ALICE USA Computing Project Status Report

R. Jeff Porter

ALICE-USA Computing Resource Meeting

February 11, 2015

U.S. DEPARTMENT OF ENERGY | Office of Science

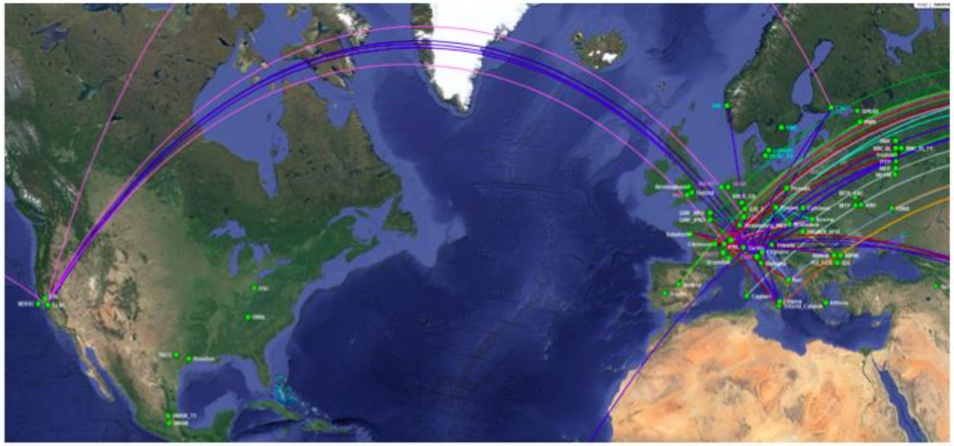
Outline

- **Really just a rambling set of slides that touch on many of the details of T2 operation via project history.**
- **Brief overview of project evolution from LLNL LC to ORNL CADES**
- **List of topics we'd like to cover**

ALICE-USA Computing Project

- **Goal: supply grid-enabled computing resources to ALICE**
  - Fulfill MoU-based ALICE USA obligations for CPU & storage resources to ALICE

- **Original 2009 Project Proposal**
  - Operate facilities at 2 DOE labs
    - NERSC @ LBNL
    - Livermore Computing @ LLNL
  - LBNL as the host institution

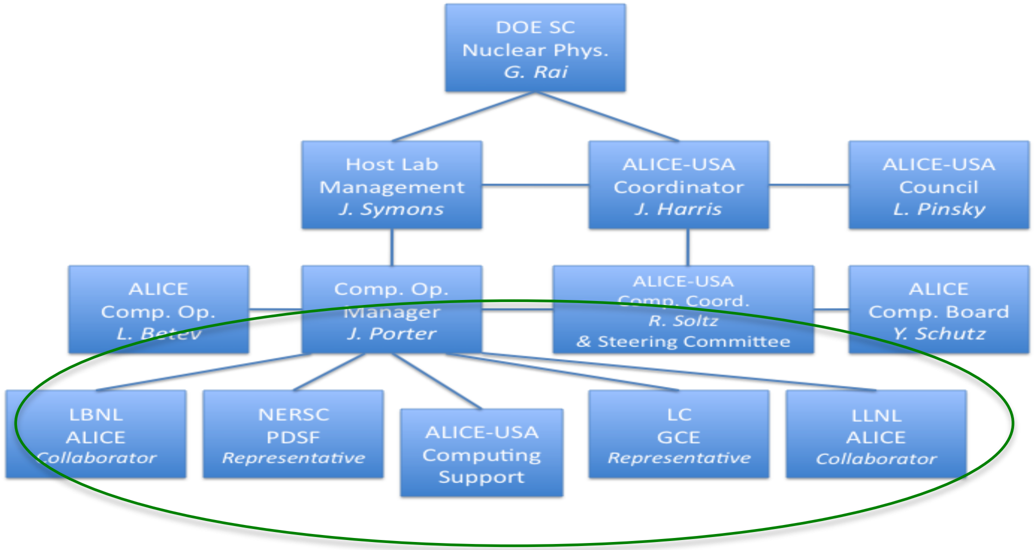


➢ **In operational since 2010**

- **Project working documents:**
  - Project MoU: Institutions and roles
  - Project Execution & Acquisition Plan: → **PEAP**

Project Organization & Computing Steering Committee

Project Org. Chart from original PEAP

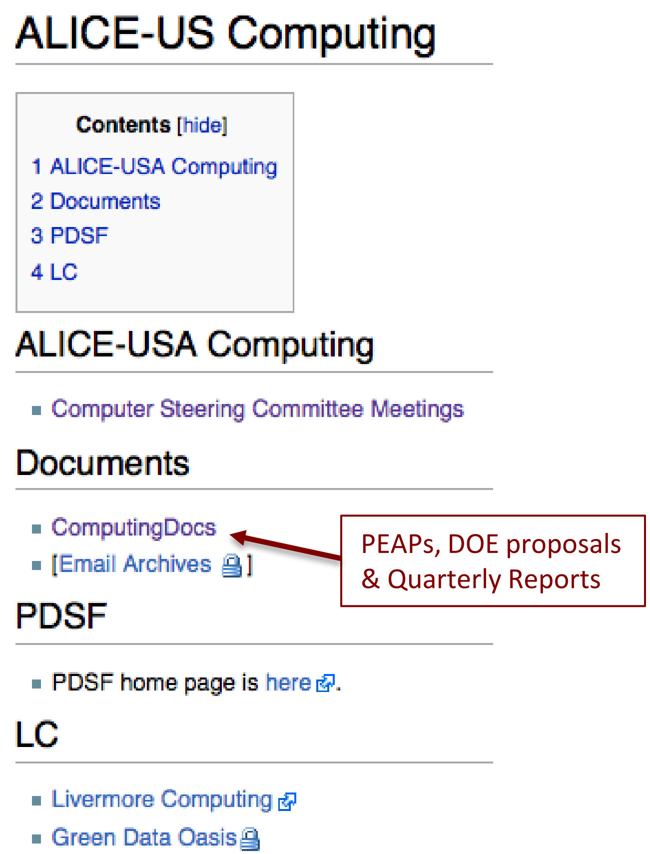


- **Steering Committee:**
  - Jeff Porter LBNL: project manager & ALICE Grid Manager for NERSC
  - Ron Soltz LLNL: Former Computing Coordinator & LLNL ALICE Rep.
  - Jeff Cunningham LLNL: System Admin and ALICE Grid Manager for LC Glcc
  - Iwona Sakrejda & Lisa Gerhardt LBNL: PDSF project lead & user support
  - Formerly Bjorn Nilsen Creighton U.: ALICE-USA contributor (left the field 2013)

Project Organization
Computing Steering Committee

- **Project Communications:**
  - Local wiki: http://rnc.lbl.gov/Alice/wiki/index.php/ALICE-US_Computing
    - Document repository
    - Meeting Agenda & minutes
  - Email list
  - Monthly Meetings

- **Connection to ALICE Grid Operations**
  - Alice-grid-task-force email list
  - Annual US meeting with CERN team since 2012
  - Annual ALICE T1/T2 workshops
    - 2012 @ KIT Germany: I. Sakrejda & J. Cunningham
    - 2013 Lyon, Fr: J. Cunningham & J. Porter
    - 2014 Tsukuba, Jp: J. Cunningham & J. Porter
  - Annual AliEn Developers Workshops
    - 2010 – 2012, J.Porter
    - 2013, J. Porter & B. Nilsen



ALICE-USA Obligation Evaluation

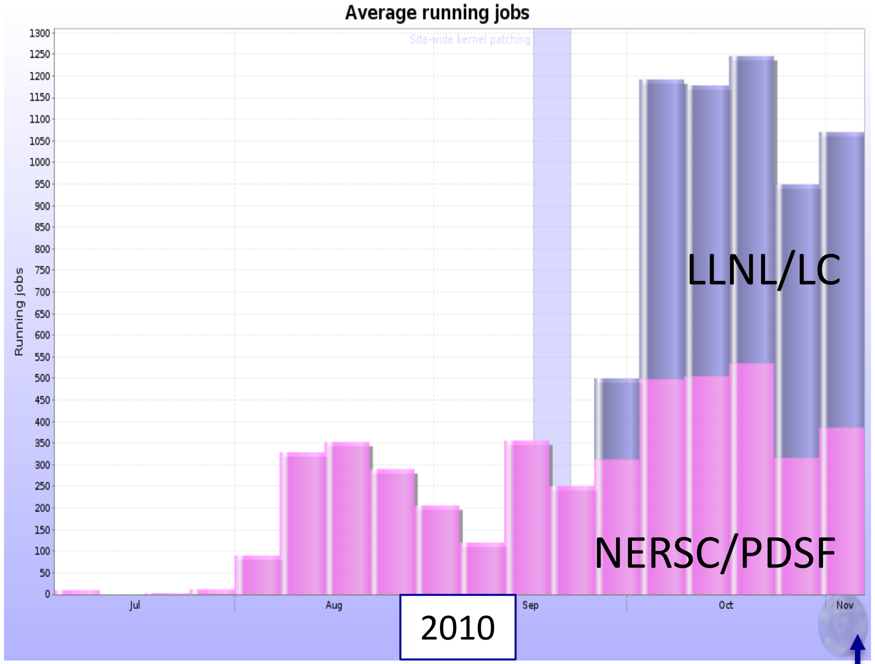
ALICE

- **ALICE Computing Requirements**
  - Annual report to the ALICE Computing Board
  - based on # events, event size, real/MC processing times & samples, data replication …
- **Requirements vetted by WLCG**
  - Final requirements recorded WLCG DB
    - 6 months before they take effect
- **ALICE-USA Obligations:**
  - Fraction of ALICE Requirements
    - Defined by proportion of ALICE-USA to ALICE
  - Each ALICE-USA site pledges its fraction of resources
  - Delivery of combined T2 sites determines whether ALICE-USA obligations are satisfied

Year	FY13	FY14
ALICE Requirements		
CPU (kHEPSPEC06)	265	300
Disk (PB)	26.6	22.9
ALICE-USA Participation		
ALICE Total Ph.D. (Total-CERN)	528	555
ALICE-USA Ph.D.	41	42
ALICE-USA/ALICE (%)	7.8	7.6
ALICE-USA Contributions		
CPU (kHEPSPEC06)	20.7	22.8
Disk (PB)	2.0	1.7

Project History
Startup Phase

- **Initial DOE Funding Released in February 2010**
  - NERSC PDSF deployment
    - Compute & storage, June 2010
    - Final configuration, July 2010
  - LLNL LC deployment
    - Storage, May 2010
    - CPU installed, Aug 2010
    - Final configuration, Sept 2010



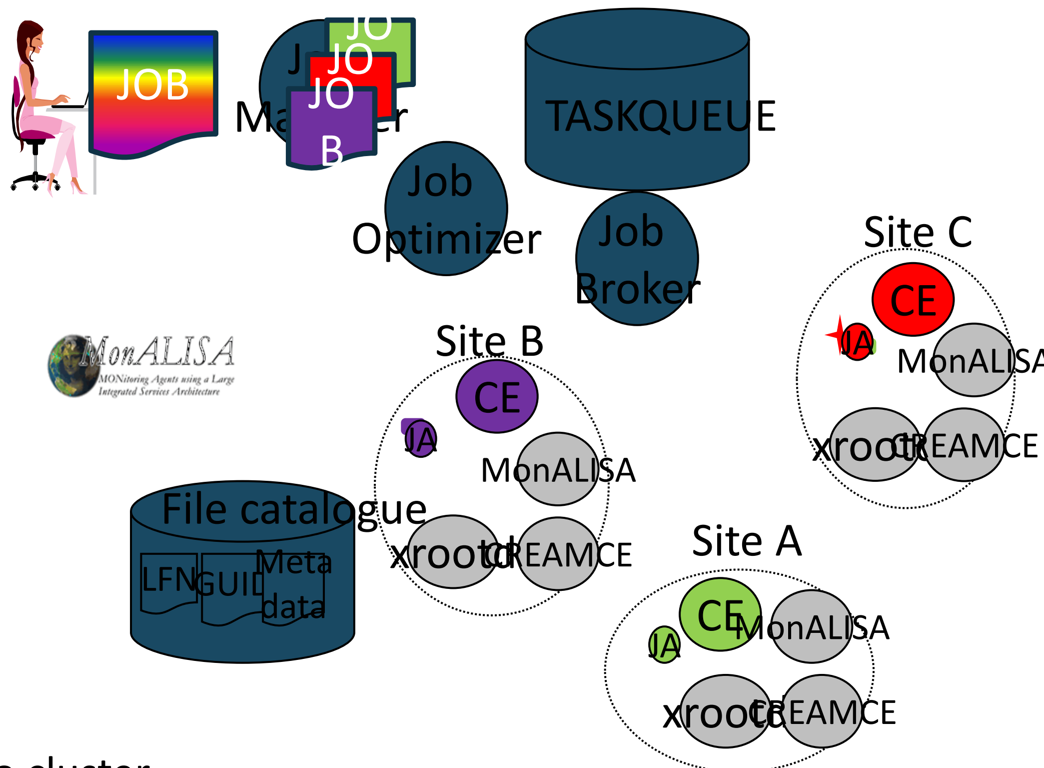
1st LHC Heavy Ion Run

- **Fully Commissioned prior to 2010 LHC Heavy Ion run**
  - Approx. 6-7 months after release of funds

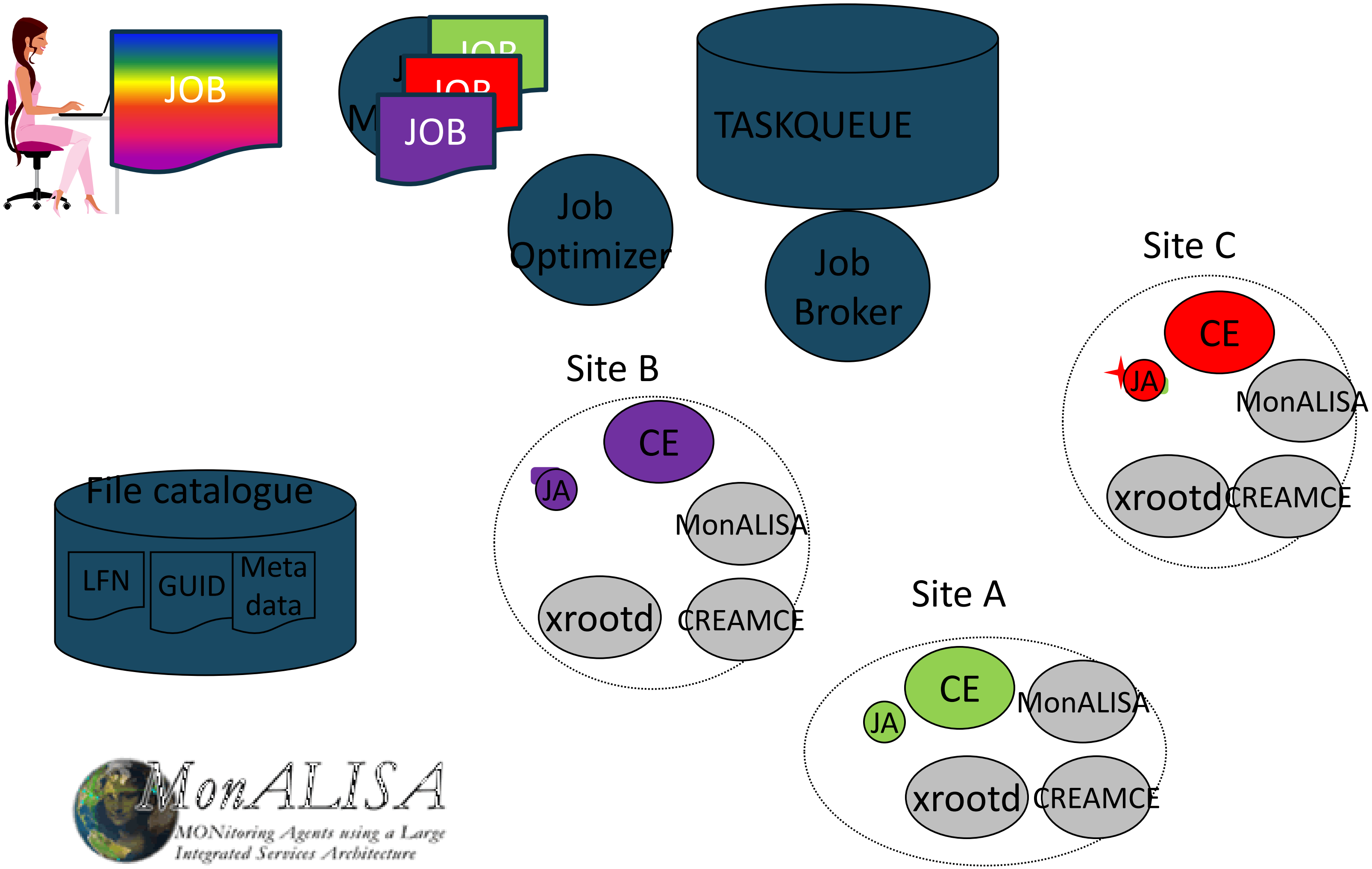
➢ **Computing model was completely new to both facilities**

ALICE Grid Computing Model

- **ALICE Grid Facility**
  - In production since ~2004
  - Small Ops & Dev team @CERN
- **AliEn: 'Alice Environment'**
  - Central Services at CERN
    - Task Queue / Job Broker
    - AliEn File Catalog
    - Monitoring data repository
  - Site Services: VObox
    - Job submission onto site
    - Proxy renewal
    - ~~Software deployment~~
      - now under cvmfs
    - Monitoring
    - POC for central services
  - Job Agents (pilot jobs) submitted onto cluster
    - Submitted when match of job to site resources
    - Pull job information from task queue & executes
  - Grid-enabled storage (SE) at each site
    - Jobs that require input data run at site where data exists



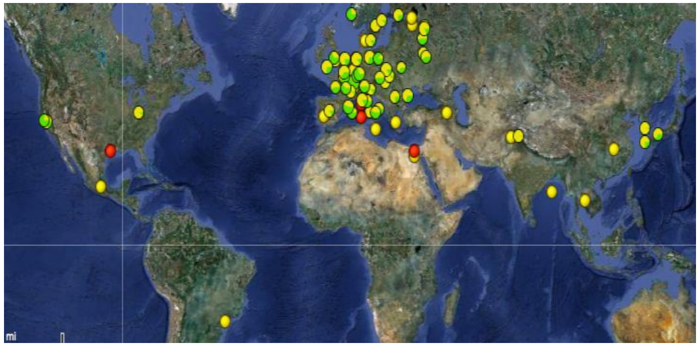
ALICE Grid Model: Job execution



Project History
Early Operations

- **US sites were unique on ALICE Grid**
  – Isolated time zone
  – Largest sites far from Europe
  – Pledged ALICE-only T2 sites
  – No external access to VObox
    - LLNL LC by policy
    - NERSC PDSF by operational details
      – no remote gsissh access
  – WLCG via Open Science Grid (OSG)
    - PDSF submission through OSG CE
    - LC submission direct to PBS w/ OSG accounting

2012 pict.



% of ALICE Pledges outside of Europe
2010 ~1% , 2012 ~10%, 2014 ~20%

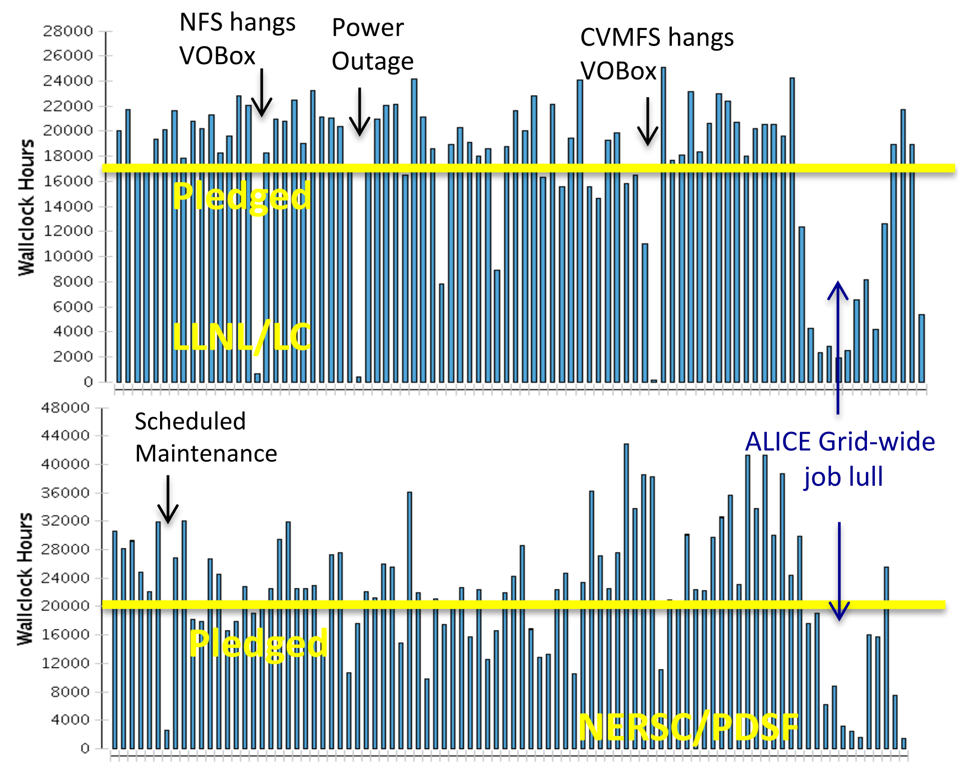
ALICE-USA & The Open Science Grid

- **ALICE-USA computing project leverages OSG capabilities**

  – OSG Registration Authority
    - ALICE-USA user certificates
    - Host & service certificates

  – Reports to WLCG
    - Accounting Reports
      – Gratia site service to OSG rep.
      – Central OSG service to WLCG
    - ~~Availability and Reliability~~
      – ~~critical services scans~~
      – Discontinued as of 01/2014

OSG Gratia Records

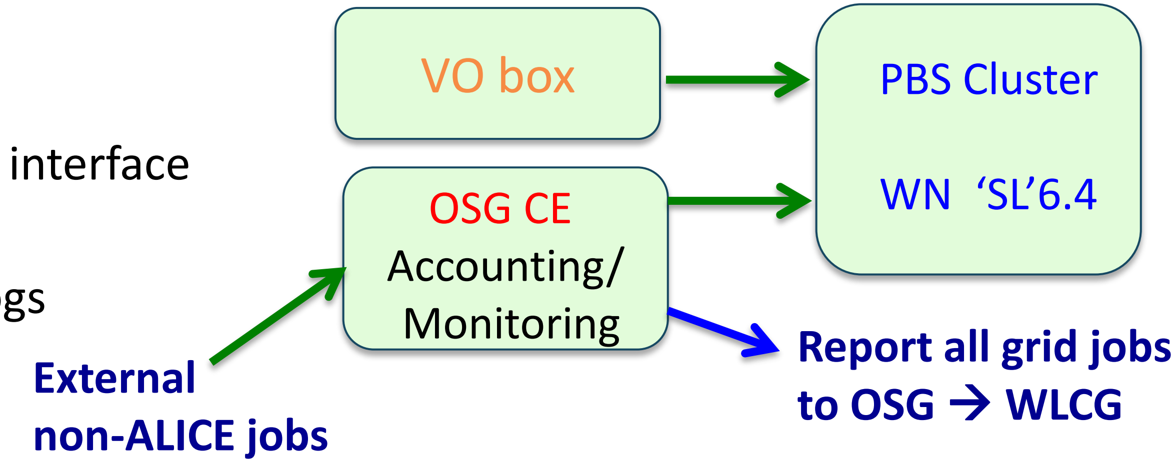


Q1FY14 Project Report Oct 1 – Dec 31, 2013

US Site Configurations

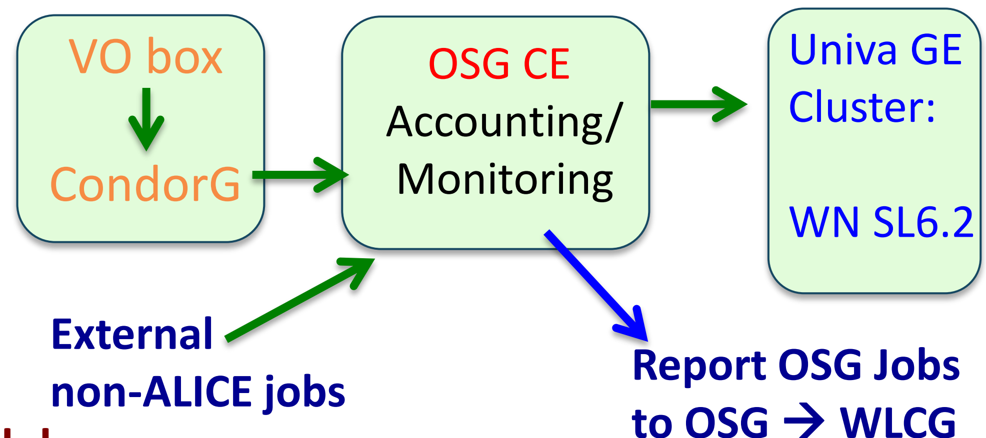
LLNL LC

- Vobox submits to PBS
- OSG-CE: external-only interface
- OSG Accounting
  - Monitors batch logs



LBNL NERSC PDSF

- Vobox submits to CondorG
- CondorG submits to OSG-CE
- OSG-CE submits to UGE
- OSG Accounting
  - Monitors batch logs



- **PDSF expects to move to LLNL model**
  - **ORNL likely as well**

Project History
First DOE Review

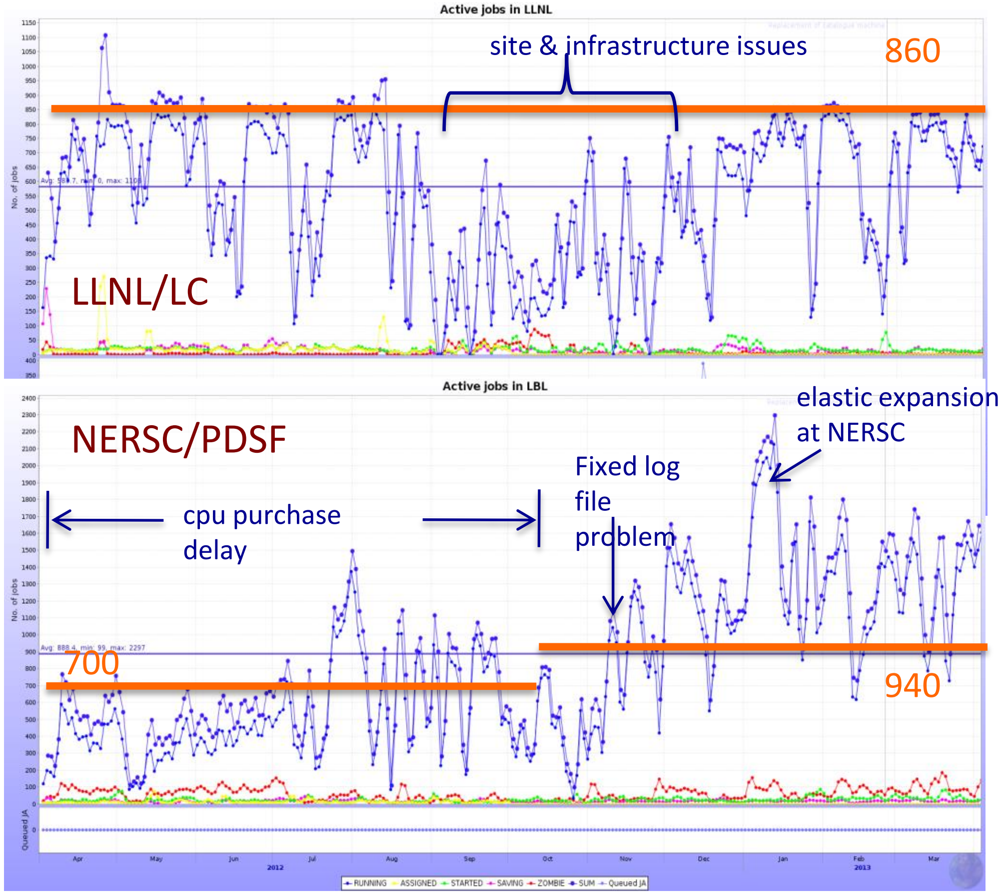
- **1st External Project Review, Oct 2011**
  - Commended project on operations
  - Major Recommendations:
    - Transition to T1 should be delayed or canceled
    - Invite CERN team for annual review
    - Annual update to project plan
      - Review disk procurements based on utilization

Review Finding: ~low disk occupancy after 16 months of operation:
- LLNL::SE ~ 20%
- LBNL::SE ~ 30%

Adolescence: Job levels - 2012 RRB Year

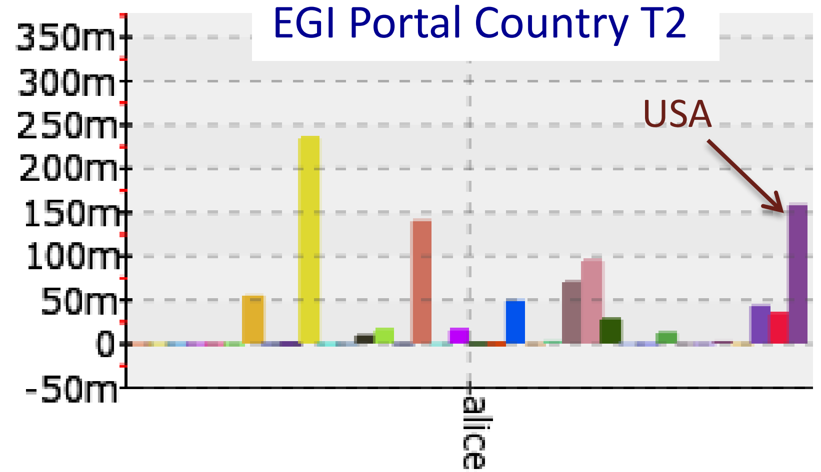
- **Wall clock utilization:**
  - LLNL/LC
    - <Jobs> = 590
    - 9.2 kHS ~ 80% pledge
  - PDSF
    - <Jobs> = 890
    - 13 kHS ~ 110% pledge

- **Issues shown**
  - Unaccounted usage gaps
    - Site services control?
  - cpu deployment delay
  - log issue suppressed use
    - AliEn vs Condor-G
  - Zombie grass on PDSF
    - vmem as a consumable
      - Jobs killed by SGE



Maturing : CPU Utilization 2013 RRB Year

- **CPU Utilization eff: CPU/wall**
  - 65%-70% at both sites
    - Consistent with T2 on ALICE Grid
    - 70% included in WLCG Accounting



- **Utilization relative to pledges**
  - LLNL LC
    - Pledge : 11,500 HS x 24 x 365 x 0.7 (allowed eff.) = 70.5 MHS-hrs
    - Delivered: 66.1 MHS-hrs → **94%**

Under-delivery essentially due to long 3-week upgrade, complicated by no-access to VObox

  - LBNL NERSC
    - Pledge: 12,900 HS x 24 x 365 x 0.7 = 79.1 MHS-hrs
    - Delivered: = 95.0 MHS-hrs →**120%**
  - Combined
    - Pledge = 149.6 MHS-hrs , Delivered = 161.1 MHS-hrs →**108%**

Matured … CPU Utilization 2014 RRB Year

- **More steady operations**
  - Ave job counts:
    - LLNL LC = 780
    - LBNL PDSF = 1056
  - CPU Efficiency
    - LLNL LC = 80%
    - LBNL PDSF = 82%
    - ALICE Grid T2s = 78%
  - Reduced Zombie Grass
    - Allocate 6.5 GB/job
    - costs #-jobs
  - 3 week downtime @LLNL
    - Again due to non-access to VObox

Project History
Storage Capacity & Utilization

- **Storage Deployment History**
  - LLNL LC
    - Initial installation of 685 TB on day 1
  - LBNL NERSC
    - Steady ramp up: 144TB →360TB → 720 TB by 2012
    - Original plan continued ramp to 1.4PB

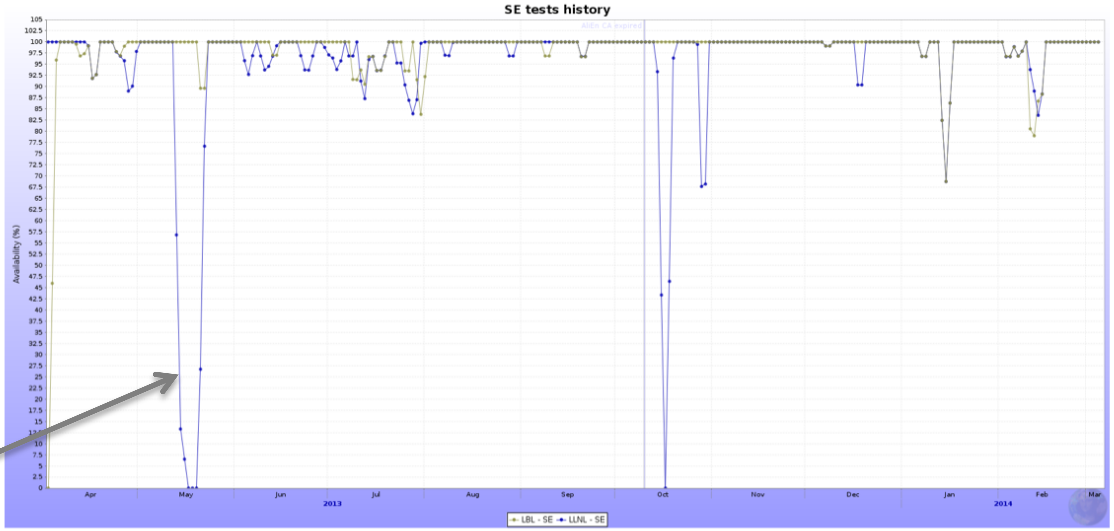
ALICE-USA Storage Elements Capacities & Usage: 05/2014

ALICE SE	#-servers	Useable Space (TB)	Used Space (TB)	% Used
LBL:SE	10	716	447	62.5
LLNL:SE	12	688	376	54.7
Total	22	1404	823	58.6

SE Availability Tests MonALISA Monitoring

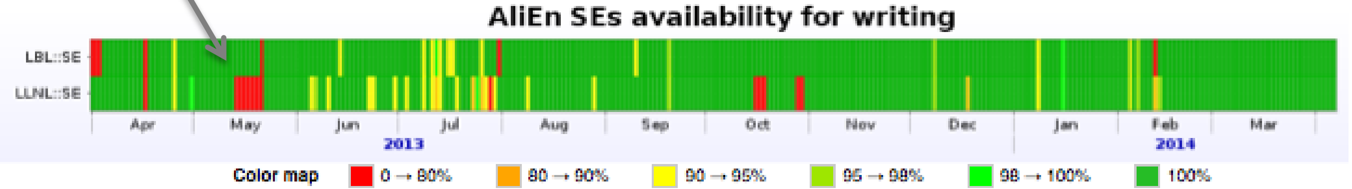
- **AliEn SE availability**
  - LLNL::SE → 96%
  - LBL::SE → 98%

LLNL Upgrade outage



SE tests history

	Series	Last value	Min	Avg	Max
1.	LBL - SE	100	0	98.19	100
2.	LLNL - SE	100	0	95.04	100
	Total	100		96.62	

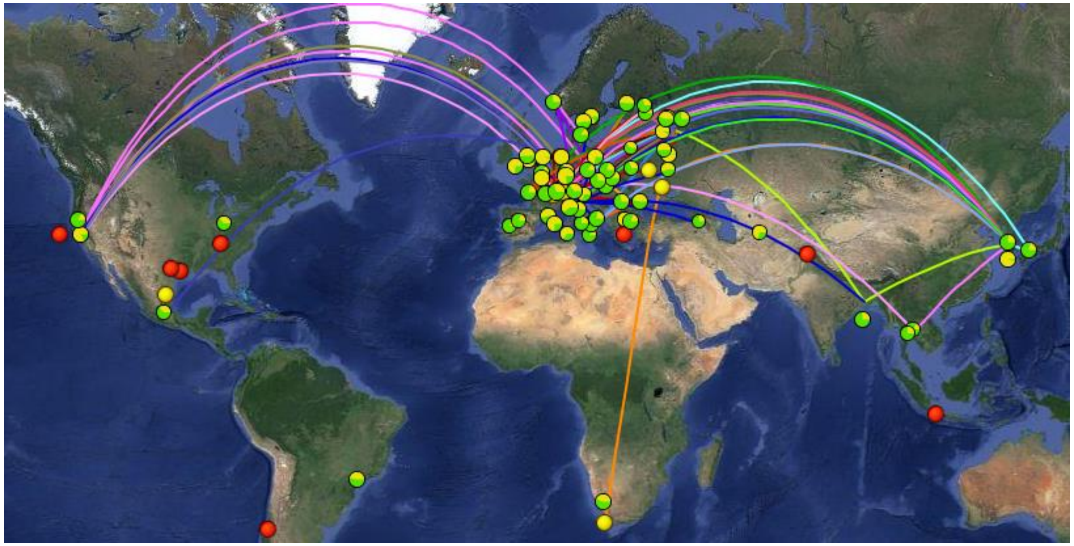


Statistics

Link name	Data		Individual results of writing tests			Overall
	Starts	Ends	Successful	Failed	Success ratio	Availability
LBL::SE	31 Mar 2013 06:05	07 Apr 2014 04:19	4383	75	98.32%	98.47%
LLNL::SE	31 Mar 2013 06:04	07 Apr 2014 04:20	4268	190	95.74%	96.01%

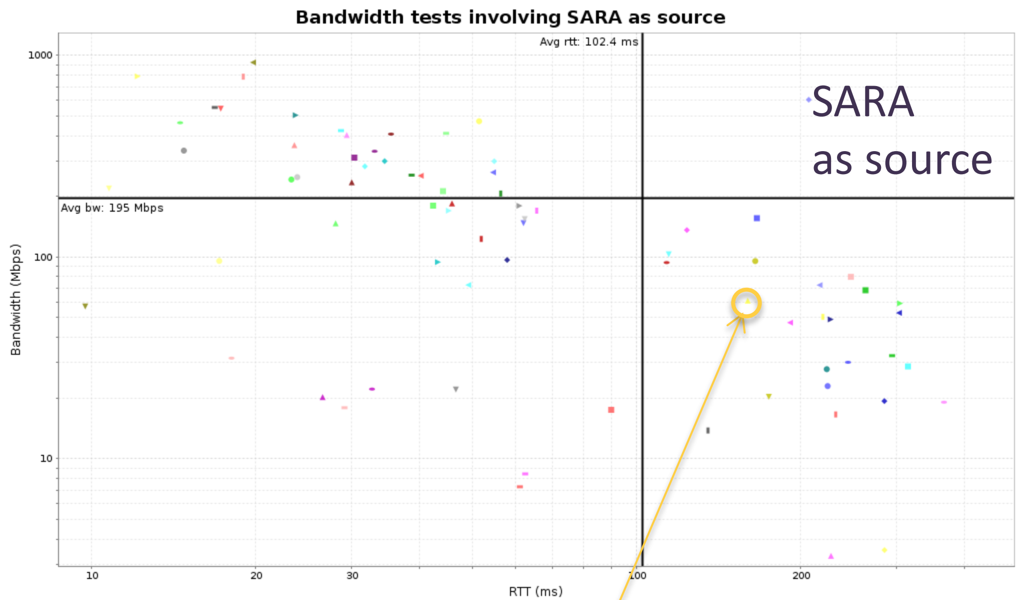
Storage Utilization & ALICE Data Replication Model

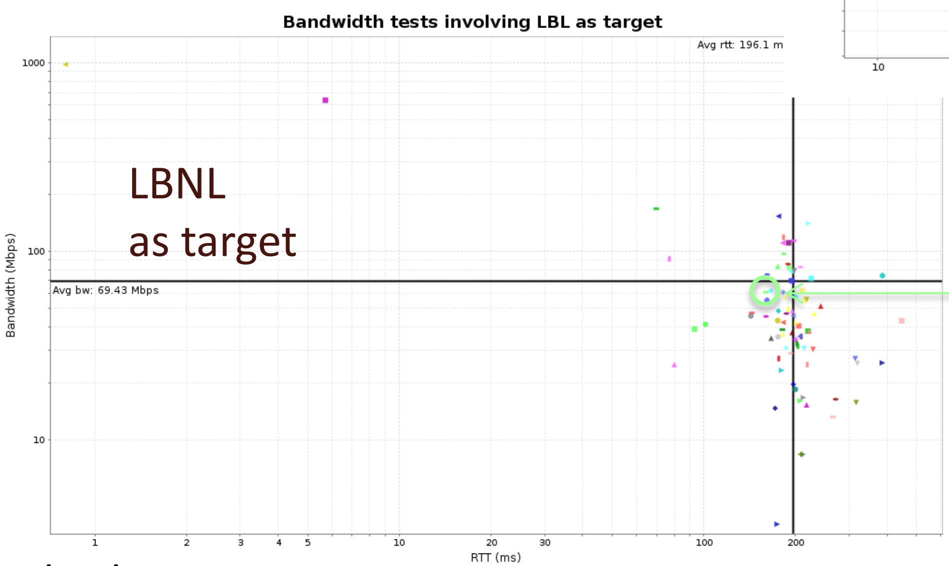
- **Data replication done at job completion**
- **Generated data**
  - 1 copy sent to local storage element
  - 1 copy to storage that is “nearby” in RTT time
    - RTT between sites are measured routinely
  - 1 copy may be randomly distributed



AliEn Network tests used in data replication algorithm

- **Probes: single stream**
  - algorithm based on RTT
- **All ALICE sites → LBNL**
  - <RTT> = 196 ms
- **SARA → all ALICE sites**
  - <RTT> = 102 ms

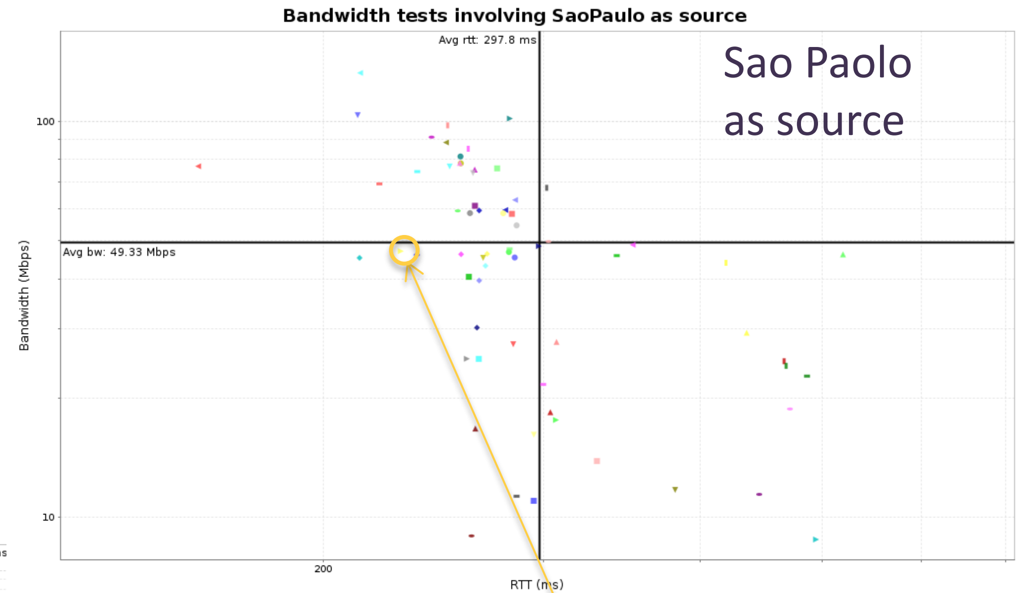


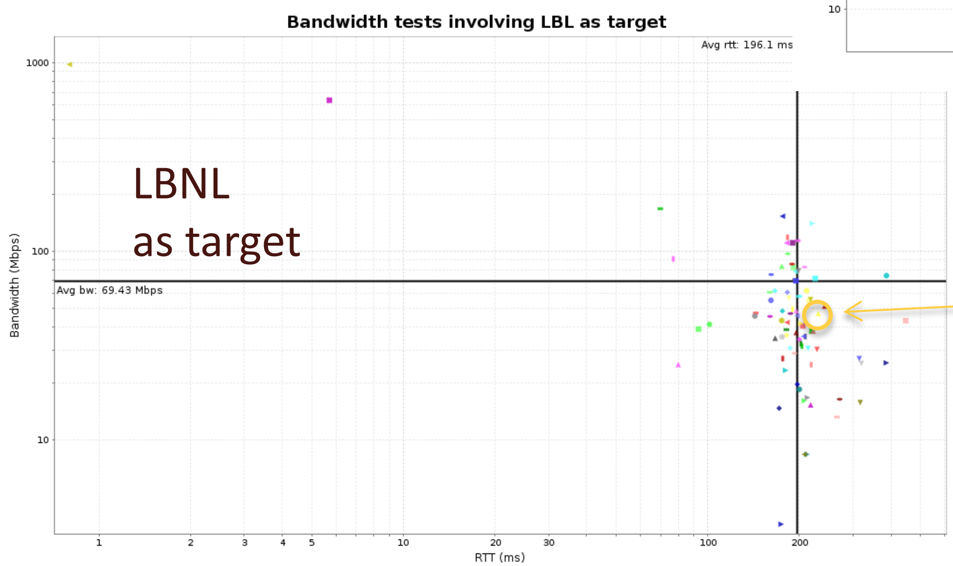


SARA → LBL
RTT = 160 ms

AliEn Network tests used in data replication algorithm

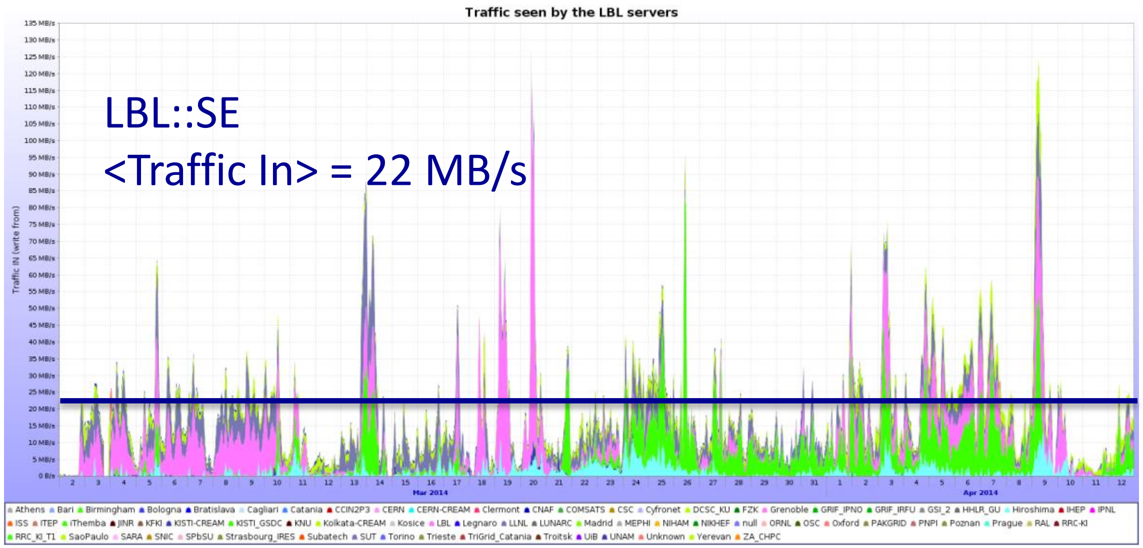
- **Probes: single stream**
  - Algorithm based on RTT
- **All ALICE sites → LBNL**
  - <RTT> = 196 ms
- **Sao Paulo → all ALICE sites**
  - <RTT> = 300 ms



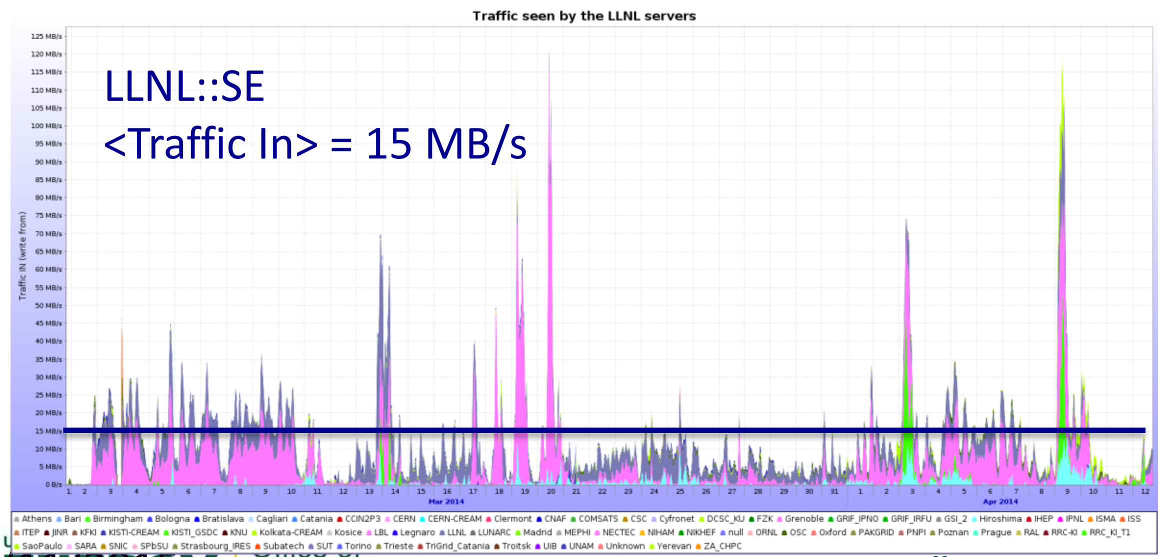


Sao Paulo → LBL
RTT = 230 ms

Traffic Into US Storage by Source



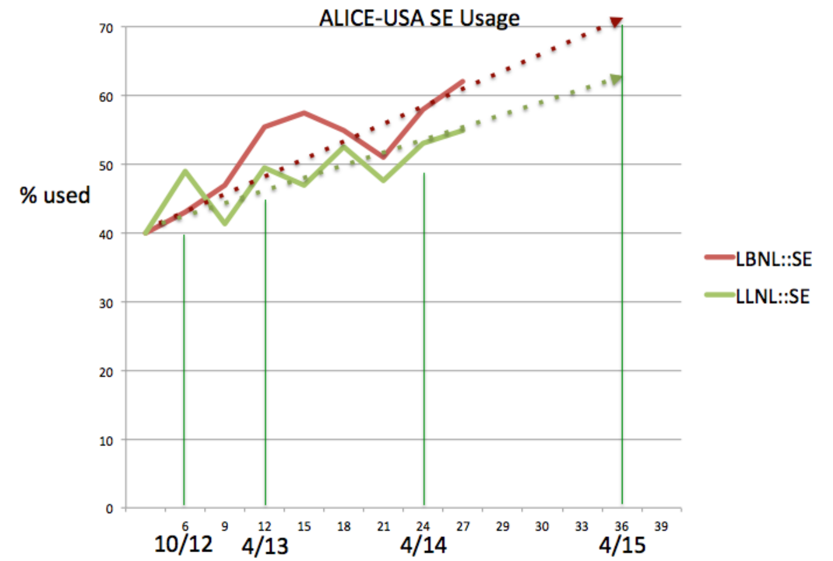
Top Sites	LBL::SE
LBNL	6.0 MB/s
KISTI	5.0 MB/s
LLNL	4.5 MB/s
Sao Paulo	2.0 MB/s
Hiroshima	1.5 MB/s
UNAM	0.5 MB/s
All Europe	**1.0 MB/s**

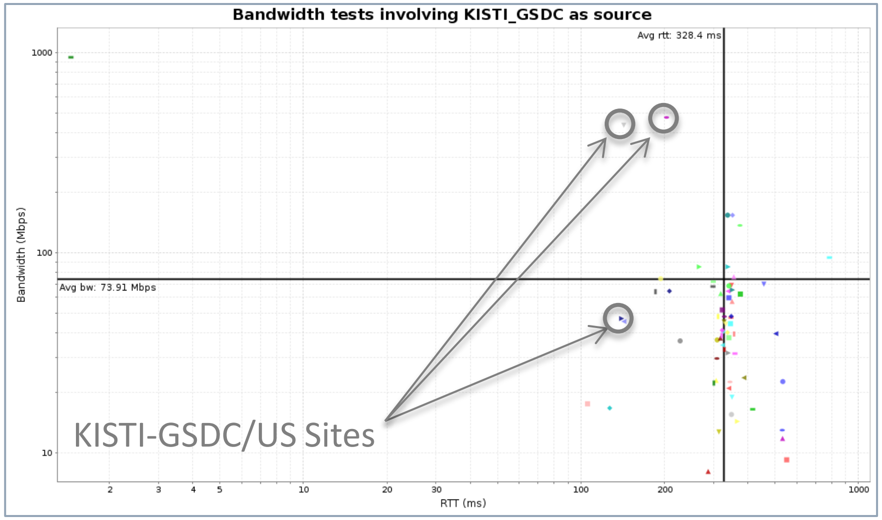


Top Sites	LLNL::SE
LBNL	6.0 MB/s
LLNL	4.5 MB/s
KISTI	1.0 MB/s
Hiroshima	1.0 MB/s
Sao Paulo	0.5 MB/s
UNAM	0.5 MB/s
All Europe	**1.0 MB/s**

Storage utilization in the future

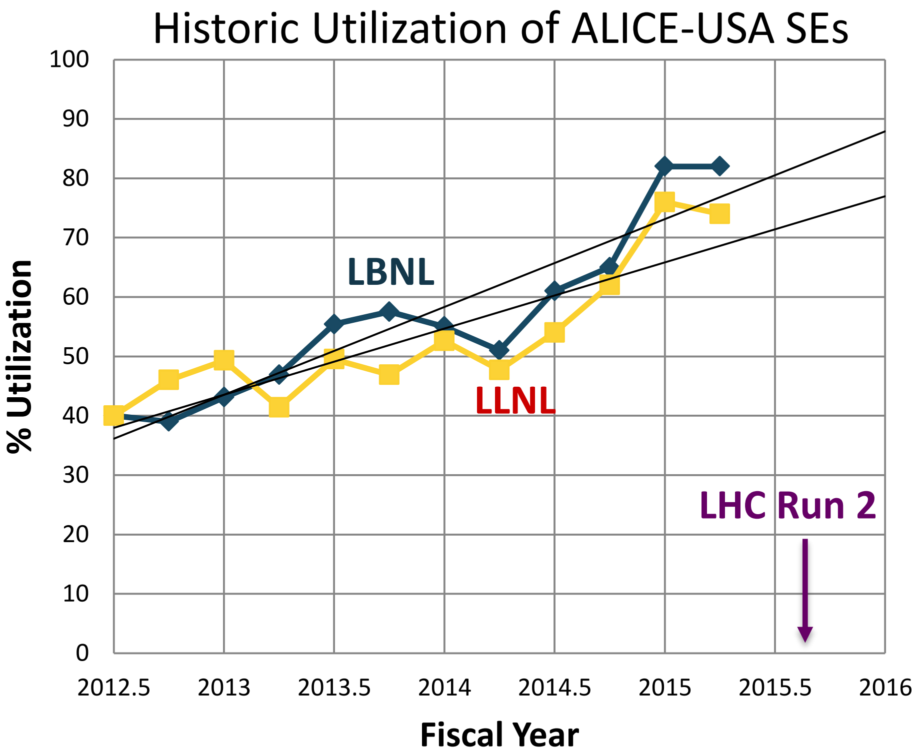
- **Storage growth pattern**
  - LLNL::SE ~ 50 TB/year
  - LBNL::SE ~ 70 TB/year
- **Potential change for Run 2**
  - Tier 1 @ KISTI established in LS1
  - Larger CPU resources than in US
    - will participate in raw data reco
  - KISTI sees US sites as ‘nearby’





… and in fact, we're in the future now

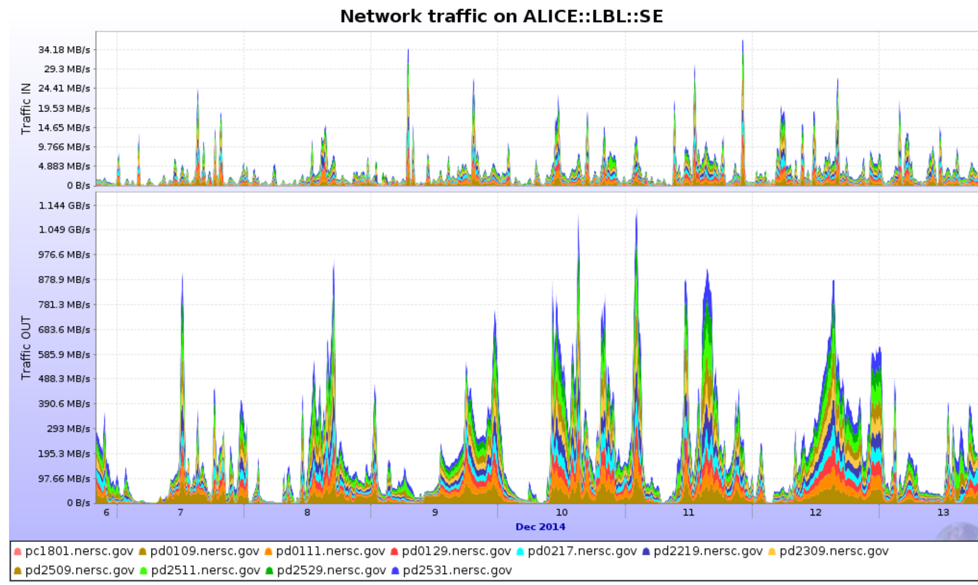
- **April – September saw 30% increase in utilization**
  - Algorithm preference to high-available SEs
  - Cleaning operations reduced all SEs in Fall 2014



SE I/O Performance

- **ALICE::LBL::SE**
  - ALICE XRootD installation
  - 10 Servers + 1 redirector
  - 720 TB

- **Observations**
  - Data & I/O evenly distributed across servers
    - via XRootD
  - Ave ~250MB/s aggregate
  - ~250MB/s peak/server
    - 2.5GB/s peak aggregate



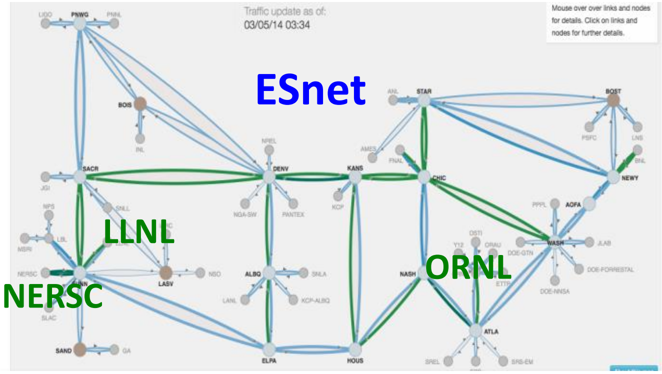
	Series	Last value	Min	Avg	Max	Total
1.	pc1801.nersc.gov	4.253 KB/s	0.302 KB/s	4.694 KB/s	47.26 KB/s	2.705 GB
2.	pd0109.nersc.gov	18.19 MB/s	0.237 KB/s	22.85 MB/s	144.5 MB/s	13.17 TB
3.	pd0111.nersc.gov	24.72 MB/s	0.23 KB/s	18.36 MB/s	241.2 MB/s	10.58 TB
4.	pd0129.nersc.gov	25.24 MB/s	0.231 KB/s	18.81 MB/s	138.4 MB/s	10.84 TB
5.	pd0217.nersc.gov	32.17 MB/s	0.229 KB/s	20 MB/s	128 MB/s	11.53 TB
6.	pd2219.nersc.gov	28.15 MB/s	0.216 KB/s	21.74 MB/s	167.2 MB/s	12.53 TB
7.	pd2309.nersc.gov	27.56 MB/s	0.231 KB/s	19.39 MB/s	146.9 MB/s	11.17 TB
8.	pd2509.nersc.gov	44.9 MB/s	0.226 KB/s	24.28 MB/s	187.6 MB/s	13.99 TB
9.	pd2511.nersc.gov	50.14 MB/s	0.227 KB/s	26.28 MB/s	178.4 MB/s	15.14 TB
10.	pd2529.nersc.gov	28.8 MB/s	0.23 KB/s	21.87 MB/s	160 MB/s	12.6 TB
11.	pd2531.nersc.gov	60.78 MB/s	0.236 KB/s	26.6 MB/s	155.7 MB/s	15.33 TB
	Total	**340.7 MB/s**		**220.2 MB/s**		**126.9 TB**

Project Future
Run 2 and Beyond

- **Our FY14 PEAP update included a refresh of all LLNL HW**
- **2nd External Review was scheduled for Feb 20-21, 2014**
  - ➢ Dec. 2013, LLNL Group informed ALICE-USA of plan to withdraw from ALICE
    - ALICE T2 site @ LLNL to be decommissioned at the end of FY2015

- **DOE NP requests a new project proposal & rescheduled review**

- **New 2014 Project Proposal:**
  - Re-establish distributed ALICE T2 facility
    - Continue T2 operations at NERSC PDSF
      - with relocation to new building at LBNL
    - Establish new T2 site at ORNL CADES
  - Retain LBNL NSD as the Host Institution



2nd External Project Review

- **Presented new proposal and Project Execution and Acquisition Plan (PEAP)**
  - June 2-3 2014 @ DOE in Germantown, Md.

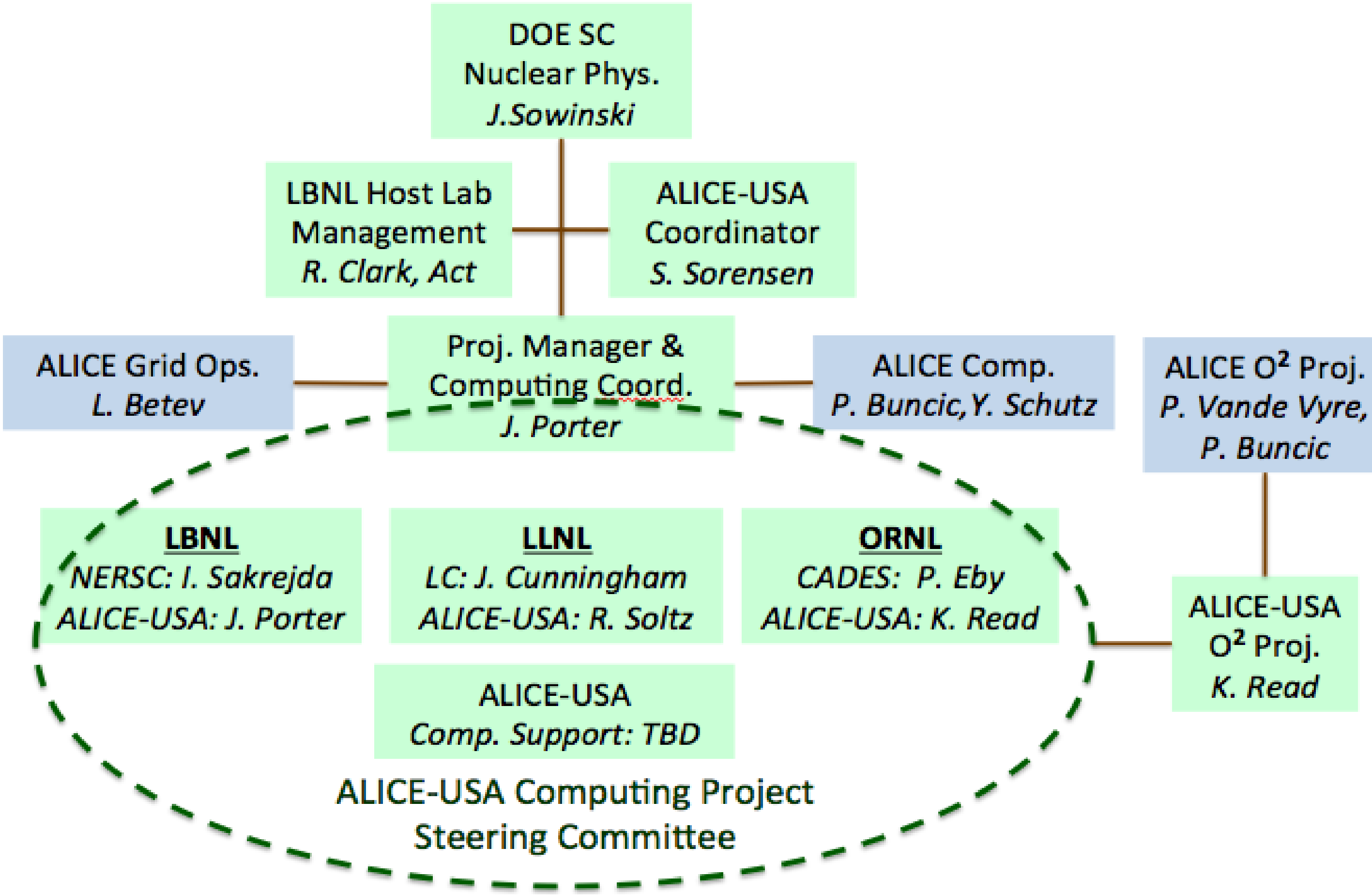
- **Overall endorsement of the project proposal:**
  - "The [ALICE-USA LHC T2] site has been run well and has met its obligations to the collaboration both in resources installed and in performance."
  - "The participation of ORNL/CADES as the second site for the ALICE-USA Tier 2 site is an excellent proposal and the flexibility to optimize for ALICE applications is a valued approach."

- **Review provided four recommendations to improve operations**
  1. Define & present to DOE NP clearer site performance metrics
  2. Design a contingency plan to address disk shortfall in case of greater ALICE utilization
  3. Revised new hardware cost estimates base on extrapolated multi-year trends
  4. Hold an external expert review to assess technology choices prior to major purchases

- **Project response has satisfied all four recommendations**

  ➢ DOE Released funds in January 2015

Project Future Organization



Retains current structure with ORNL added plus input from ALICE O^2 Project

Project Organization Continues

- **Project Communications:**
  - Local wiki: http://rnc.lbl.gov/Alice/wiki/index.php/ALICE-US_Computing
    - Document repository
    - Meeting Agenda & minutes
  - Email list
  - Monthly Meetings

- **Connection to ALICE Grid Operations**
  - Alice-grid-task-force email list
  - Annual US meeting with CERN team since 2012
    - 2014 https://indico.cern.ch/event/310399/
      - with ORNL participation
  - Annual ALICE T1/T2 workshops
    - 2012 @ KIT Germany: I. Sakrejda & J. Cunningham
    - 2013 Lyon, Fr: J. Cunningham & J. Porter
    - 2014 Tsukuba, Jp: J. Cunningham & J. Porter
    - 2015 Torino, Italy: P. Eby & J. Porter


ALICE-US Computing

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ALICE-USA Computing

- Computer Steering Committee Meetings

Documents

- ComputingDocs
- [Email Archives]

PDSF

- PDSF home page is here.

LC

- Livermore Computing
- Green Data Oasis

Random list of items we'd like to cover during this workshop

- **Hardware deployment schedule**
- **Transition details**
  - Copy data to new SEs
  - Pledging resources
  - Decommissioning LLNL LC
- **HS06 measurements**
- **Role of OSG, optimum deployment**
- **SLURM @ NERSC/ORNL?**
- **EOS deployment / configuration**
- **LAN → bandwidth (vs efficiency)**
- **WAN → firewall, LHCONE: ORNL, NERSC?**
- **Memory use & cpu**
- **Service status monitor**
- **Local monitoring tips**