Petascale System Infrastructure

Presented by

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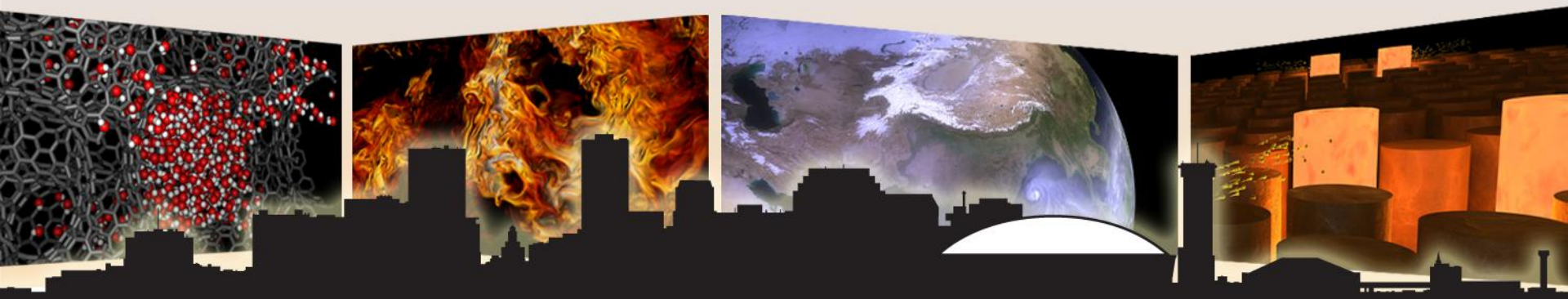

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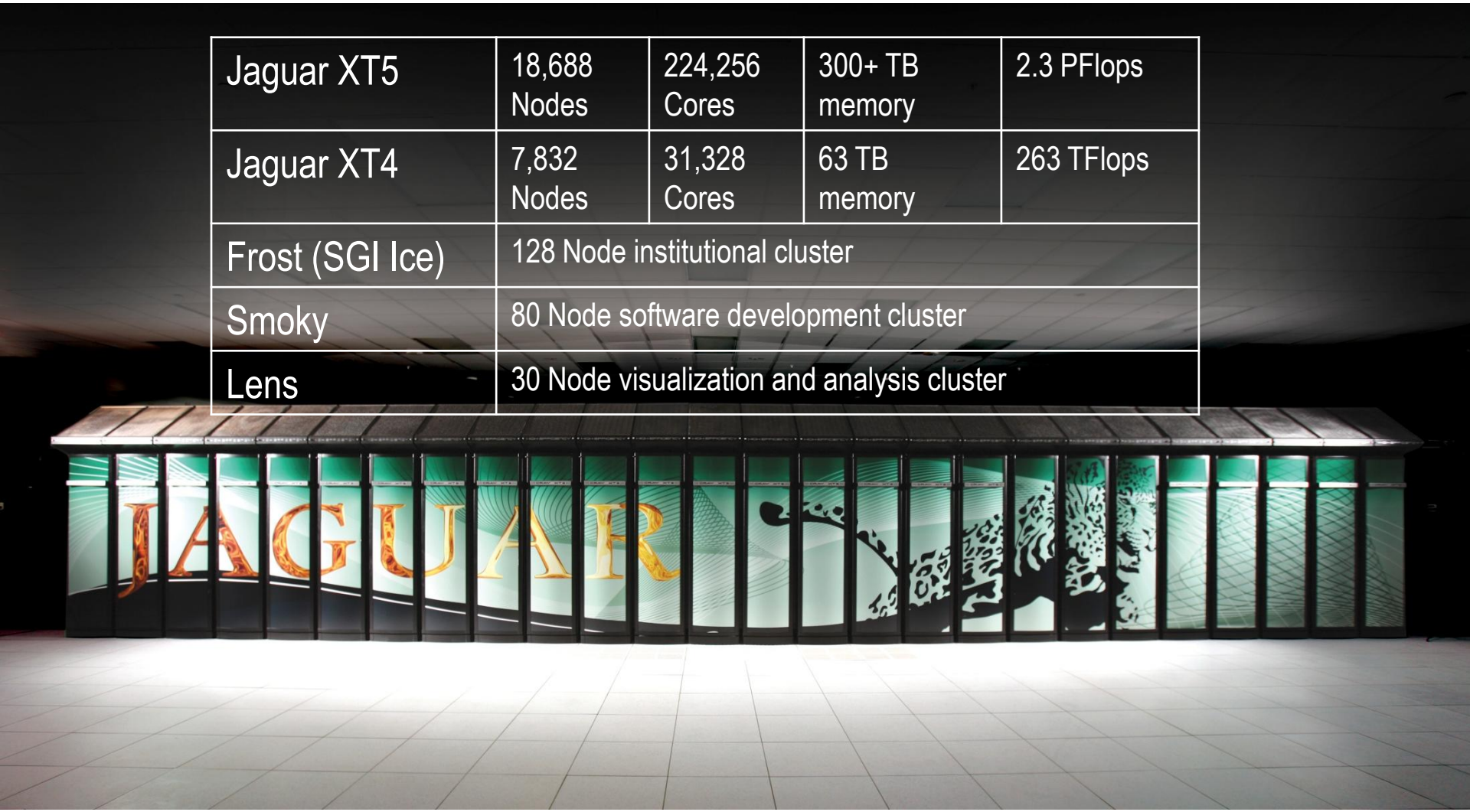
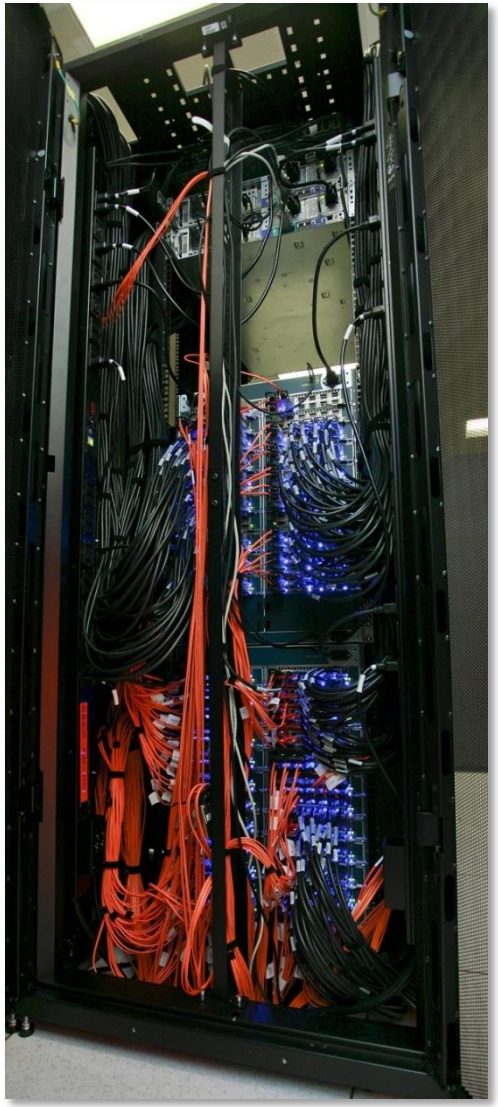
OAK RIDGE National Laboratory

A demanding computational environment

Jaguar XT5	18,688 Nodes	224,256 Cores	300+ TB memory	2.3 PFlops
Jaguar XT4	7,832 Nodes	31,328 Cores	63 TB memory	263 TFlops
Frost (SGI Ice)	128 Node institutional cluster			
Smoky	80 Node software development cluster			
Lens	30 Node visualization and analysis cluster			



OLCF networking

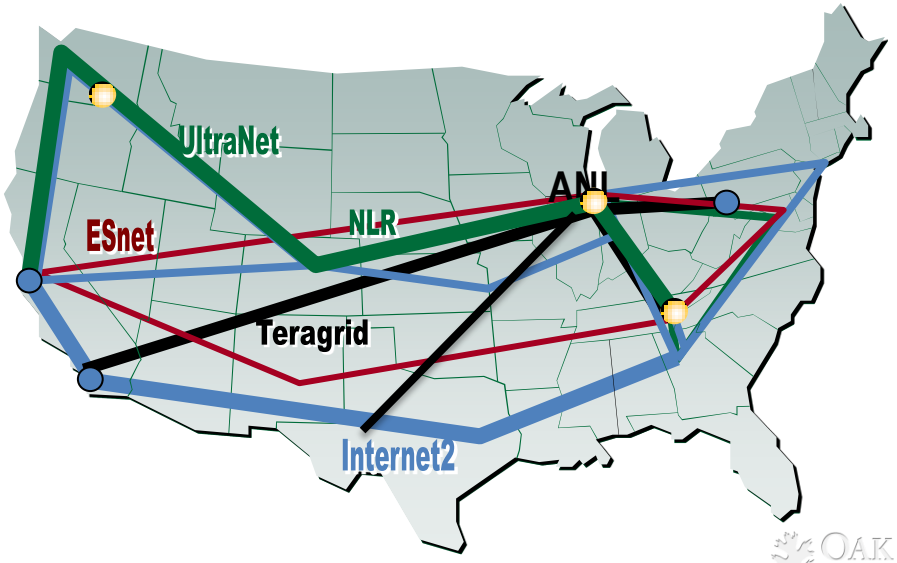


- A service-rich computational environment interconnected via our InfiniBand System Area Network
  - Over 3,000 InfiniBand ports
  - Over 3 miles of cables
  - Scales as computational environment grows
  - An InfiniBand-based network helps meet the bandwidth and scaling needs for the center at reasonable costs
- A robust Ethernet network
  - Ubiquitous connectivity for systems management
  - Over 750 1-GBe and 150 10-GBe ports
- Wide-area networking via ESNet and others

High bandwidth connectivity to NCCS enables efficient remote user access

Connected to Major Science Networks ORNL-owned dark fiber and DWDM equipment linking ORNL to Chicago, Nashville, and Atlanta	
OC192 to ESNET with backup OC48 - Added 10 Gb SDN dynamically reconfigurable (layer 2)	10 Gb to NSF Teragrid
10 Gb to Internet2	2 x 10 Gb UltraScienceNet
4 x 10 Gb to National Lambda Rail	10 Gb Futurenet to NSF Cheetah net

- ORNL participating in the Advanced Networking Initiative (ANI)
  - 100 Gb native optical network in a loop that includes OLCF, ALCF, and other facilities in the northeast as well as a spur from Chicago to the west coast
  - Anticipate 100 Gb Ethernet client standard, with client interfaces in 2011



Spider

Fastest Lustre file system in the world

Demonstrated bandwidth of 240 GB/s on the center-wide file system

Largest scale Lustre file system in the world

Demonstrated stability and concurrent mounts on all major OLCF systems

- Jaguar XT5
- Jaguar XT4
- Opteron Dev Cluster (Spider)
- Visualization Cluster (Lens)

Over 26,000 clients mounting the file system in production

Over 282,000,000 files

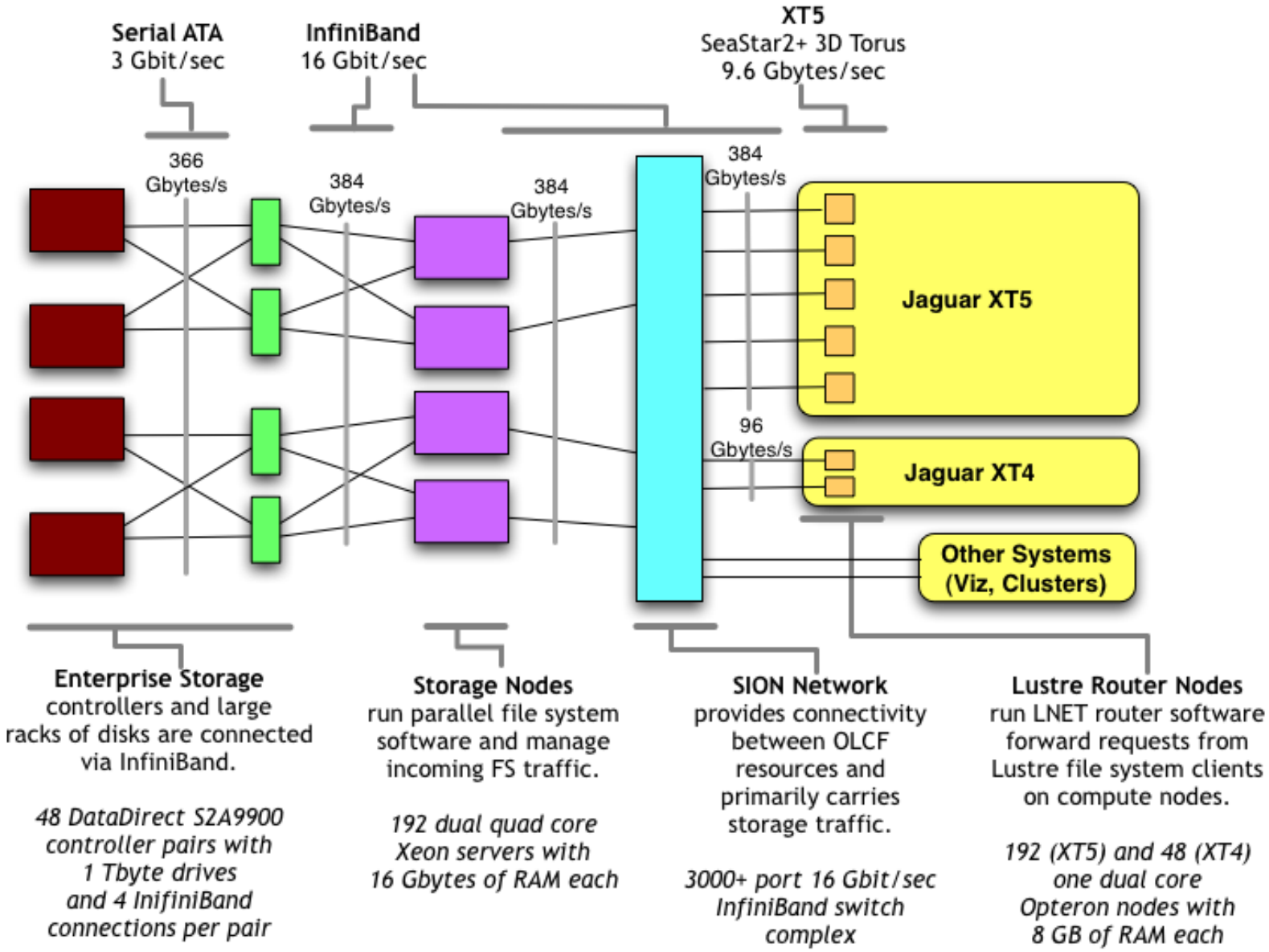
Multiple petabytes of data stored

Cutting edge resiliency at scale

Demonstrated resiliency features on Jaguar XT5

- DM Multipath
- Lustre Router failover

Spider—speeds and feeds



Archival storage infrastructure

HPSS

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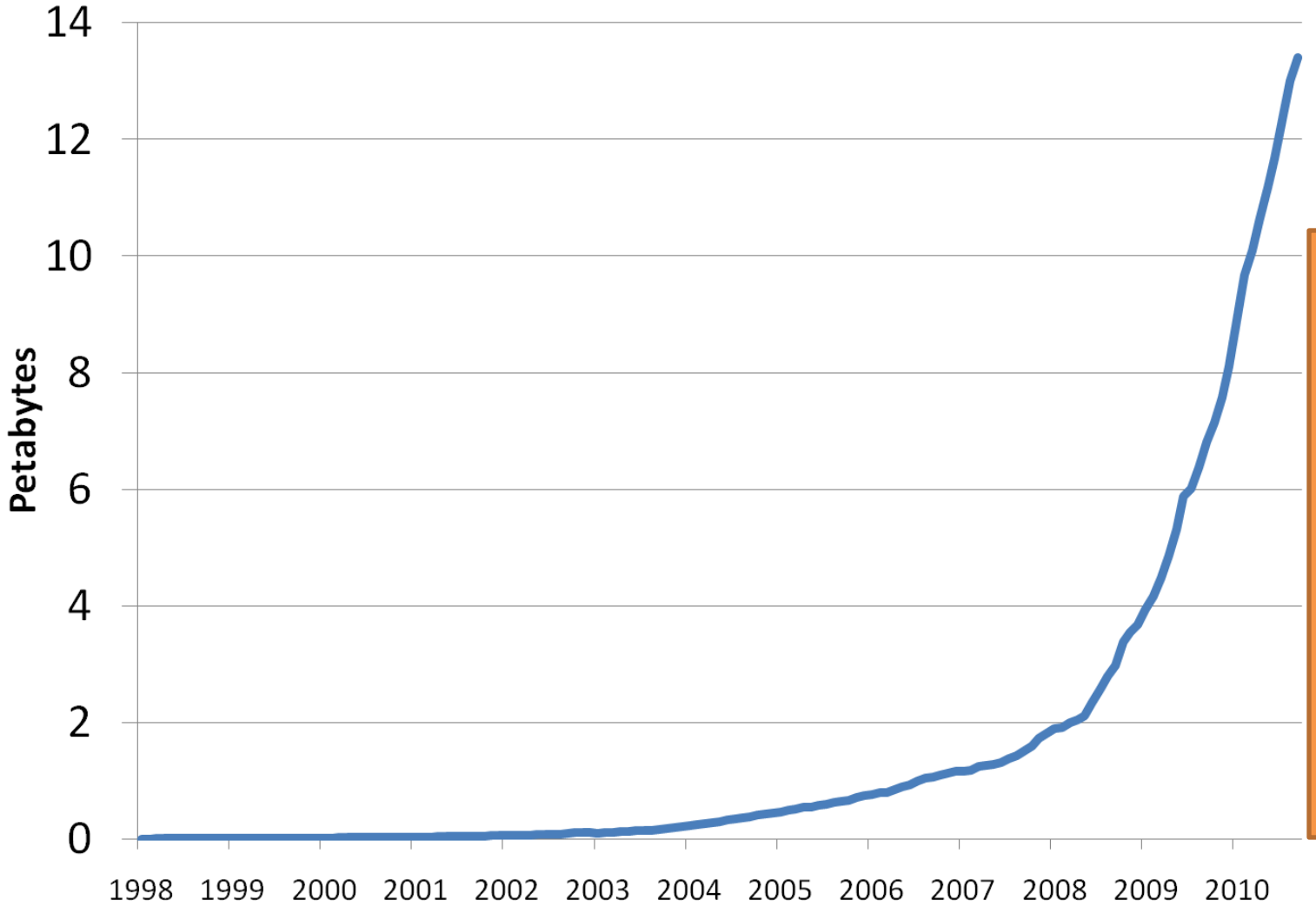
- HPSS provides archival storage for all systems (60 PB capacity; easily expandable)
- HPSS has been upgraded with two additional tape libraries to add additional capacity and bandwidth
- HPSS software has already demonstrated ability to scale to many petabytes
- Capacity and bandwidth on both tapes and disks are scaled to maintain a balanced system
- Utilize new methods to improve data transfer speeds between parallel file systems and archival system (transfer agent, LFM)

HPSS—managing exponential growth in storage



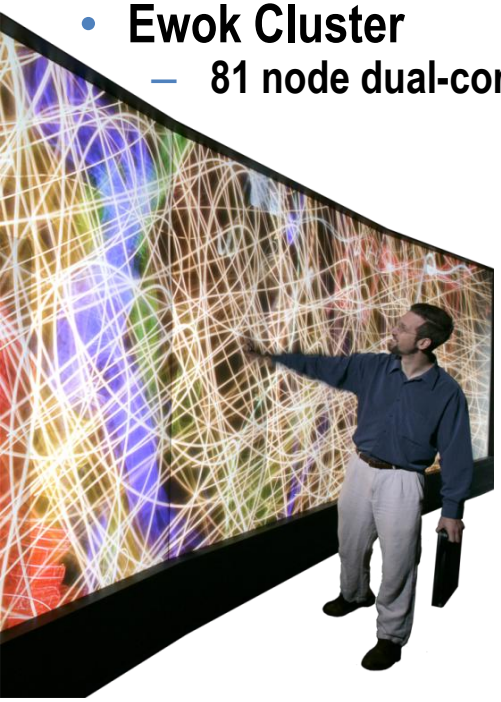
HPSS Growth:	
PB	Months
1	101.5
2	20.3
3	6.2
4	4.3
5	3.1
6	2.6
7	2.8
8	2.1
9	1.4
10	1.4
11	2.1
12	1.8
13	1.5

HPSS is managing 13 PB and growing at more than 30 TB per day.

Visualization and data analysis resources

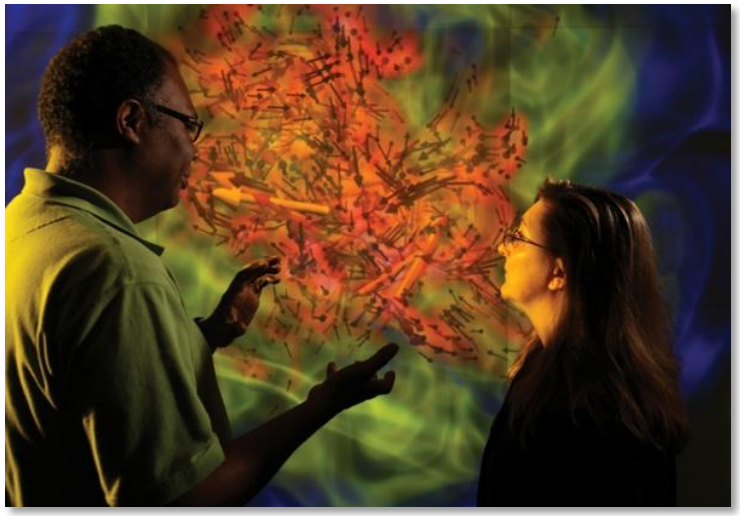
Hardware

- Everest Powerwall
  - 30 ft by 8 ft 35 megapixel display wall
- Lens Cluster
  - 32 nodes each with 64 GB and four quad-core Opterons w/ GPUs
- Everest Cluster
  - 18 nodes to drive display wall
- Ewok Cluster
  - 81 node dual-core Xeons



Software

- VisIT
- EnSight Gold and DR
- ParaView
- AVS/Express
- R MPI
- IDL
- SCIRun
- Xmgrace, Gnuplot, Kepler



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