Edinburgh Forward Look

Andrew Washbrook

University of Edinburgh

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Eddie Mk3 Status and Future

Eddie Mk3 Compute

- Research computing facility available **free** at the point of use to all staff and students

- Groups can either purchase their own equipment to be hosted by Research Services or buy a dedicated share of Eddie resources

- Around **600** active users so far

Total number of cores	6,200
Cores free at point of use	**4,000 (increasing to 5,000 very soon)**

Server	Dell Poweredge R630
CPU	**2 x E5-2630v3 2.4GHz 8/16C**
Memory	**64 GB**
Storage	**1 TB scratch**

Eddie Mk3 Worker Node specifications

Eddie Mk2 cluster is (effectively) gone! No legacy equipment will be supported

Eddie Mk3 Storage

- High performance storage for data created or modified on the cluster
  - **370 TB** of fast disk (10k) directly attached to core cluster network
  - GPFS, metadata on SSDs
  - Specified to deliver minimum 100 iops to a fully occupied cluster

- General research data storage is provided by **Datastore**
  - **8 PB** of slower (7.2k) high capacity disks
  - GPFS
  - Hosted across three sites, extensive use of tape storage for backup and DR purposes

- IBM Active File Management
  - Acts as a cache for frequent access to Datastore files from cluster worker nodes
  - Write performance equivalent to HPC storage
  - Early issues with stability and performance have been resolved

This storage is used for Tier-3 (local group) activities but not for our Tier-2 operations

GridPP computing on Eddie Mk3

Paid for guaranteed baseline access

- **11** ring-fenced nodes exclusively for our use
- **352** (HT) cores
- We are allowed to add bespoke requirements
    - Hyperthreading, alternative job resource limitations, application profiling
- Level of guaranteed baseline access can be expanded or contracted depending on funding

Opportunistic resources and share management

- Access to over **5,000** cores
- Scheduling configuration needs to be tuned to match our MoU requirements
- All done by *functional tickets* to give a point in time job priority
    - Applied at group level for GridPP workload
    - Ticket allocation can be sub-divided to allow internal prioritisation

Fully Costed Resource

- Power, infrastructure and support are incorporated into the core-hour price
- Opportunistic resources and ongoing cluster expansion are essential to avoid a funding "death spiral"

Eddie Mk3 Migration

I often talk about this in our weekly tech meetings - why is it taking so long?

- Forced to make the leap from SL6 to SL7 (and not CC7)
  - ATLAS and LHCb have not yet validated their software for SL7
  - Grid middleware still working on migration

- Had to regenerate the Grid pool accounts from scratch
  - Now managed by University Information Services (not ECDF) through Active Directory
  - Major effort required to get these created and working with the cluster

- Switch from Cream CE to ARC CE
  - No playbook on how to get ARC working on a shared facility
  - Required full understanding of ARC software to add necessary modifications

- Various shared cluster limitations
  - Overhaul of all our legacy dependencies (back to 2009!)
  - Negotiating access to Eddie submit hosts from CEs for job submission and monitoring
  - Bespoke requirements for worker nodes

Migration Status

- Eddie Mk3 move is almost complete
- We are the one of only two customers still running on old Eddie Mk2 kit!

Worker Nodes

- CVMFS installed
- Resolved SL7 dependencies
- Grid certificates and revocation set up
- NFS area available for sharing ARC directories, pool account home directories and local configuration

Middleware

- New CE and ARGUS services deployed
- Jobs can be submitted to Eddie Mk3 (currently ring-fenced nodes only)
- All functional tests passing

VOs

- ATLAS functional tests pass and software validation mostly done
- LHCb: bug in pilot that affects environment setup - has been addressed by developers
- Other VOs yet to be validated (but expected to be less of a problem than LHC software)

Eddie Mk3 Forward Look

- Year on year expansion of the Eddie cluster over the next five years
- Individual groups are procuring batches of hardware to add the cluster
  - Allows "reverse" ring-fencing which we benefit from
- Provisioning and testing of new Cloud service (see next slide)

2016-17 Investment

- Core expansion of the cluster (adding over **1,000** cores)
- Rolling memory upgrade across the cluster (**192 GB** per node)
- Large memory machines (**3 TB** per node)
- "Hundreds" of GPUs (Nvidia K80 and Titan X) as part of Data Science investment

Take advantage of new equipment for our Tier-2 operations

- More opportunistic resources available
- High memory servers
  - LHC upgrade tracking studies
- GPU cluster
  - Ground work in accessing GPUs to the Grid already been covered (CHEP 2013 study)
  - Accept new types of workload (LHC simulation and tracking, deep learning techniques, Non-LHC VO applications)
- Cloud computing resources

Eddie Cloud service

- Research Services are deploying Openstack using 26 nodes from the Eddie cluster
- The number of hypervisors will scale as usage grows

- Consultation with Sardina systems
    - **FishOS** cloud management platform

- Started to talk to groups to get early adopters
    - LSST (Marcus) and GridPP signed up already

- Use 250TB **Ceph** backing storage (both block and object based)

- Length of evaluation window undetermined
- Resource usage will not charged during this time

- If successful then long term idea to move standard batch system instances into the cloud to allow dynamic adjustment

Middleware and Storage Plans

Middleware Forward Look

- Purchased two new Dell Poweredge R630s to host a new middleware platform as part of GridPP4+ capital refresh

Strategy

- Consolidate services and use resources we have more efficiently
  - We are limited by both budget and power
- Virtualise everything (if possible)
- Explore High Availability options
  - Marcus exploring DRBD/Pacemaker/Corosync solution (see HEPSYSMAN talk)
- Review configuration management and service redundancy practices
- Enhance monitoring and analytics reach based on previous efforts

Warranty forward look

- GridPP4+ capital limited our exposure to out of warranty equipment
- Storage servers refreshed with new 8 TB disks
- Perfsonar server warranty runs out at the start of next year. What then?

Storage Forward Look

- All our dedicated storage (**~1 PB**) is now managed by ZFS (see Marcus' talk later this morning)

RDF

- **215 TB** available as part of middleware readiness testbed for some time
- To be updated to about **700 TB** RDF storage
- Scaling testing needed to determine how to make this available through our production DPM

University Datastore

- Initial exploration of how this can be used for Grid storage earlier this year
- Testing was inconclusive but we were on a tight timeframe for GridPP4+. Revisit?

Storage R&D

- Some ideas for future work from Marcus:

Multi-VO XrootD only installation
- DPM-less
- Distributed endpoints could work like a single UK site
- Wouldn't matter if one site is down but still give the advantage to have all data distributed to all sites
- New VOs do not need any special tools and no file catalogue

ZFS Functionality
- File compression studies on VO files
- De-duplication: Evaluate practical use for Grid storage and determine memory overhead
- Lustre installation based on ZFS

Storage Compute
- Use idle CPU on DPM clients to provide boost to our baseline
- Minimal batch system + CE required

HPC

HPC Activities

- Aim to integrate the University share of **Archer** resources into our Tier-2 operations
- Private MC simulation run last year demonstrated we can process high volumes of ATLAS workload on HPC
- Now working to become a MC simulation production facility for ATLAS
    - Working with ATLAS ADC developers on pilot submission and job validation

HPC model developed for CSCS
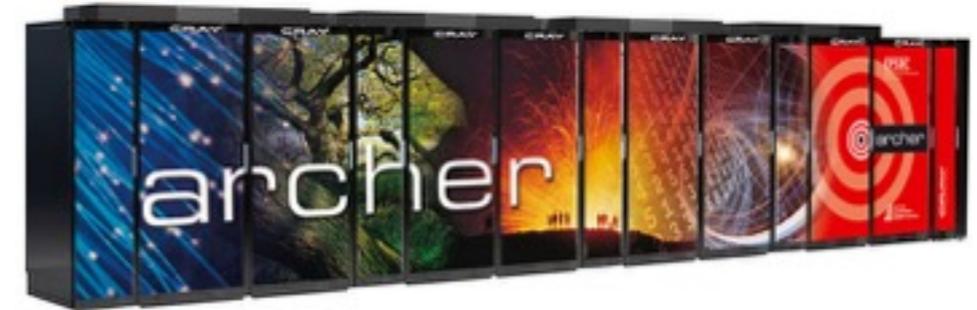
Workload Management Model
- Settled on **ARC CE + ACT** job submission
- ARC CE shares *Session* and *Cache* directories with Archer frontend
- Job I/O handled by ARC CE before and after job
- Lack of external connectivity not an issue
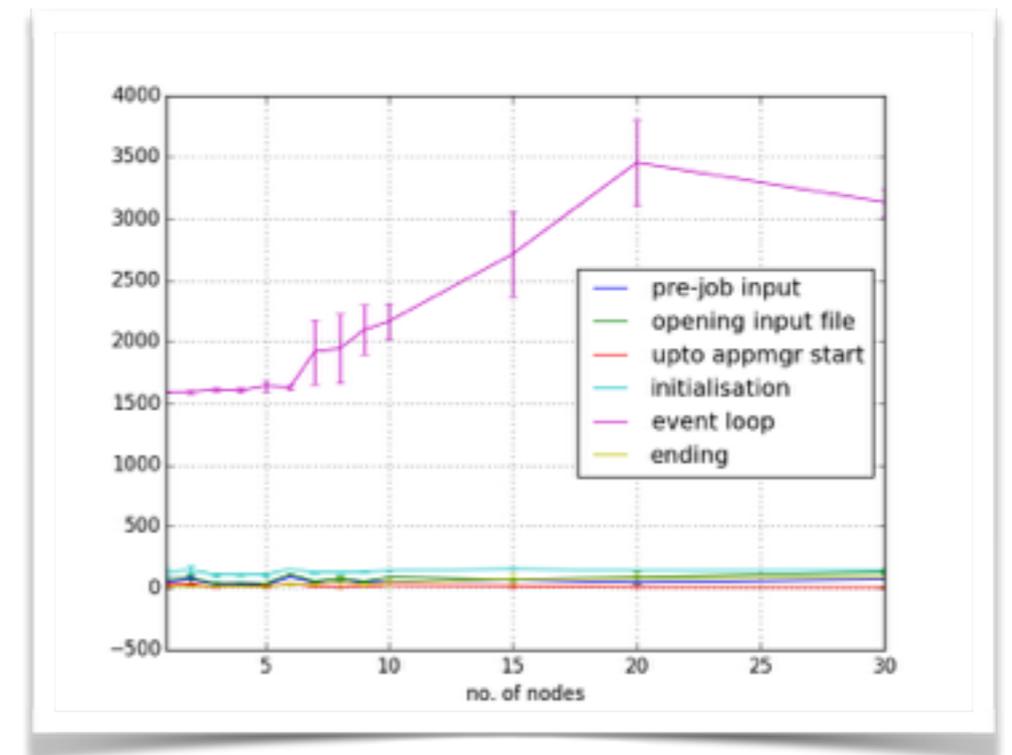- Software delivery is enabled by CVMFS over **Parrot**
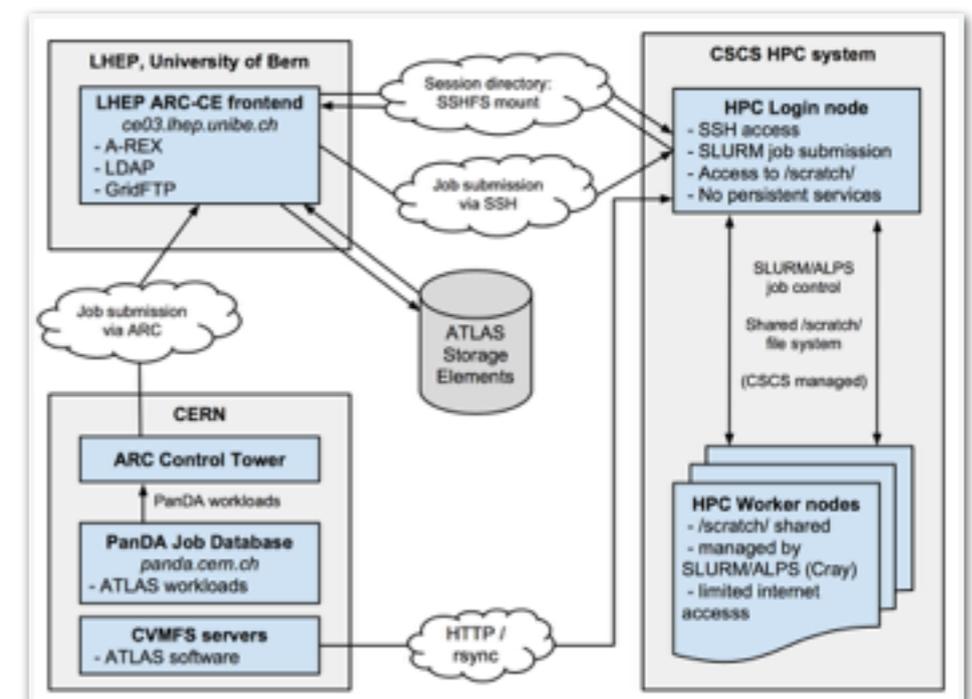
HPC Activities

**Optimisation Studies Summer Project**

- Job performance significantly suffers as workload is scaled up
- Conducting timing studies varying number of cores, nodes, events processed per job
- Main culprit: Looking into file operations during job lifetime

Preliminary timing studies varying number of concurrent compute nodes

Long term goals

- Move to the **Event Service** model with MPI (Yoda)
- Jobs can be pre-empted with limited impact to mainstay HPC users
- Not necessarily limiting use to ATLAS - use of containers to virtualise workload requirements (e.g **Shifter**) a possibility
- Have to convince Archer admins to make changes
- Lots of overhead in setting up but a big win if pre-emption enabled
  - Even better if this we can widen resource to allow other VOs

10,000 free CPU cores
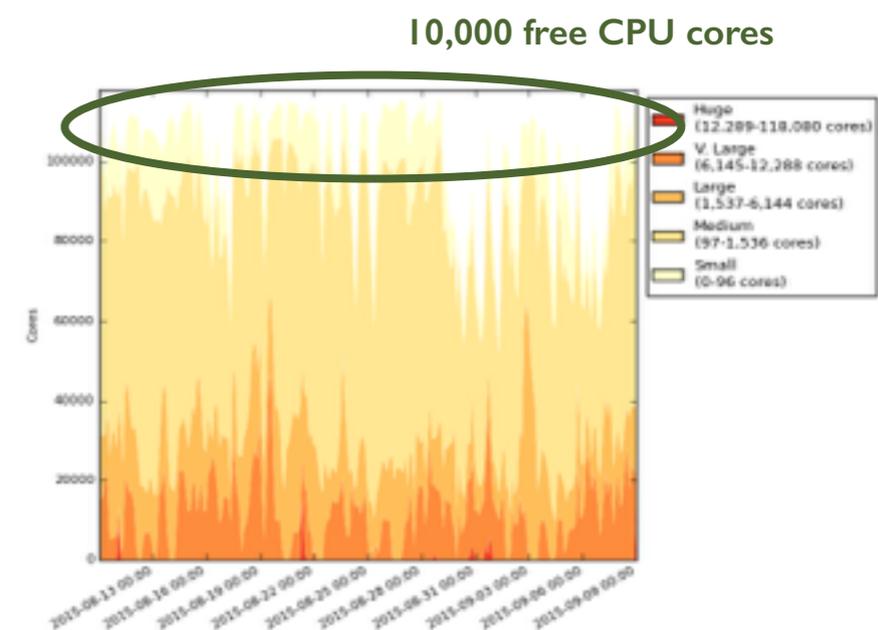
Archer Utilisation

Coverage

VO Coverage

ATLAS

- MC production **only** until Analysis pilots are fixed for SL7/CC7

LHCb

- Continue as for Eddie Mk2 once setup scripts in pilot have been fixed

CMS

- Tier-3 like resource possible once stable running on Mk3

LSST

- Workload to be re-validated (Marcus 50% on LSST)

LZ

- Provided **50 TB** of storage for local job submission, re-validate on Mk3

EUCLID

- Parallel effort from RAL - working with ROE staff on long-term data processing project

HyperK/Titus

- Provided support for Tier-3 compute and now migrating their work to the Grid

Any more we should include as part of a coordinated Scotgrid strategy?

Wrap up

- It has been a busy year!
  - A transition to a new (shared SL7) cluster
  - Migrated all our storage to ZFS
  - Overhaul of all middleware services
- Building in practices to reduce future overhead
  - High Availability for middleware
  - Collaboration, issue tracking and documentation: **Gitlab**, **Slack**

Future Direction
- Diversify site operations across different types of resources (HPC, Cloud, Many core)
- Continue to expand our VO coverage beyond LHC