Sharing Hardware between Big Data, AI, HTC and HPC

Lessons learnt expanding CSD3
using OpenStack Ironic

John Garbutt, StackHPC

StackHPC

StackHPC Company Overview

- Formed 2016, based in Bristol, UK
  - Based in Bristol with presence in Cambridge, France and Poland
  - Currently 16 people
- Founded on HPC expertise
  - Software Defined Networking
  - Systems Integration
  - OpenStack Development and Operations
- Motivation to transfer this expertise into Cloud to address HPC & HPDA
- "Open" Modus Operandi
  - Upstream development of OpenStack capability
  - Consultancy/Support to end-user organizations in managing HPC service transition
  - Scientific-WG engagement for the Open Infrastructure Foundation
- Develop skills and know-how in Hybrid Cloud

StackHPC

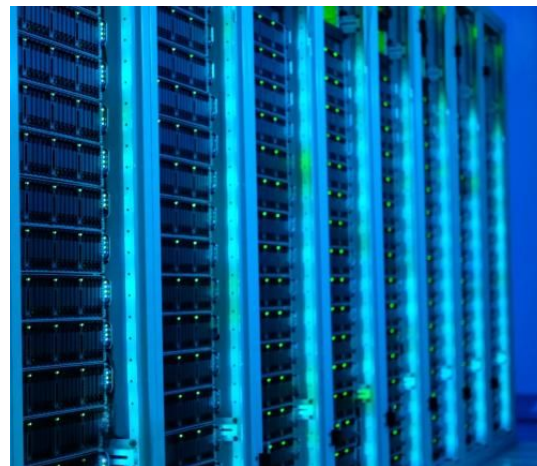Open Infrastructure
FOUNDATION

SILVER MEMBER

CSD3: Cambridge Service for Data-Driven Discovery

StackHPC

- Intel Xeon, Intel KNL, Nvidia P100

- #75 in the November 2017 Top500 list

- xCAT provisioned Slurm Cluster
  - Running node converted to image
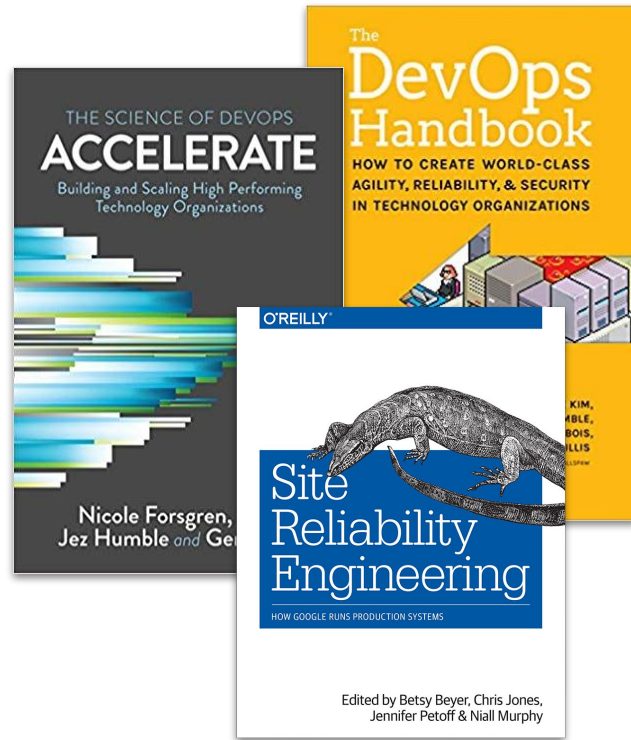
- Resources only accessible via Slurm
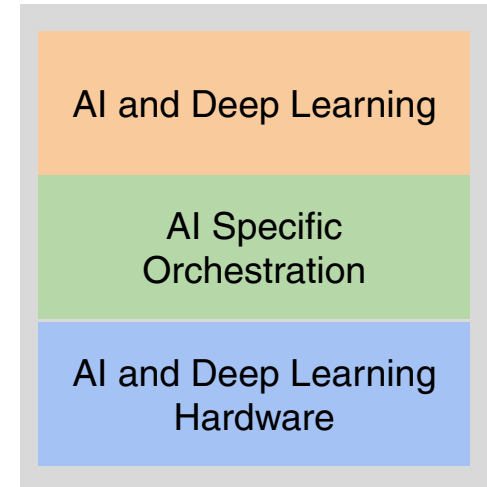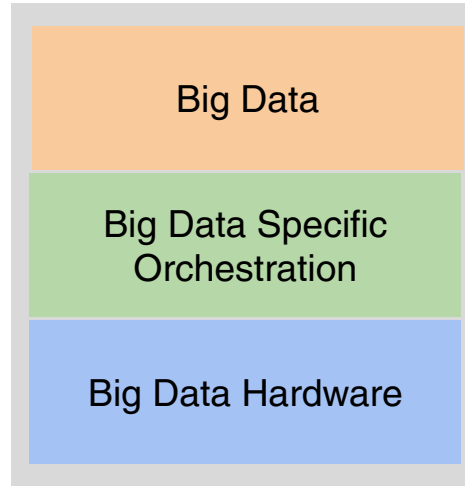
https://www.hpc.cam.ac.uk/

Motivations Driving a Change
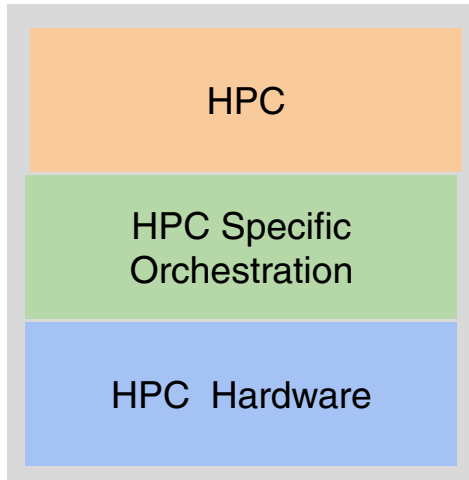
- Manage the increasing complexity

- Better knowledge sharing

- Move away from Resource Silos

HPC Stack 1.0

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HPC	Big Data	AI and Deep Learning
HPC Specific Orchestration	Big Data Specific Orchestration	AI Specific Orchestration
HPC Hardware	Big Data Hardware	AI and Deep Learning Hardware
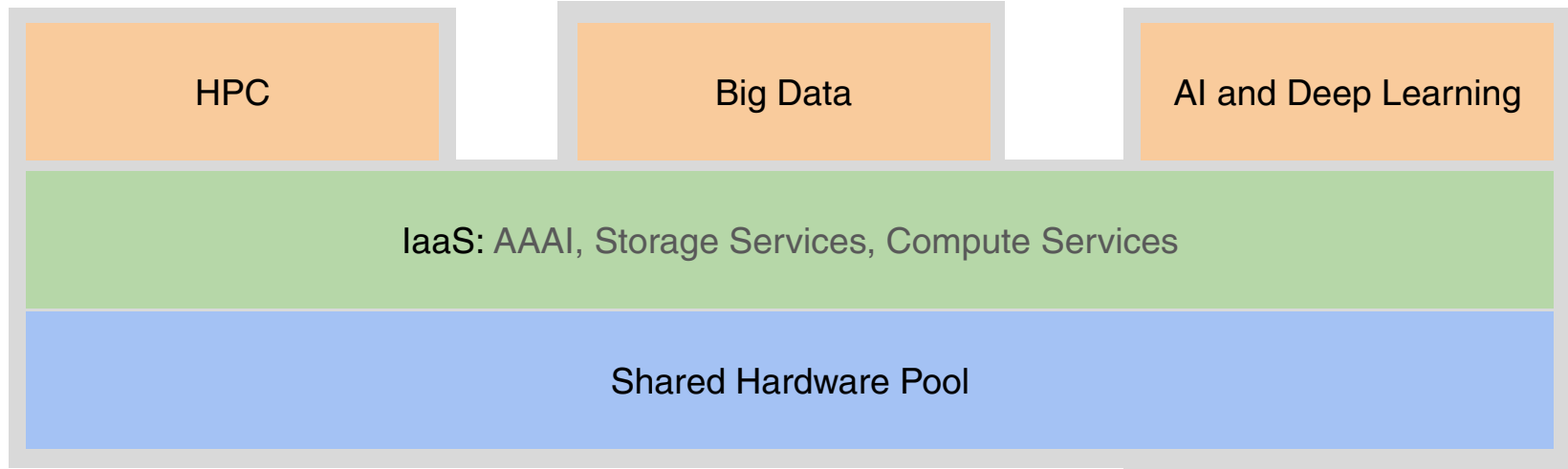
HPC Stack 2.0

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HPC	Big Data	AI and Deep Learning

IaaS: AAAI, Storage Services, Compute Services

Shared Hardware Pool
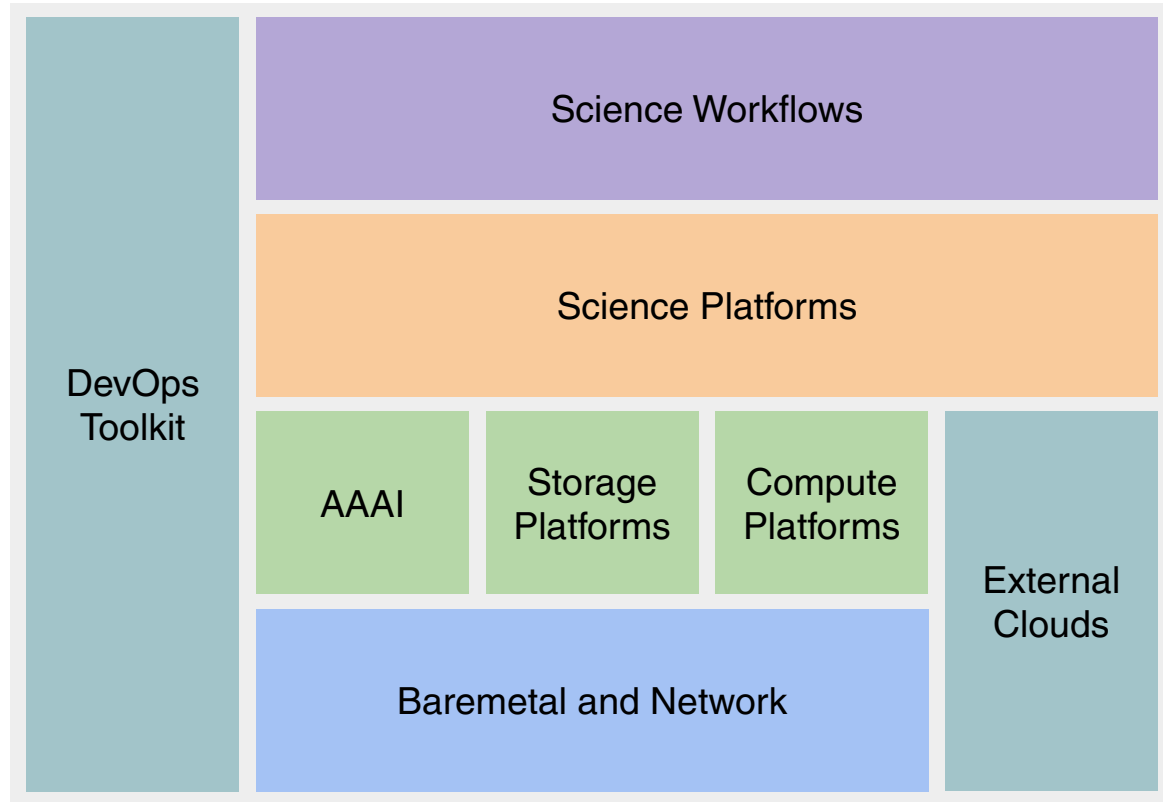
HPC Stack 2.0

HPC Stack 2.0
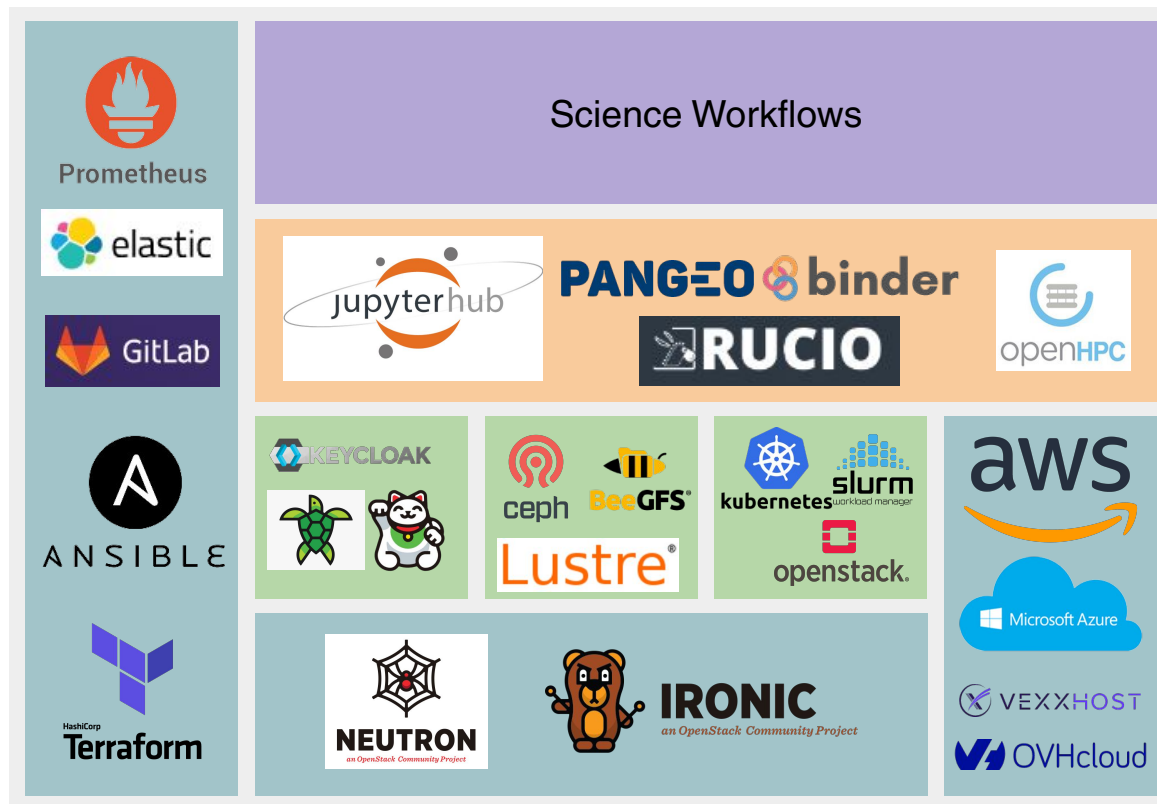
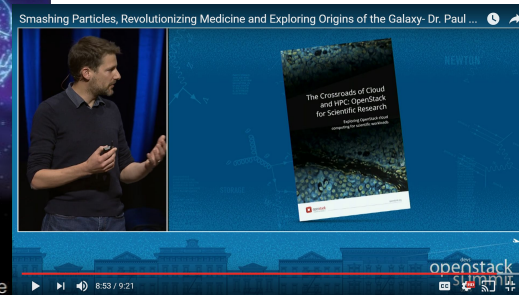# Cambridge HPCS
OpenStack Journey

StackHPC

In the Beginning (c. 2015)

- Capture use-cases for Software Defined HPC
- Help establish a Research Computing SIG within OpenStack Foundation
- Establish Cambridge as thought-leader in Scientific OpenStack
- Leverage SKA use-case and develop OpenStack Kayobe

OpenStack in Cambridge (c. 2020)

StackHPC

- Clinical Cloud (2016+)
  - Virtualised Cloud for Brain Imaging, etc
- OpenCB (2016+)
  - Genomics Platform
- AlaSKA (2016+)
  - Bare metal platform for SKA-SDP prototyping
- STFC-IRIS (2018+)
  - Virtual and bare metal cloud for medium scale HPC
- Secure Research Computing Platform (2018+)
  - Virtualised resource for medical informatics
- Arcus (2020+)
  - Unified OpenStack, including Large-scale HPC
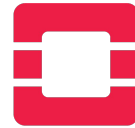
openstack®

Expanding CSD3 using OpenStack

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Arcus Architecture Overview

- 672 Dell PowerEdge C6420
    - 2 x Intel Xeon 8276, local SSD
   - 1GbE for iDRAC, optionally visible in OS
    - Mellanox ConnectX-6

- Networks
    - HDR100 Infiniband, Mellanox MQM8790
    - 50GbE Ethernet, Mellanox MSN3700
    - 1GbE Ethernet, Dell S3048

- Currently building a similar system that is twice as big

Bootstrapping Compute Nodes

- Scan nodes
  - Re-using existing scanning procedure
  - Encouraged by OpenDev
- iDRAC DHCP
  - MAC from scanning, Neutron for DHCP
- Ansible driven Ironic Enrollment
  - Ansible enables IPMI, updates Firmware
  - State machine stored in Ironic
- Ironic Inspector
  - First on 1GbE, and update ConnectX-6
  - Re-inspection on 50GbE, LLDP to get switch info

https://github.com/stackhpc/arcus-terraform-idrac
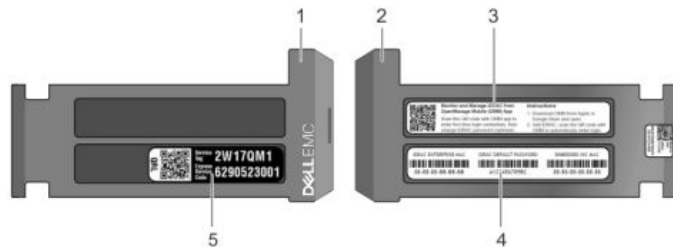
Building Slurm on OpenStack

StackHPC

- Create cluster
  - Terraform: AZ mapping used to target specific baremetal node
  - Image based deploy, auto joins existing CSD3 Slurm cluster
  - NFS used to provide configuration
  - Ansible for image build and ad-hoc changes
- Rebuild via Slurm
  - Slurm can schedule a reboot after current job completes
  - Can use accounting to limit number of concurrent reboots
  - Slurm reboot takes a reason, include target image
  - Custom reboot script talks to OpenStack

https://github.com/stackhpc/slurm-openstack-tools
https://github.com/stackhpc/ansible-role-openhpc

slurm
workload manager

Tuning Ironic for Scale

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- Focus on on rebuild all hosts to apply new kernel

- networking-generic-switch
    - Added cumulus driver to networking-generic-switch
    - Added experimental "batching" of config

- Ironic-conductor configuration
    - IMPI driver, avoids reboot in iDRAC driver
    - Direct deploy, not iSCSI
        - force_raw_images = false
        - Avoid neutron router bottleneck
    - Turned off power sync
    - Server Delete: increased rpc_timeout

- connect_timeout in HAproxy and MariaDB

IRONIC
OPENSTACK BARE METAL ®

https://github.com/RSE-Cambridge/cumulus-kayobe-config/blob/jg-arcus-tests/etc/kayobe/kolla/config/ironic/ironic-conductor.conf

Building Storage on OpenStack

Ceph

- Object Storage
- OpenStack Cinder (RBD)
- OpenStack Manila (CephFS)
- Kubernetes Cloud Provider OpenStack

Storage Managed Services (Software Defined)

- Local or virtual storage, Dedicated disaggregated or Hyperconverged
- Lustre: Spinning Disk, NVMe Data Accelerator, Hadoop, BeegFS...
- … but data preservation inherently limits flexibility

Monitoring

- kolla-ansible built in
  - Prometheus and Grafana
  - Fluentd, Elasticsearch and Kibana

- Useful extras
  - Node Exporter on Cumulus
  - Redfish exporter
  - GMR: Guru Meditation Reports

Prometheus

What is next?

Baremetal Node <-> Hypervisor

StackHPC

- Works today to deliver STFC IRIS cloud on CSD3

- Kayboe and Kolla-Ansible, OpenStack Ussuri

  - Kayobe uses ansible to configure the network switches

- Moving to use overcloud Ironic to deploy hypervisors

  - Usually Bifrost used to deploy hypervisors and controllers

- Networking

  - Currently no trunk support in ngs cumulus driver

  - Work around using flat network driver

KOLLA

an OpenStack Community Project

Future Consolidation

"One OpenStack to rule them all"

- Migrate previous hardware generations from xCAT to OpenStack
  - More flexibility around accessing GPU resources
- SR-IOV: get RDMA inside VMs with both IB and RoCE
- More diverse Kubernetes clusters
  - Already using OpenStack Magnum
  - … add in SR-IOV and GPU templates, for things like Horovod
- Improve the "Day 2" Operational Tooling
  - Moving to Prometheus metric based Unified Alerts

https://github.com/RSE-Cambridge/iris-magnum

kubernetes

How can I get involved?

OpenStack Special Interest Groups

StackHPC

Scientific OpenStack SIG
https://www.openstack.org/use-cases/science/

Bare Metal SIG
https://www.openstack.org/use-cases/bare-metal/
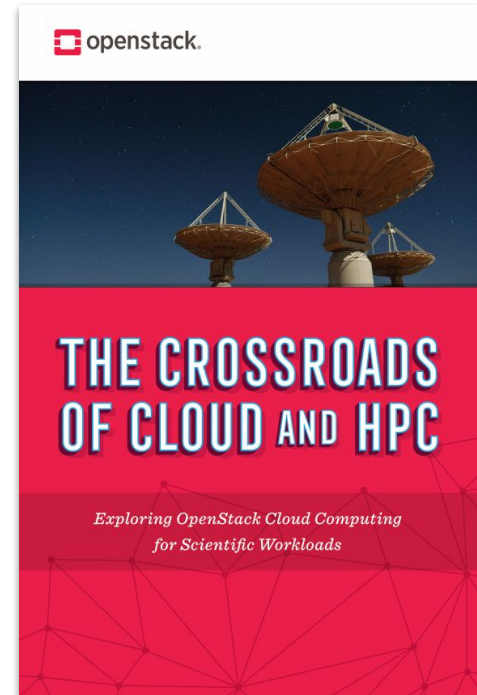
Thank You!

StackHPC

- OpenStack Community

- Cambridge University HPCS

- EPSRC, STFC, MRC, HDR UK, UKAEA

- Dell, Intel, NVIDIA, Mellanox Technologies

https://epsrc.ukri.org/newsevents/news/supercomputing-services-to-drive-scientific-breakthroughs/