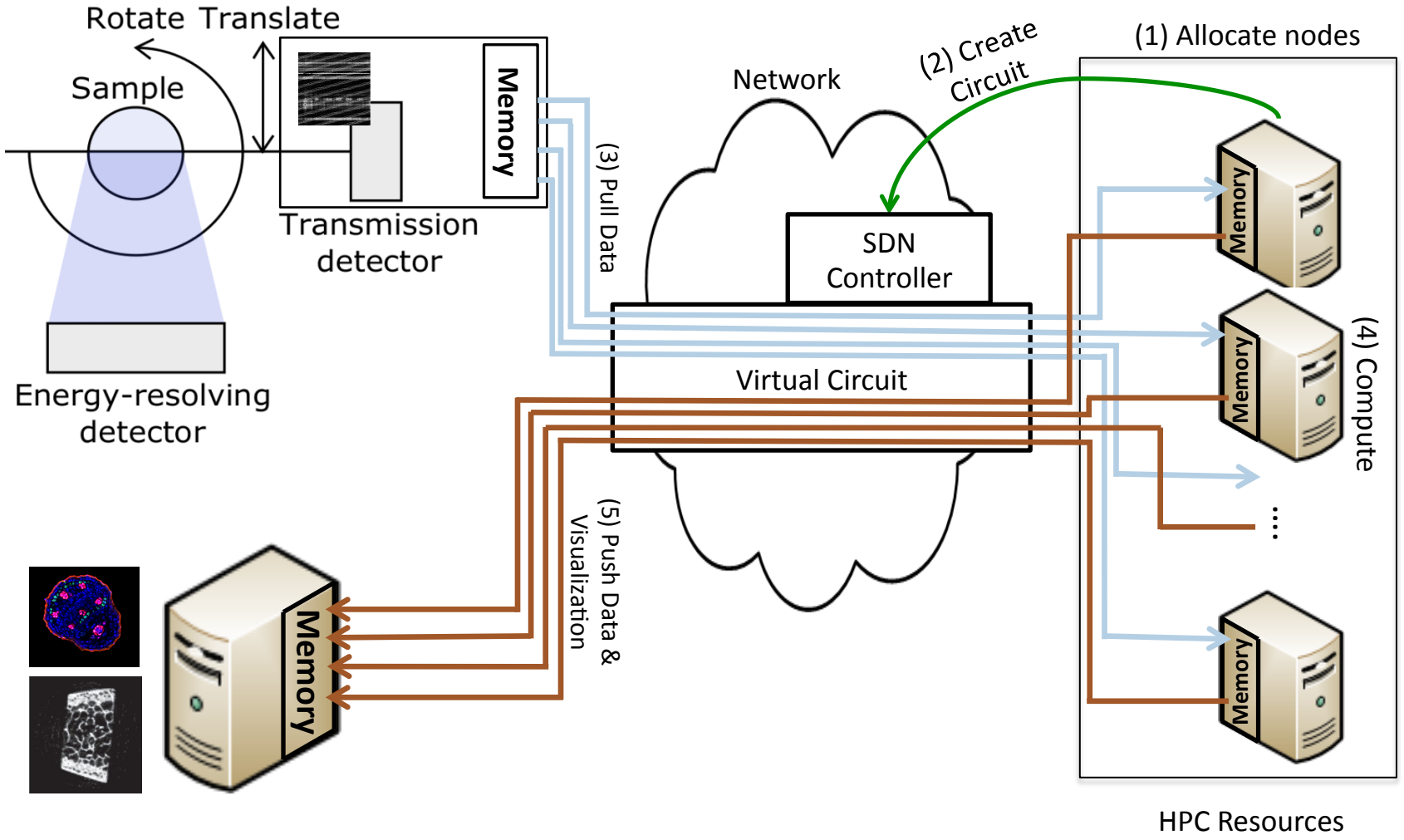


Iterative tomographic reconstruction





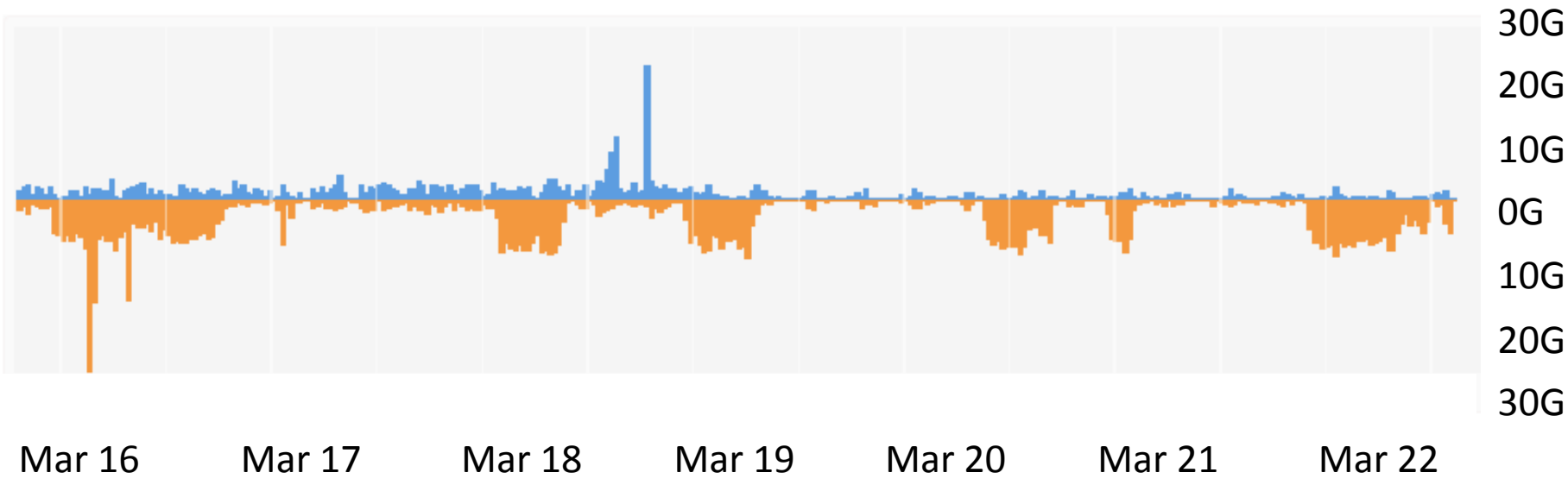
Science workflow - future



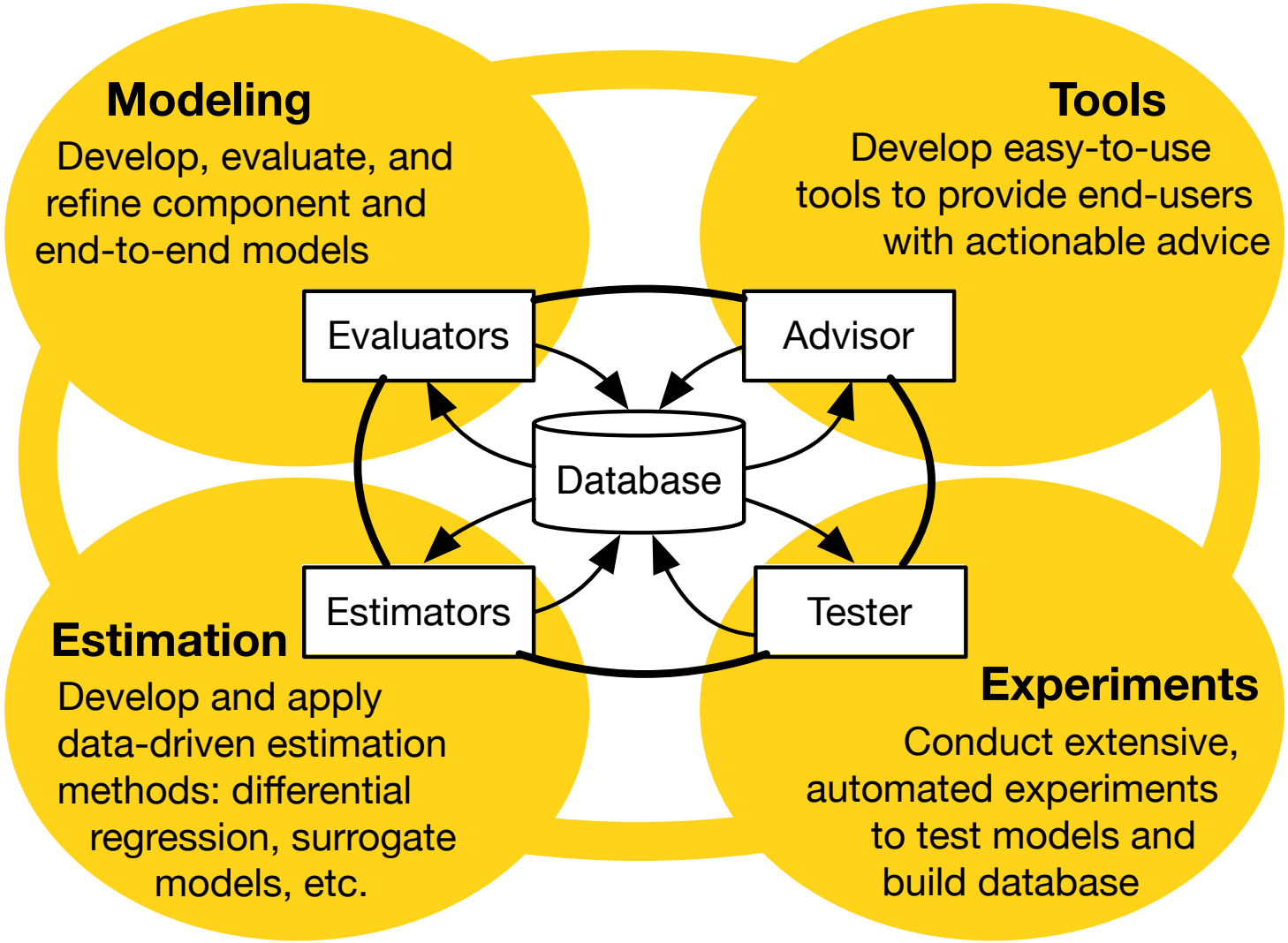
On-demand computing in supercomputers

- Real-time queue?
  - Higher charge rate
  - NERSC has modest number of nodes allocated
- Steal resources that service the batch queue?
  - Preempt batch jobs
  - Low-priority queues?
    - Lower charge rate
- How to keep the average utilization of the system high?
  - Bursty real-time loads
- Checkpointing
  - User or system?
  - Restart overhead

Peak vs. average network utilization



Robust Analytical Models for Science at Extreme Scale (RAMSES) project



Questions