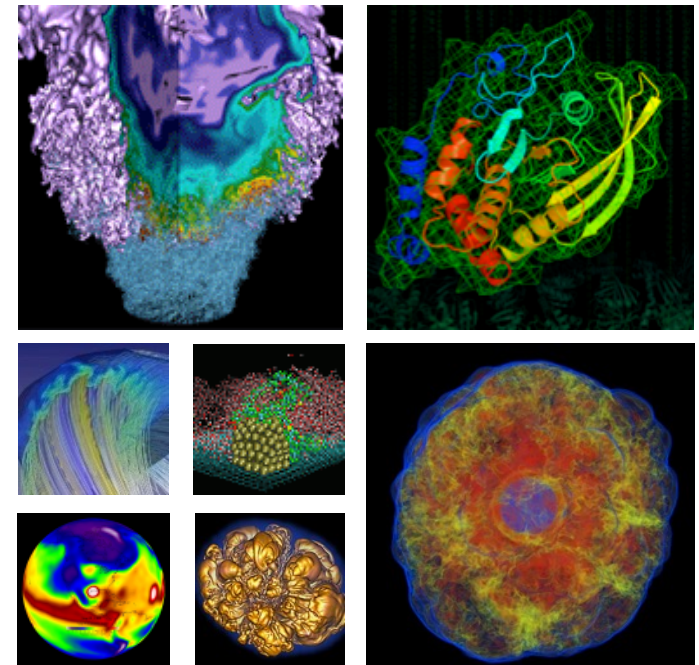


Simplifying data management through storage system design



Glenn K. Lockwood, Ph.D.
Advanced Technologies Group

May 1, 2019

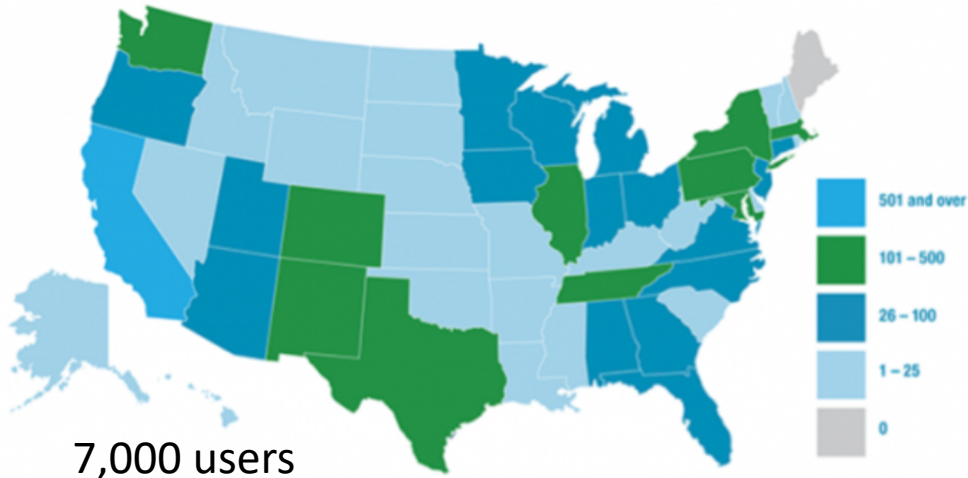
What are our issues and challenges around data storage?
(deletion/retention policy and practice, cost, duplication,
hot/cold storage, types of storage)

- I. Storage architecture has gotten *very* complicated**
- II. NERSC wants to deploy systems that accelerate scientific discovery by simplifying data management through innovations in system *hardware* and *software***
- III. We need to *manage complexity* to simplify user interfaces**

NERSC: the mission HPC facility

for the U.S. Department of Energy Office of Science

NERSC



7,000 users

800 projects

700 applications

2,000 publications per year

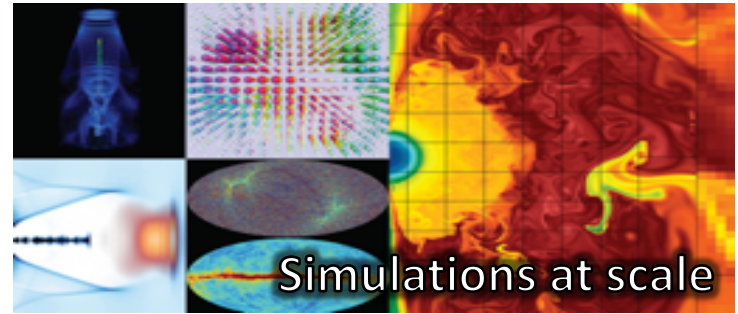
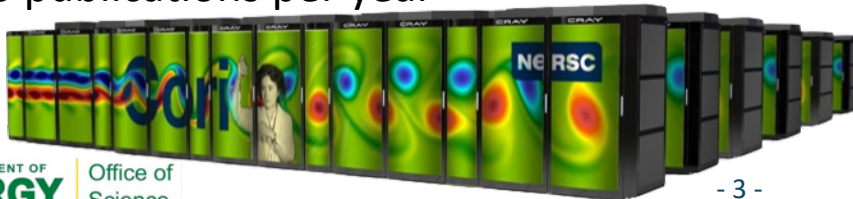


Photo credit: CAMERA



NERSC's dual mission

Advance science and advance the state-of-the-art in supercomputing

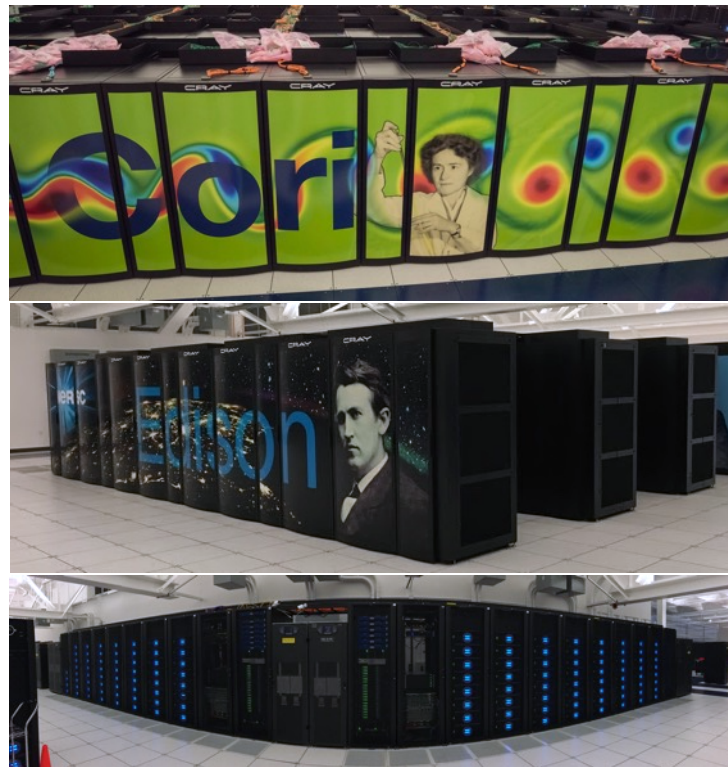


Advancing Science

- Provide a productive computing environment for science applications
 - software/programming environment
 - advanced app/system performance expertise
- Tightly couple with workflows of DOE's experimental and observational facilities

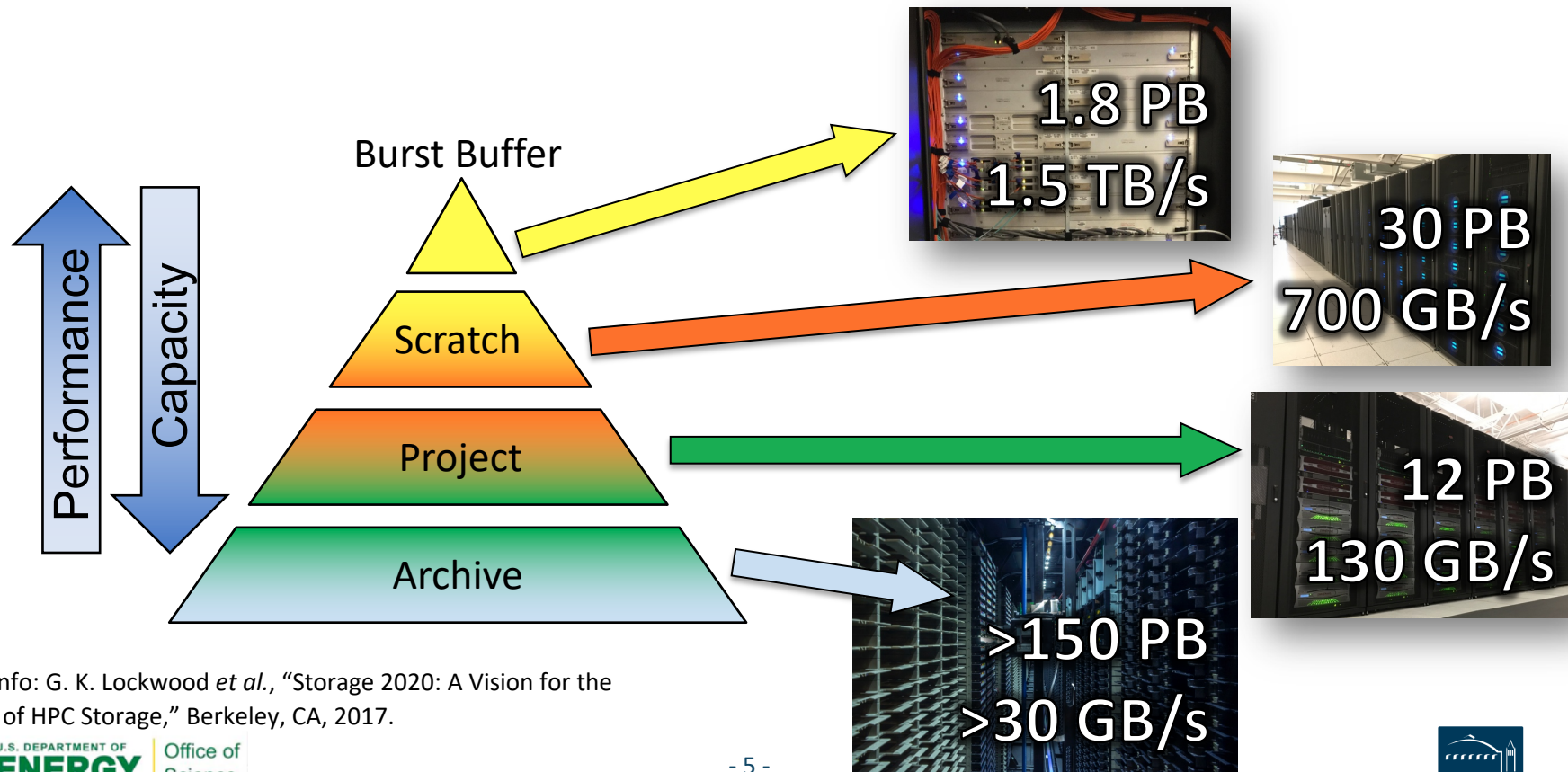
Advancing HPC

- Collaborate with HPC vendors years before system delivery to deploy advanced systems/new capabilities at scale



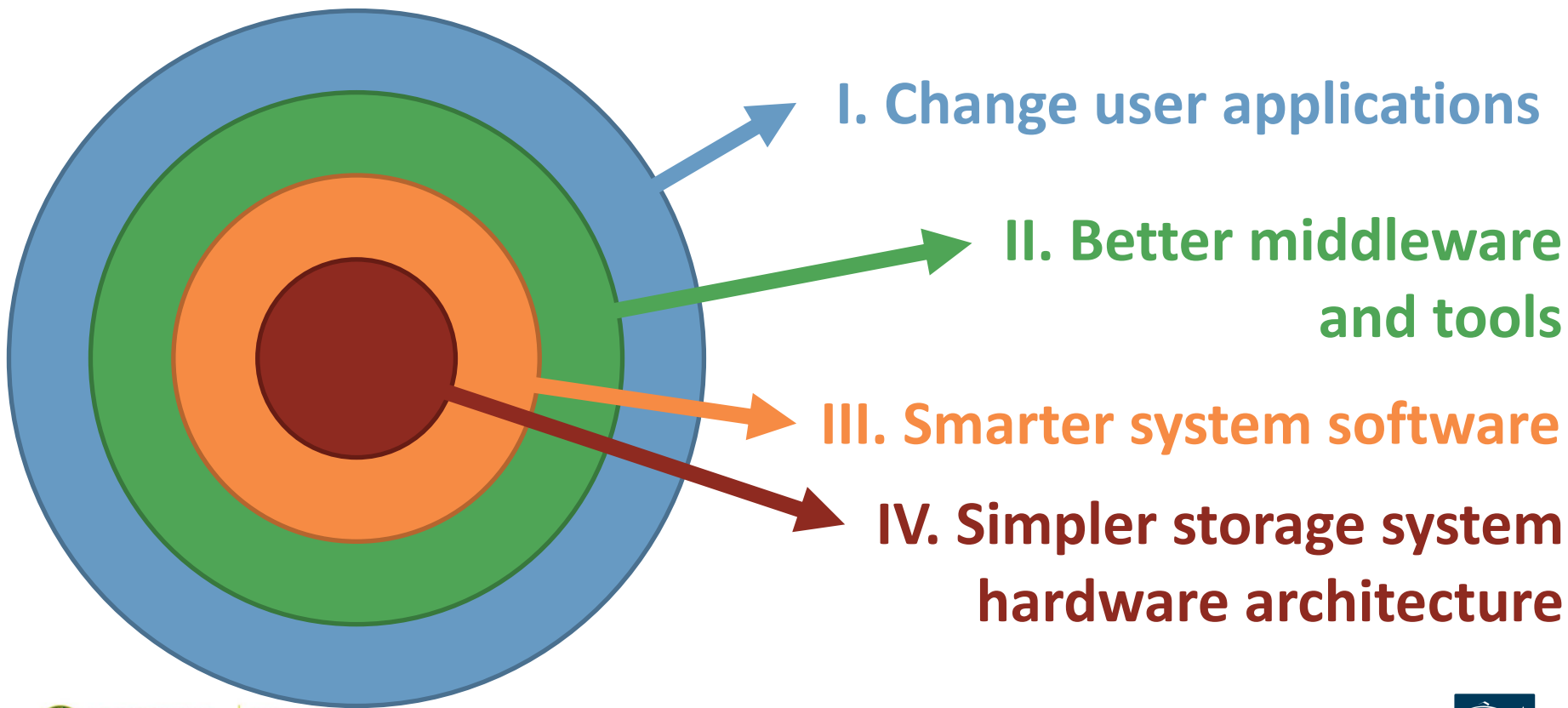
Storage architecture is getting complicated

NERSC



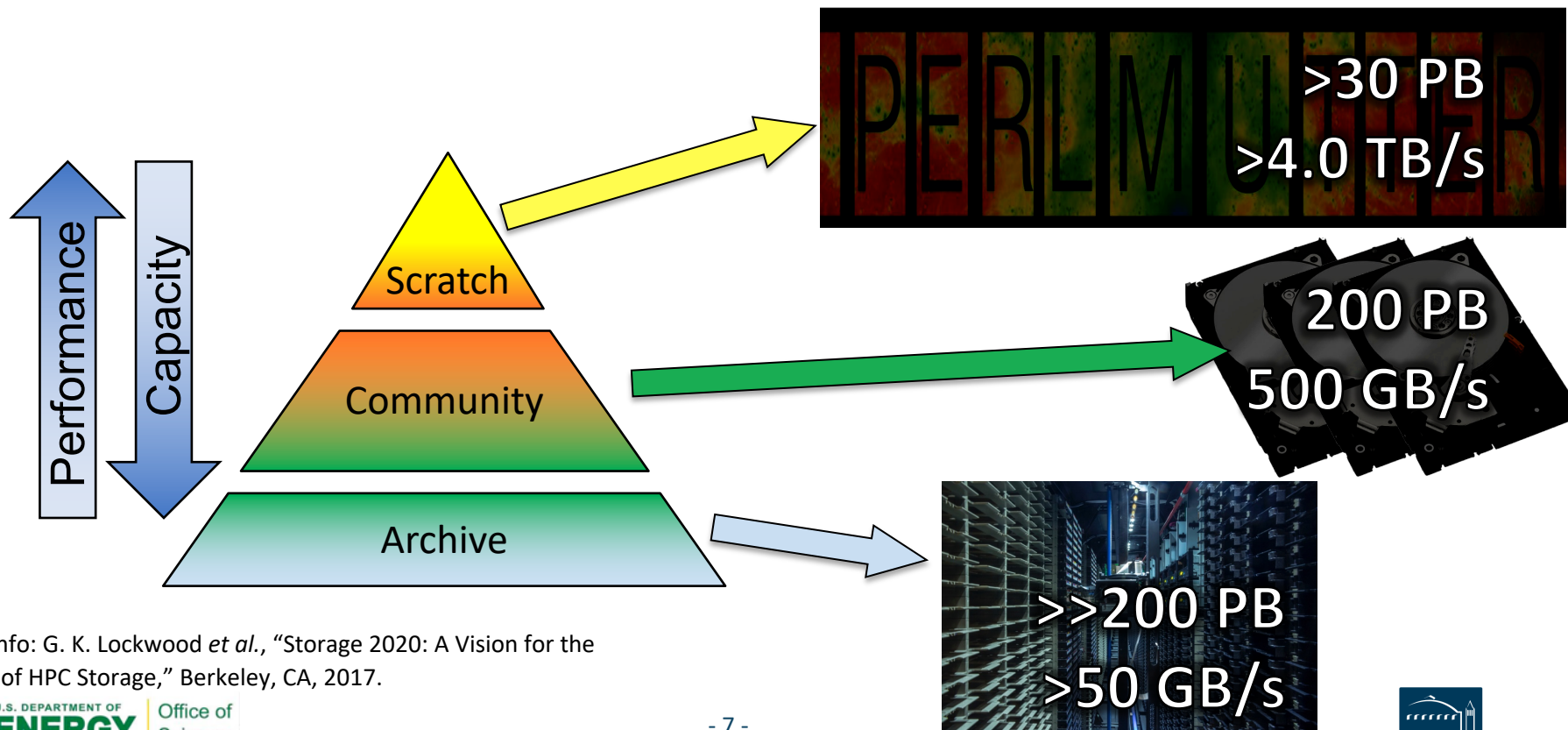
More info: G. K. Lockwood *et al.*, "Storage 2020: A Vision for the Future of HPC Storage," Berkeley, CA, 2017.

Addressing complexity of data management



Simplifying storage system architecture in 2020

NERSC

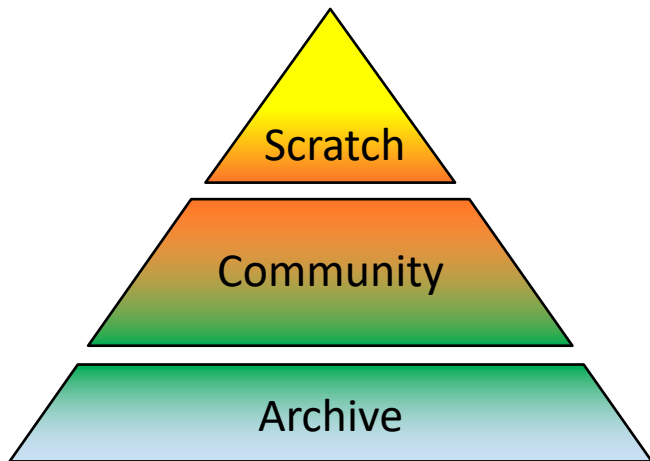


More info: G. K. Lockwood *et al.*, "Storage 2020: A Vision for the Future of HPC Storage," Berkeley, CA, 2017.

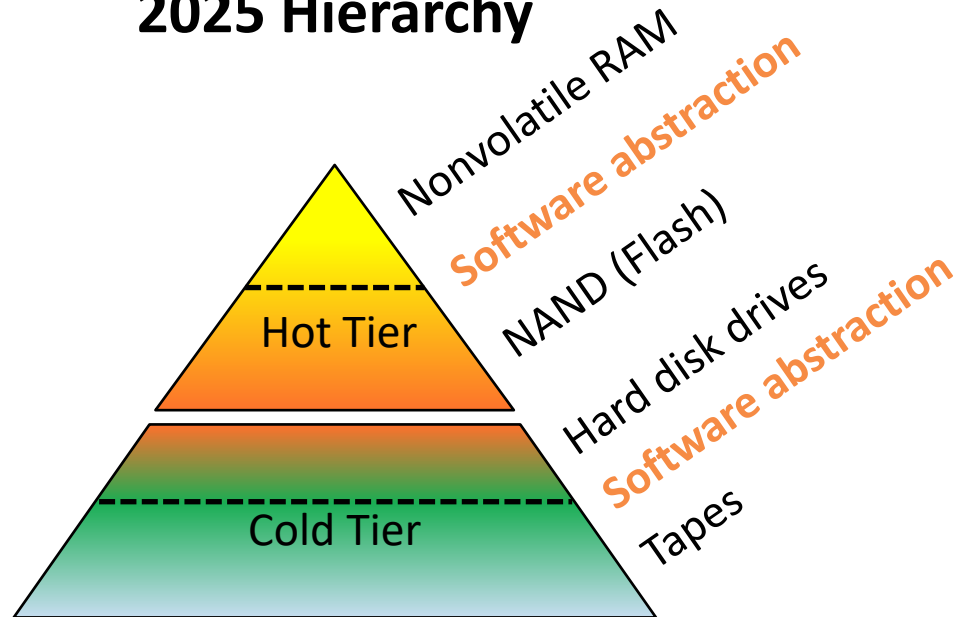
2025 requires smarter storage system software



2020 Hierarchy



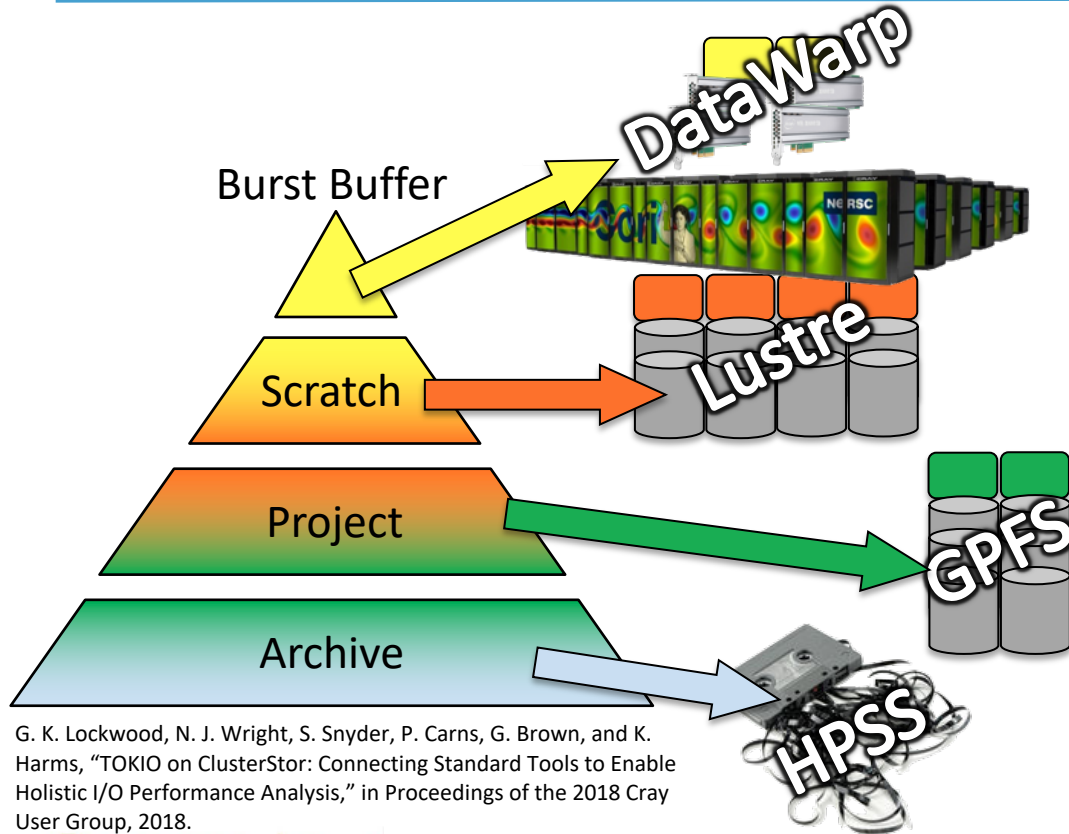
2025 Hierarchy



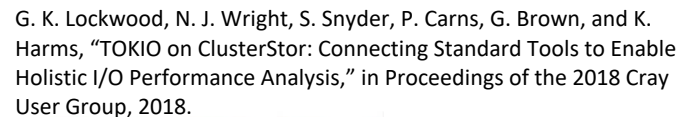
More info: G. K. Lockwood *et al.*, "Storage 2020: A Vision for the Future of HPC Storage," Berkeley, CA, 2017.

Towards intelligent data management systems

through quantitative analysis

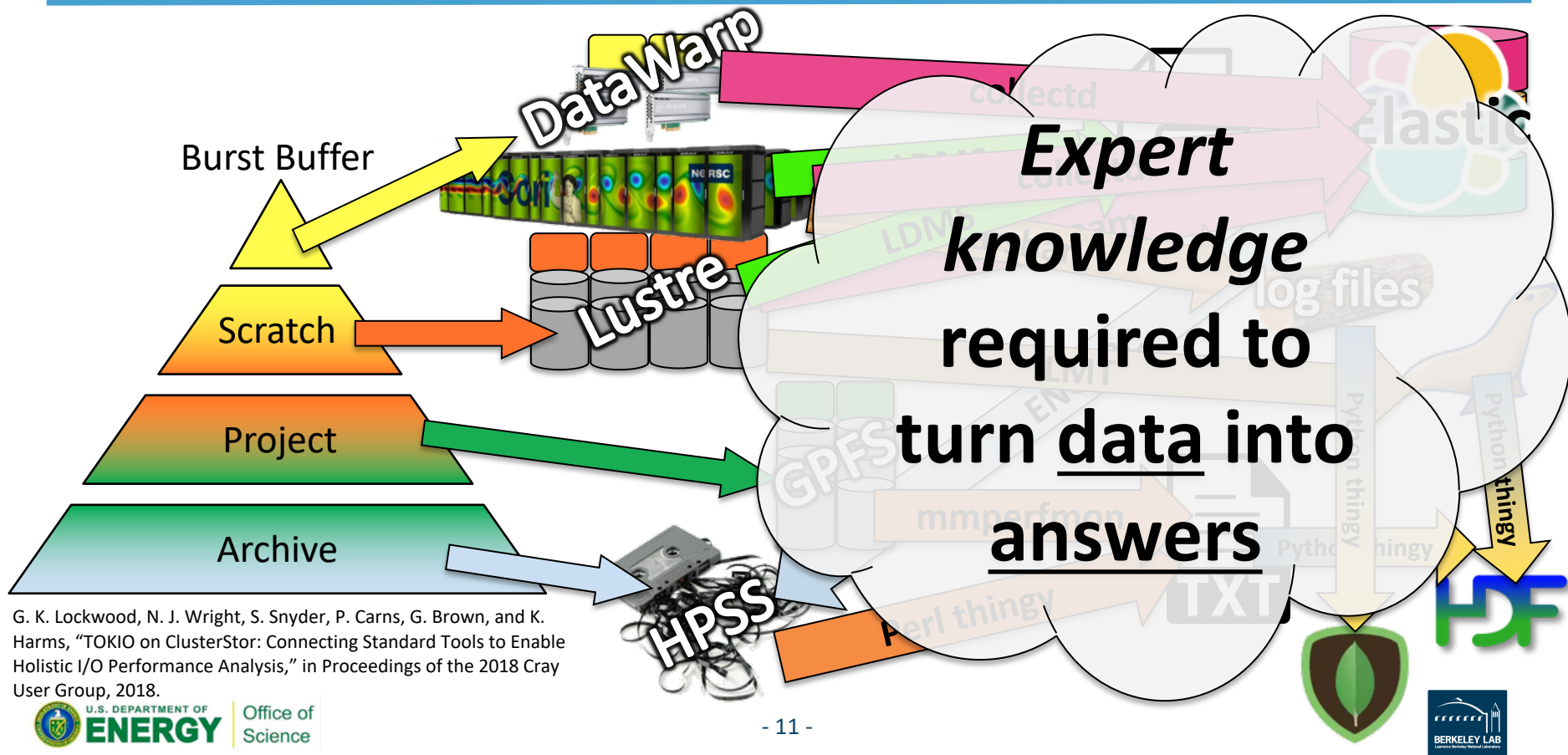


G. K. Lockwood, N. J. Wright, S. Snyder, P. Carns, G. Brown, and K. Harms, "TOKIO on ClusterStor: Connecting Standard Tools to Enable Holistic I/O Performance Analysis," in Proceedings of the 2018 Cray User Group, 2018.



State of the art in understanding I/O today

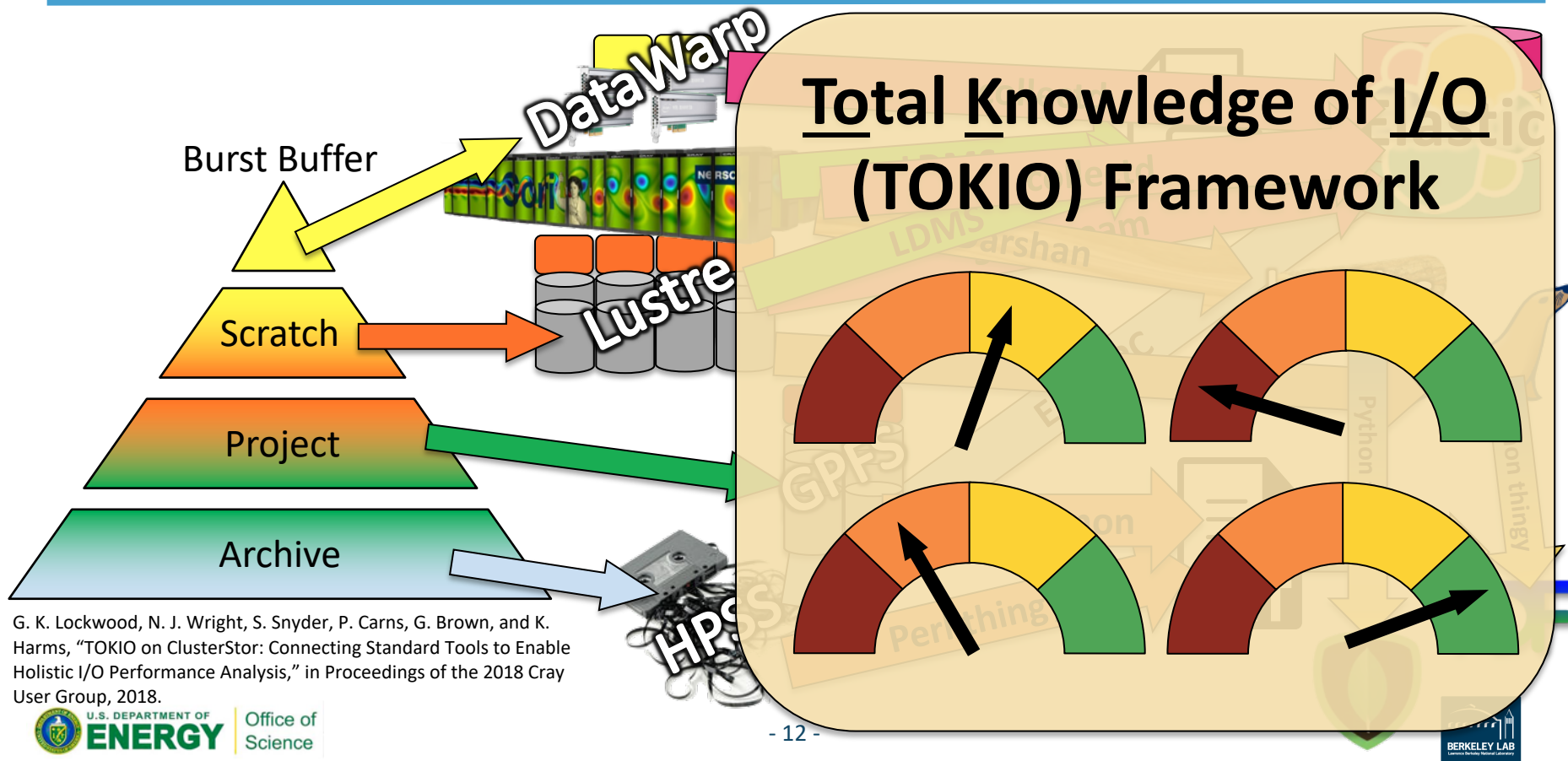
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G. K. Lockwood, N. J. Wright, S. Snyder, P. Carns, G. Brown, and K. Harms, "TOKIO on ClusterStor: Connecting Standard Tools to Enable Holistic I/O Performance Analysis," in Proceedings of the 2018 Cray User Group, 2018.

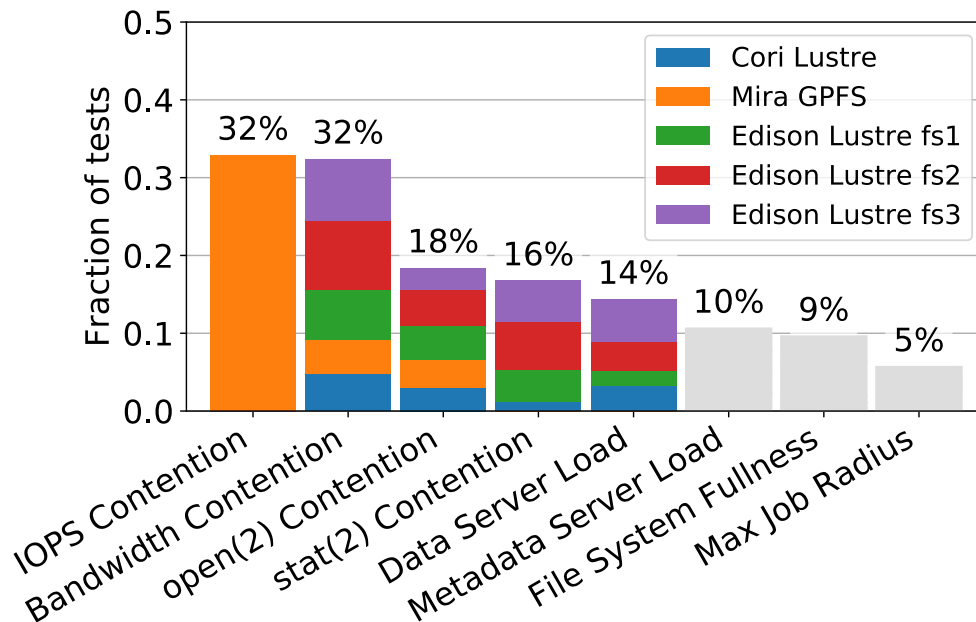
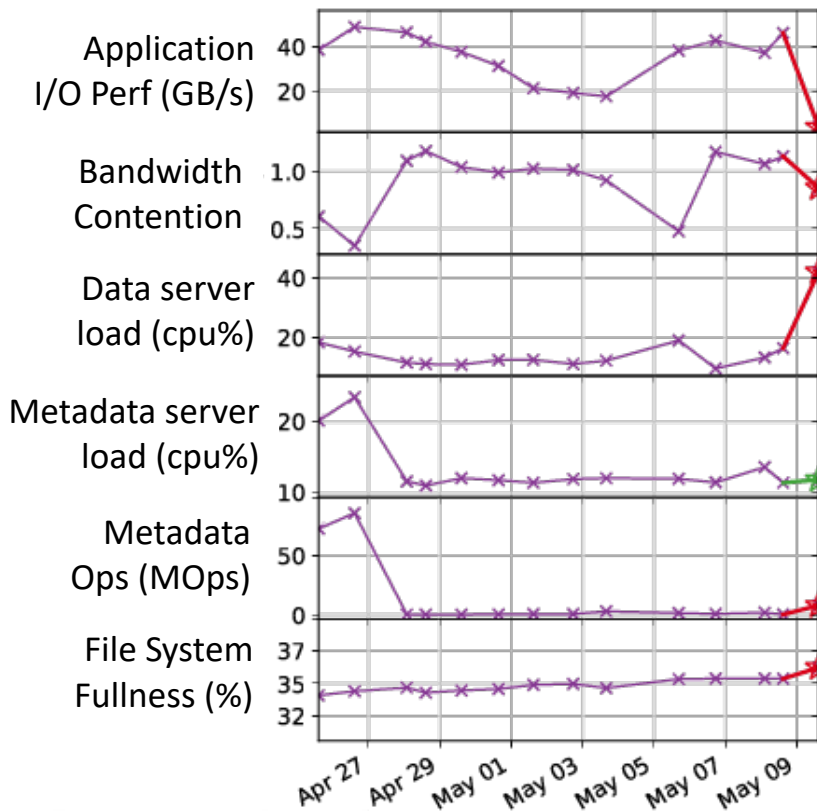
TOKIO to give insight into data movement

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G. K. Lockwood, N. J. Wright, S. Snyder, P. Carns, G. Brown, and K. Harms, "TOKIO on ClusterStor: Connecting Standard Tools to Enable Holistic I/O Performance Analysis," in Proceedings of the 2018 Cray User Group, 2018.

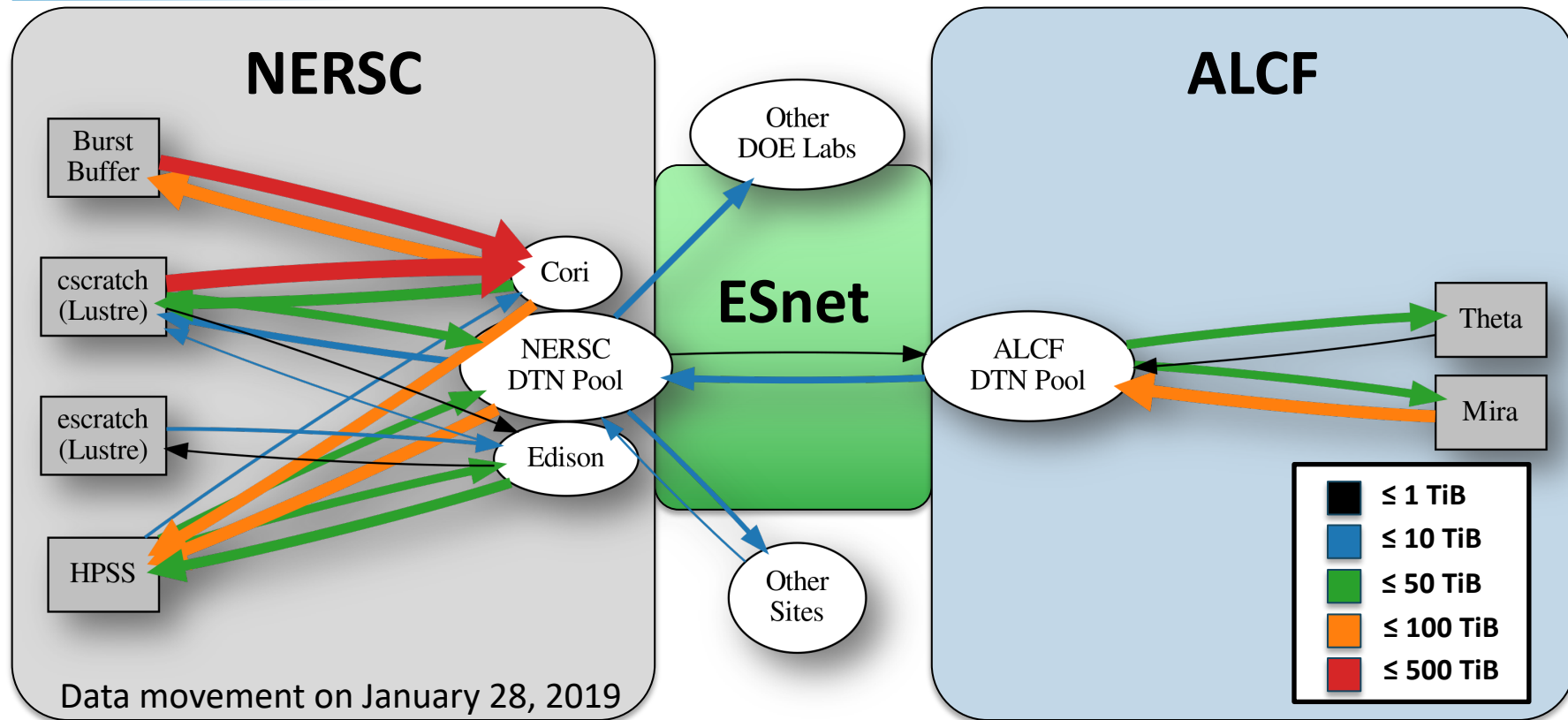
Why is I/O slow?



Top: G. K. Lockwood, S. Snyder, T. Wang, S. Byna, P. Carns, and N. J. Wright, "A Year in the Life of a Parallel File System," in Proceedings of SC'18, 2018, p. 74:1--74:13.

Left: G. K. Lockwood et al., "UMAMI: A Recipe for Generating Meaningful Metrics through Holistic I/O Performance Analysis," in Proceedings of PDSW-DISCS'17, 2017, pp. 55--60.

How does data move during workflows?



Managing complexity in data management requires increasingly intelligent storage systems to offset increasing architectural complexity

- Simpler, all-flash storage hierarchy is a viable short-term solution
- Holistic understanding of the entire storage system is becoming essential
- TOKIO is a software foundation for holistic understanding and working towards adaptive storage

The Total Knowledge of I/O (TOKIO) Project, a collaboration between Lawrence Berkeley National Laboratory and Argonne National Laboratory, is supported by the U.S. Department of Energy, Office of Science, under contracts DE-AC02-05CH11231 and DE-AC02-06CH11357,

<https://www.nersc.gov/research-and-development/tokio/>

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The Networking and Information Technology Research and Development
(NITRD) Program

Mailing Address: NCO/NITRD, 2415 Eisenhower Avenue, Alexandria, VA 22314

Physical Address: 490 L'Enfant Plaza SW, Suite 8001, Washington, DC 20024, USA Tel: 202-459-9674,
Fax: 202-459-9673, Email: nco@nitrd.gov, Website: <https://www.nitrd.gov>

