Belle II Computing Overview

DAVID ASNER, DAVID COWLEY, KEVIN FOX, MALACHI SCHRAM, LYNN WOOD
Pacific Northwest National Laboratory
2015 Open Science Grid All-Hands Meeting
Belle II Collaboration

March 24th, 2015

2015 Open Science Grid All-Hands Meeting

Belle II Collaboration

ATLAS: 38 countries, 177 institutes, ~3000 members
CMS: 42 countries, 182 institutes, 4300 members
ALICE: 36 countries, 131 institutes, 1200 members
LHCb: 16 countries, 67 institutes, 1060 members

c.f.

Asia: ~45%  N. America: ~16%  Europe: ~39%
Japan: 141  US: 72  Germany: 88
Korea: 36  Canada: 17  Italy: 61
Taiwan: 26  Mexico: 8  Russia: 38
India: 26  Slovenia: 17
China: 19  Austria: 14
Australia: 21  Poland: 11
others: < 5 colleagues / country
Czech rep.: 7
The Belle II Computing model will manage in a geographically distributed environment the following main tasks:

- RAW data processing.
- Monte Carlo Production
- Physics analysis
- Data Storage and Data Archiving

On going activities

- Resource Estimation
- Defining strategy for analysis and data distribution
- Developing automated data replications and failover
- Evaluating technologies
The Belle II Computing Sites are categorized as follow:

- **Raw data Center**: Stores the RAW Data and data processing and/or data reprocessing

- **Regional Data Center**: Large data center that stores mDST and participates at the Monte Carlo production

- **MC Production site**: Data Center that produces and stores Monte Carlo simulations, that included:
  - Grid Site
  - Cloud Site
  - Computing Cluster Site
Belle II Distributed Computing Model

Belle II Computing Model

Raw data storage and processing
KEK Data Center
PNNL Data Center
Raw Data Center

Asia
Regional Data Center

Europe 1
Europe 2

MC production site
GRID site

Cloud site
Computer cluster site

Local resource

Raw data
mdst Data
mdst MC
dashed inputs for
Ntuple

CPU
Disk
Tape

MC production and
Physics analysis skims

User analysis
(Ntuple level)
US Belle II Computing Operations

► Provide all required Belle II services for proper site operations

► Lead the Belle II networking and data transfer effort
  ■ Coordinate network connectivity between sites (LHCOME, etc.)
  ■ Lead network data challenges
  ■ Network monitoring

► Develop and deploy components of the Data Management System
  ■ Develop Belle II Storage Accounting System (B2SAS)
  ■ Develop automated data replications and failover system
  ■ Develop and optimize FTS3/DIRAC interface

► Develop and deploy the Distributed Database System

► Participate in Monte Carlo and processing/re-processing efforts
US/PNNL Role: 15% of Belle II Compute/Data

“Each Belle II member institute provides… the computing resources to produce, store, and make available for analysis a fraction of the total simulated dataset… The fraction corresponds to the fraction of PhDs in the international Belle II collaboration”

PNNL is ideally suited to provide this capability:

- Office of Science Laboratory
- Core capability in advanced computer science, visualization, and data
- EMSL and ARM user facilities
- Wide Area Network Connectivity via ESNet
- Ability to draw on resources across organizational boundaries/disciplines

Belle II Resources come from multiple entities

- PNNL: Olympus nodes, Data Transfer Node, /pic filesystem space, 10 Gigabit WAN connectivity
- US-Japan: Servers, Storage, Network switches
- DOE: Labor, Hardware
PNNL Belle II Site Planning

- Underlying infrastructure

- OSG Software Stack
  - Authorization Service
  - Compute Element
  - Worker Nodes
  - Storage Elements

- Other Software
  - DIRAC servers
  - CVMFS stratum-0 and clients
  - Squid servers
  - Conditions database services
  - FTS3 servers
  - perfSONAR servers and mesh
Established System Support

- Experienced computational staff matrixed to the project:
  - High Performance Computing Operations
  - Wide Area Networking
  - Database Design and Development
- Dedicated 10 Gbps LHCONE
- Shared 10 Gbps via Public Internet
- Set up Belle II data infrastructure
  - 175 TB storage capacity
  - Mixture of Lustre filesystem and CEPH distributed object store
- Implemented system administration infrastructure with monitoring and trouble ticket systems for Belle II

March 24th, 2015
2015 Open Science Grid All-Hands Meeting
Established Software Stack

- Standardized on Scientific Linux 6 plus OpenStack private cloud technology for compute services
  - Enables rapid prototyping, development, testing, deployment of services
  - Increases flexibility, reliability of PNNL Belle II resources
  - Provides better utilization of compute resources by provisioning virtual machines
  - Job throughput (as reported by DIRAC) is twice that of the Olympus (PIC) system, using identical hardware
- Demonstrated that HEP jobs could productively be run in backfill windows on EMSL Cascade supercomputer
Cloud tenants enable separation of production and development environments

Current activities in development and testing on cloud tenants:

- Grid services: CE, SE, Squid, CVMFS clients
- Database: REST API, BASF2 Conditional Databases Services, CVMFS stratum-0
- BelleDIRAC: Metadata catalog & distributed data system
Compute Element

- Originally using OSG CE stack (push-method)
  - Interaction between DIRAC/OSG-CE is inefficient for job scheduling
  - Limited batch system support (Condor, PBS, LSF, and SGE are presently supported)
  - Using CondorHT for dedicated HEP cluster queue (grid & local use)
    - Previous updates removed site specific configurations

- Migrate to DIRAC SiteDirector (pull-method)
  - Quick solution to increased job scheduling efficiency (nearly 100%)
  - Developed for SLURM batch system support for PNNL HPC resources
  - Easier to get cyber security approval

- We are re-visiting OSG CE stack to provide opportunistic compute cycles to OSG community
Worker Nodes

- Using OSG WN stack
- Worker nodes are launched on our private OpenStack cloud
- Using heat templates to configure/launch node in cloud
  - Base heat template and/or VM images from OSG?
- Using CVMFS client to access experiment repos (Belle II, ILC, and other HEP experiments)
  - Proxy through a local load balanced Squid farm
  - Access remote and local CVMFS stratum-0 and stratum-1
Storage Element

- Using Lustre backend file system

- Initially using Bestman2, however, problems:
  - Randomly unresponsive
  - Adler-32 support not working properly
  - Updates overrides existing configurations files
  - Unclear how to scale system: stateless vs. stateful information
  - No response from developers

- Investigating Storm SE
  - Clear stateless/stateful separation for scalability
  - Support Adler-32 out of the box
  - Active development and quick response

March 24th, 2015
Other Services

- Squid farm behind a Virtual Load Balancer
  - Common external hostname
  - Several modes to load balance

- CVMFS Stratum-0 at PNNL
  - Belle II conditional database payload repository
  - Other HEP experiments software (superCDMS, MiniCLEAN, etc.)

- File Transfer Service 3 (FTS3)
  - Used for mass data transfers
  - Clear stateful/stateless separation for scalability

- PerfSONAR server and mesh
  - Used for network monitoring
  - perfSONAR servers are online
  - Dedicated Belle II perfSONAR mesh is ready for testing
Belle II MC4 Monte Carlo Campaign Successful

- September 22 – November 7 2014
- Typically ~576 jobs running
- PNNL Belle II Grid Site contribution:
  - 24 compute nodes
  - 90,102 jobs
  - 22,128.3 Wall Clock Days
- PNNL Cascade Supercomputer contribution:
  - 63,132 jobs
  - 5,804 Wall Clock Days
- Issue: periodic job stalling events.
  - Cause: aggressive port scans by PNNL’s own cyber security organization
  - Fix: get them to turn down intensity
Enabling Opportunistic HPC Computing for HEP

- Ideal resource for stressing the distributed system while delaying procurements of dedicated resources
- PNNL has several large clusters (e.g. Cascade, etc.)
- We setup a gateway node on Cascade to provide gateway services for HEP computing (ATLAS/Belle II)
  - NAT through gateway node allows Cascade nodes to talk to selected HEP sites
  - Appropriate firewall changes were made
- OSG client software was integrated into Cascade node image
- Developed Belle II DIRAC SLURM Site Director agent (submitted to DIRAC developers)
- New queue was setup on Cascade to allow multiple single-core jobs to share a compute node
- Approximately 10% of the available CPU on Cascade was used at one time (>20kHEPSpec)
Goal: Demonstrate that HEP jobs can run in “backfill” windows on parallel supercomputers

- 20,000 node hours allocated on PNNL/EMSL Cascade supercomputer
- DIRAC Site Director, Squid, and CVMFS set up on an ancillary Cascade node
- Cascade queuing policy adjusted to:
  - Create “Shared” queue that allowed more than one job on a node
  - Not clean the entire compute node when a job completed
HEP on HPC Lessons learned

- HEP workload can backfill very effectively between large parallel jobs!
- HEP jobs need to be tailored to fit well on parallel HPC systems
- Opportunities:
  - Run multicore jobs
  - “Right-size” job length for the target system
Latest network requirements for Belle II estimates a total of 35Gbps in/out at designed luminosity
- Does not include user analysis

FTS3 Server:
- Previously used for Data Challenges and performance studies
- Requires continuous studies of the FTS3 transfers to tune the channels as needed (FTS3 optimization not perfect yet)

DIRAC Integration:
- Prototype Belle II FTS3 DIRAC Agent was developed to automate the Data Challenges and to gain experience with DIRAC/FTS3
- Working on doing DIRAC transformation using FTS3
- Monitoring and tuning distributed computing data transfers will be vital to stable operations
  - Using WLCG FTS3 Dashboard, however, we should move to DIRAC monitoring
  - We will deploy Belle II perfSONAR mesh this spring to provide automated network monitoring
Belle II Raw Data Distribution

**Scenario 1** (copy from KEK)
- KEK Data Center (100%)
- PNNL Data Center (100%)
- North America
  - PNNL Data Center (30%)
  - Canada Data Center (10%)
- Asia
  - India Data Center (10%)
  - Korea Data Center (10%)
- Europe
  - Germany Data Center (20%)
  - Italy Data Center (20%)

**Scenario 2** (2-step copy, KEK → PNNL → Europe)
- KEK Data Center (100%)
- PNNL Data Center (70% → 30%)
- North America
  - PNNL Data Center (70% → 30%)
  - Canada Data Center (10%)
- Asia
  - India Data Center (10%)
  - Korea Data Center (10%)
- Europe
  - Germany Data Center (20%)
  - Italy Data Center (20%)
Goals Achieved based on Pacific Network and Computing Requirements

The purpose was to address the wide-area networking requirements for science in general and of the Belle II experiment in particular.

Report can be found at:
http://www.es.net/assets/pubs_presos/Belle-II-Experiment-Network-Requirements-Workshop-v18-final.pdf

Various goals were defined, for example:

- Setup KEK-PNNL VC
  - Done

- Preliminary data challenge goals are:

<table>
<thead>
<tr>
<th>Date</th>
<th>Summer 2013</th>
<th>Summer 2014</th>
<th>Summer 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>100MB/sec</td>
<td>400MB/sec</td>
<td>1000MB/sec</td>
</tr>
<tr>
<td>Duration</td>
<td>24 hours</td>
<td>48 hours</td>
<td>72 hours</td>
</tr>
</tbody>
</table>

Very Challenging
Higher Data Transfer Rates Achieved using File Transfer Service 3 (FTS3)

- Tuning FTS3 allowed us to reach ~8.8 Gbps transfer rates from PNNL to KEK
- Load balanced cloud implementation is currently being tested
Goals Achieved based on European Networking Workshop

- Network requirements and milestones need to be reviewed

- The purpose of this workshop was to begin preparation for addressing the wide-area networking requirements for science in general and of the Belle II experiment in Europe

- Initial milestones:

<table>
<thead>
<tr>
<th>Date</th>
<th>Winter 2013</th>
<th>Summer 2014</th>
<th>Summer 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>100MB/sec</td>
<td>200MB/sec</td>
<td>400MB/sec</td>
</tr>
<tr>
<td>Duration</td>
<td>24 hours</td>
<td>48 hours</td>
<td>72 hours</td>
</tr>
</tbody>
</table>

*Using ANA-100 link*
Trans-Atlantic Goals Achieved using Belle II ANA-100 Setup

- First few days we conducted tests using **IPERF** for true network testing
- Required several parallel transfers to reach network saturation

- Transitioned to FTS3 server
- Reached network saturation but rates fell very quickly
- Large amount of dropped packets
The network requirements for Belle II are similar to the LHC experiments.

Most Regional Data Centers are already part of LHCONE

Belle II presented the computing/networking requirements at LHCONE Meetings

- LHCONE Asia-Pacific Workshop - Nantou, Taiwan, 13 August 2014
  (presented by Takanori Hara)
- LHCOPN-LHCONE Meeting - Ann Arbor, Michigan, Sept. 15-16th 2014
  (presented by Malachi Schram)

LHCONE agreed to add Belle II at the Ann Arbor meeting

New LHCONE Acceptable Use Policy explicitly includes Belle II:

https://twiki.cern.ch/twiki/bin/view/LHCONE/LhcOneAup
Connecting PNNL, KEK, and LHCONE
(Setup to stay in place thru June 2016)

- KEK-PNNL VC transfer tests are ongoing
- Debugging LHCONE connection
- One dedicated Data Transfer Node
- Moving other DTNs to Belle II dedicated network VC

LHCONE Global Network

PNNL (AS65428)
- Gateway: 198.129.43.1
- PNNL site test subnet 198.129.43.0/24

ESnet (AS293)
- VLAN 4000
- 192.188.41.1/30
- 192.188.41.1/30
- 192.223.118/30

SUNN
- VLAN 4000
- 202.13.197.192/26

LAX-dc GM
- 202.13.223.117/30
- VLAN 4000

KEK - Japan
- KEK site test subnet 202.13.197.192/26

LHCONE

North America

March 24th, 2015
2015 Open Science Grid All-Hands Meeting
PNNL was explicitly requested by Belle II spokesperson and the computing and software coordinators to lead the Belle II database effort.

- Provided a plan and the infrastructure to test the distributed database effort.
- Belle II effort is being developed within a dedicated cloud tenant at PNNL.
Belle II Computing requirements are very similar to those of the LHC experiments.

PNNL is the led US laboratory and the primary off site computing center providing numerous grid services.

PNNL computing infrastructure is based on Cloud technology:
- PNNL has deployed several OSG software stack.
- Experienced problematic upgrades that overwrite site configurations.
- Will OSG provide Cloud templates or VM for grid services in the future?

Example comments from Belle II University member:

“What we found was that setting up a new CE or SE from scratch is actually quite difficult; at some point we needed a dedicated person either on-site or off-site to help us, at least until the set-up was complete.”
Backup Slides
Belle II Total Data Network Requirements
Scenario 2

March 24th, 2015

Total Data - Inbound

Total Data – Outbound

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Viet Nam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thailand*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malesia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Rep.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PNNL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KEK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2015 Open Science Grid All-Hands Meeting
Summer 2014 Networking Goals Achieved

- Transfer rate from KEK to PNNL during 48hr stability test met summer 2014 goal (>400MBps)
- Transfer rate from PNNL to Germany during 24 hr stability test was >100MBps
Network Setup:
- Network providers (Geant, ESnet, GARR, DFN) setup the VLAN
- Local network providers and sites coordinated final configurations
- Sites must configure hardware interface to match destinations

Testing Tools:
- `Traceroute` was used to confirm the routing to each Data Transfer Nodes (DTN)
- `Iperf` was used to do initial network transfer rate tests
- `gridftp` and/or `srm-copy` was used to test site
- `FTS3 server` at GridKa was used to schedule data transfers

Goal:
- Test the ANA-100 Trans-Atlantic link
- Test/tune/profile the performance of current Belle II data transfer tools

Dates:
- June 2nd to 6th use dedicated VLAN
Challenges encountered:

- The main issue was the configuration of the local network apparatus
- Having all the servers at each site using/checking the proper network route
- Hardware limitation (router, storage, etc.)
- Not having dedicated setups (shared with ATLAS, etc.)

Modification to sites to accommodate the increased rates:

- Modification of TCP windows was performed at PNNL and Italy
- Routing hardware interface
- Configure/tune network interrupts for multicore
- Modification of the FTS3 optimization
Sites and Data used for File Transfers

Sites:
- KEK2 - kek2-se01.cc.kek.jp
- PNNL - se.hep.pnnl.gov
- KIT - gridka-dcache.fzk.de
- DESY - dcache-se-desy.desy.de
- UVIC - charon01.westgrid.ca

Setup:
- All Regional Data Centers except KEK are now using LHCONE
- ~100 files with each file ~10 GB => This implies ~1 TB of data
- Each SE will temporarily require 2 x 1 TB of disk space
- Each SE has:
  - <SE-Path>/belle/DC2014/in
  - <SE-Path>/belle/DC2014/out
  - All previous files were deleted from belle/DC2014/ using srmrm command.
- 5x4 FTS3 transfers are initiated for 5 sites with each job assigned 20 files
- Channels are configured using fts-config-set + json
Transfer Efficiency & Failure Rate: From KEK to PNNL

KEK to PNNL
On Dec 3, 2014

Y-axis: Efficiency

X-axis: #Concurrent Transfers

On Dec 15, 2014

Same as above except for date

Y-axis: Failure Rate

X-axis: #Concurrent Transfers

On Dec 3, 2014

Storm1
Storm2
Storm3
Storm4

Same as above except for date

Series 1
Series 2
Series 3
Series 4
## WLCG FTS3 Belle II Dashboard

<table>
<thead>
<tr>
<th>Destinations</th>
<th>TOTAL-</th>
<th>charon1.westgrid.ca+</th>
<th>dcache-se-desy.desy.de+</th>
<th>gridka-dcache.fzk.de+</th>
<th>kek2-se01.cc.kek+</th>
<th>se.hep.pnnl.gov+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>98 % 1 GB/s</td>
<td>100 % 182 MB/s</td>
<td>98 % 309 MB/s</td>
<td>99 % 207 MB/s</td>
<td>97 % 238 MB/s</td>
<td>99 % 195 MB/s</td>
</tr>
<tr>
<td></td>
<td>8498 130</td>
<td>1374 2</td>
<td>2322 52</td>
<td>1554 9</td>
<td>1787 51</td>
<td>1461 16</td>
</tr>
<tr>
<td>charon1.westgrid.ca+</td>
<td>97 % 19 MB/s</td>
<td>100 % 51 MB/s</td>
<td>97 % 95 MB/s</td>
<td>100 % 4 MB/s</td>
<td>100 % 27 MB/s</td>
<td>93 % 2 MB/s</td>
</tr>
<tr>
<td></td>
<td>140 4</td>
<td>384 0</td>
<td>95 3</td>
<td>4 0</td>
<td>27 0</td>
<td>14 1</td>
</tr>
<tr>
<td>dcache-se-desy.desy.de+</td>
<td>99 % 303 MB/s</td>
<td>91 % 113 MB/s</td>
<td>95 % 5 MB/s</td>
<td>92 % 64 MB/s</td>
<td>87 % 23 MB/s</td>
<td>93 % 21 MB/s</td>
</tr>
<tr>
<td></td>
<td>2288 29</td>
<td>852 83</td>
<td>36 2</td>
<td>486 45</td>
<td>173 25</td>
<td>157 11</td>
</tr>
<tr>
<td>gridka-dcache.fzk.de+</td>
<td>100 % 368 MB/s</td>
<td>100 % 61 MB/s</td>
<td>100 % 145 MB/s</td>
<td>100 % 70 MB/s</td>
<td>100 % 91 MB/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2732 2</td>
<td>455 0</td>
<td>1080 0</td>
<td>520 2</td>
<td>677 0</td>
<td></td>
</tr>
<tr>
<td>kek2-se01.cc.kek.jp+</td>
<td>100 % 328 MB/s</td>
<td>100 % 66 MB/s</td>
<td>99 % 87 MB/s</td>
<td>100 % 57 MB/s</td>
<td>99 % 118 MB/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2486 12</td>
<td>499 0</td>
<td>661 4</td>
<td>433 1</td>
<td>893 7</td>
<td></td>
</tr>
<tr>
<td>se.hep.pnnl.gov+</td>
<td>100 % 328 MB/s</td>
<td>100 % 66 MB/s</td>
<td>99 % 87 MB/s</td>
<td>100 % 57 MB/s</td>
<td>99 % 118 MB/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2486 12</td>
<td>499 0</td>
<td>661 4</td>
<td>433 1</td>
<td>893 7</td>
<td></td>
</tr>
</tbody>
</table>