

# State of OSG

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**OSG Executive Director**  
**UCSD/SDSC**

# **Advance Open Science through distributed High Throughput Computing**

**Let's parse this OSG statement of purpose a little ....**

- All of open science irrespective of discipline
- Advance the maximum possible dynamic range of science, groups, and institutions
  - From **individual undergraduates** to international collaborations with thousands of members.
  - From **small colleges, museums, zoos**, to national scale centers of open science.
- Advancing this entire spectrum requires us to have a **diversified portfolio of services**

# OSG Accounting by Field of Science

Order here is from most active to least active.

High Energy Physics   Astrophysics   Medical Sciences   Biological Sciences  
 Neuroscience   Particle Physics   Nuclear Physics   Training   Gravitational Physics  
 Bioinformatics   Physics   Engineering   Physical Chemistry   Economics  
 Biophysics   Evolutionary Sciences   Statistics   Physics and astronomy   Chemistry  
 Community Grid   Biochemistry   Ecological and Environmental Sciences   Zoology  
 Fluid Dynamics   Computational Condensed Matter Physics  
 Biological and Critical Systems   Computer and Information Science and Engineering  
 Chemical Engineering   Earth Sciences   Mathematical Sciences   Medical Imaging  
 Geographic Information Science   Educational Psychology   Biomedical research  
 Technology   Plant Biology   Education   Genomics   Materials Science  
 Astronomy   Information, Robotics, and Intelligent Systems   Multi-Science Community

Category is based on self-identification ... i.e. people say what they do.



# OSG Accounting by Organization

People self-declare  
their organization

Fermilab University of Wisconsin University of Pittsburgh DUNE  
 Indiana University Fermi National Accelerator Laboratory CERN  
 University of Chicago Georgia Institute of Technology Duke University  
 Fermi National Accelerator Lab Syracuse University Wayne State University  
 New Mexico State University University of California San Diego SeaQuest  
 Massachusetts Institute of Technology University of Colorado Boulder JLAB  
 University of Nebraska-Lincoln University of Minnesota Georgia State University  
 Clemson University University of Arizona CU Boulder University of Oklahoma  
 Illinois Institute of Technology University of Nebraska University of Texas-Austin  
 Harvard Medical School Stanford University MIT Yale University  
 Wichita State University University of Oxford Arizona State University  
 University of Florida UC Riverside University of Pennsylvania  
 University of Notre Dame University of Tennessee University of Michigan  
 Colorado School of Mines Oregon State University Princeton University  
 Baylor University University of New Mexico University of California Santa Cruz  
 Southern Illinois University Darkside Northwestern University  
 University of California - San Diego University of Colorado  
 Wright State Research Institute Johns Hopkins University Purdue University  
 Northeastern University Rutgers University University of California Berkeley  
 University of Nebraska - Lincoln University of California, San Diego  
 Stony Brook University Pacific Northwest National Laboratory University of Utah  
 University of North Carolina at Chapel Hill Ohio State University  
 Florida Institute of Technology UC San Diego Icahn School of Medicine at Mount Sinai  
 Vanderbilt University ISI CDMS Columbia University  
 Texas A&M University, University of Illinois at Urbana-Champaign Brown University  
 University of Missouri University of Colorado, Boulder DOSAR  
 American Museum of Natural History USC UCR University of Southern California  
 UNIVERSITY of COLORADO at BOULDER University of Central Florida  
 National Institute for Computational Sciences University of Illinois at Chicago  
 University of Rochester Brookhaven National Laboratory University of Maryland  
 North Dakota State University University of Wisconsin Madison  
 University of Minnesota Duluth

# OSG serves 4 distinct groups

- The **individual researchers** and small groups on OSG-Connect
- The **campus Research Support Organizations**
  - Teach IT organizations & support services so they can integrate with OSG
  - Train the Trainers (to support their researchers)
- **Multi-institutional Science Teams**
  - XENON, GlueX, SPT, Simons, and many many more
  - Collaborations between multiple campuses
- The 4 **“big science”** projects:
  - US-ATLAS, US-CMS, LIGO, IceCube



# distributed High Throughput Computing (dHTC)

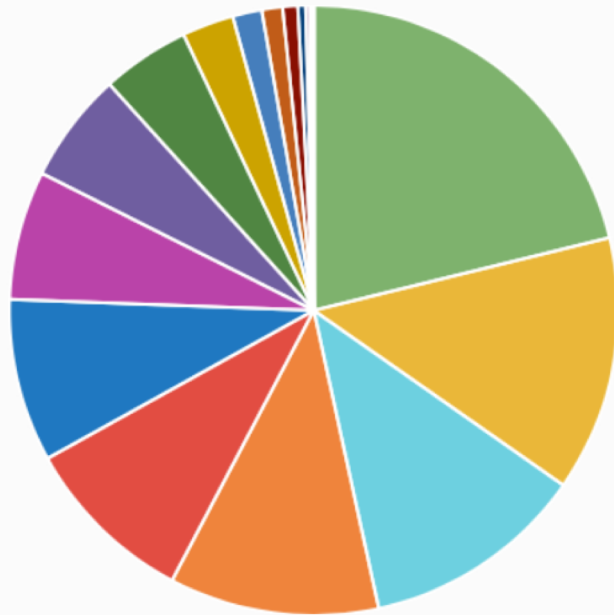
- The challenge in successful dHTC is two-fold:
  - Separate a big computing problem in many individually schedulable small problems.
  - Minimize your requirements in order to maximize the raw capacity that you can effectively use.
- **We teach researchers how to meet these challenges.**
- We take your many small problems, and schedule their successful execution.
- We allow you to curate & publish your software & data and deliver them to you at runtime.

## Ingenious Parallelism



Open Science Grid

# GPU computing is part of dHTC

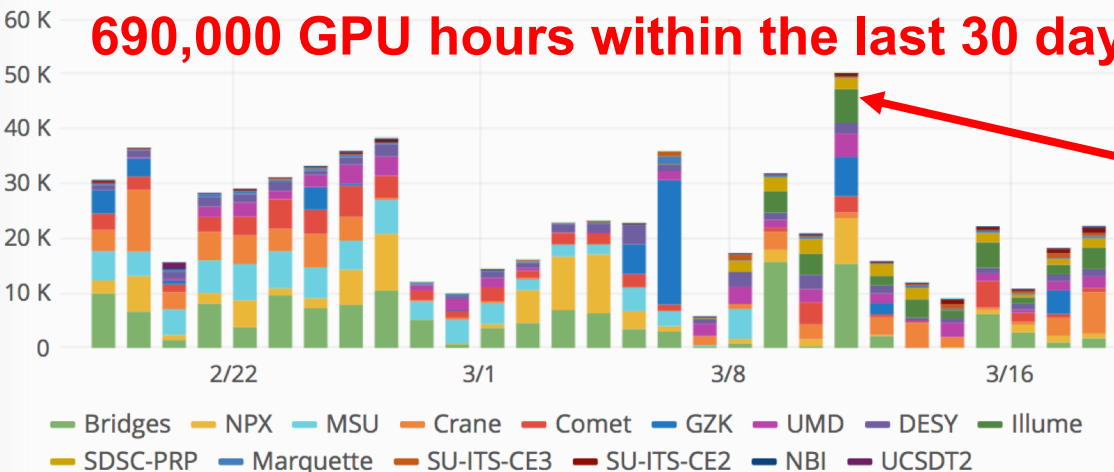


Bridges	145.2 K
NPX	92.9 K
MSU	81.4 K
Crane	76.4 K
Comet	63.3 K
GZK	59.3 K
UMD	46.9 K
DESY	40.3 K
Illume	32.1 K
SDSC-PRP	18.8 K
Marquette	10.64 K
SU-ITS-CE3	7.55 K
SU-ITS-CE2	5.48 K
NBI	2.798 K
UCSDT2	1.429 K

**Almost all of it  
consumed by IceCube**

WallHoursSpentOnJobsByFacility

**690,000 GPU hours within the last 30 days**



**Peaking at 2,000 GPUs  
concurrently.**



# Advance = Growing effective Capacity

- 10 years ago, OSG provided an integrated software stack that organizations had to deploy in order for their researchers to benefit from OSG.
  - We learned the hard way that this is too high a bar to jump across for most researchers and institutions.
- Today, **we offer to operate services ourselves in order to minimize the threshold to entry for everybody else.**

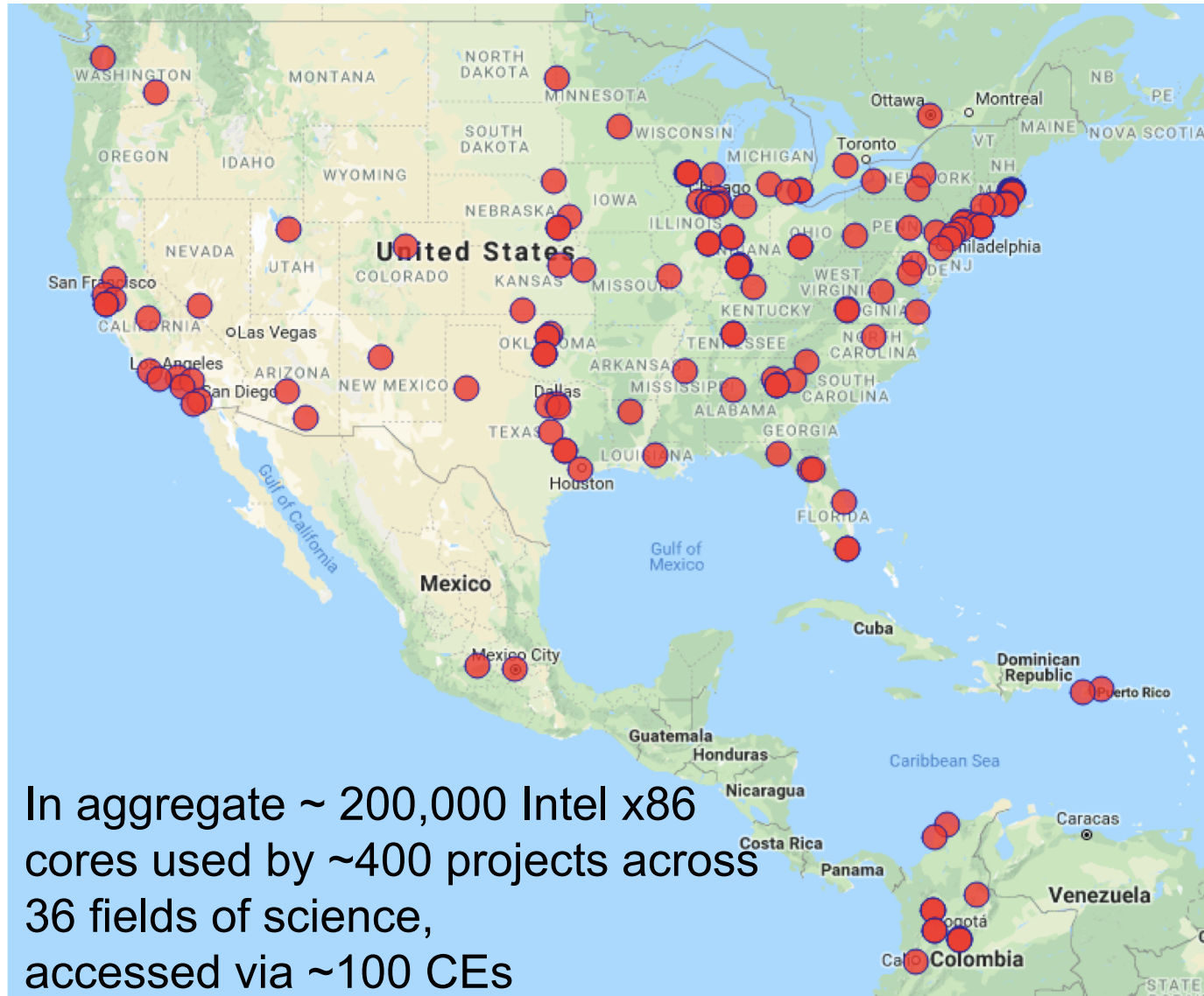
## **Our Aspirational Goal:**

A campus Research IT Organization should not have to learn anything "non-standard" in order to have their researchers benefit from OSG, or have their resources be available via OSG.

**Well, .... we got some ways to go before we reach that goal ...**

- OSG-Connect, a submission host for individual researchers.
  - You get an account, and we teach you how to use OSG.
- A Compute Federation
  - gWMS system that submits glideins to 300+ CEs globally.
  - HTCondor pools for multiple VOs
  - HTCondor Annex to integrate commercial cloud resources into your HTCondor pool.
  - CVMFS infrastructure to support software publication, including a module environment supporting >200 software modules.
  - Compute Elements to integrate clusters into OSG

# OSG Compute Federation

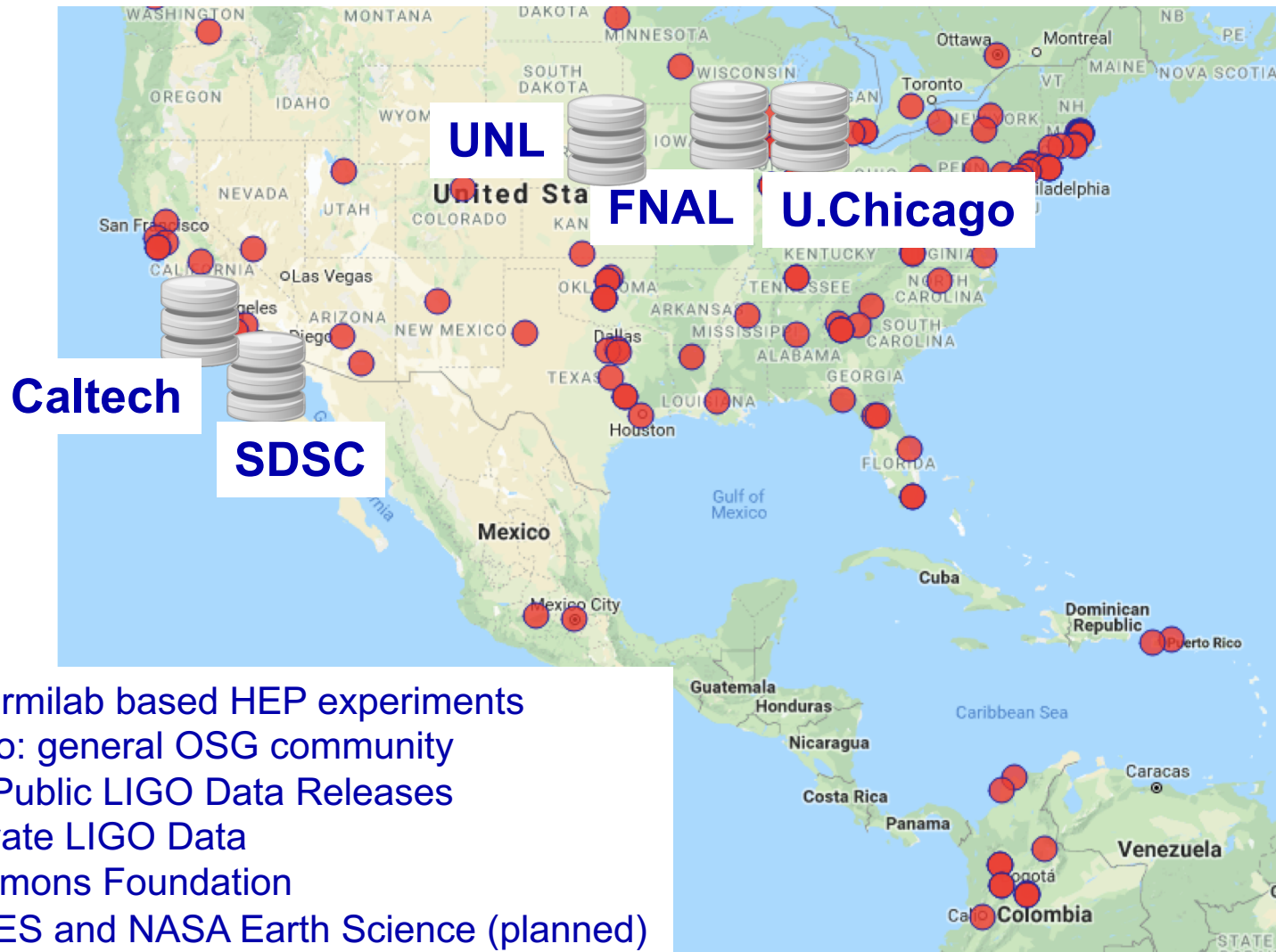




- **A Data Federation**
  - 1.5 PB disk space on our submission host that is exported into OSG
    - Individual undergraduates have storage allocations
  - An xrootd infrastructure that anybody can add their own data origin(s) to.
  - Data publication in our federated namespace using CVMFS.
  - Xrootd caches to hide data access latencies and reduce network traffic.
- Policy-based data placement (Rucio)

**We have created the illusion of a read-only global file system for all of open science.**

**We want your Data in our Federation !!!**





# Caches in network & at endpoints

## 6 Data Origins and 9 Data Caches



**Cache at I2 peering point with Cloud providers in Chicago to support elastic scale out.**

# Data Federation used by individual researchers and science collaborations

**May 2018**

**September 2018**

XRootD StashCache By Logical Directory

XRootD StashCache By Logical Directory

Directory ↕	Bytes ↕
/user/jeanjack	660.125TB
/pnfs/fnal.gov/usr/minerva	197.651TB
/pnfs/fnal.gov/usr/des	159.64TB
/user/ligo	14.078TB
/user/wpoehlm	12.513TB

Directory ↕	Bytes ↕
/gwdata/O1	158.889TB
/pnfs/fnal.gov/usr/minerva	98.705TB
/user/ligo	65.925TB
/pnfs/fnal.gov/usr/des	23.495TB
/user/jeanjack	17.567TB

**“Genomics”**  
Jeanjack  
wpoehlm

**Public LIGO**  
gwdata/01

**Private LIGO**  
ligo

**Astronomy**  
des

**HEP**  
minerva

## Last 30 days

Directory ▾	Bytes ▾
/pnfs/fnal.gov/usr/dune	390.114TB
/gwdata/O1	180.208TB
/pnfs/fnal.gov/usr/minerva	99.352TB
/pnfs/fnal.gov/usr/des	63.204TB

Directory ▾	Bytes ▾	Bytes ▾
/pnfs/fnal.gov/usr/dune	396.578TB	58.211TB
/pnfs/fnal.gov/usr/minerva	395.986TB	
/gwdata/O1	295.03TB	
/pnfs/fnal.gov/usr/des	182.369TB	
/user/ligo	104.744TB	
/user/dteam	55.197TB	
/pnfs/fnal.gov/usr/nova	31.768TB	

## Last 60 days



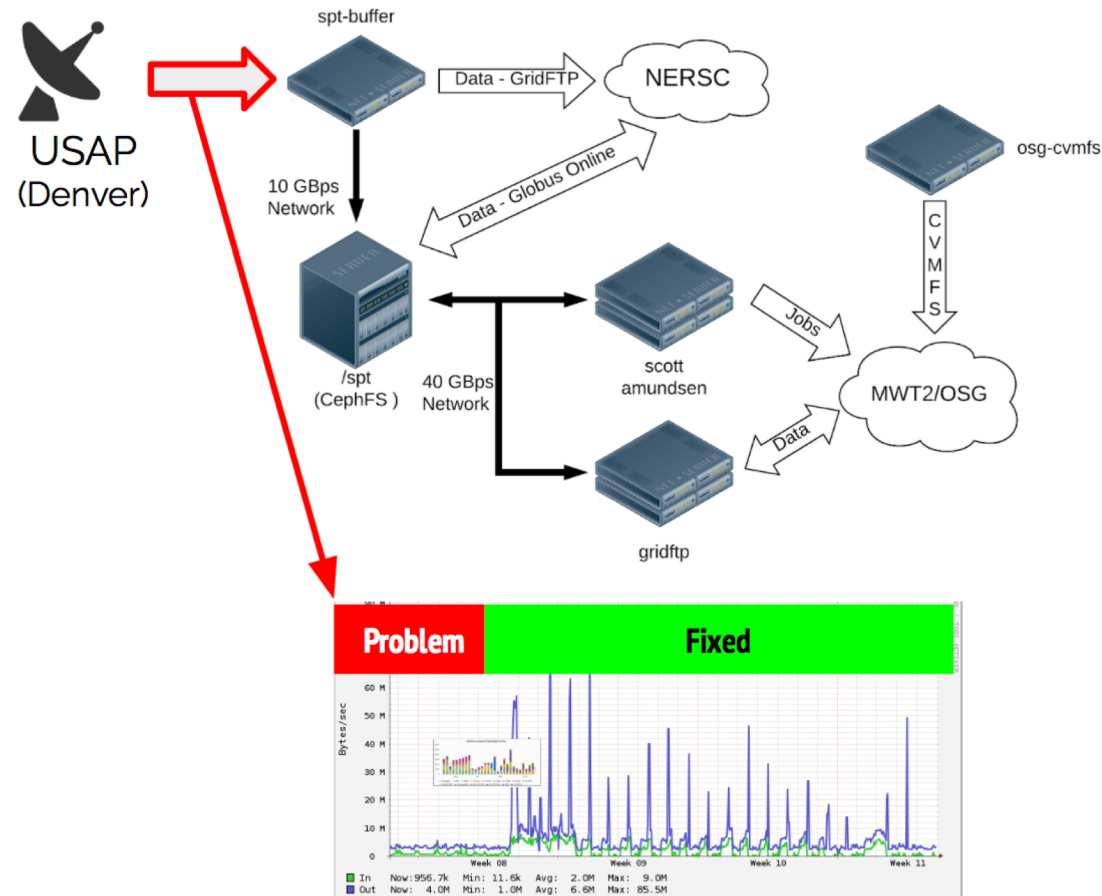
# OSG offers “service bundle” to Campus IT organizations

- **Collaboration:** GaTech PACE, LIGO, OSG @ UChicago, UCSD
- Cluster setup - node provision & config
- Cluster setup - HTCondor batch, login
- OSG HTCondor Compute Element
- OSG Worker Node Client
- OSG Frontier-Squid, CVMFS
- OSO-LIGO Job Submission Service
  - integrated grid & local submissions
- OSG GridFTP Server
- StashCache - authenticated and un-auth
- Integration with existing LIGO LDAP and Shibboleth Services
- LIGO application validations
- gsi-ssh clients & troubleshooting
- Site-specific support documentation, configuration management (salt), staff training

**Goal:**  
**Help GaTech deploy a cluster  
that is part of LIGO production.**

# OSG helps Science Collaborations develop & debug their Infrastructure

- OSG operates daily satellite data collection and archival for SPT-3G
- In February, poor transfers from USAP to UChicago
- Consulting with OSG, UChicago & UCAR network experts.
- Feb 26, Dave Feldt (USAP) shut down the InterNAP link (one of two commercial uplinks for USAP) and saw 10x improvement in performance.



## SPT-3G Data Throughput Trouble Shooting



# OSG helps Science Collaborations develop & debug their Infrastructure

- OSG operates data collection for SPT-3G
- In February, from USAP to
- Consulting with UChicago & experts.
- Feb 26, Dave shut down the (one of two) uplinks for U improvement

**SPT-3G is a neighbor of IceCube at the south pole.**

**SPT-3G**





# OSG enabling international collaboration (last 30 days)

GPGrid	1.898 Mil	<b>Dune</b>	<b>Xenon1T</b>	SU-ITS-CE2	68.1 K
CERN-PROD	186 K	←		SU-ITS-CE3	64.7 K
UKI-SOUTHGRID-OX-HEP	164 K	←	→	NIKHEF-ELPROD	55.7 K
UKI-SCOTGRID-ECDF	57.0 K	←	→	IN2P3-CC	26.1 K
UKI-SOUTHGRID-RALPP	53.5 K	←	→	SURFsara	20.9 K
BNL-SDCC-CE01	49.0 K		→	INFN-T1	15.2 K
UColorado_HEP	35.4 K			BELLARMINE_TIER2	11.62 K
FZU	31.5 K			UColorado_HEP	11.51 K
UKI-NORTHGRID-LIV-HEP	24.0 K	←		MWT2	7.37 K
UKI-LT2-IC-HEP	22.9 K		→	WEIZMANN-LCG2	4.92 K
CIT_CMS_T2	19.8 K			CIT_CMS_T2	3.07 K
UKI-NORTHGRID-MAN-HEP	13.87 K	←		IIT_CE1	3.06 K
RAL-LCG2	7.31 K	←		FIU_HPCOSG_CE	2.493 K
IN2P3-CC	4.86 K	←		Nebraska	2.134 K
AGLT2	3.17 K			AGLT2	1.741 K
pic	977			IIT_CE2	1.622 K
Nebraska	826			UConn-OSG	1.329 K
UFlorida-HPC	759			NWICG_NDCMS	1.293 K
GLOW	751			USCMS-FNAL-WC1	1.259 K
CIEMAT-LCG2	721	←		OSG_US_ASU_DELL_M420	917

Other examples include Nova, IceCube, LIGO, ...

# Summary & Conclusion

- OSG's objective is to “Advance Open Science through distributed High Throughput Computing”
- OSG thinks of its science stakeholders in terms of 4 categories:
  - Individual Researchers
  - Campus Research Computing Organizations
  - Multi-campus Science Teams
  - “Big Science” Collaborations
- OSG offers a diversified portfolio of services to support these different science stakeholders.

# **Some Thanks are in Order**

OSG has seen some significant transitions.  
And I'd like to use the opportunity to thank the outgoing people and welcome the incoming people.



Rob developed OSG-Connect to support individual researchers on OSG, and has lead OSG’s engagement efforts with individual researchers and campuses for the last many years.

**Many Thanks Rob !!!**

He has handed responsibility for individual researchers over to Lauren Michaels to focus more on HL-LHC. His group maintains responsibility for the Multi-Institutional Science Collaborations.

**Welcome Lauren !!!**





Rob Quick lead OSG Operations for many years.

**Many Thanks Rob !!!**

He has handed over responsibility for OSG Operations to Jeff Dost.

**Welcome Jeff !!!**

