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HPC Wales User Group Meeting

Multi-Site Video Conference

14th May: 14.00 pm – 16.00 pm

Ewrop & Chymru:
Buddsoddi yn eich dyfodol
Cronfa Datblygu Rhanbarthol Ewrop

Europe & Wales:
Investing in your future
European Regional Development Fund

ERDF

Llywodraeth Cymru
Welsh Government

Agenda

Time	Item	Speaker
14.00	General HPC Wales Update	Martyn Guest
	User Concerns & Solutions	
14.25	HPC Wales Fair Use Policy	Ade Fewings
14.35	Progress on Gateways	Charlie Godfrey
14.45	Thematic User Groups	
14.55	Near Term Technology Roadmap	Glenn Fitzgerald (Fujitsu)
15.15	SME Case study	Ben Barton (Knowtra)
15.25	Studentship Video	Farzana Rahman (UoSW) and James Pack
15.35	Forum Discussion	Group Discussions & Feedback
15.55	Q&A and Close	Martyn Guest

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General HPC Wales Update

Usage of the HPC Wales Systems

May 2013 – April 2014

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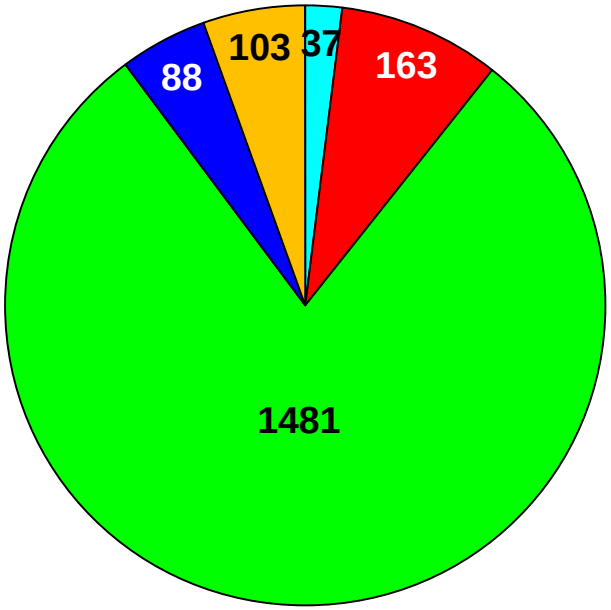
HPC Wales User Accounts

1st May 2014



- HPC Wales
- HEIs
- SAM User Accounts
- Service Providers
- External / Enterprise

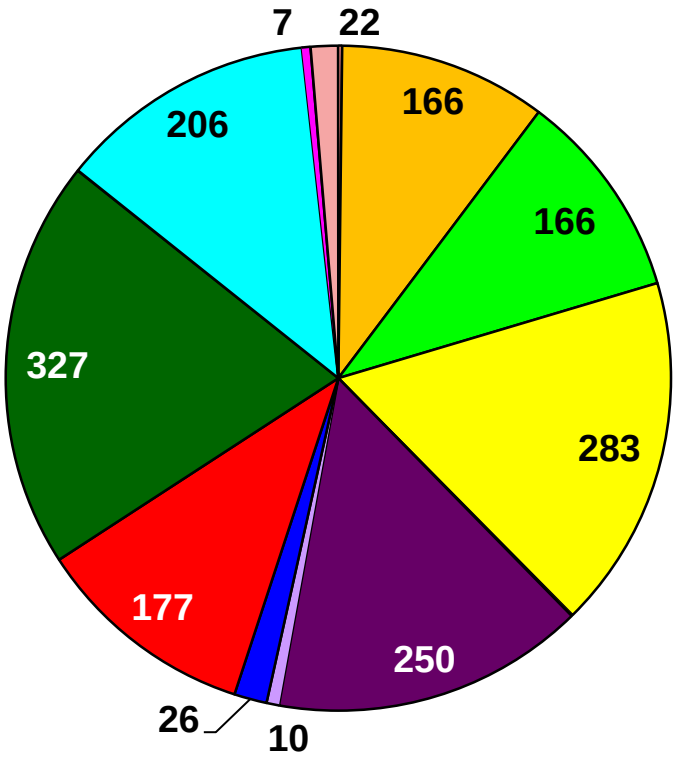
/home/hpcw.tech/user_lists

*Total of 1644 User Accounts **[+31]***

*Total of 1872 User Accounts **[+23]***

Figures in [ ] indicate change in past month

HEIs + SAMs



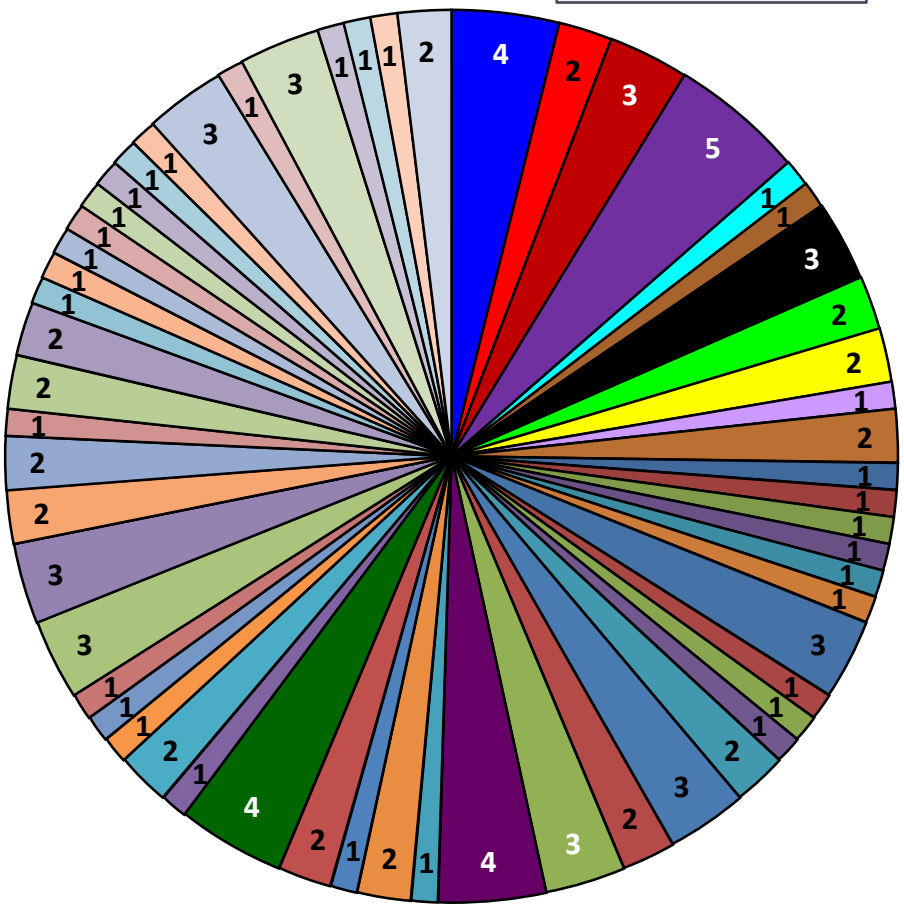
- ASTUTE
- Aberystwyth
- Bangor
- Cardiff
- Cardiff Met
- Glamorgan
- Glyndwr
- Newport
- Pembroke
- Swansea Met
- Swansea
- Collaborators
- Coleg Sir Gar

Upcoming Events

- Supercharging Pembrokeshire – Official Launch of Tier 2Bs (23rd May 2014)
- HPC Wales Summer School, Bangor (June 2014)
  - Introduction to HPC, C++ and MPI
- Digital 2014, Cardiff (9th – 10th June 2014)
- Eurovis 2014, Swansea (9th – 13th June 2014)
- ISC'14, Leipzig, Germany (22nd – 26th June)
- StartUp Weekend 2014, Swansea (21st – 23rd November 2014)

Active Enterprise User Accounts

1st May2014



- Accelero Digital
- Atticus
- Br. Ornithology Trust
- Calon Cardio
- Calsonic
- Canolfan Bedwyr
- Chaos Trend
- Habitat Info
- Knowtra
- MJR Solutions Ltd
- Nat. Botanic Garden Wales
- PICMO
- Qioptic
- TWI NDT Centre
- View Holographics
- Vizworx
- Zeeko
- ICON
- Planetary Resources
- Solray Works
- Koenigsegg
- BSM Bench Ltd
- Bloodhound Programme Ltd
- iCreate3D
- Thinkplay TV
- BapttDesigns
- Gluco Technology
- Ultranyx
- Vibe TV
- Penlon Cottage Trading
- Red Dragon Softworks Ltd
- Astra Games
- Dojo Arcade
- Syndica
- Llaisdy
- Neem Biotech
- Simulity
- Acuitas Medical
- Company85
- Make and See
- Silverwing
- Zodiac Seats
- Altair
- Farmaceutical Innovations
- Partington Marine Ltd
- Rockfield Software
- Bait Studio
- Tidal Lagoon
- Rolls Royce
- BMT WBM
- Newmill Asset Management
- Stills
- Zenotech
- Fujitsu Japan
- Bomper Studio
- Butterfly
- Dischromatics
- Concurrent Thinking ✓
- Cultech Ltd ✓
- Torquing Group ✓

Figure in [ ] indicate change in past month

*External / Commercial Organisations – 103 user accounts **[+5]***

The Skills Academy

1st May 2014

1481 user accounts ***[+30]***

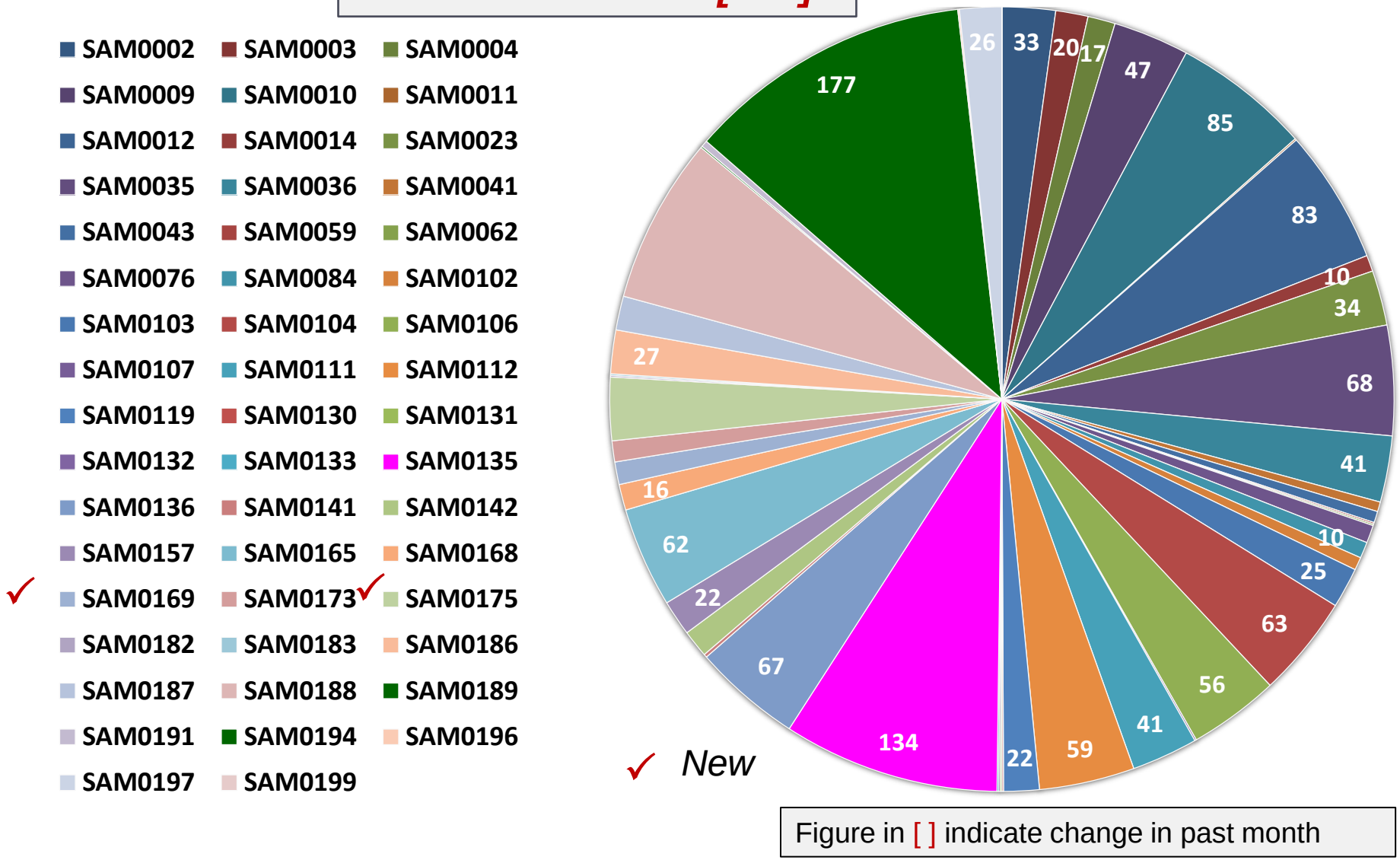
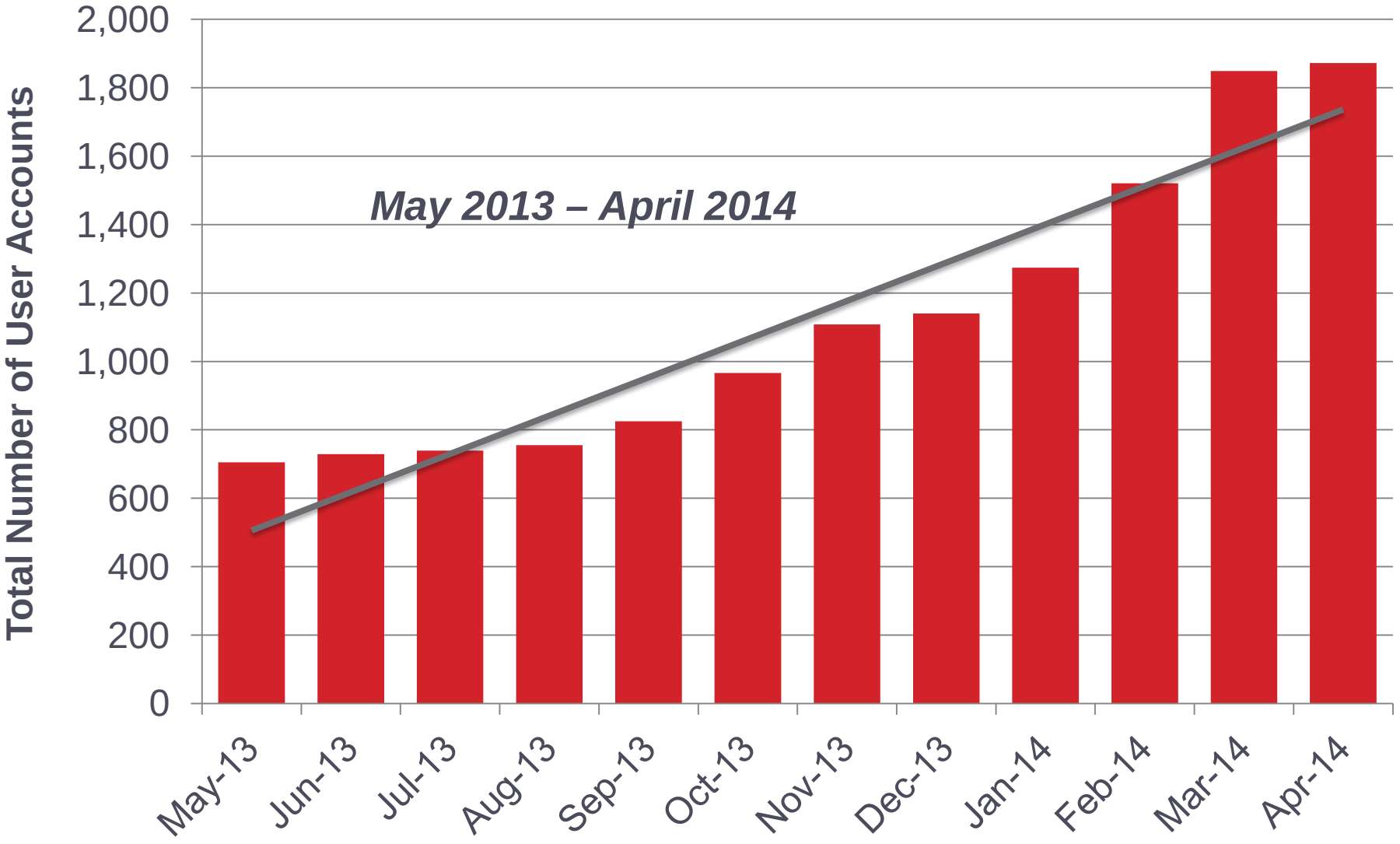
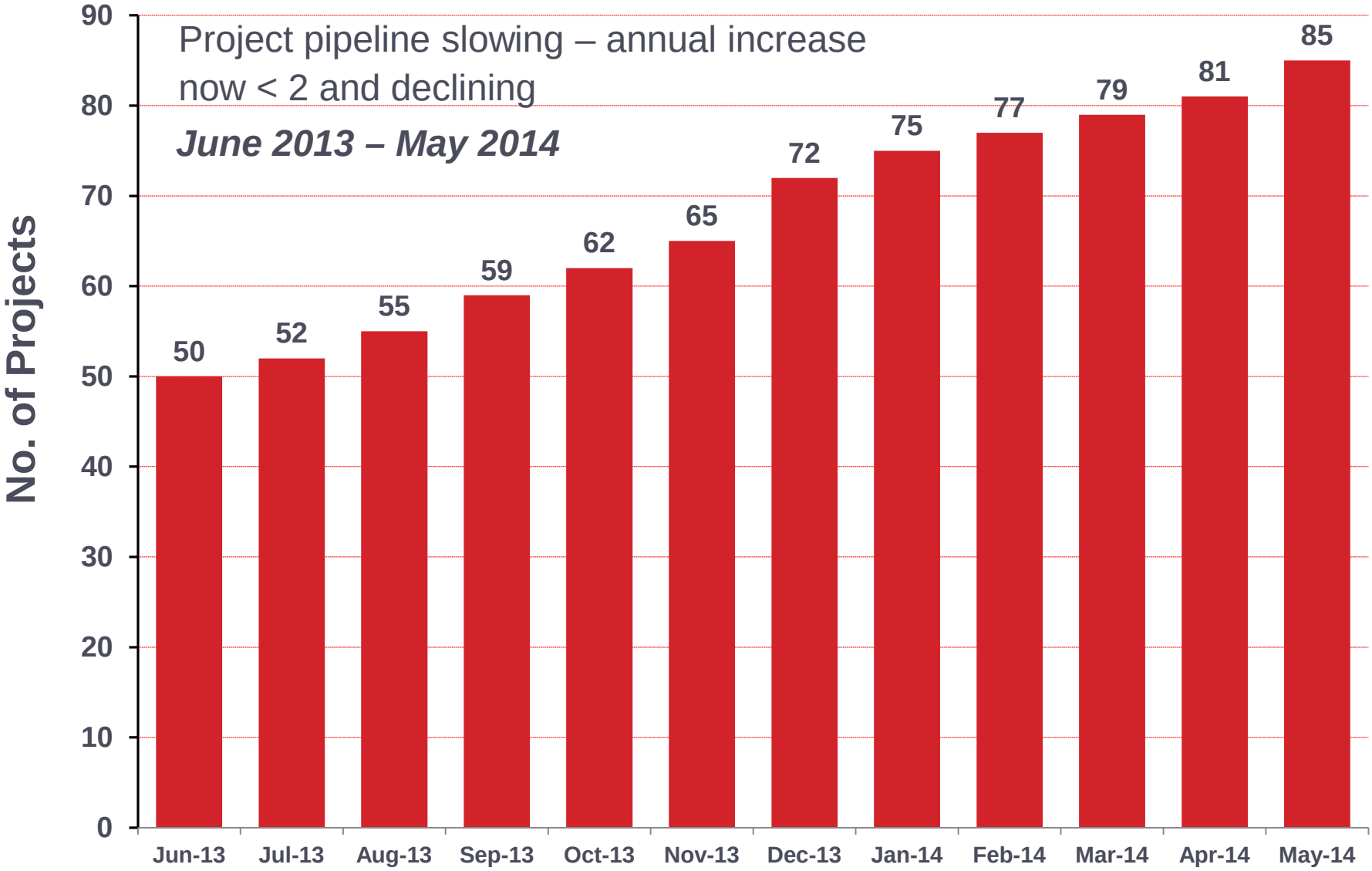


Figure in [ ] indicate change in past month

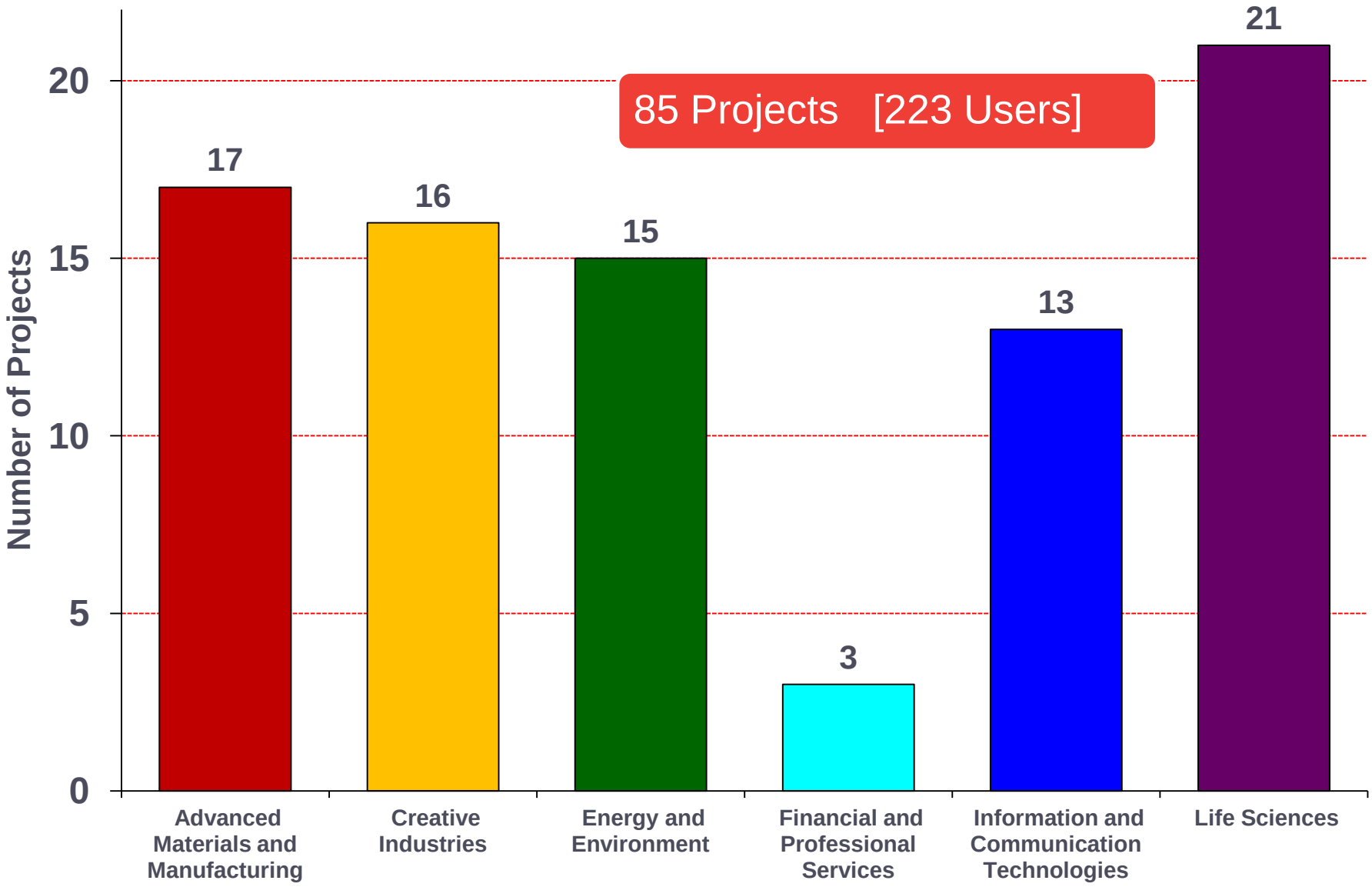
Timeline of the HPC Wales User Accounts



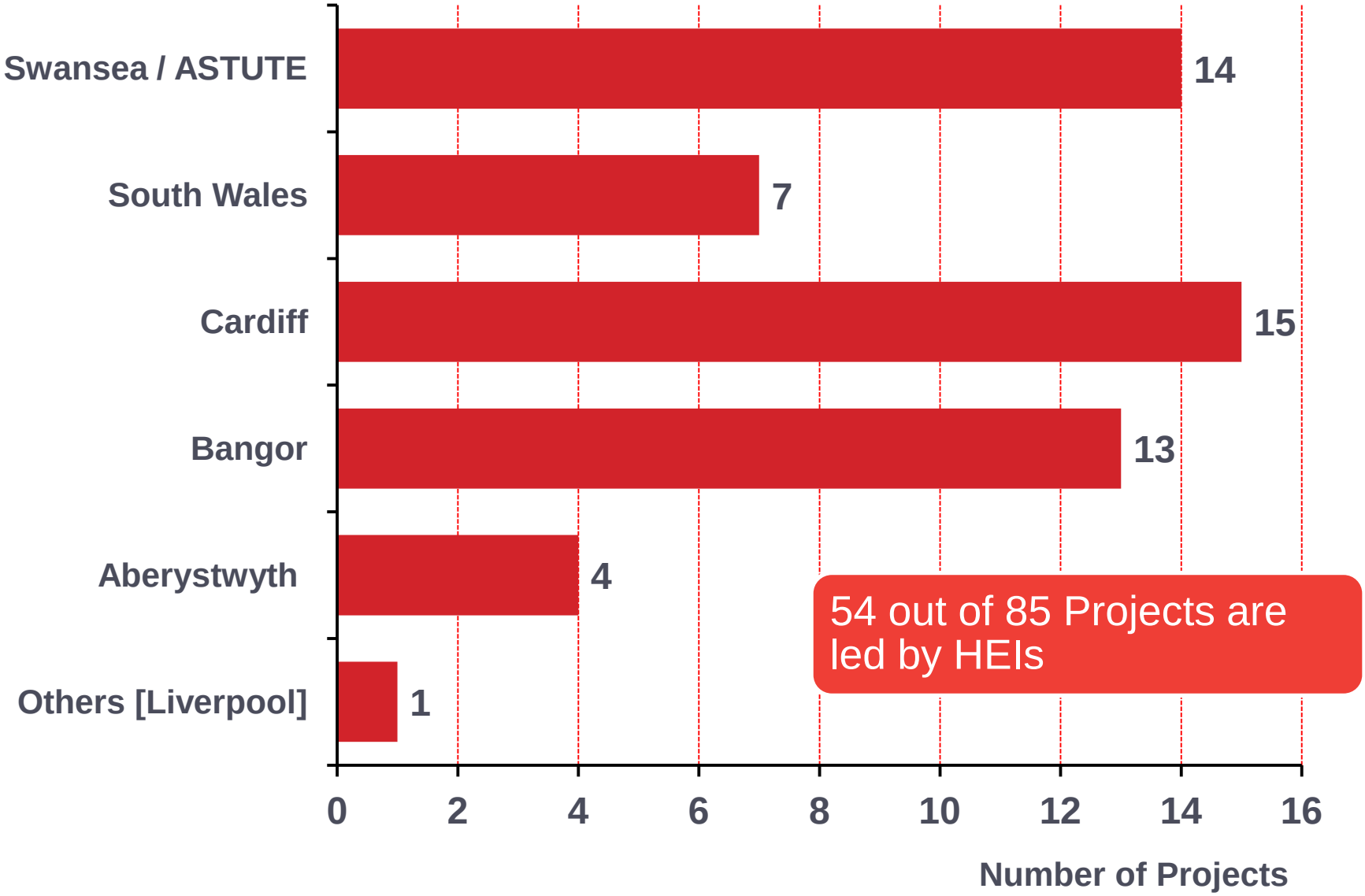
Increase in Number of HPC Wales Projects



HPC Wales Projects – By Sector



HPC Wales Projects – By HEI



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Usage of the HPC Wales Cardiff HTC System

May 2013 – April 2014

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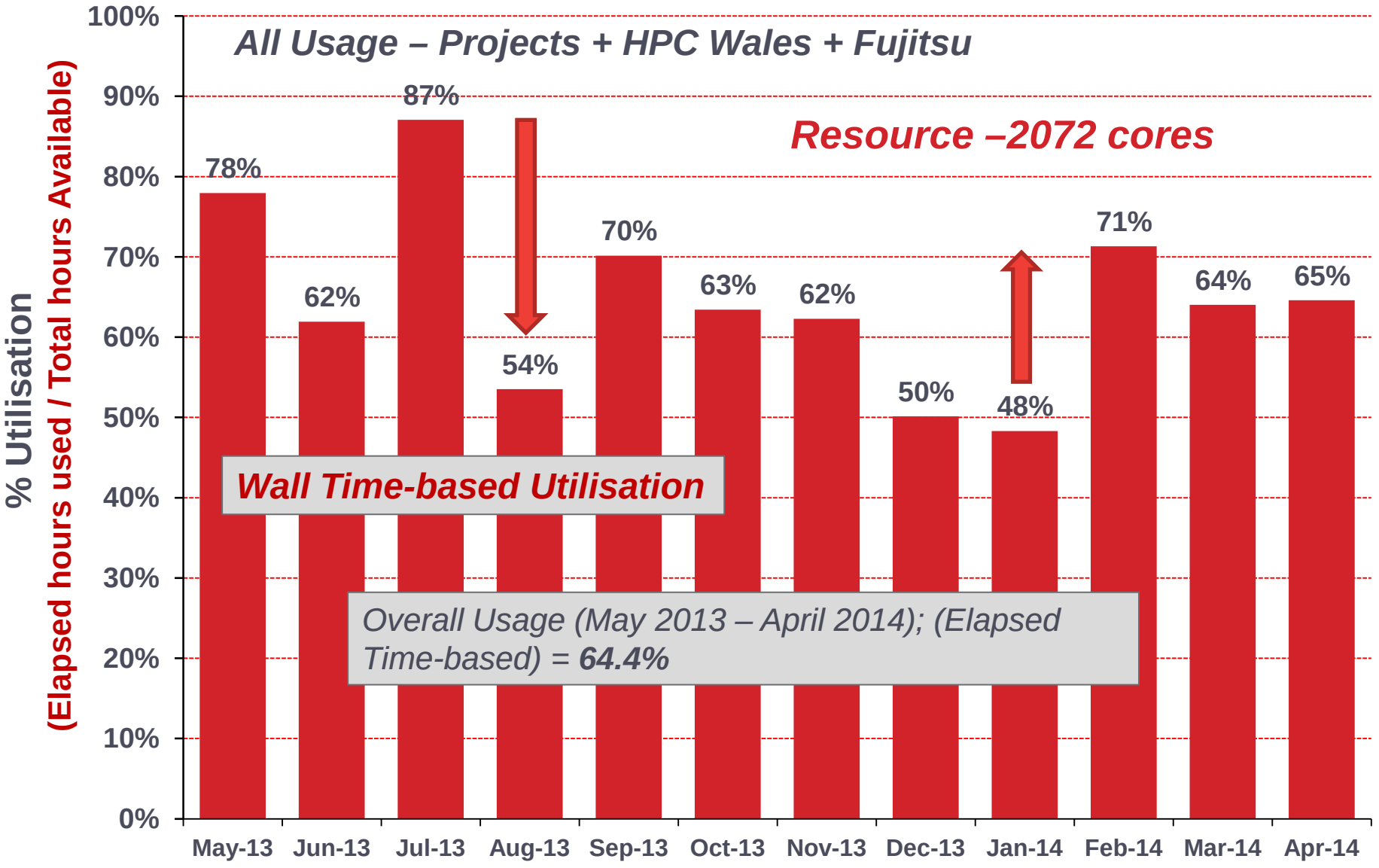
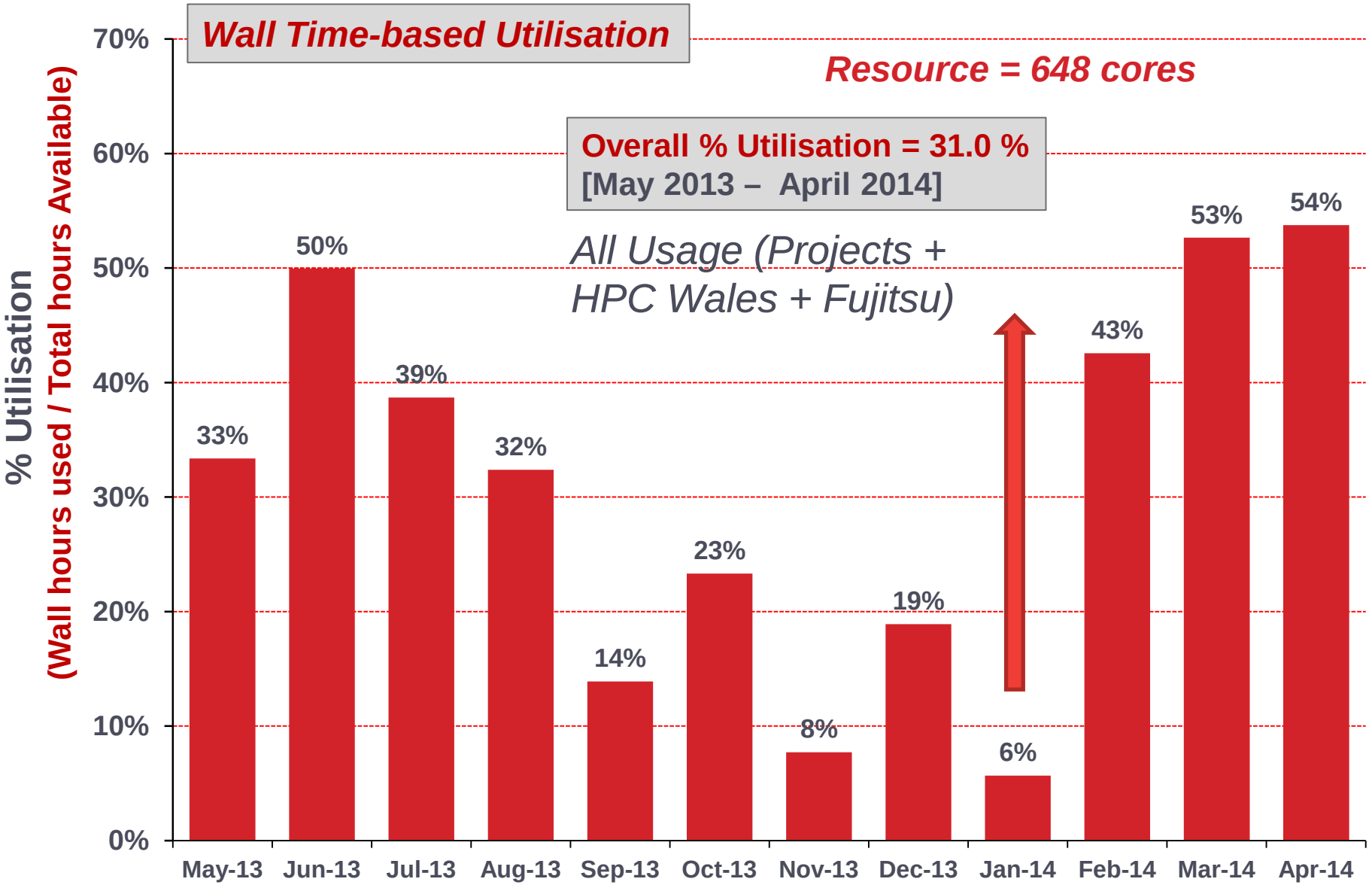
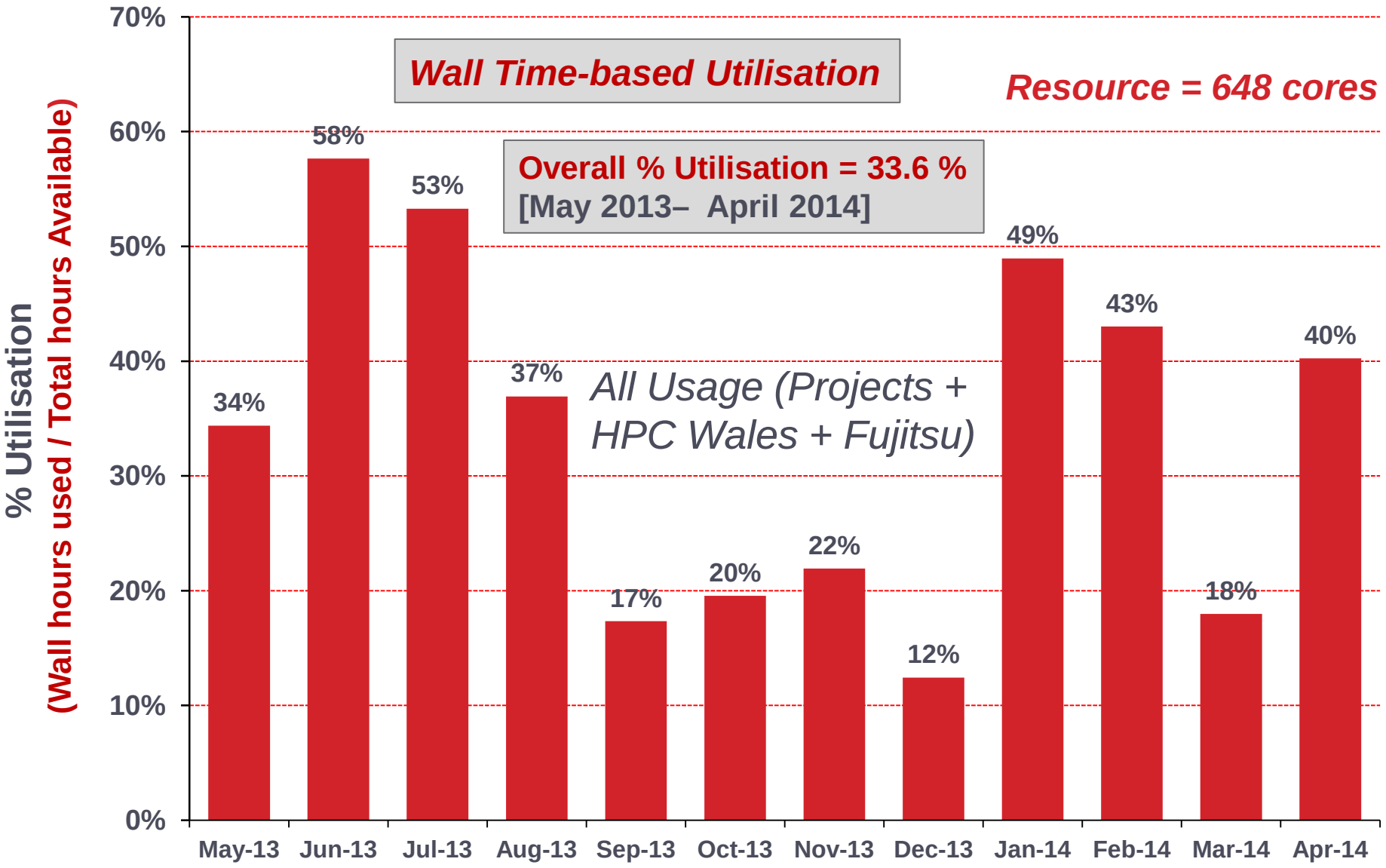
Cardiff HTC Cluster - % Utilisation (Elapsed)



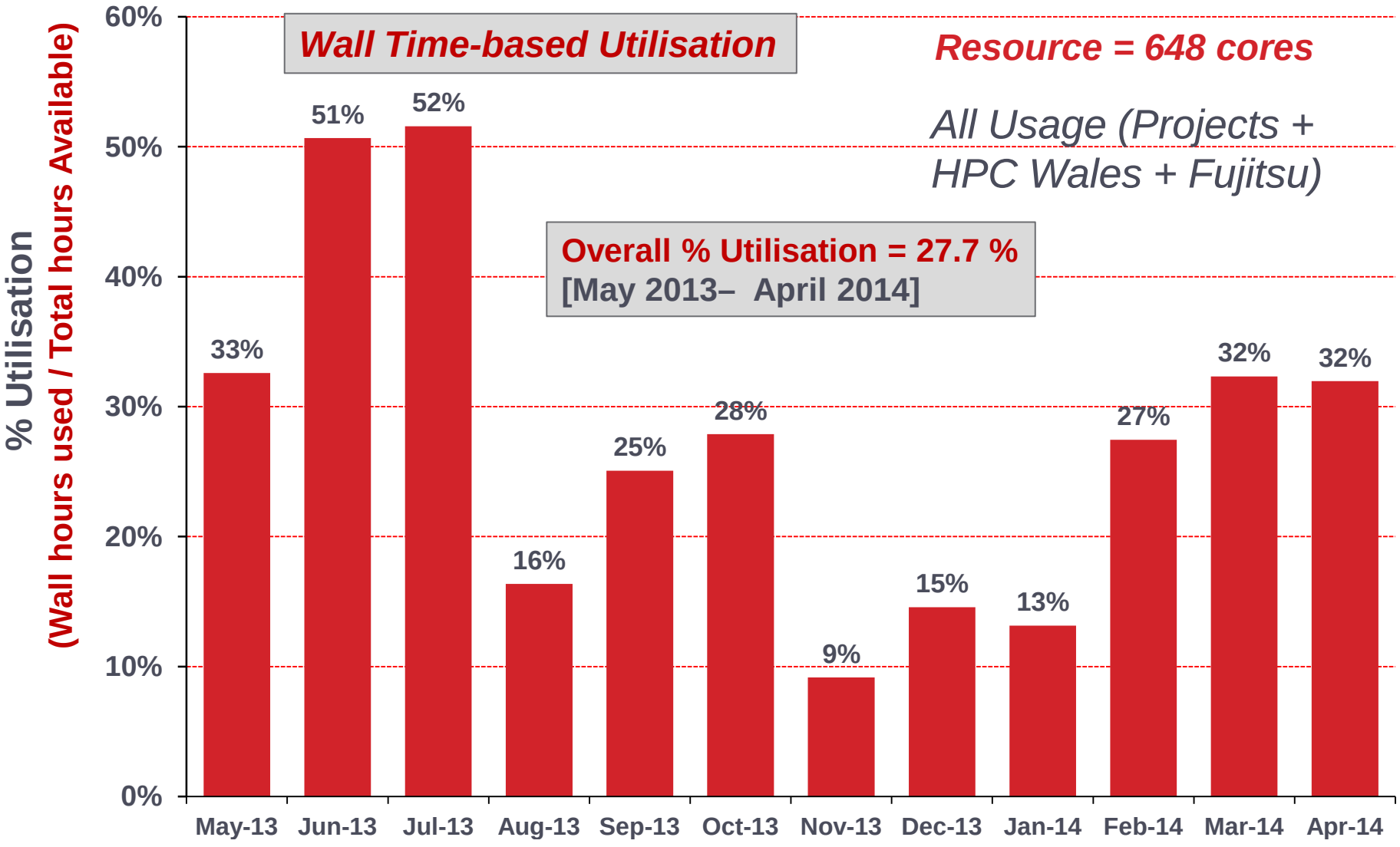
% Utilisation of the Aberystwyth T1 Cluster



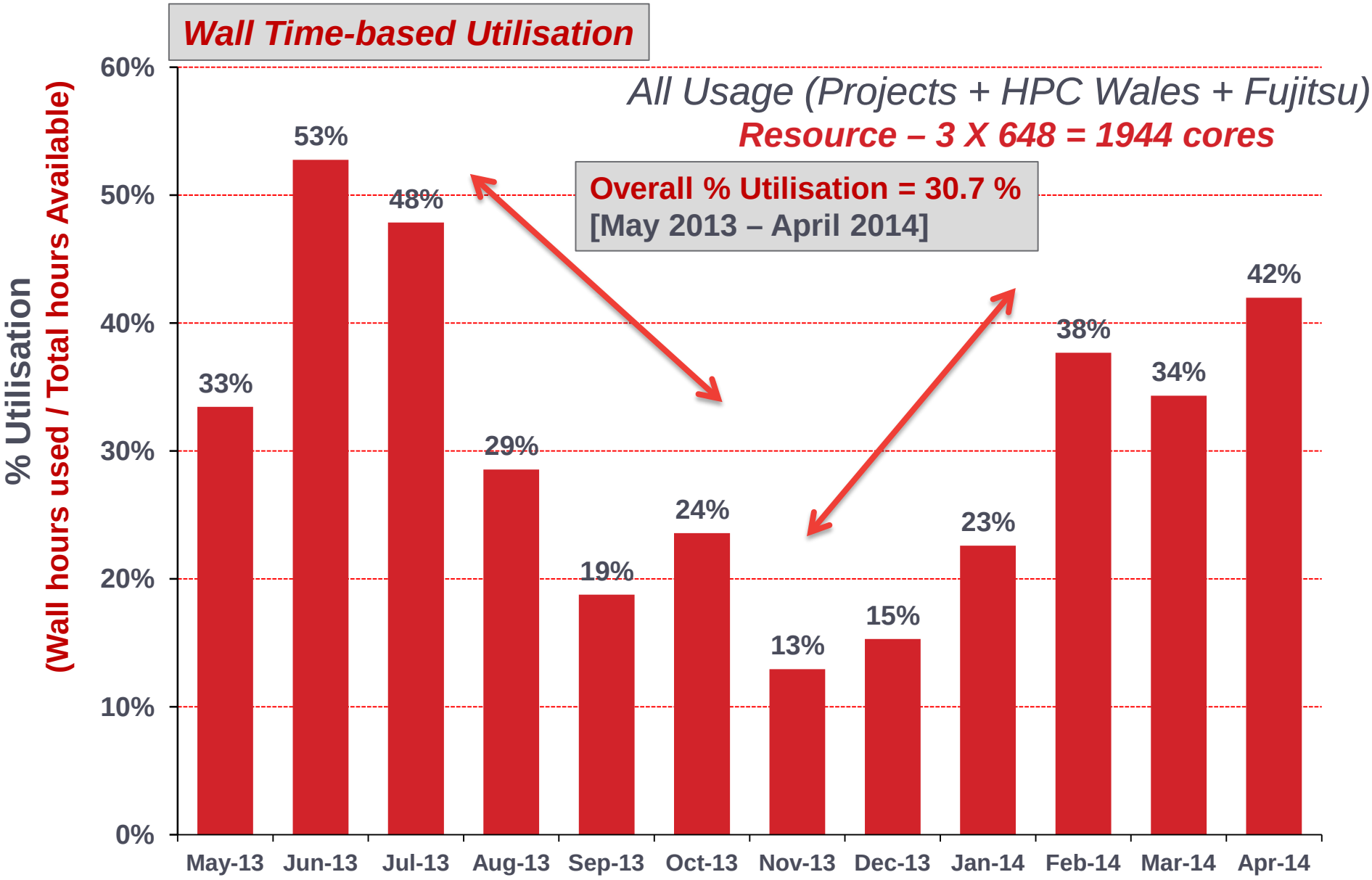
% Utilisation of the Bangor T1 Cluster



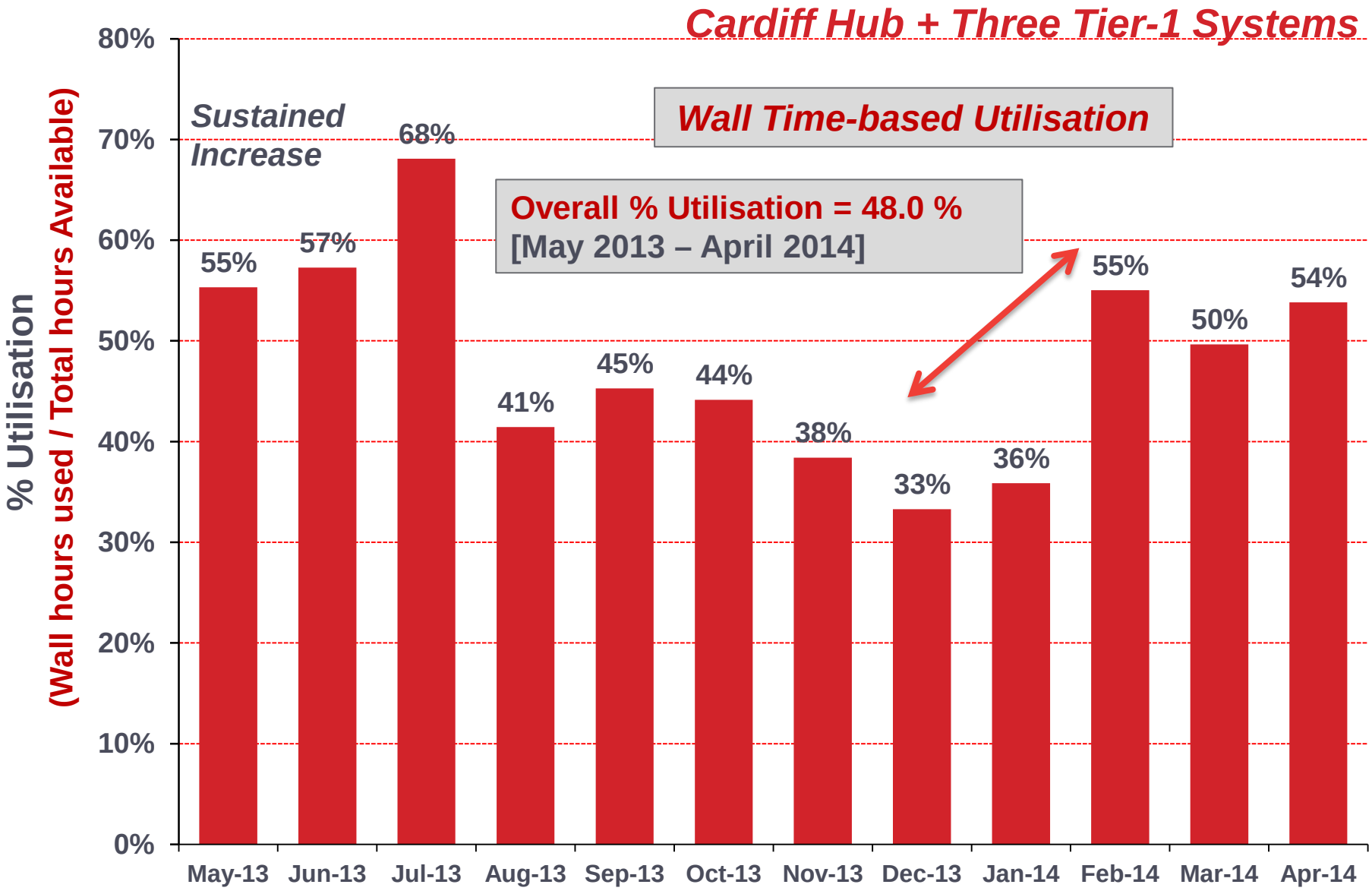
% Utilisation of the Bangor T1 Cluster



% Utilisation of the Three Tier-1 Clusters



% Utilisation of the Phase 1 Systems



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Usage of the HPC Wales Phase 2 Systems

August 2013 – April 2014

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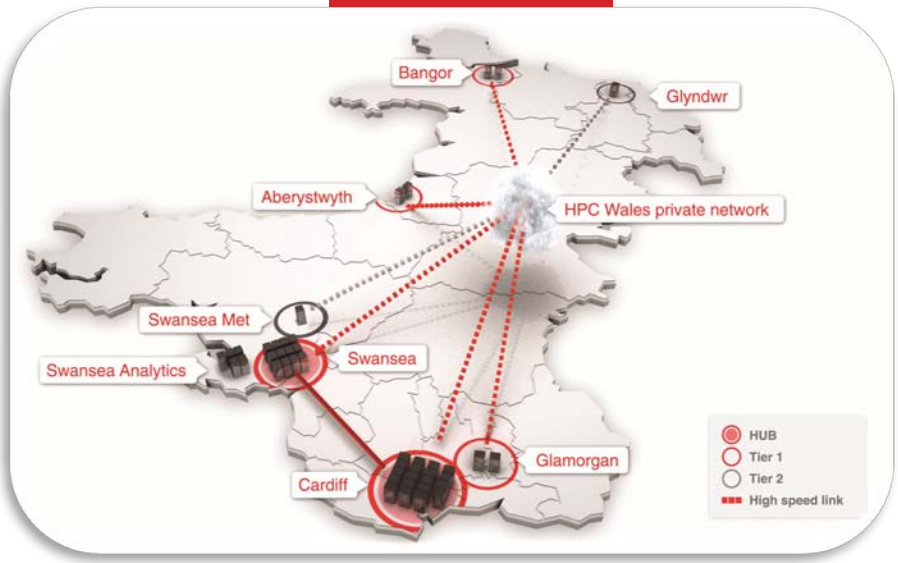
Sandy Bridge and the HPC Wales Hubs

Phase 2

256 x CX250S1 E5-2690 dual processor 16-core nodes

- 240 nodes with 64GB memory
- 16 nodes with 128GB memory
- **4096 × 2.9 GHz cores with 4/8 GB memory / core**
- Infiniband non-blocking QDR network
- 95 Tflops peak performance
- 400 TB Lustre file storage and 100 TB storage for permanent filestore



Cardiff Capacity system:

- 384 × CX250S1 e5-2670 dual processor 16-core nodes
- **6144 × 2.6 GHz cores with 4 GB memory / core**
- Infiniband non-blocking QDR network
- 128 TFlops peak performance
- Filestore shared with HTC sub-system

Swansea Capacity system:

- 128 x CX250S1 E5-2670 dual processor 16-core nodes
- **2048 × 2.6 GHz cores with 4 GB memory / core**
- Infiniband non-blocking QDR network
- 43 Tflops peak performance
- Filestore shared with Capability sub-system

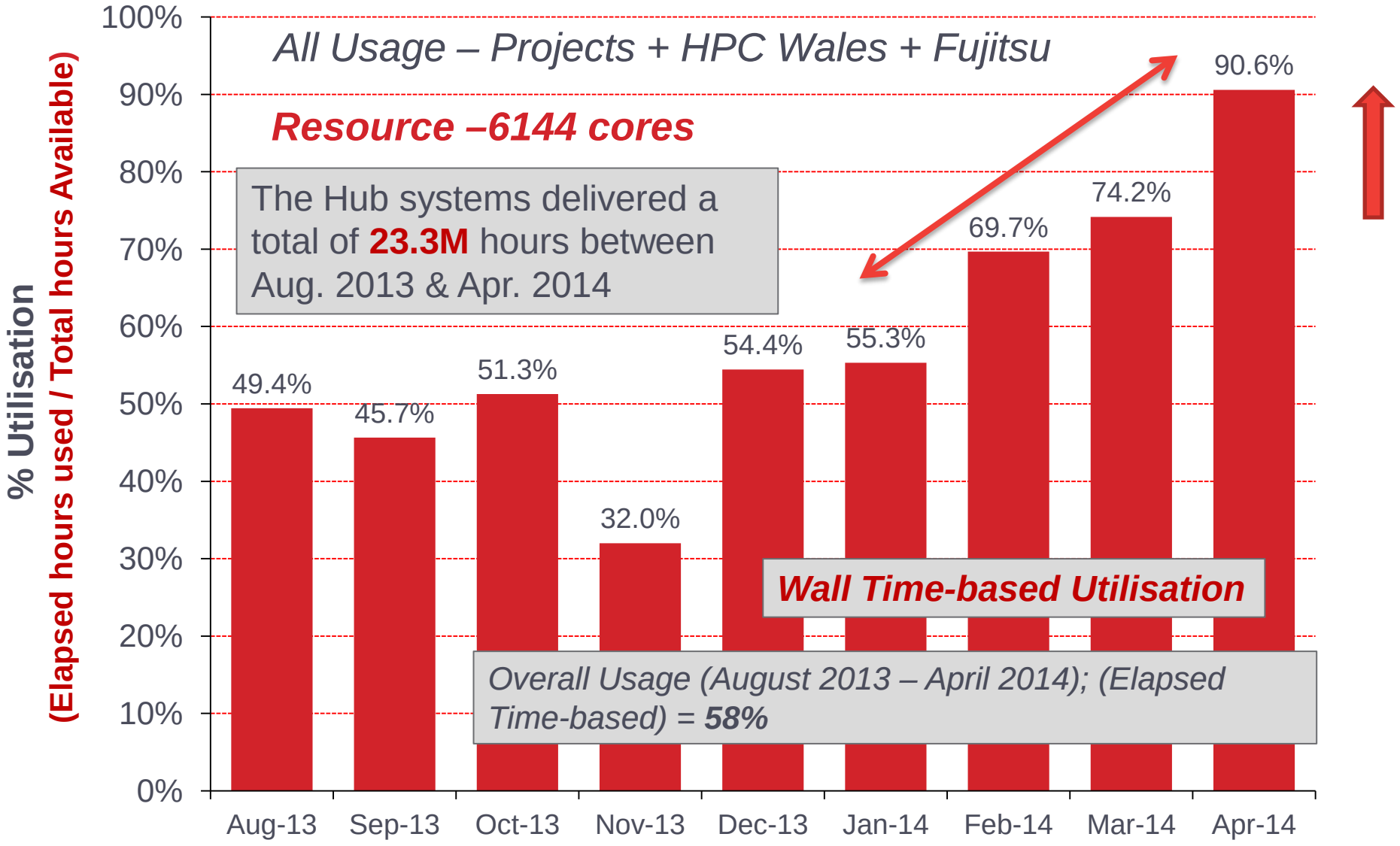
Site	System	Number of Cores	Peak Tflops
CARDIFF	HTC + Capacity	8216	149.6
SWANSEA	Capability + Capacity	6144	137.6
BOTH HUBS	GP-GPU systems	512	10.6
TIER-1 SITES	3 × Medium	1944	20.8
All Sites	All Systems	16816	318.6

Novel Architecture Sub-systems (at each Hub):

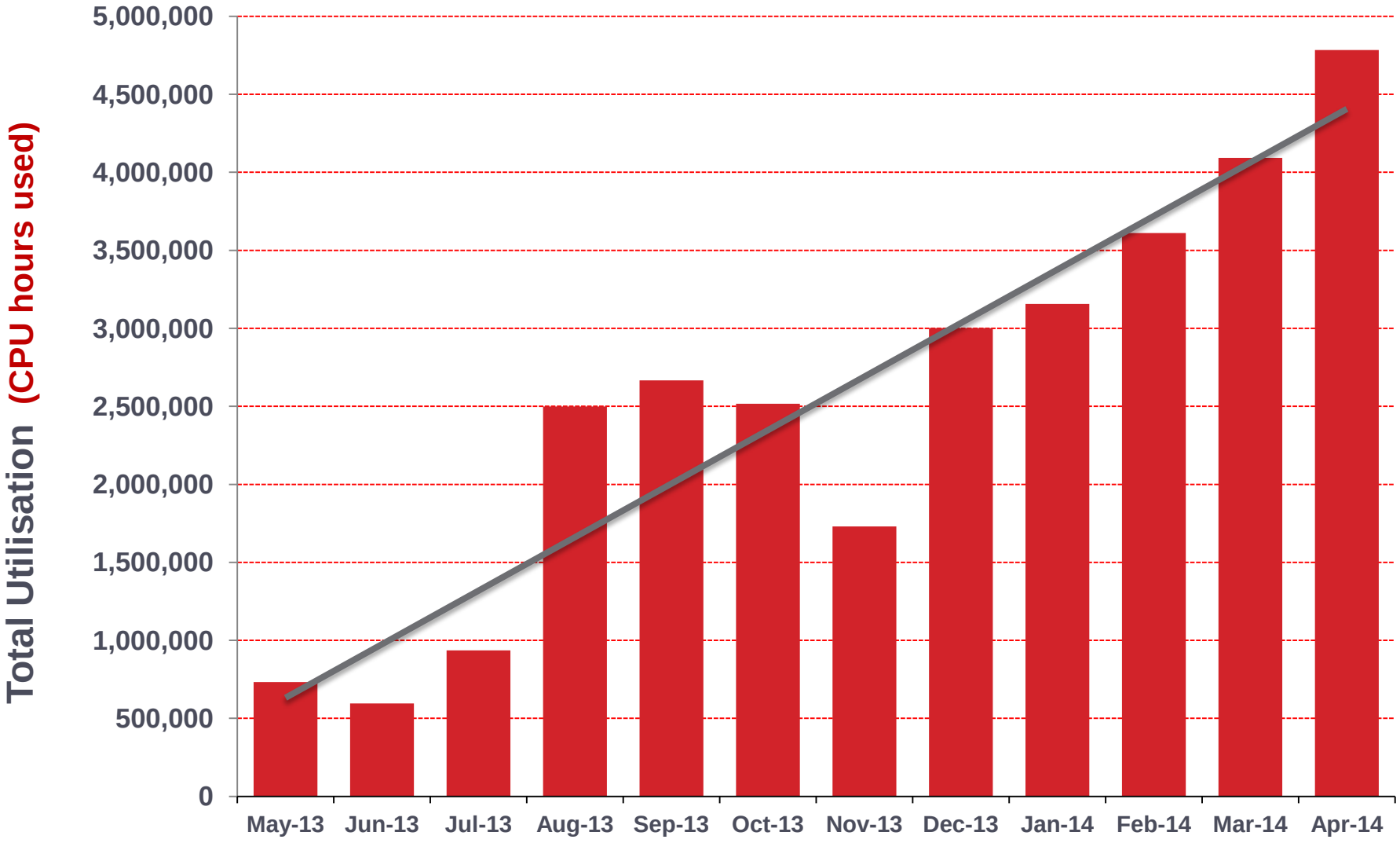
- 16 x CX270 nodes with GP-GPU capability
- 256 x 2.6 GHz cores with 4 GB memory/ core
- **each node with a M2090 GP-GPU card**
- Infiniband non-blocking QDR network

#110 in November 2013 Top 500

Swansea Cluster - % Utilisation (Elapsed)



Total CPU Utilisation – Phase 1 and Phase 2



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Phase 1 Usage Profile of the HPC Wales Projects

May 2013 – April 2014

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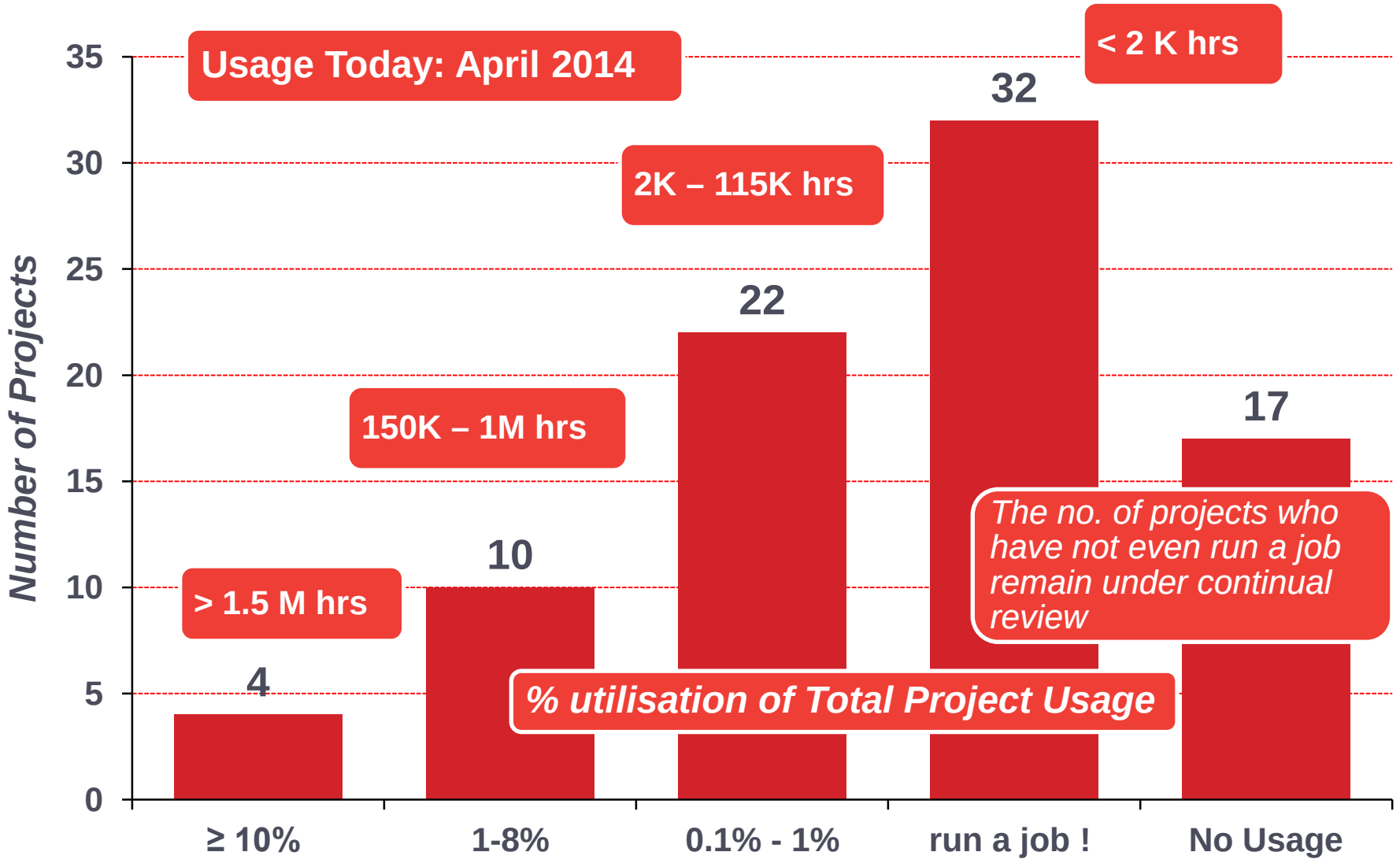
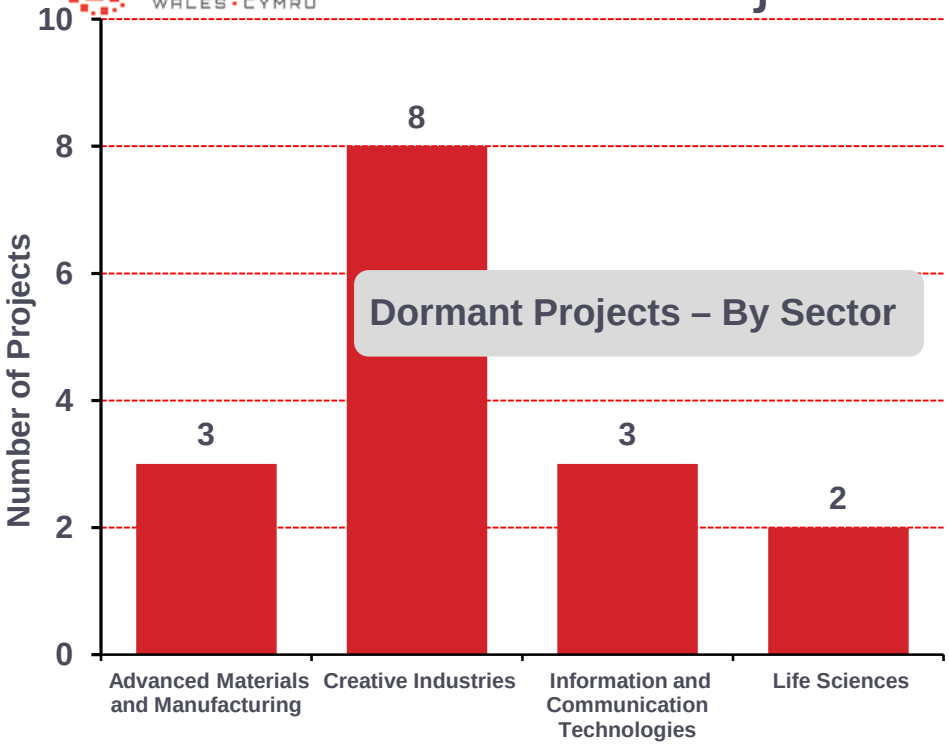
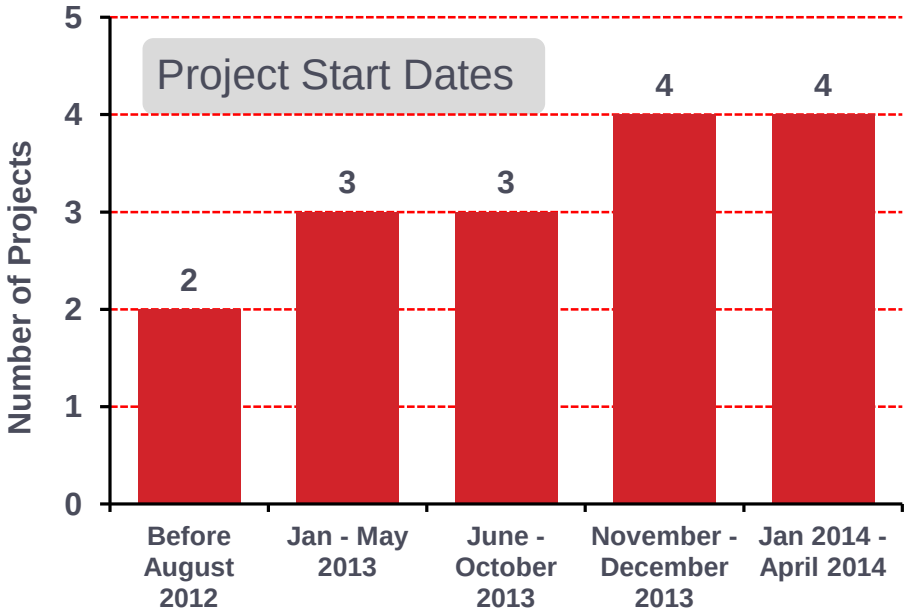
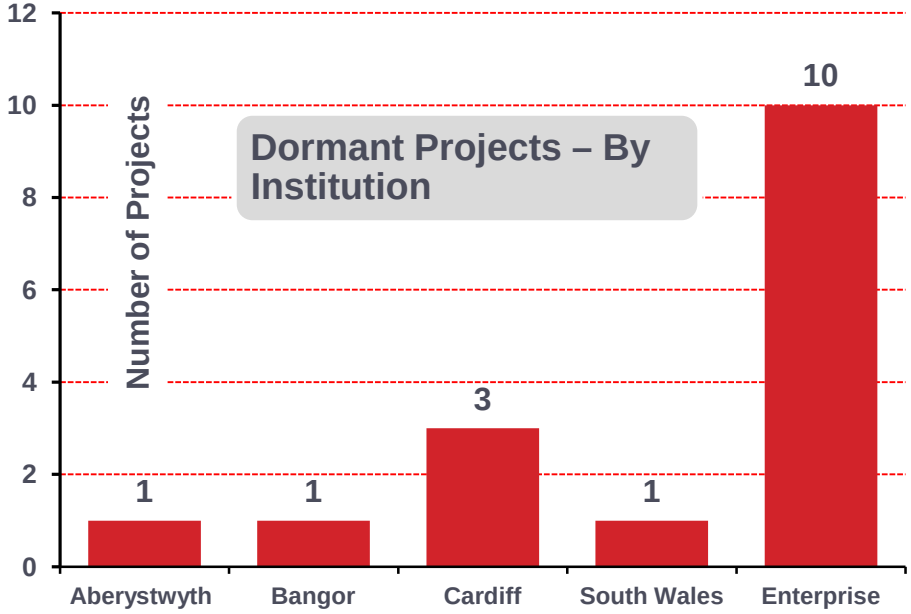
Project Utilisation Profile of the HPC Wales Phase 1 Systems



Dormant Projects







Projects that have yet to run a job on the system, going back to August 2012

Three projects activated in April – HPCW142, HPCW187 and HPCW189

Summary and Conclusions

Presented an analysis of Usage of the HPC Wales Systems

- Focus on period September 2012 – April 2014. Usage presented in terms of both CPU (core) and elapsed hours
- Levels of usage of Phase 1 systems initially impacted by the arrival of successful Phase 2 pilot service on Sandy Bridge. Project usage of the Cardiff HTC system increased somewhat in April - 54% (core CPU) and 65% (elapsed) of the total hours available.
- Usage of the Tier-1 systems also increased in April, from 15% [March 2014] to 23 **%** [April] and 34 to 42% Elapsed.

Increase in number of registered users continues

- Large number of active user accounts translates into modest number of users actually running jobs (1481 SAM accounts show modest usage, although SAM0043 a major user over Q3 2013)
- **Four** new projects on the system during April, one fronted by an HEI [HPCW166], the other 3 by industry [HPCW182, 187 and 189]. Sixteen "Trial" projects now in place.
- Number of HPCW pipeline projects not being activated onto the system remains an issue. Introduction of "trial" projects has helped here.

Usage by all 85 HPC Wales Projects of the HPC Wales systems

- Usage dominated by a few projects e.g., HPCW070, HPCW033 and HPCW106, with HPCW107 accelerating its usage.
- 11 projects account for 92% of total usage. 16 projects (19%) have still to run a job on HPC Wales systems.
- HPC Wales has delivered a total of 35.2M core CPUs hours to users in the period September 2012 – April 2014, 13.6M core CPU hours from its Phase-1 systems, and 21.6M from the Phase 2 Swansea & Cardiff Sandy Bridge systems.

Sandy Bridge service now delivered 1.6 X the no. of hours from August 2013 – April 2014 than the entire Phase 1 systems have delivered since the start of service in Feb 2012.

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HPC Wales User Group Meeting

User Concerns and Solutions

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User Concerns and Solutions

	Issue and Concern	Resolution
1	Lack of familiarity with Linux	Training available for Linux command line and other parts of the system (further learning after On boarding) Availability of NAG as part of the on-boarding process Development of LMS as part of the Skills Academy
2	Factoring in the queue system to your work schedule. Learning Linux commands.	
3	Setting things up in the first place and getting familiar with the HPC system (queue system, syntax, etc.).	
4	When I started using it I was unfamiliar with using Linux and how to run my models on the cluster so this was a big challenge to me.	
5	Getting used to running the system, basically getting used to its language and procedures	
6	Knowing what is available	Improvements to the Gateways and Documentation
7	Improving the user's skillset from beginner to intermediate level	Training from NAG and FLE

User Concerns and Solutions

	Issue and Concern	Resolution
8	Prompt resolution to tickets is the main challenge, [beyond that greater availability of training materials and courses would be useful to widen my knowledge of the subject	Improved ticket monitoring and resolution Closer monitoring of NAG tickets
9	Software design	Extend available training
10	Finding support in improving the code	NAG availability Site clinics e.g. Aberystwyth
11	Reproducibility of data when running calculations on other commonly used HPC systems within UK (e.g. Hector, Archer). e.g., broadly used codes (e.g. VASP, GAMESS-UK) should be checked for that	Discussions with Code owners and ISVs; Developing links with EPCC and HPC-SIG
12	Transferring data between Cardiff and Swansea nodes	Transfer can be managed directly by the user using sftp facilities through **sftp.hpcwales.co.uk** Also now possible to ftp out of the HPC Wales infrastructure
13	Keeping files up to date when using the UoSW cluster and the Cardiff cluster at the same time	
14	Getting data to and from the system	

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HPC Wales Fair Use Policy

Ade Fewings, Bangor Systems Engineer

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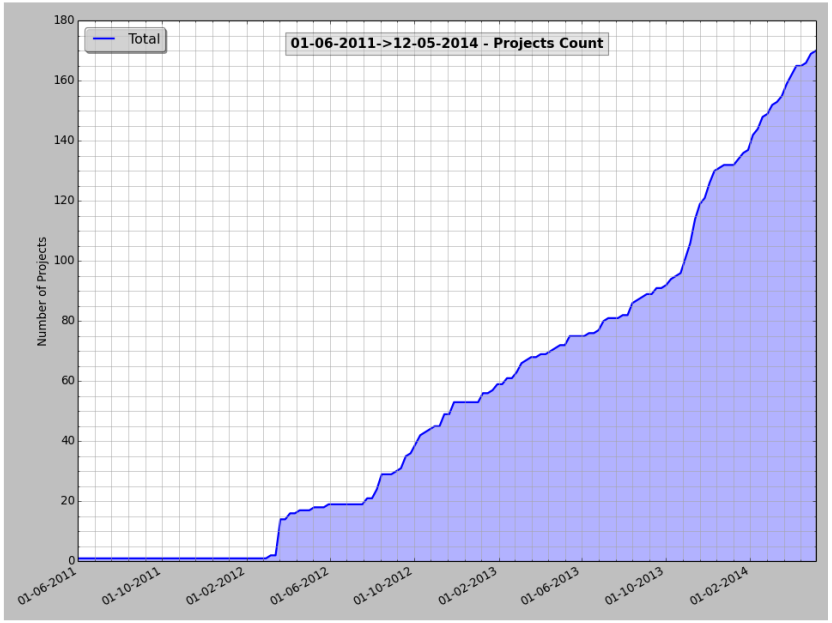
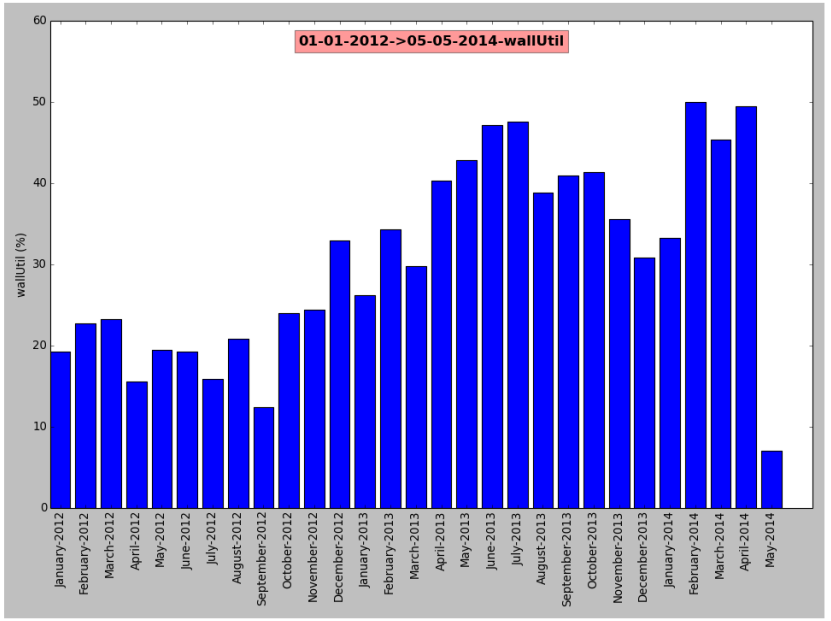
Finite Resources

- Hardware & Software
  - Processors, Memory, disk, Licenses

Increasing Consumption



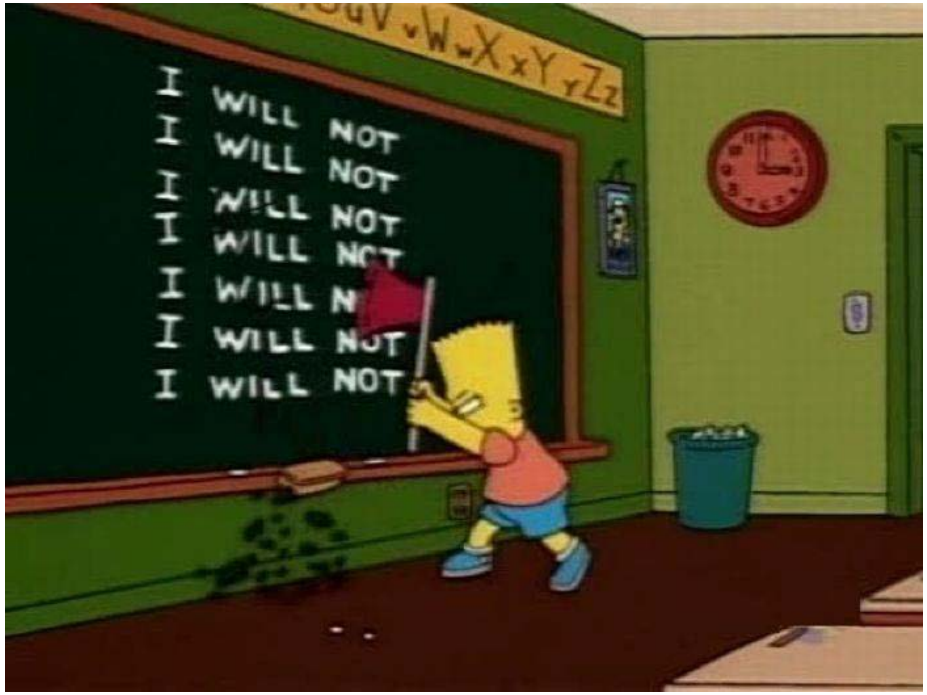


Diverse User Base

- Academia & Commercial
- Huge variety of applications
- Differing Requirements
  - Devil is in the detail

What is ‘Fair Usage’?

- We operate an open system
  - We do not want to impose draconian limits
- Set of guidelines, with just a few rules
- Broadly encouraging user awareness
- Improve service & predictability for all
  - Large proportion of usage by small proportion of users
  - More resources will come



A Few Highlights

- Computation must happen through the scheduler
- Storage is not intended for long-term dataset archival
- Keep it secure

HPC WALES

Fair Usage Policy

Rules and guidelines

The HPC Wales systems are used by a large number of users with a mixed requirement for compute resources. Our fair usage policy is designed to ensure that all of our users receive as fast and reliable a service as possible. Although there are some technical limits imposed to ensure fair usage, we also operate an open system and rely on individual users being aware of the potential impact of their activities on other users' access.

1: The home directory is for code, scripts, and small data sets

The home directories are designed for availability and safety, but not so much for performance. If your job makes a lot of disk access (reading and/or writing files), then it should do so in either a local temporary space on a compute node or a site scratch.

Please do not use the cluster file systems for long-term storage of data. Once data is not being actively used it should be moved elsewhere to free up space for other cluster users. We do not routinely operate a data archive or provide a long-term storage service; this will only be possible in special circumstances[1].

2: The scratch directory is for temporary data created/utilised by a job

The scratch directories are designed to be able to accommodate large amounts of data very rapidly. They are for a job to store temporary data and should be cleaned after the job has finished. They are not for storing data, as scratch directories are subject to arbitrary cleaning at any moment.

3: The login nodes are for compiling, debugging, and file editing activities

The login nodes are intended for interactive SSH sessions, file editing, compiling, debugging and managing jobs in the job scheduler. They are reserved for activities which do not consume lots of processing or memory resource. Any job dedicated to computing must be run on a compute node.

[1] Users requiring such a service should in the first instance make their requirements known to the appropriate HPC Wales Training and Outreach member or the corresponding member of the Technical team.

hpcwales.co.uk

through the job scheduler

urces fairly and efficiently. It makes sure that a requested. It is unfair to other users, and mpute node that has not been assigned to you y a node running your job). Access to the low users whose jobs failed/crashed to clean l information about the crash (core dumps, g on the node to monitor CPU and memory

g system.

bs, please be aware of the number of other submit if necessary. Please do not use/ ultaneously - be aware of your usage across more draconian technical measures.

y as possible

ur program is able to use them all. Do not ch cannot run in parallel. Do not request cores signed for message passing. Do not reserve) (consider revising the default values in your rements for jobs will leave more resources ur job to be scheduled sooner. Try to

cess HPC Wales systems are yours only and erators require access, please contact your ct your private access has been to the HPC Wales Support Desk immediately.

fair use policy, you may be asked to f the fair use policy will result in limits or vices.

Page 2 of 2

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Progress on Gateways

Charlie Godfrey, Skills Academy Manager

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Topics

- HPC Wales User Portal
- Knowledge Base (additions and changes)
  - User Group
  - Video Tutorials
  - Other Guides
- Gateways
  - Project Summaries
  - Calendars
  - Team Discussions

Knowledge Base

Knowledge Base

Site Actions | Browse | Page

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Search this site...

Public Website | General Portal | Knowledge Base | Support Desk | Gateways | Skills Academy

You are here: HPC Wales / Knowledge Base

- About
  - About HPC Wales
  - Questions About the HPC Wales Project
  - Technical FAQs
- Quick Guides
  - Accessing Systems with SSH
  - Command Line Environment
  - Data Storage & Management
  - University Access to HPCW Systems
  - Other Guides
- User Guide
- Software List
- HPC Wales User Group
- Video Tutorials

Knowledge Base

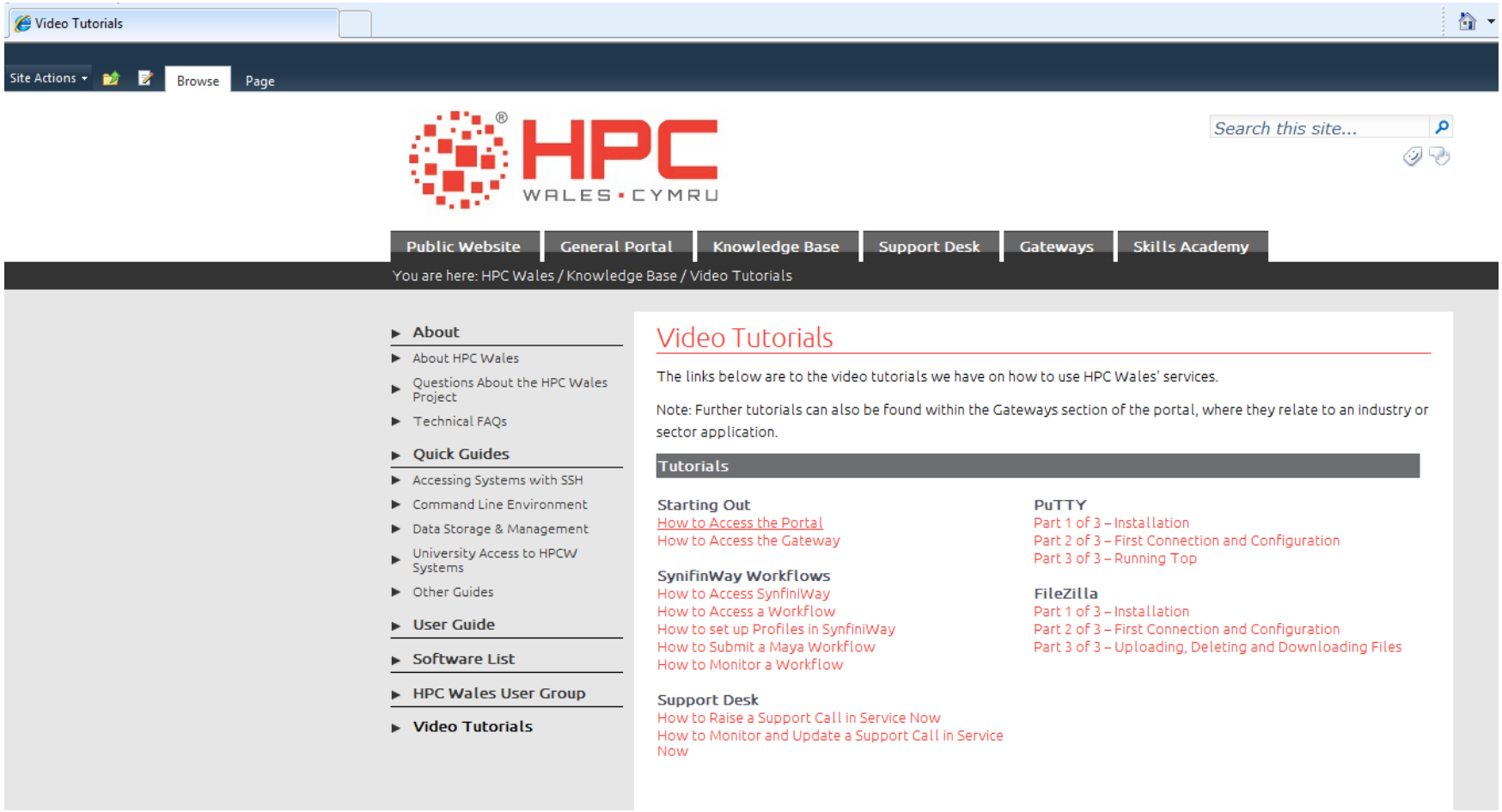
The Knowledge Base contains a variety of documentation on the HPCW project and use of the systems and services.

Please access the links to the left in order to learn more.

Recent Software Updates & Additions

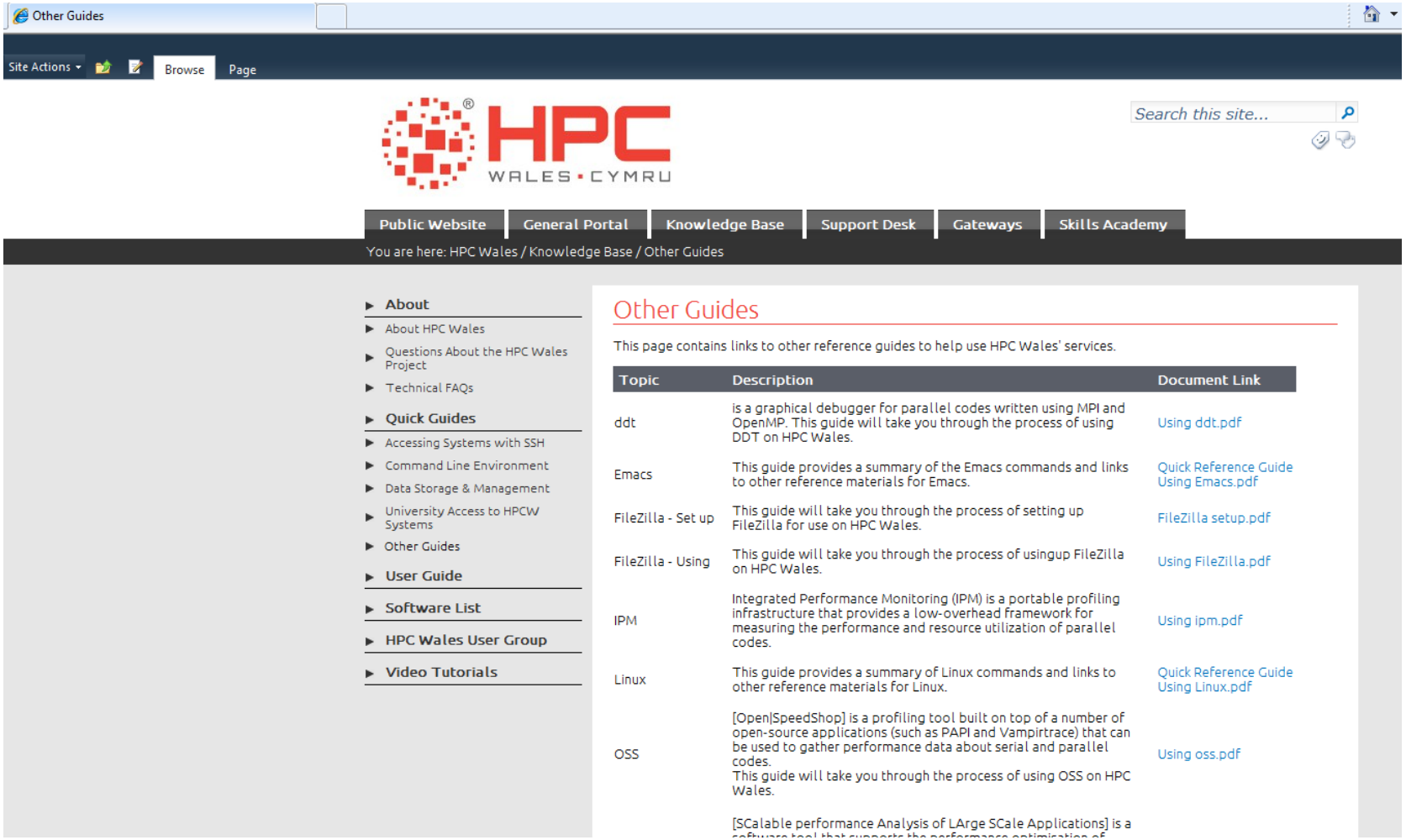
Name	Version & Build Details
LS-DYNA	Version R6.1.1.
MAXWELL-3D	Version 16.0.
CRYSTAL09	2.01 built with the Intel Compiler v11.1, and Intel MPI 4.0. For the MPP version, the Intel Scalapack libraries have been used.
gaussian	09d01
fastx_toolkit	version 0.0.13.2 It requires libgtextutils version 0.6.x which was built separately). Both were compiled using GNU compiler.

Knowledge Base – Video Tutorials

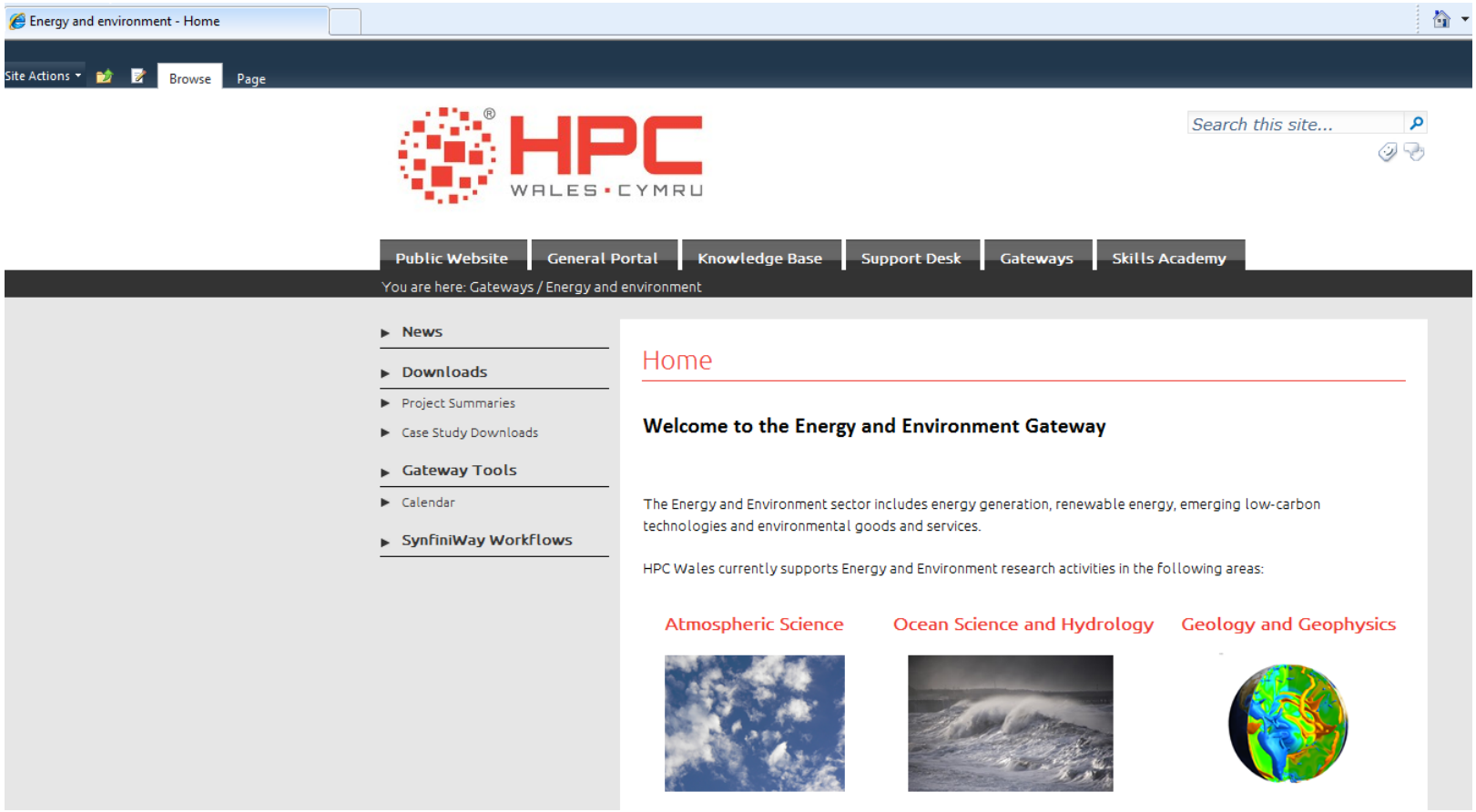


Knowledge Base – How to Access the Portal

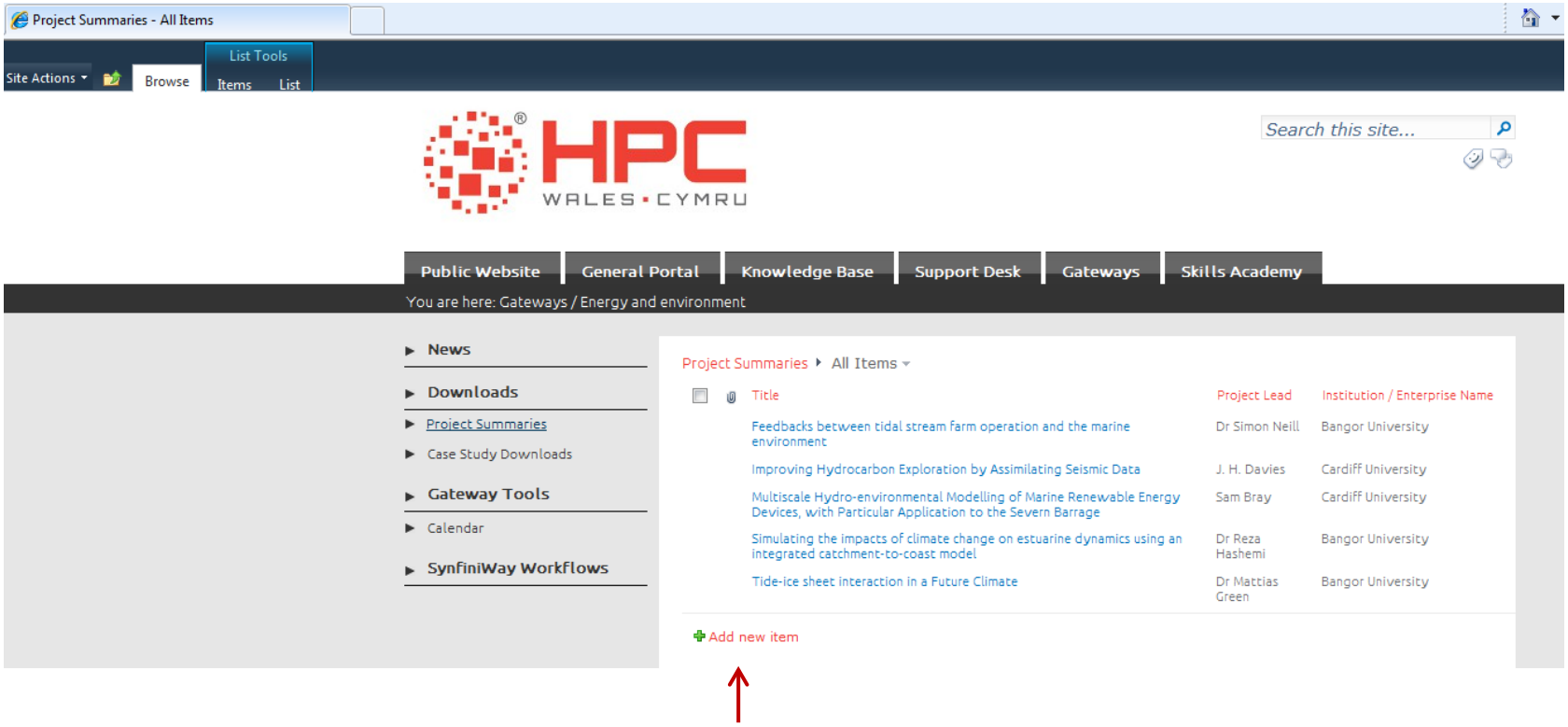
Knowledge Base – Other Guides



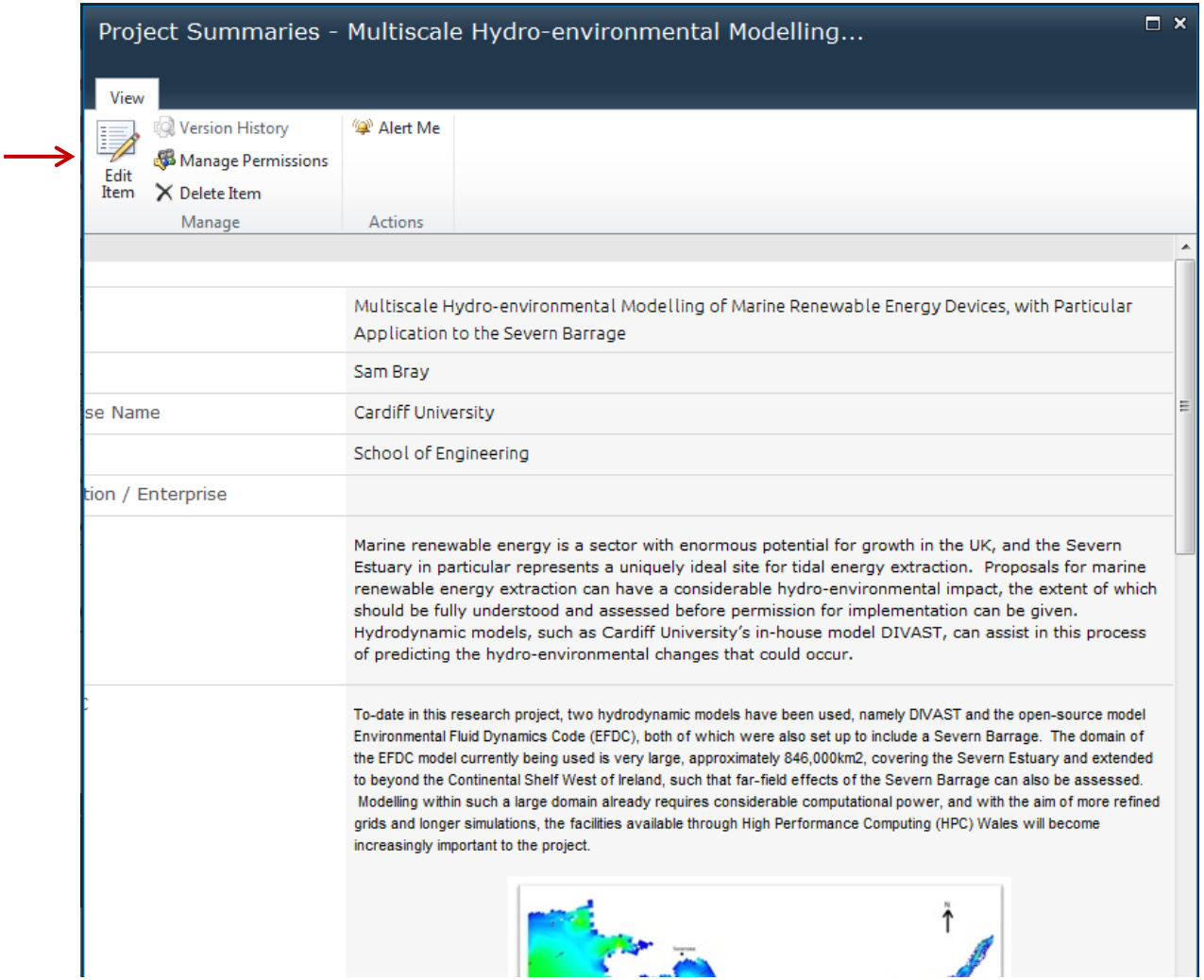
Gateways – Energy & Environment



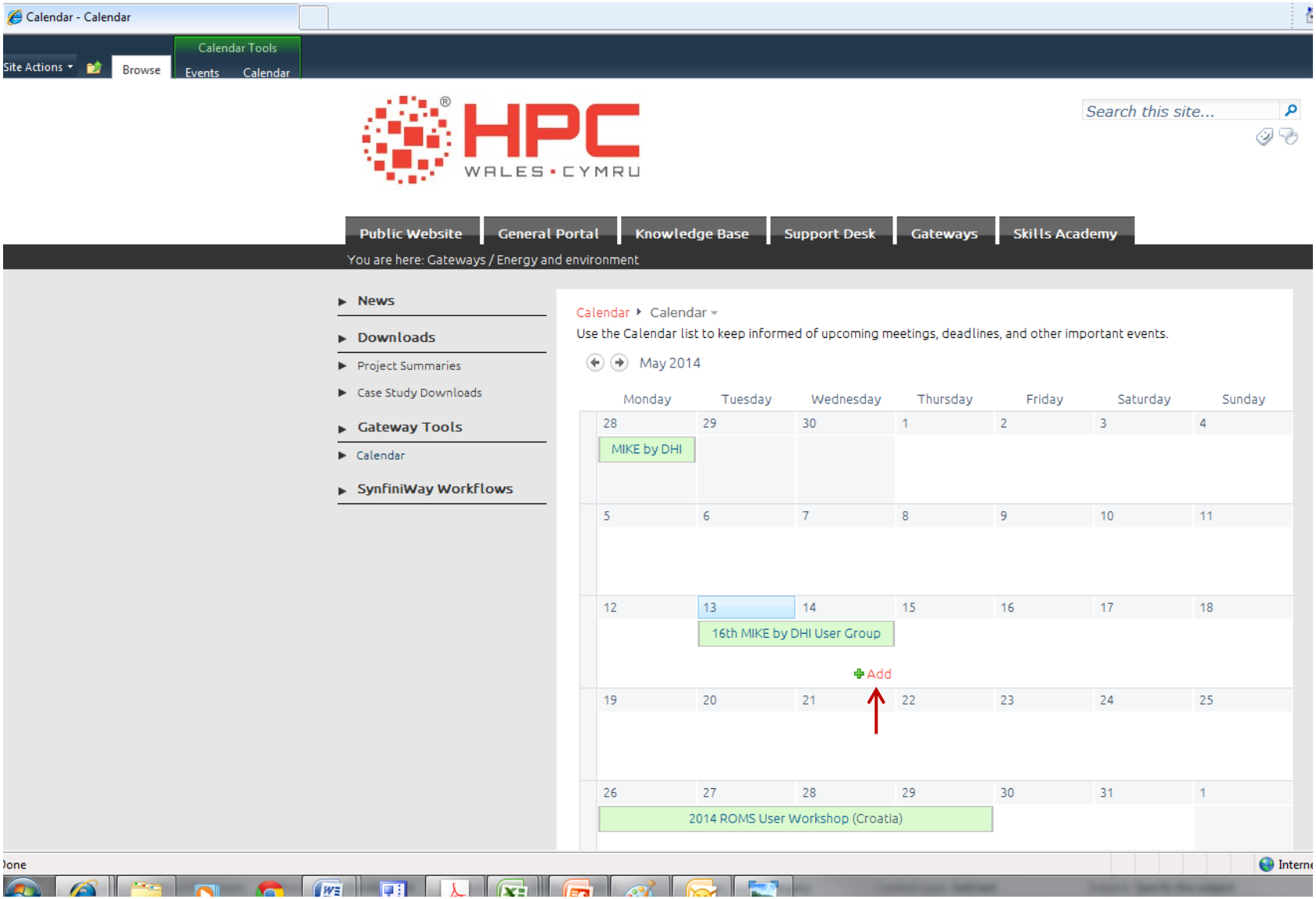
Gateways – Project Summaries



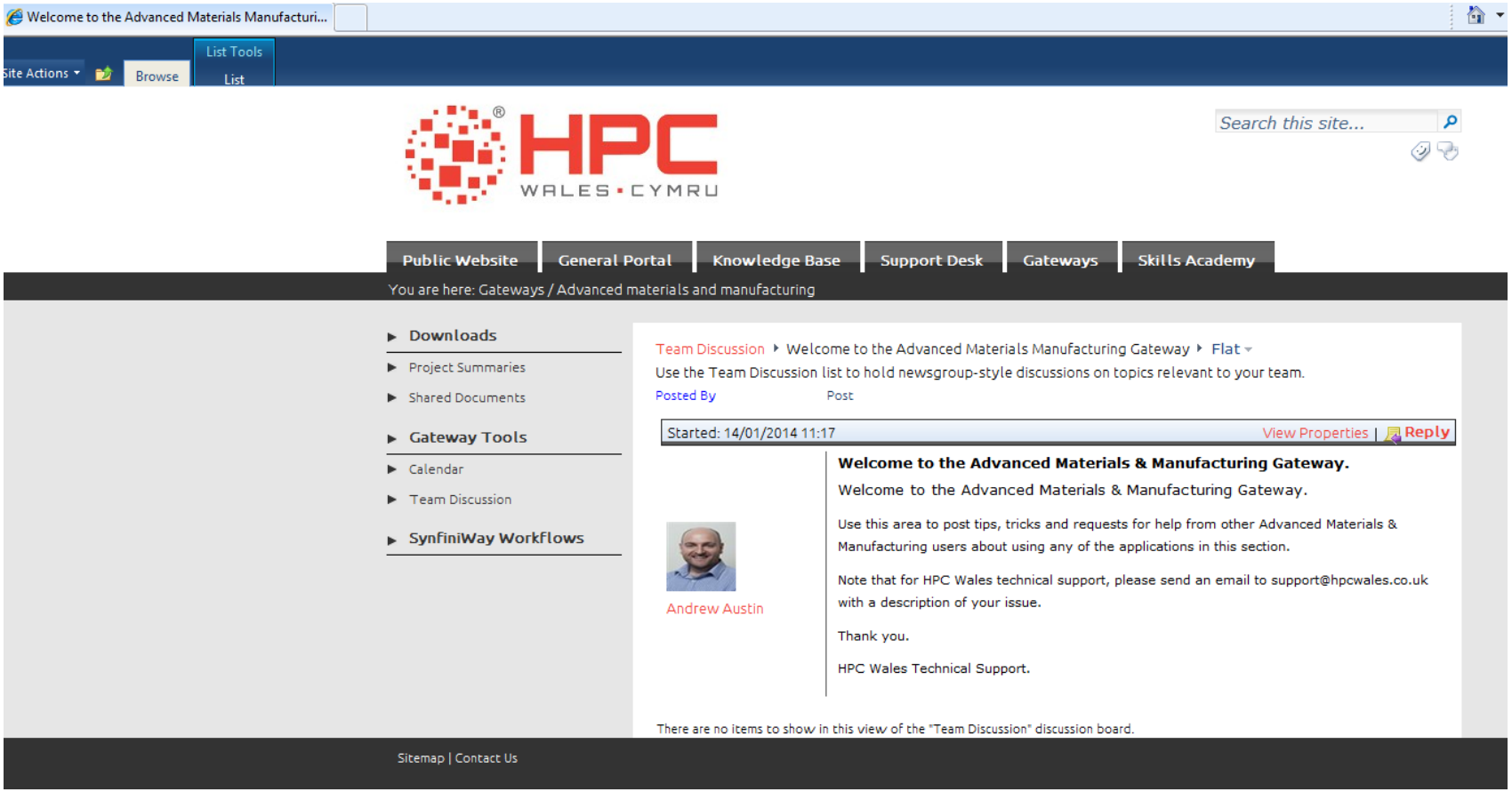
Gateways – Project Summaries



Gateways - Calendar



Gateways – Team Discussion



HPC WALES • CYMRU

Powering Success
Pweru Llwyddiant

Thematic User Groups

Charlie Godfrey, Skills Academy Manager

Ewrop & Chymru:
Buddsoddi yn eich dyfodol
Cronfa Datblygu Rhanbarthol Ewrop

Europe & Wales:
Investing in your future
European Regional Development Fund

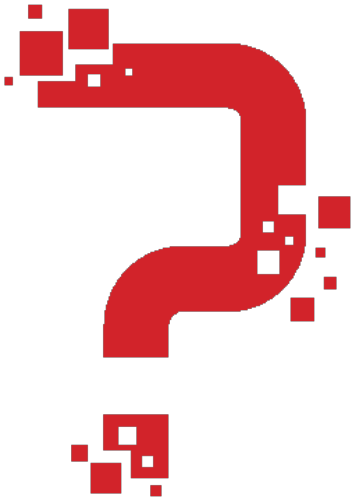
ERDF

Llywodraeth Cymru
Welsh Government

Thematic User Groups – What's Being Considered

- Life Sciences
  - Genomics (8th -9th Oct 2014)
  - Bio-molecular Simulation
- ICT
  - Big Data
- Advanced Materials & Manufacturing
  - Chemistry
  - Computational Dynamics
- Energy & Environment
- Creative Industry
- Optimising Tools & Libraries

What Would You Like To See?



HPC WALES · CYMRU

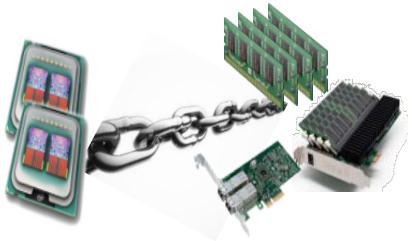
FUJITSU
shaping tomorrow with you

HPC Wales User Group, 14th May 2014

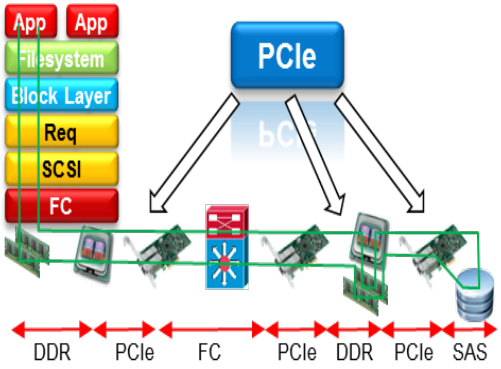
Vendor Technology Presentation

Application Optimized Server Design

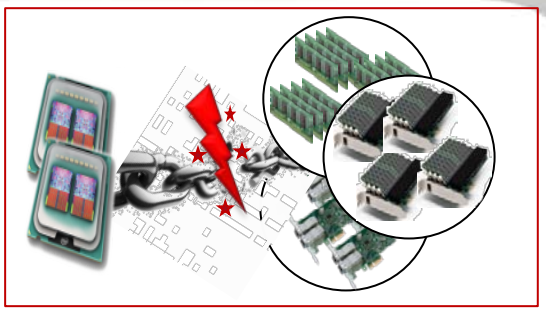
Server Design Evolvement

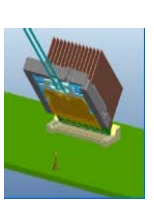


10 to 40Gbps (copper)
<=10 meter
~37 mW/Gbps QSFP
~250 mW/Gbps 10GbaseT

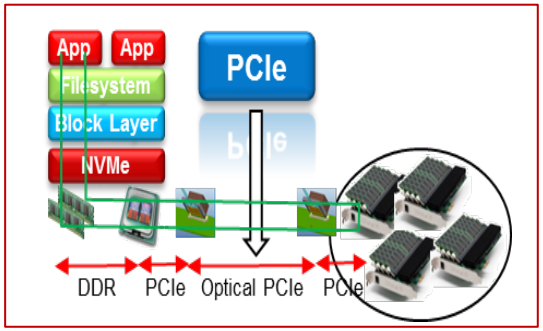


- From chained memory and I/O to flexible pool of resources.
- From complex, fault-prone and costly cable management to thin fail-save wired once cabling.
- From limited copper cable bandwidth to boundless high bandwidth optical cable.
- From big power hungry copper interconnects to lean power saving optical interconnect.
- From heavy and compute intensive protocols to lightweight low latency protocols and connections.

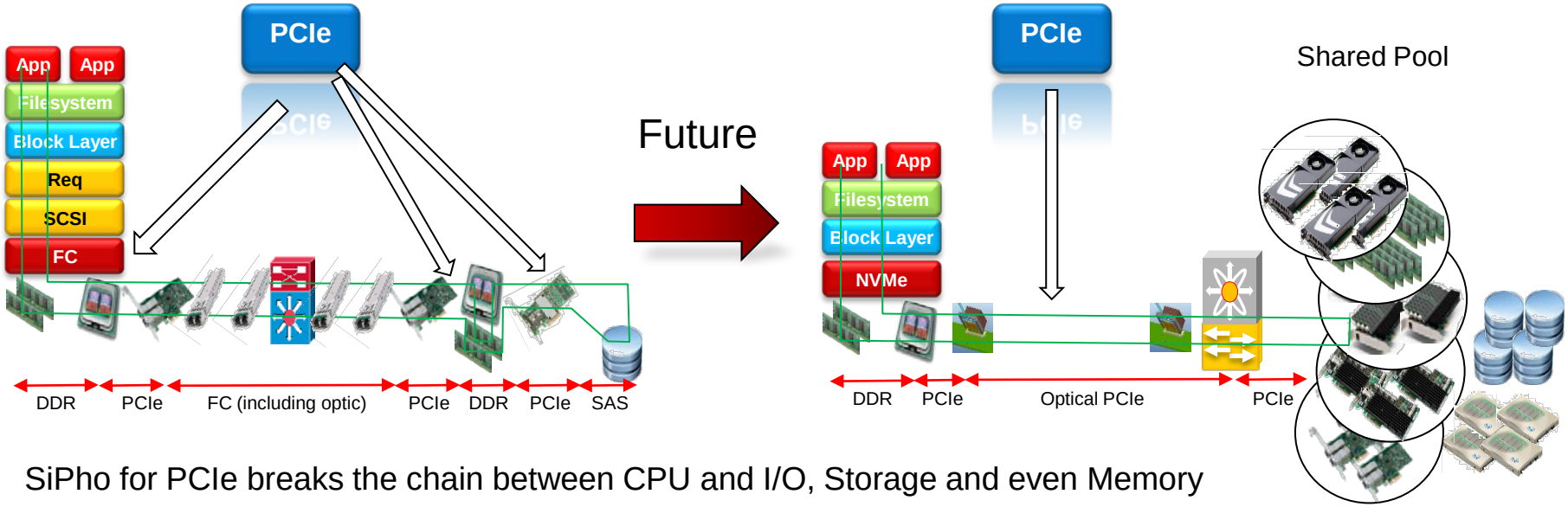




100 to 400Gbps (optic)
Up to 300 meter
~11 mW per Gbps



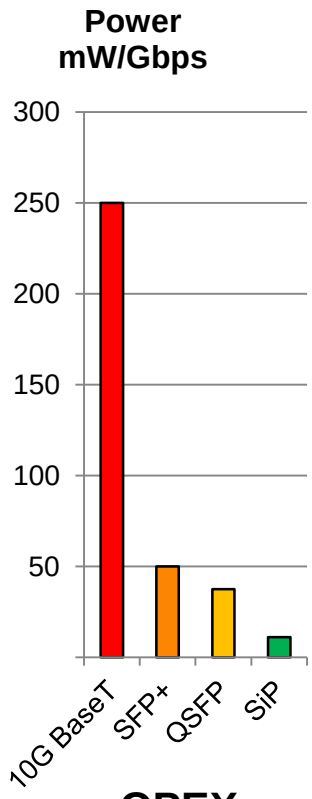
From chained Memory and I/O to flexible Pool of Resources



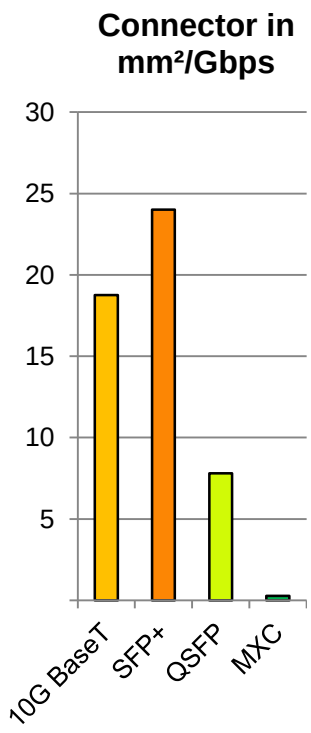
- SiPho for PCIe breaks the chain between CPU and I/O, Storage and even Memory
  - SiPho for PCIe is able to provide enough bandwidth (hundreds of Gbps) low overall latency as well as huge distance (up to 300 meter).
  - Allows great part and therefore cost reductions in CAPEX (parts) as well as OPEX(cabling, maintenance, power).
  - Enable new data-center architectures with pooled resources flexible available on demand.
    - No overprovision at individual server instead lean server with remote pooled I/O
- PCIe on the way to be the major storage interface
  - NVMe, SATAExpress, SCSI over PCIe they all rely on PCIe interface.
  - With PCIe SFF even traditional HDD's gets it PCIe based counterparts

Some SiP Metrics

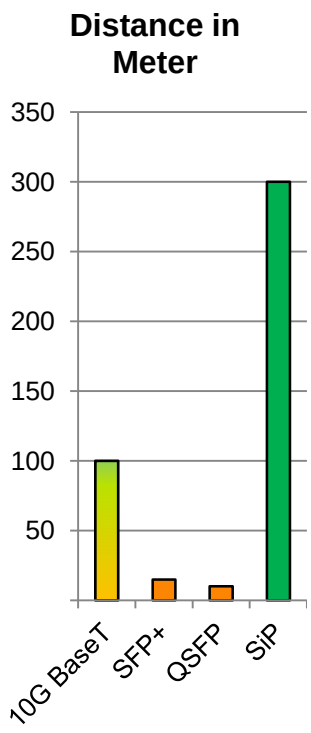
Comparison done on major network interfaces in the Data-Centre.
10GbaseT, SFP+, QSFP are copper based (Cat5/6Twinax), ClearCurve/MXC

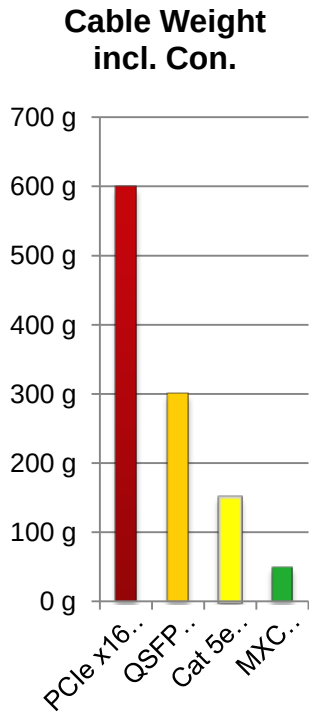


OPEX

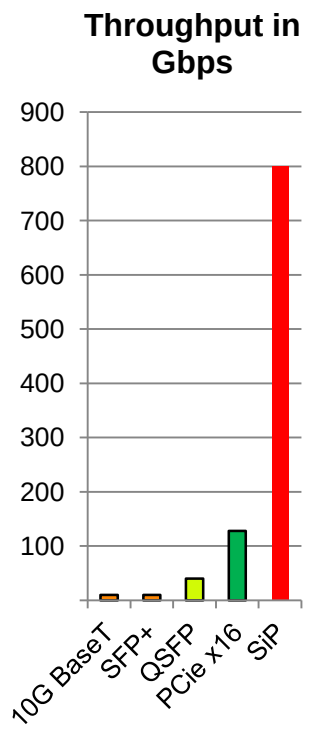


Density





DC Concepts

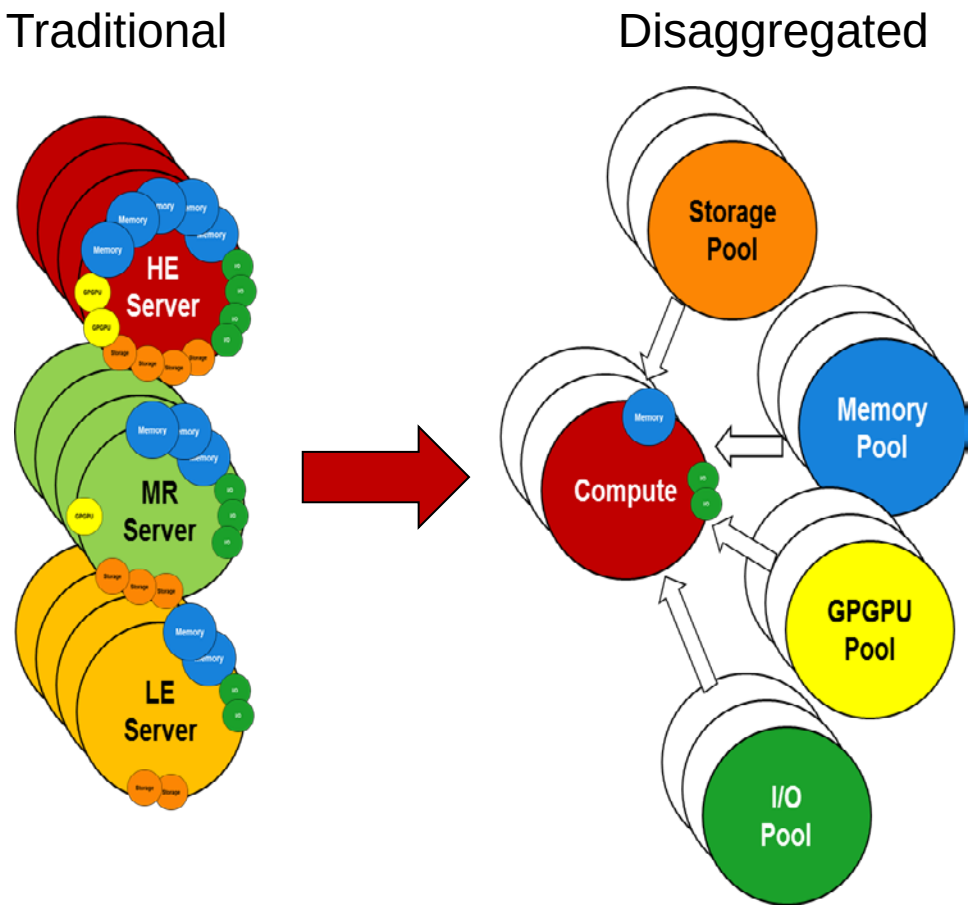


Performance

Benefits enabled by SiP based Architectures

- Rack scale resource provisioning to accomplish app-optimized server build
- Business-driven (re-) build of IT-Infrastructure at any time
- Lowest TCO by disaggregation of compute, memory, storage and networking
- High Bandwidth, long reach, very dense and power efficient Interconnects

Traditional versus Disaggregation



- From fixed server for different workloads towards slim compute nodes flexible configured for different application demands

New IT Usage Models

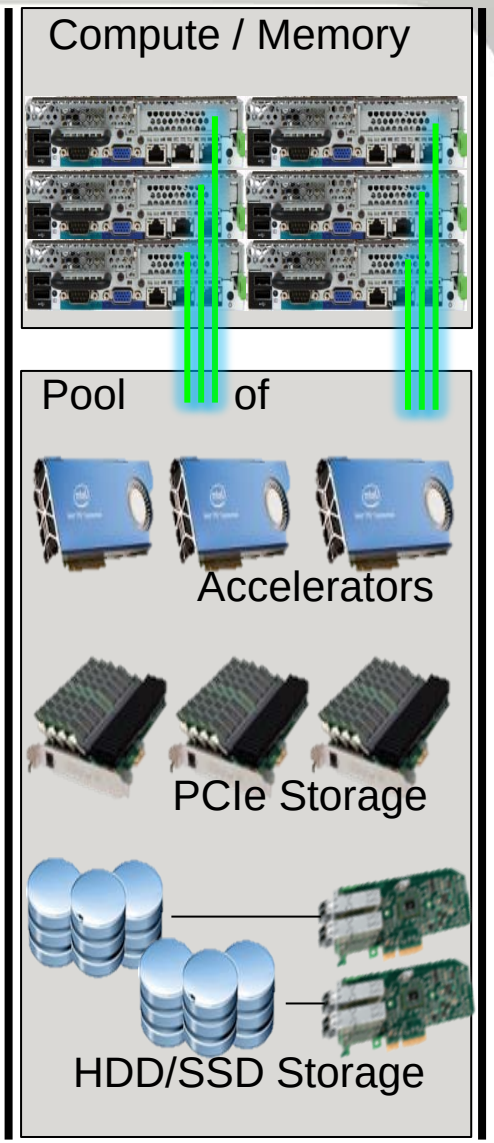
- New IT usage models require business driven build of IT HW
  - **Cloud**

    on customer demand compute, storage and network resources
  - **XaaS**

    HW resource usage model changes over system lifetime
  - **Big Data**

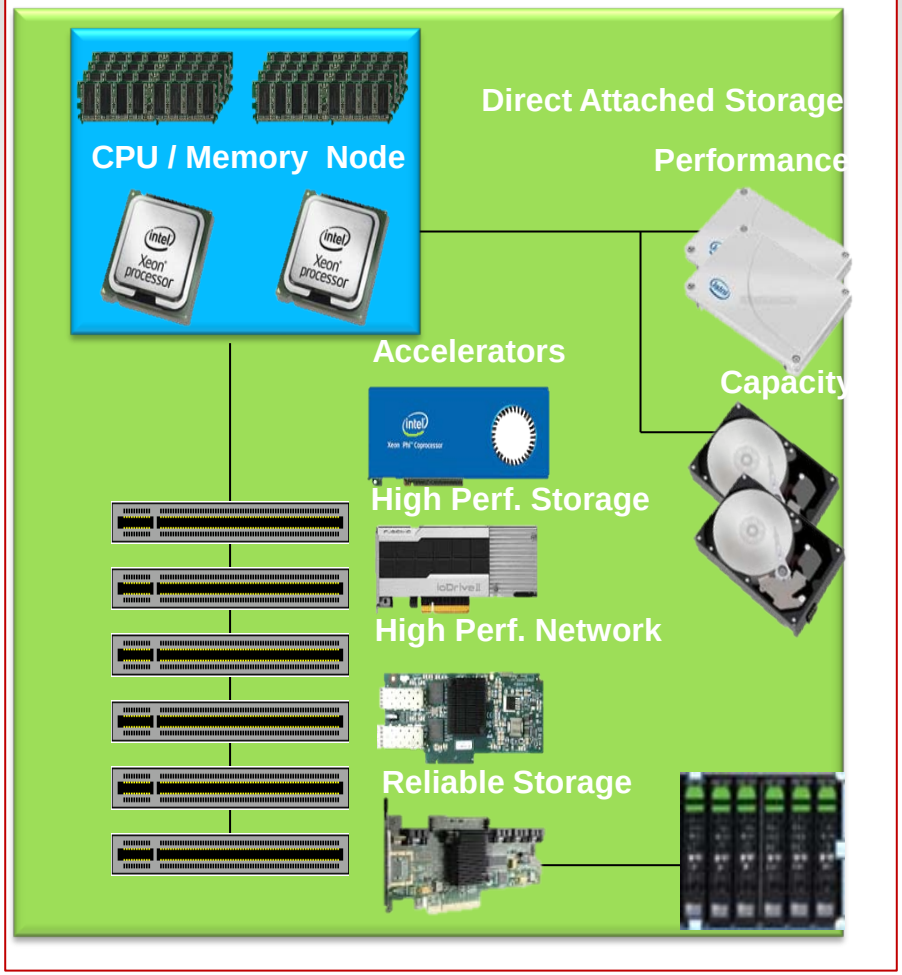
    varying compute, network and storage requirements (hot, cold, dark)
  - **HPC**

    from static to application optimized system configuration

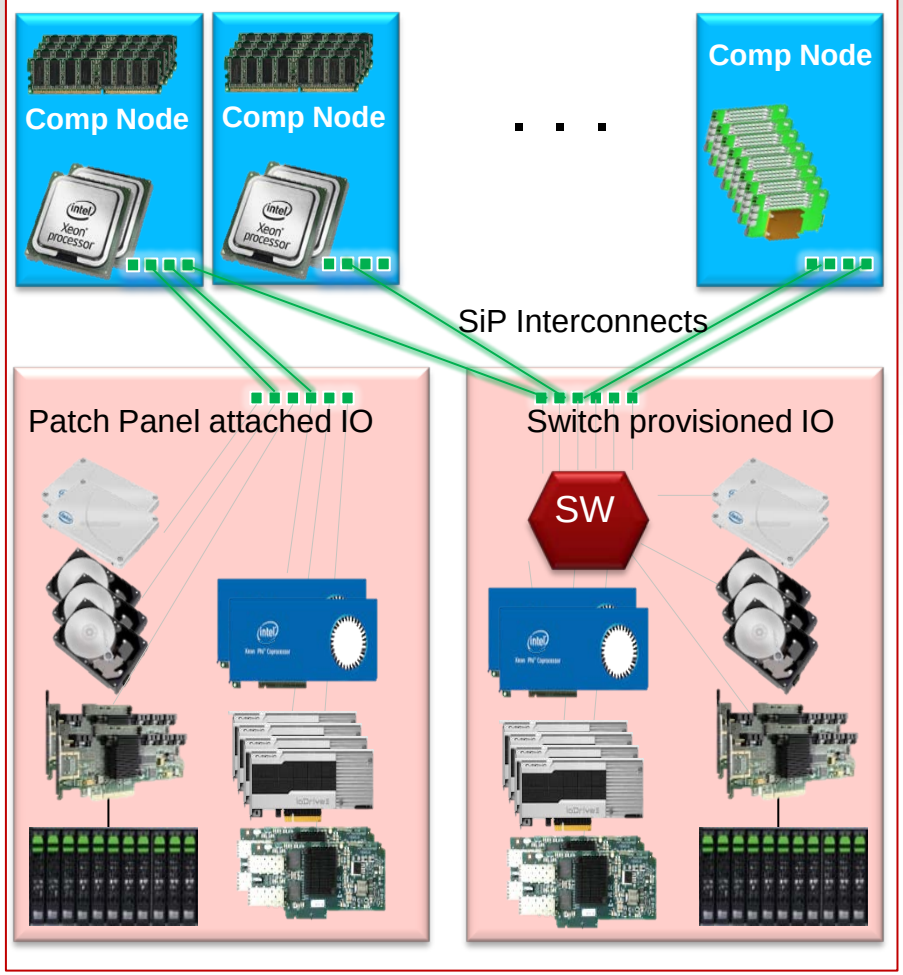


State of Art vs. App. Optimized Server

State of Art



App optimized



Server Features: State of Art vs. App. optimized

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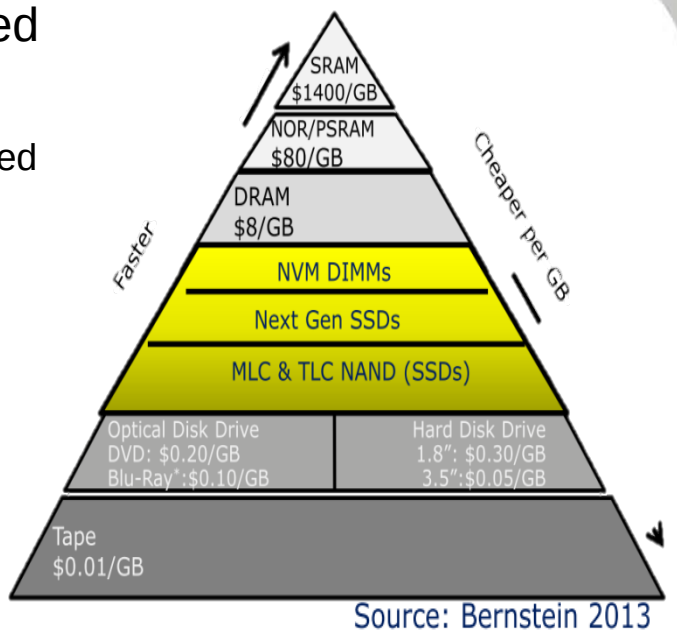
State of Art Server	App optimized Server
One enclosure for multi purpose usage - Optimized for sweet spot of deployments - Complex design w/ config options to extend server range of use	Server build from rack level resource pools - Optimized for individual Application and Business - More Simple design by building block (re-)usage - HW attached and/or SW provisioned Resources - enabled by Intels SiP opt.IF Technology
Mostly oversized for dedicated usage - IO Slots, Disk space, PSU capacity, … - more space consuming than required - CAPEX, OPEX disadvantages	Optimized for dedicated user application - Compute, Storage, Network, .. deployed as needed from dense packaged, resource pool offerings - CAPEX, OPEX advantages
IO config Limitations - High Power/Space demanding Devices like GPGPUs, PCIe SSD - Full Height, full Length slots	Support of App Specific HW Requirements - more Space/Power for CPU/Memory by disaggregation - diverse resource pool offerings to cover broad range of individual App specific requirements
Common Life Cycle for Server Resources	Individual Life Cycles of Server Resources - e.g. CPU Technology update w/o side impacts

Silicon Photonics enables Resource Pool provided NV Storage Benefits

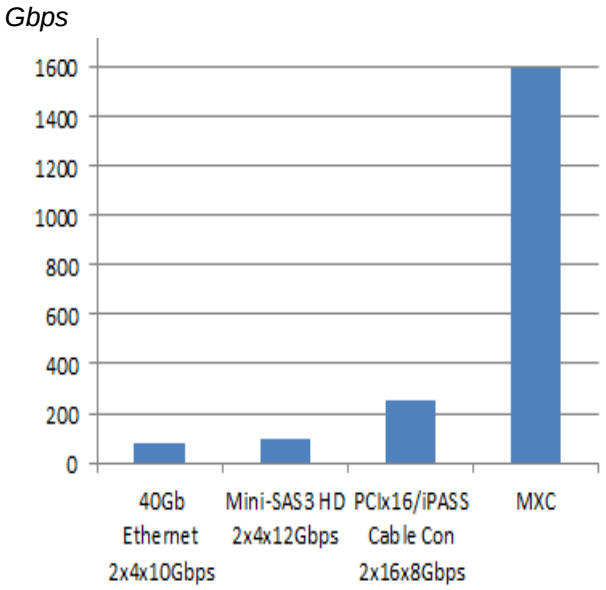
- Flexible provisioning of new NV storage TIERs required
  - Significant cost/performance differences between storage TIERs
  - Demand for business driven provisioning of different TIERs required
    - Especially in Cloud, XaaS, Big Data environments
- Usage model of NV storage is changing
  - from caching to storage of important system and application data
    - new Kernel OS and Application APIs emerging
  - No High Avalability for Server local only accessible NV storage
- Resource Pool provided new NV Storage becoming obvious to meet new IT usage requirements
  - On-demand assignability of resources to Compute Nodes
  - Failover support by Multi Node accessibility

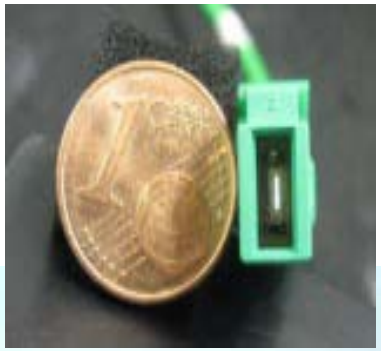


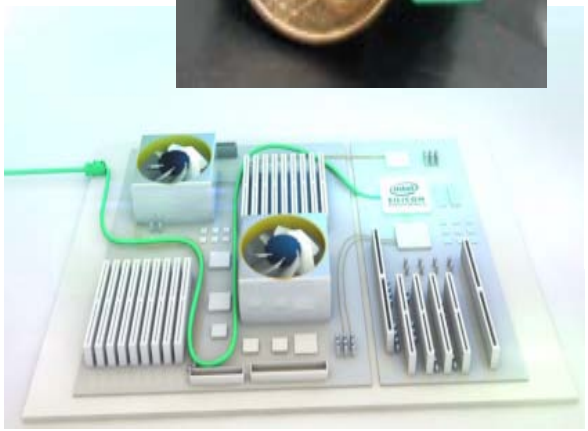
MXC Optic Connector - Presented at IDF 2013

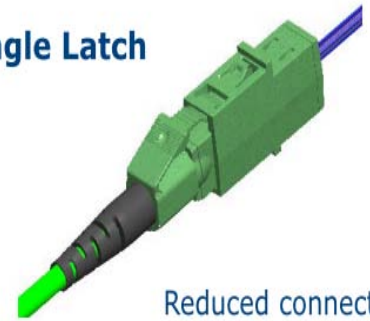
- up to 25Gbps per Fiber
- Up to 64 fibers/connector
- 1.6Tbps, up to 300m via LX MMF cable

Different Interconnect Bandwidths

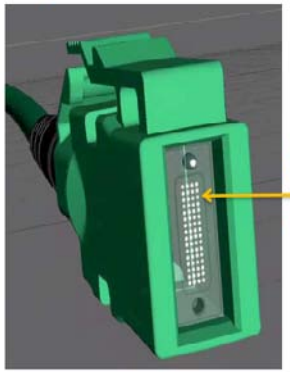


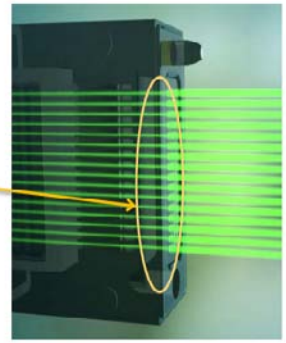






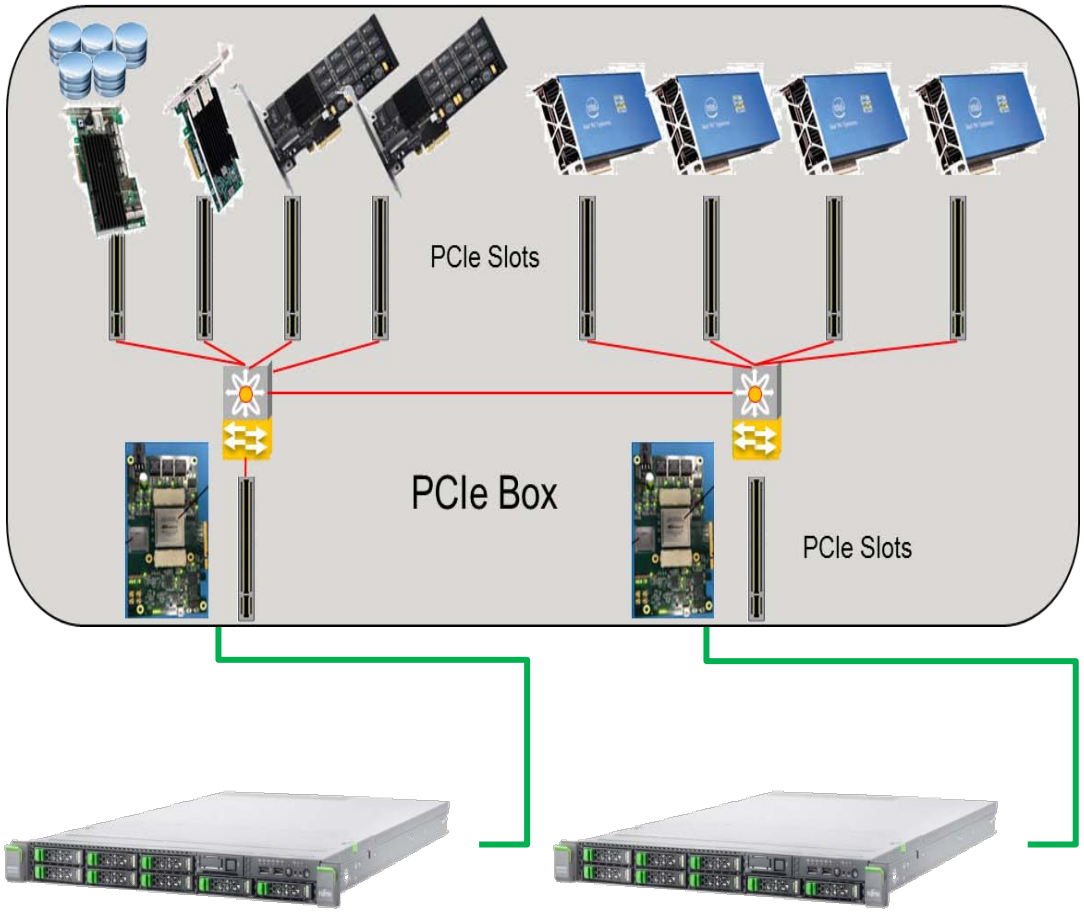
Expanded Beam Interconnects





MXC and Clear Curve Fiber Video: http://www.youtube.com/watch?v=EBM6mmSbe_8

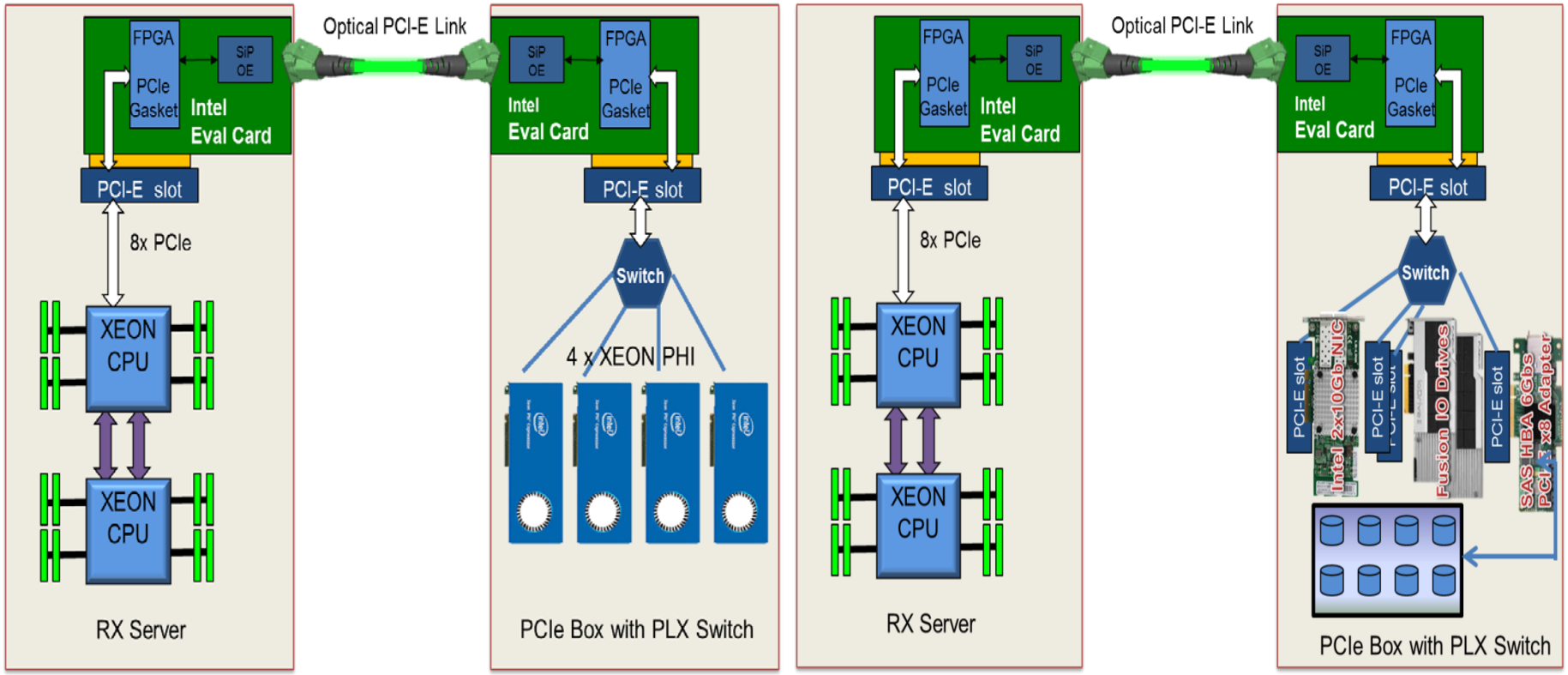
Proof of Concept Configuration



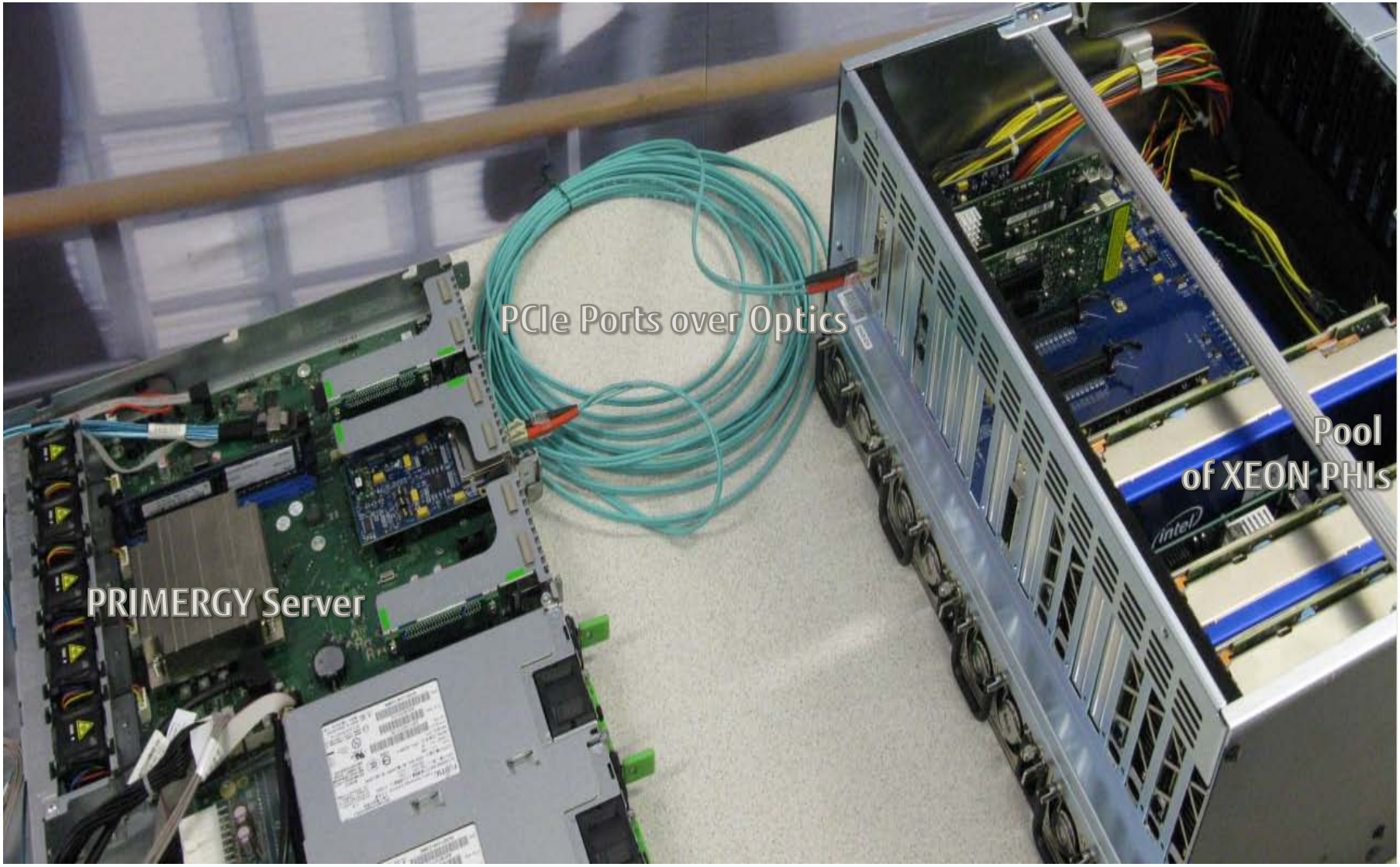
- 2 x PRIMERGY RX200 S8 as Compute Nodes
- 2 x MXC Connector and ClearCurve® Fibre
- 1 x PCIe I/O Box
- 4 x Optical Engine and FPGA PCIe gasket on PCIe card
  - Placed inside the server and the PCIe I/O Box
- Two PLX PCIe Switches inside the PCIe I/O Box
- 1 x10GBaseT adapter from Intel
- 1 x Cougar LSI RAID Controller connected to 8 HDD'S inside the PCIe I/O Box.
- Two FusionI/O PCIe SSD's with 1,5 and 1 Terabyte connected to the PRIMERGY RX200 S8
- 4 x Intel XEON Phi™ connected to the PRIMERGY RX200 S8
- Microsoft Windows 2012 R2 for the video workload
- Linux RedHat 6.4 for the GPGPU workload

Opt. PICe Demo Scenarios

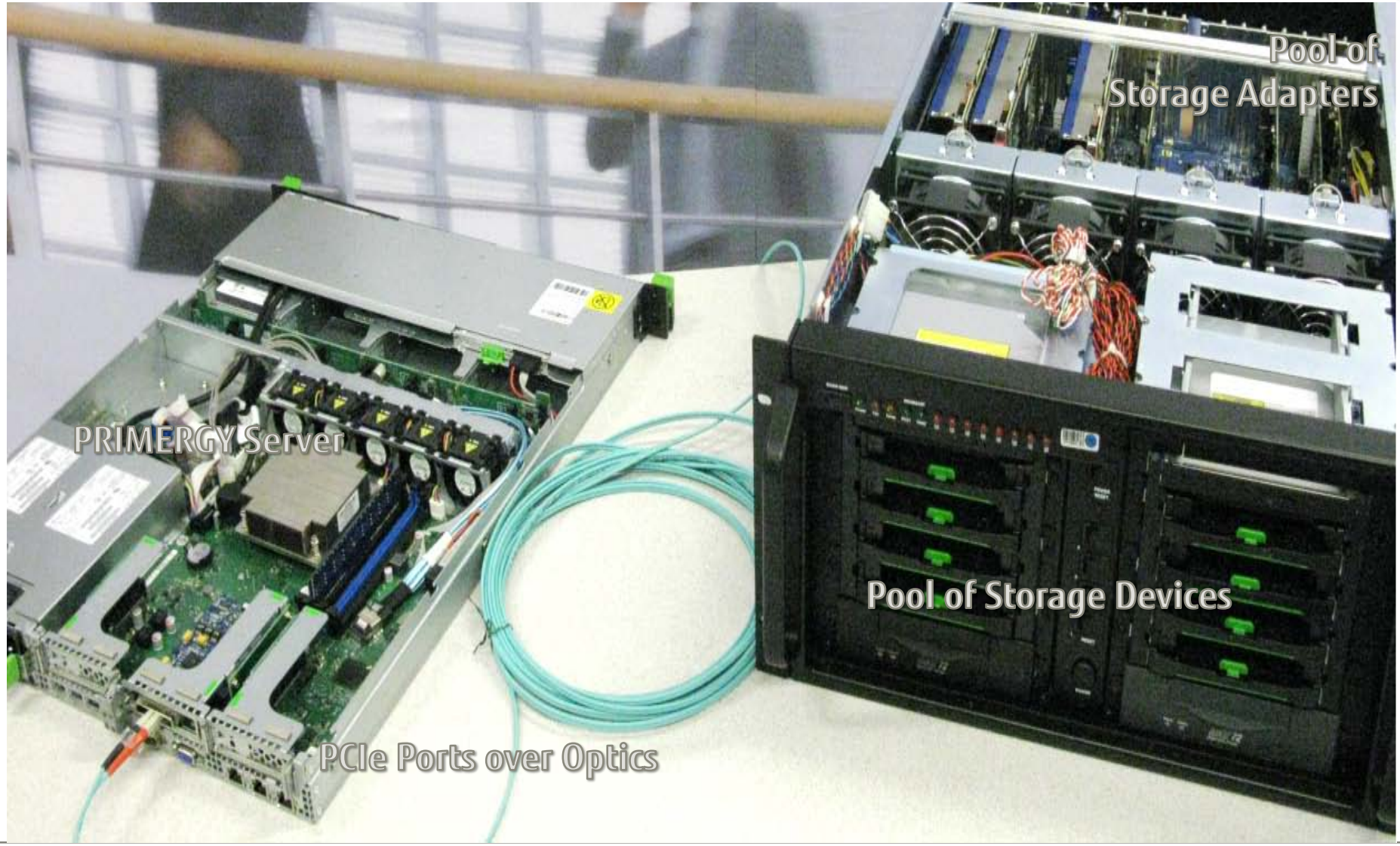
Erläuterungen B.Sch.

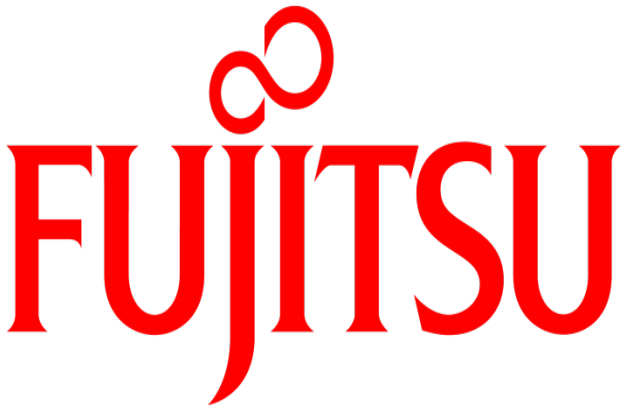


Remote pool of XEON PHIs



Remote Pool of Storage





shaping tomorrow with you

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Powering Success
Pweru Llwyddiant

SME Case Study

Ben Barton, Knowtra

Ewrop & Chymru:
Buddsoddi yn eich dyfodol
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Llywodraeth Cymru
Welsh Government

knowtra

- Ocean, weather and climate expertise
- IT and training solutions

Applying physical oceanography for business problems – from the Nigerian creeks to global renewables

Ben Barton

Knowtra Limited

My background

- Studied the MSci in Oceanography at Southampton
  - Particle tracking simulation of radioactivity pollution
  - Experience in using range of data sources including satellite data
  - Sound grounding to ocean physics and data collection
- Now for working for Knowtra on metocean problems

Dr Steve Spall's background

- Maths graduate
- Studied the MSc in Oceanography at Southampton
- PhD at Southampton – modelling the impact of ocean fronts of plankton growth
- Work at the Met Office for 9 years
  - Climate change modelling
  - Managing modelling projects for MoD
- Now freelance working on metocean problems

knowtra

- Ocean, weather and climate expertise
- IT and training solutions

The talk

- Usage and Benefits of HPCWales
- Modelling Shetland for oil spill response
- Challenges of projects in Nigeria

HPCWales usage

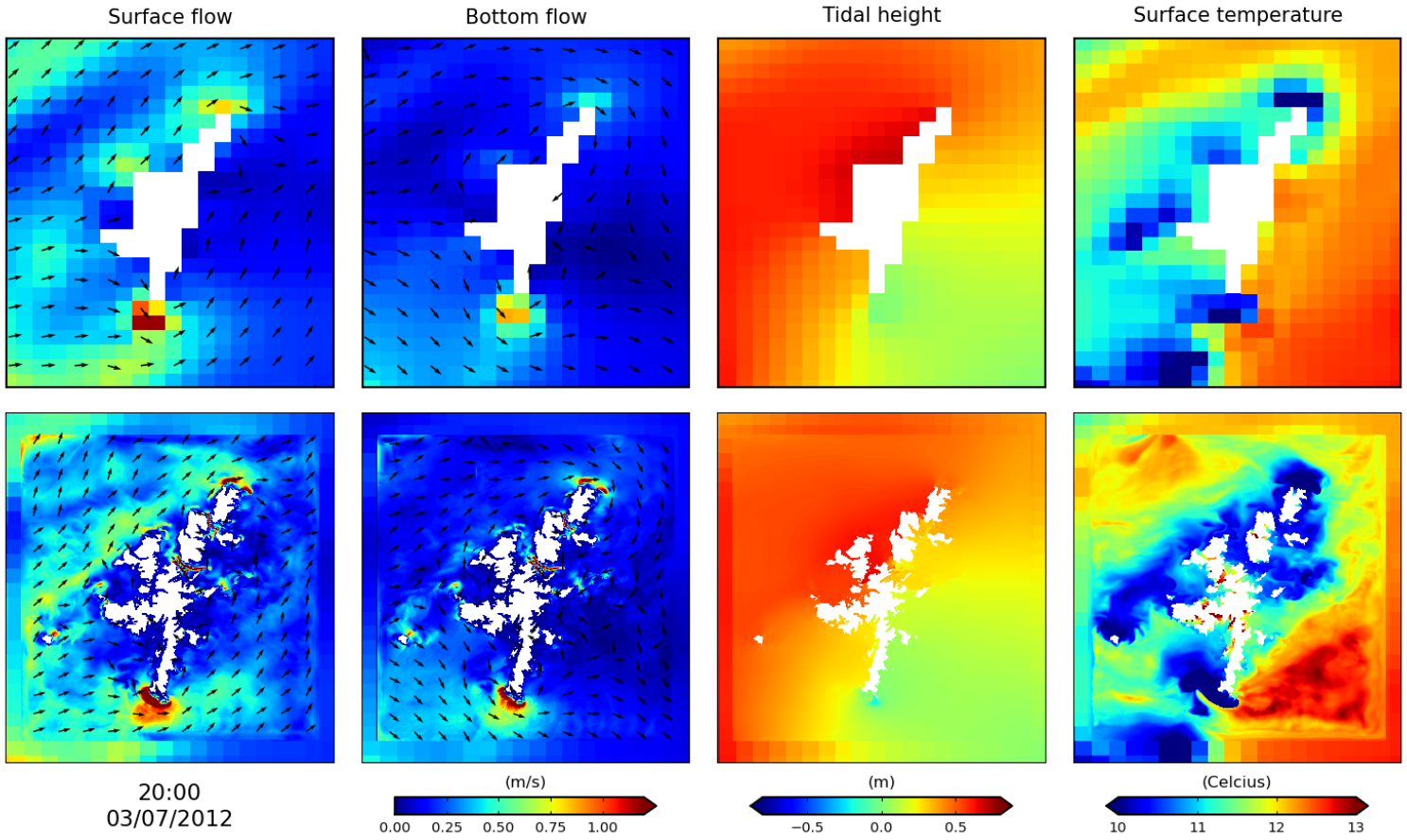
- Regional Ocean Modelling System (ROMS)
- SWAN wave model
- Python (for data analysis)

knowtra

- Ocean, weather and climate expertise
- IT and training solutions

Benefits of HPCWales

High resolution model for Shetland



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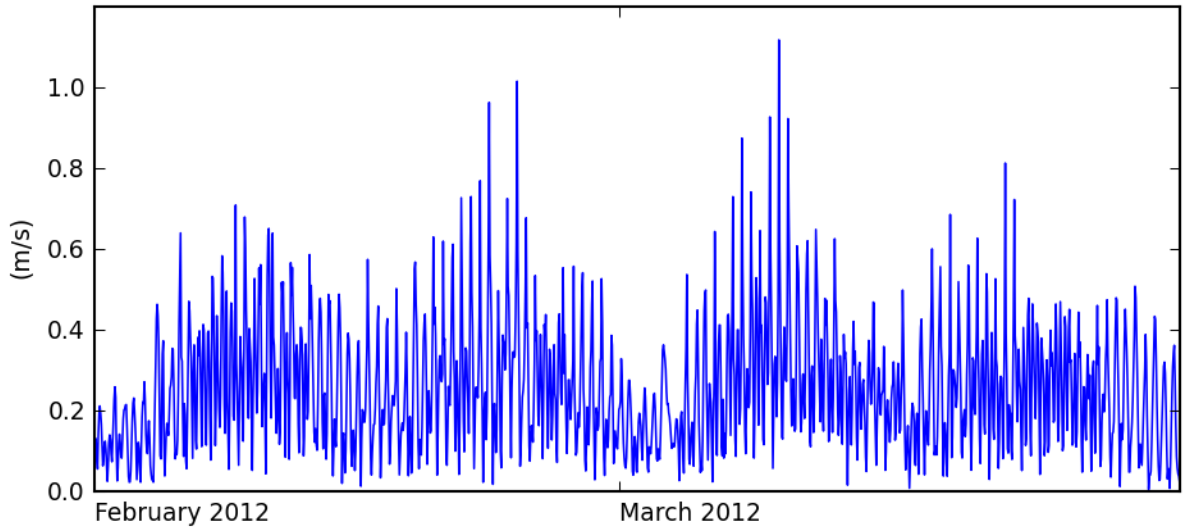
- IT and training solutions

High resolution model for Shetland

- Using the ROMS model and HPC Wales for computing
- Forced with North West European (NWE) Shelf currents
- Hourly current forcing at top, middle and bottom
- Wind forcing from the ECMWF model

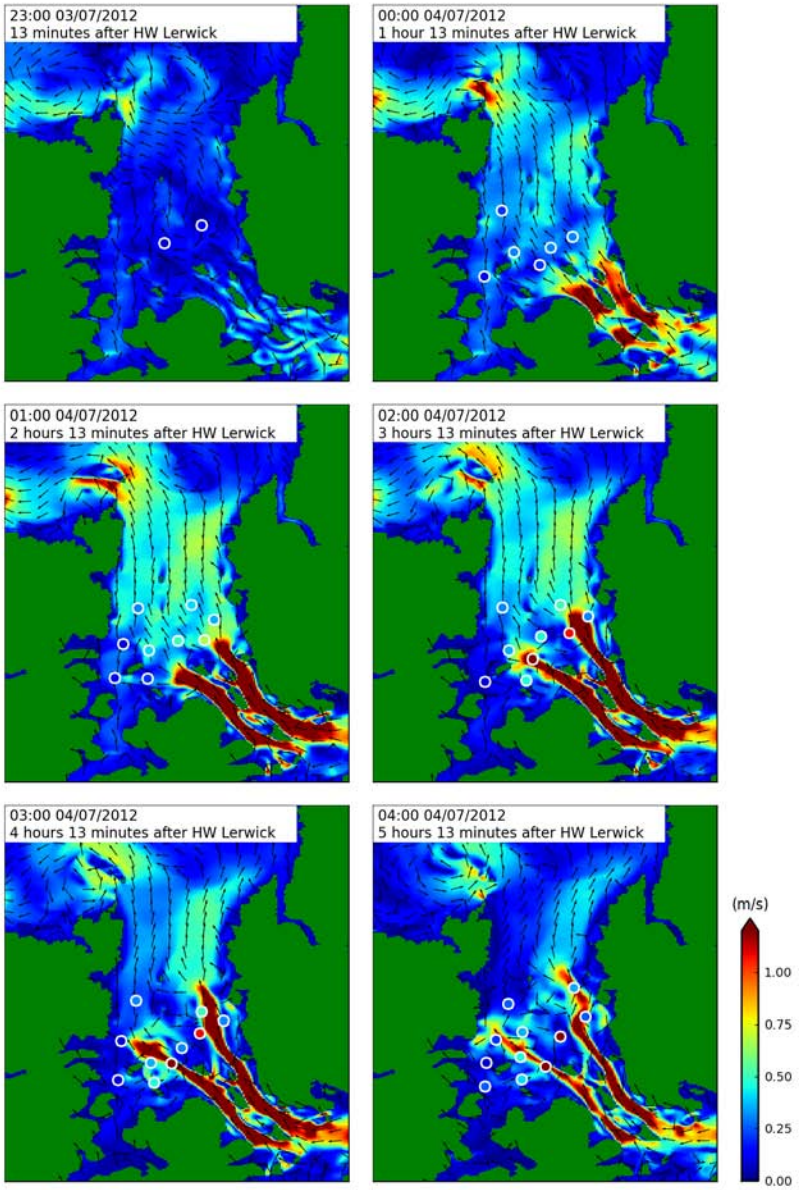


knowtra

- Ocean, weather and climate expertise
- IT and training solutions

High resolution model for Shetland

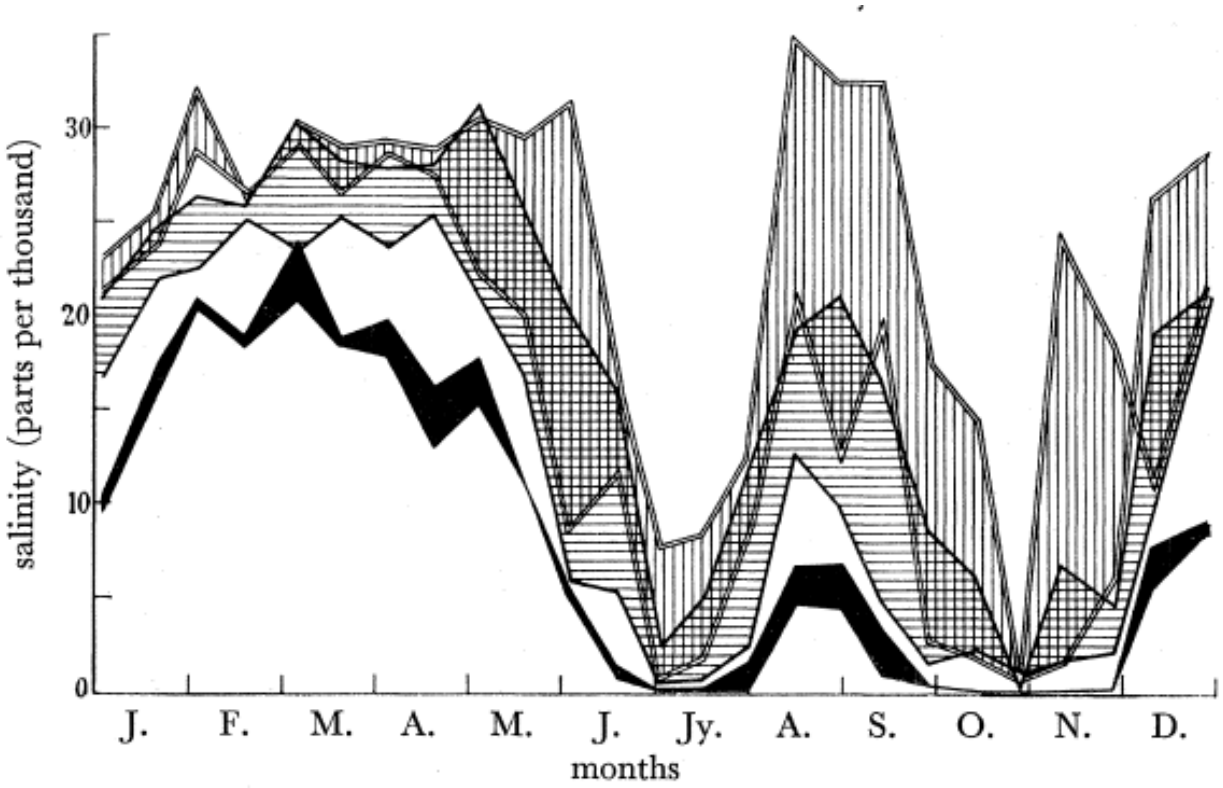
- Compared surface currents to the Admiralty tidal atlas for Shetland
- Coloured circles show the flow speeds from the atlas
- Example of adding detail as needed for local spill modelling



Challenges for Nigeria

- Lack of historic accessible data
- Complex creek systems
- Security issues
- Restricted project budgets
- Need to make the most of what information there is

Lagos Harbour salinity



Salinity data collected in Lagos Harbour in 1954

Hill and Webb

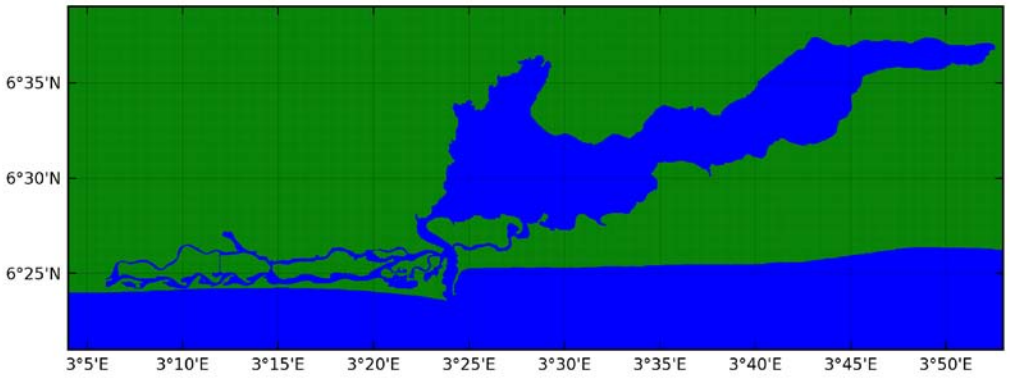
Phil. Trans. R. Soc. Lond. B 1958

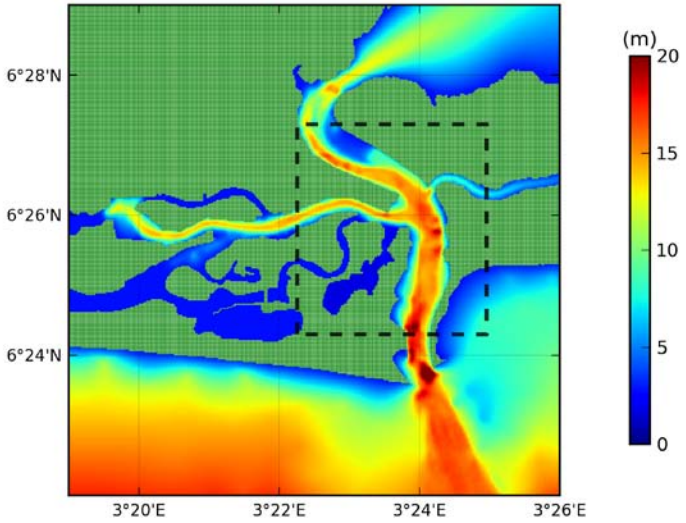
***241**, 319-333*

knowtra

- Ocean, weather and climate expertise
- IT and training solutions

Hydrodynamic models





Lagos Harbour

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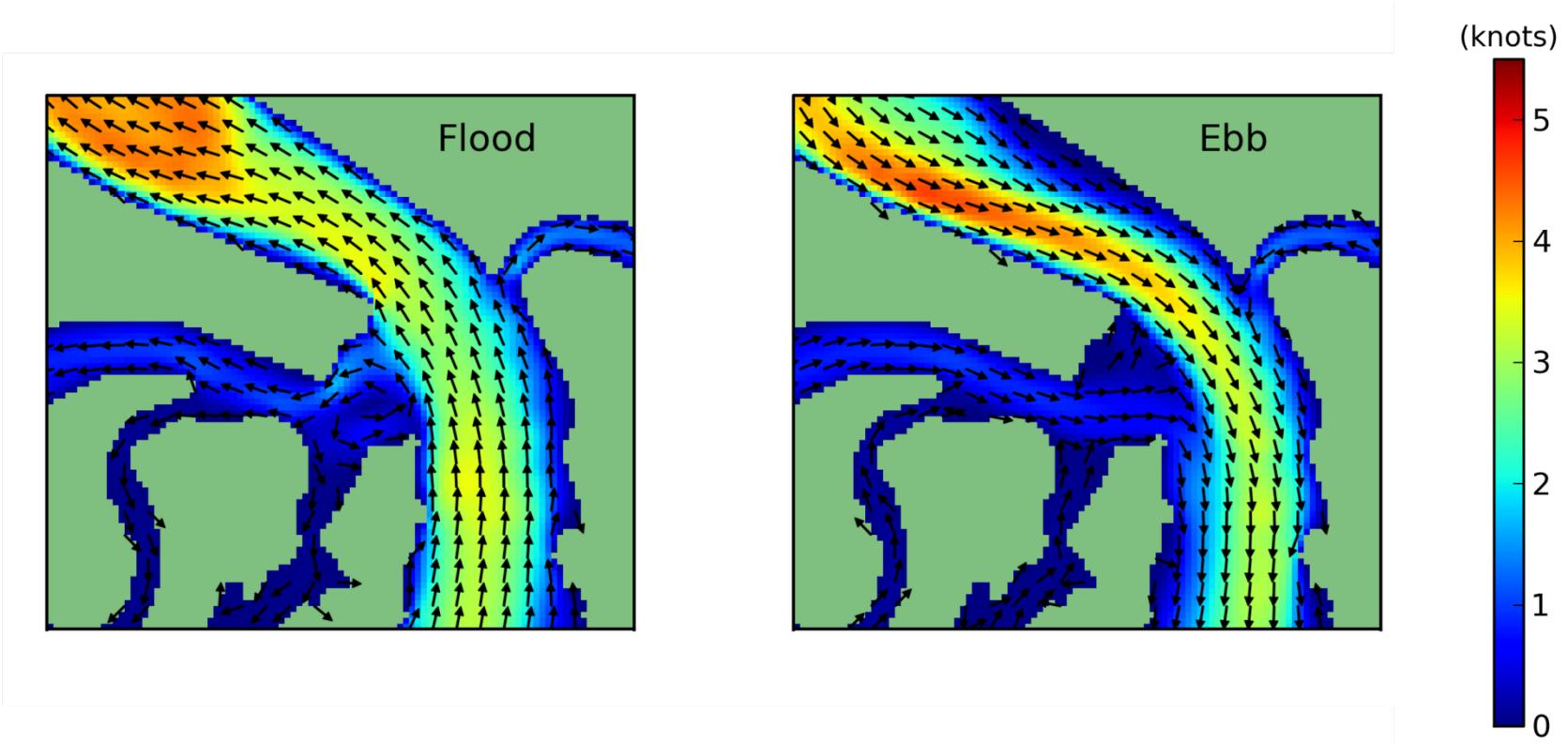
- Ocean, weather and climate expertise
- IT and training solutions

Hydrodynamic models



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- Ocean, weather and climate expertise
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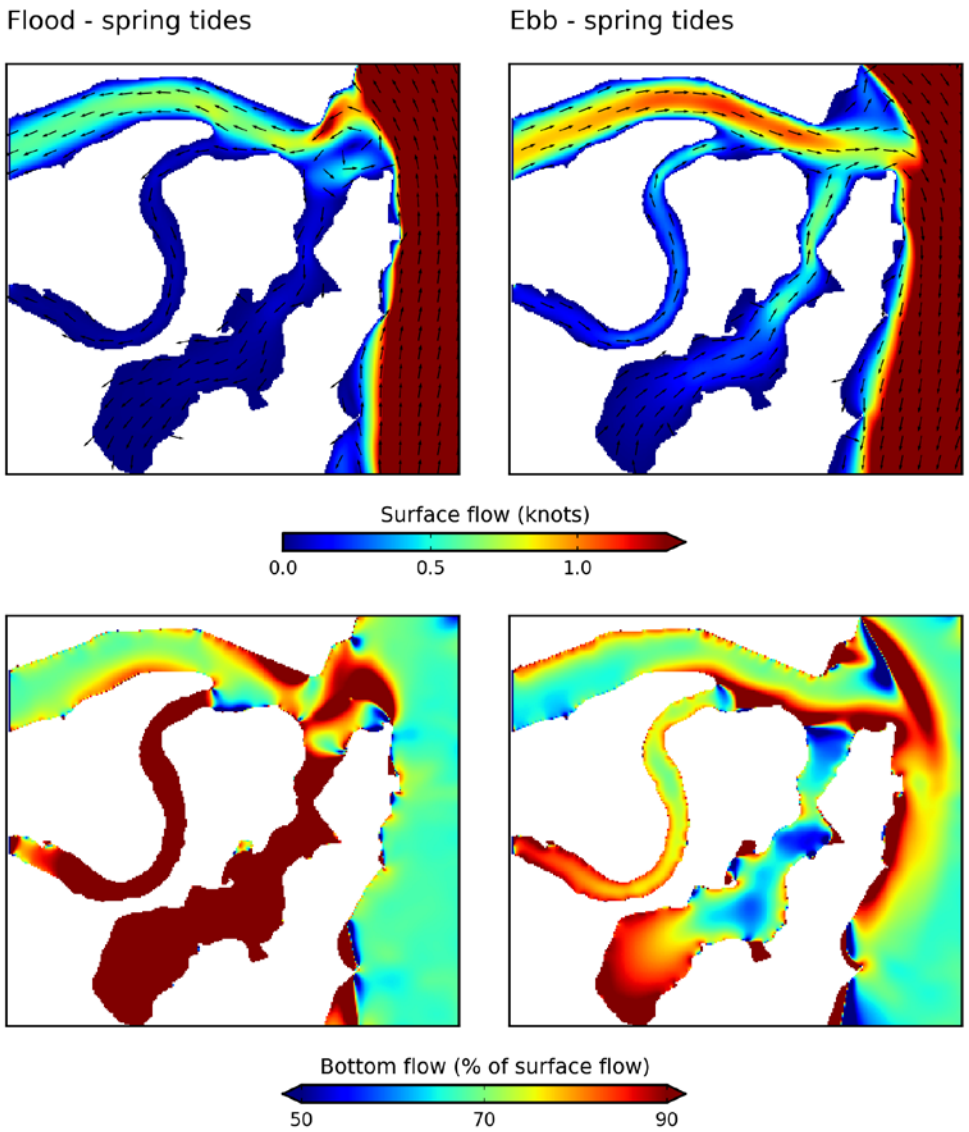

Higher resolution nested model

- Interesting top to bottom differences in flow
- What are the implications for sediment transport?

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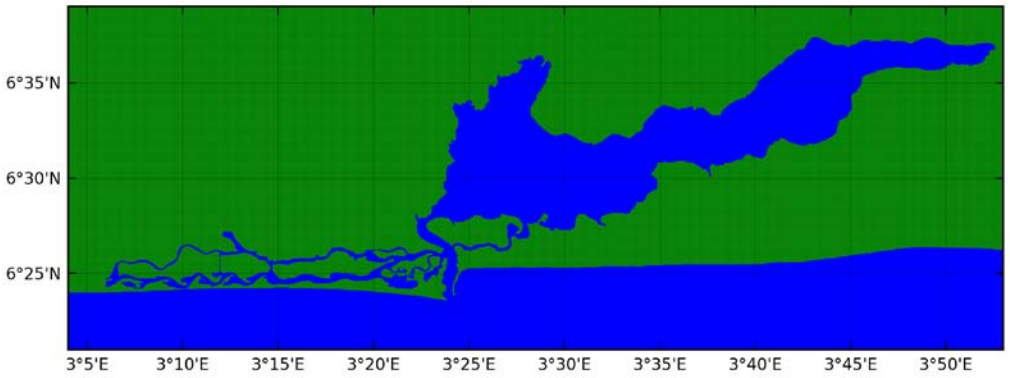
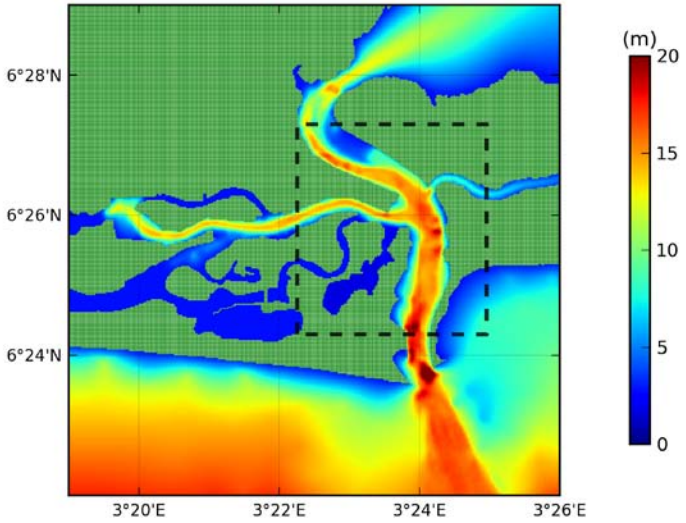
- Ocean, weather and climate expertise
- IT and training solutions

Wave models





Lagos Harbour

knowtra

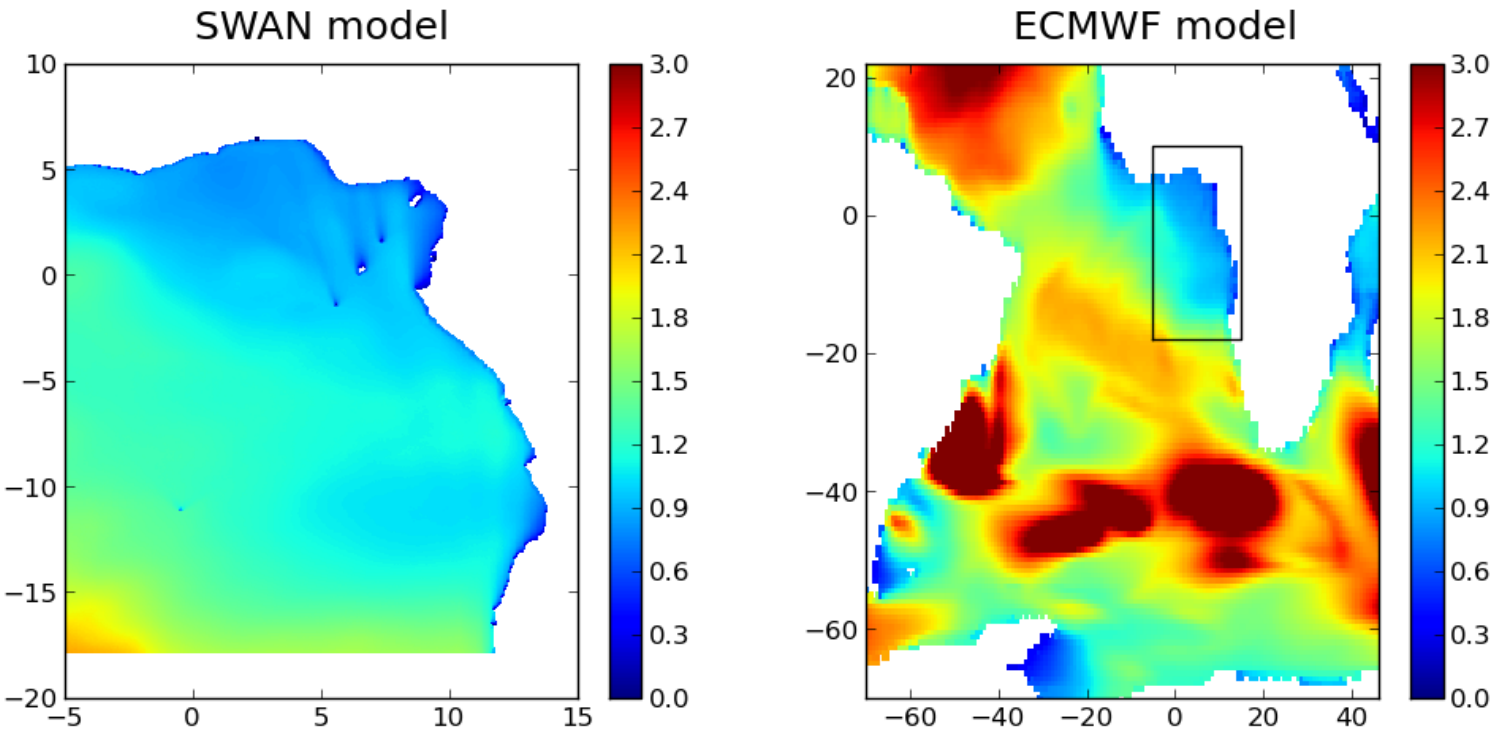
- Ocean, weather and climate expertise
- IT and training solutions

Wave models

knowtra

- Ocean, weather and climate expertise
- IT and training solutions

Our future use of HPCWales



I hope it has been interesting – and thank you for listening

Questions welcome

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Powering Success
Pweru Llwyddiant

Studentship Video

Farzana Rahman

Ewrop & Chymru:
Buddsoddi yn eich dyfodol
Cronfa Datblygu Rhanbarthol Ewrop

Europe & Wales:
Investing in your future
European Regional Development Fund

ERDF

Llywodraeth Cymru
Welsh Government

Studentship Case Study, Farzana Rahman

- PhD student, Farzana Rahman from Bangladesh, has been selected by EPSRC to compete in the prestigious UK ICT pioneer 2014 competition
- Combatting Bacterial Toxicity: Using Super Computing to Transform Health Services

- Video produced by the University of South Wales – Link to video

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Forum Discussion

Ewrop & Chymru:
Buddsoddi yn eich dyfodol
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