HECToR Quarterly Report

July – September 2009

1 Introduction

This report covers the period from 1 July 2009 at 0800 to 1 Oct 2009 at 0800.

Section 3 summarises service availability, performance statistics and utilisation for this quarter. Section 4 shows Helpdesk statistics. An overview of system hardware changes, service failures, and node failures is available in Section 5. A summary table of the key performance metrics is given in the final section.

The Appendices define some of the terminology and incident severity levels and list the current HECToR projects together with their overall utilisation profile to date.

This report and the additional SAFE report are available to view online at http://www.hector.ac.uk/about-us/reports/quarterly/3Q09.php

2 Executive Summary

- The HECToR Phase2a acceptance tests were completed on 7th July 09. The 10-day availability trial was completed as planned on 18th July. In summary, the upgrade went very smoothly. Per the details in Section 5.2, the upgrade has had no adverse impact on the reliability of the service.

- XT utilisation in 3Q09 was 61%. This was on a par with 2Q09 at 60%. Further details are available in Section 3.2 of the report. A number of initiatives for increasing utilisation have been approved. A 'Capability Incentive' scheme for discounting large jobs was approved by the SMB in early October. The initial EPSRC Resource Allocation Panel (RAP) call is due to be announced shortly.

- There were 13 service failures in 3Q09. 9 failures were attributed to technology problems compared to 8 in 2Q09. So far, reliability on quad-core has been on a par with dual-core. Further details on the failures are available in Section 5.2. The overall MTBF decreased on 2Q09 from 274 to 169 hours.

- The volume of single node failures has remained comparable to the previous quarter. There were 82 node failures in 3Q09, as opposed to 63 in 2Q09. There was an initial peak of node failures in July as a result of the quad-core upgrade. We are continuing to track and investigate the cause of all failures and an analysis of these can be found in Section 5.3 of this report.

- The X2 Vector system was very reliable in 3Q09. Charging remained suspended in 3Q09, resulting in an overall utilisation of 45%. Further details on the impact of the suspension of X2 charging are available in Section 3.2.2.

- The helpdesk statistics were again excellent. The volume and type of queries received at the helpdesk remained constant from 2Q09.

- The HECToR website was updated in 3Q09 in line with ideas discussed by the Strategic Management Board. The website now has a more accessible 'public face'. Case studies were kindly provided by HECToR users to illustrate examples of HECToR use. The existing user site remains intact.

- Work commenced on the implementation of the HECToR Archive solution in 3Q09. Acceptance testing and early user trials are scheduled for November. Further details are available in Section 5.1.2 of the report.

- The Contract Change Notice for HECToR Phase2b was signed in August. Detailed planning has commenced for the upgrade to 'Baker 'in March 2010, followed by an upgrade to the Gemini interconnect in late 2010. Details of the Phase2b solution are available in Section 5.1.

3 Quantitative Metrics

3.1 Reliability

The monthly numbers of incidents and failures (SEV 1 incidents) are shown in the table below:

	July	***August***	***September***
Incidents	48	22	28
Failures	4	4	5

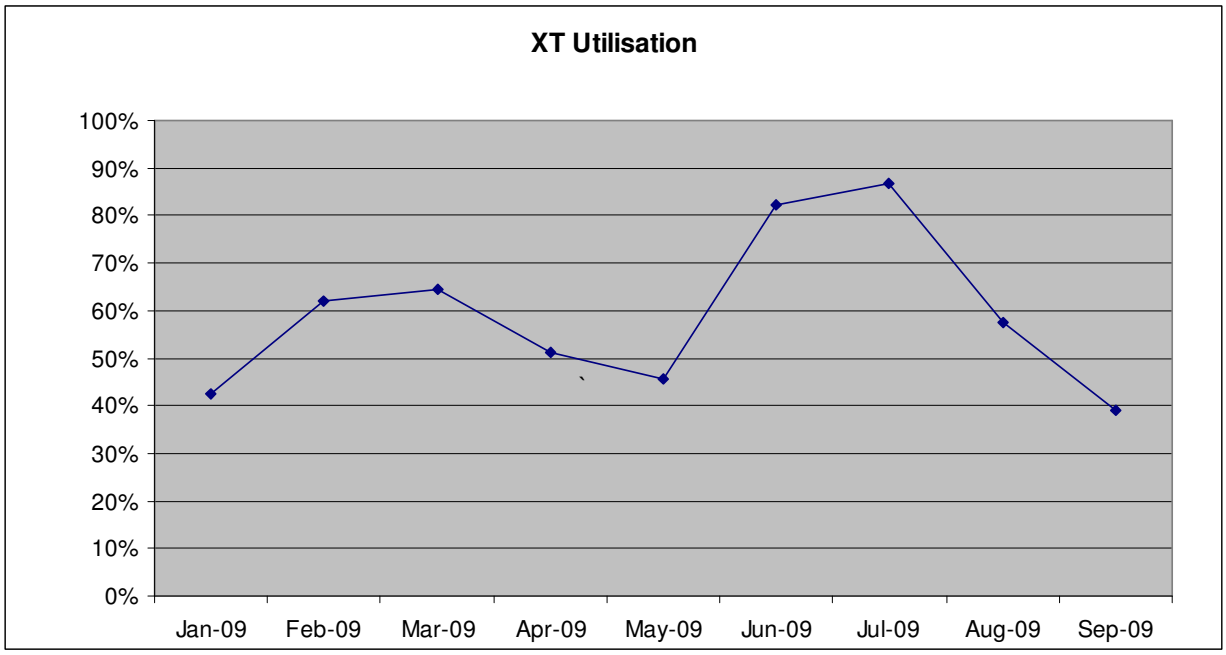
3.1.1 Performance Statistics

- MTBF = (732)/(number of failures in a month)
  Quarterly MTBF=(3x732)/(number of failures in a quarter)

Attribution	***Metric***	***July***	***August***	***September***	***Quarterly***
Technology	Failures	3	4	2	9
	MTBF	244	183	366	244
Service Provision	Failures	1	0	1.5	2.5
	MTBF	732	∞	488	8784
External	Failures	0	0	1.5	1.5
	MTBF	∞	∞	488	1464
Overall	Failures	4	4	5	13
	MTBF	183	183	146	168.9

3.2 HECToR Utilisation

3.2.1 XT Utilisation



The utilisation quarterly average in 3Q09 was 61%, compared to 60% in 2Q09. The peak in utilisation seen in July was as a result of the open access during the quad-core upgrade. Charging was resumed on 3rd August and utilisation started to drop back to where it had been prior to the suspension of charging.

Utilisation is a major concern and a number of initiatives to address this have been reviewed.

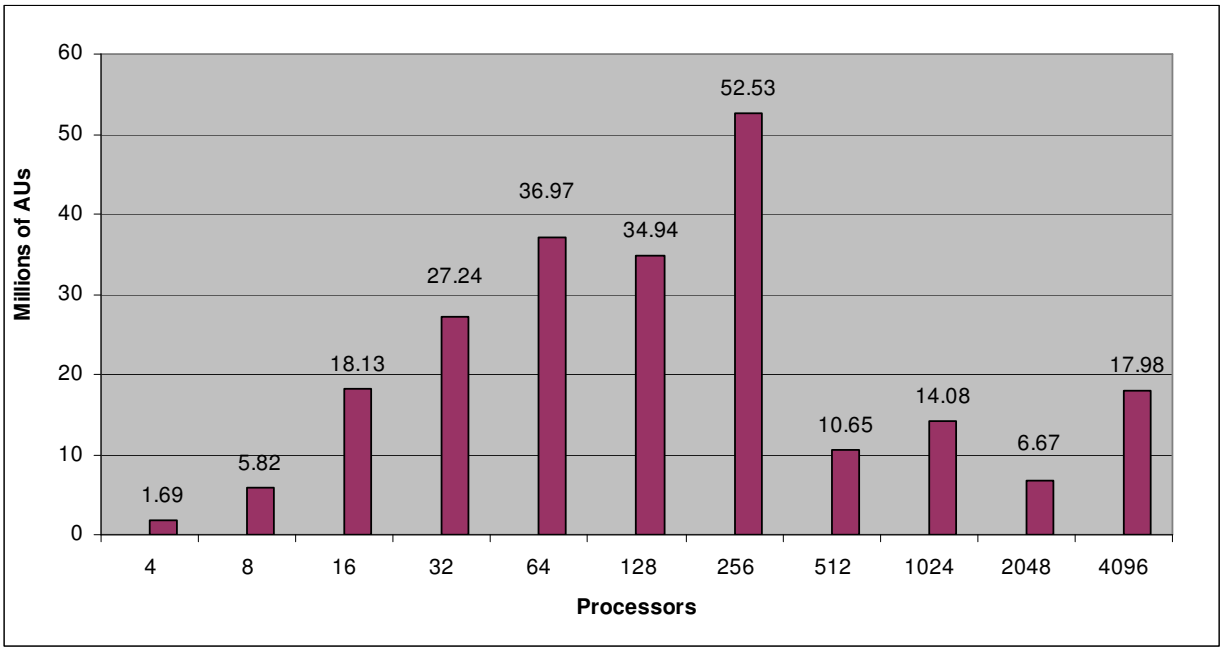
Capability Incentives
Prior to the release of this report, it was agreed at the HECToR Strategic Management Board to enable capability incentives for all users who run large jobs. Jobs will be discounted as follows:

Level	***Minimum Number of Cores***	***Discount***
Bronze	1024	5%
Silver	2048	15%
Gold	4096	30%

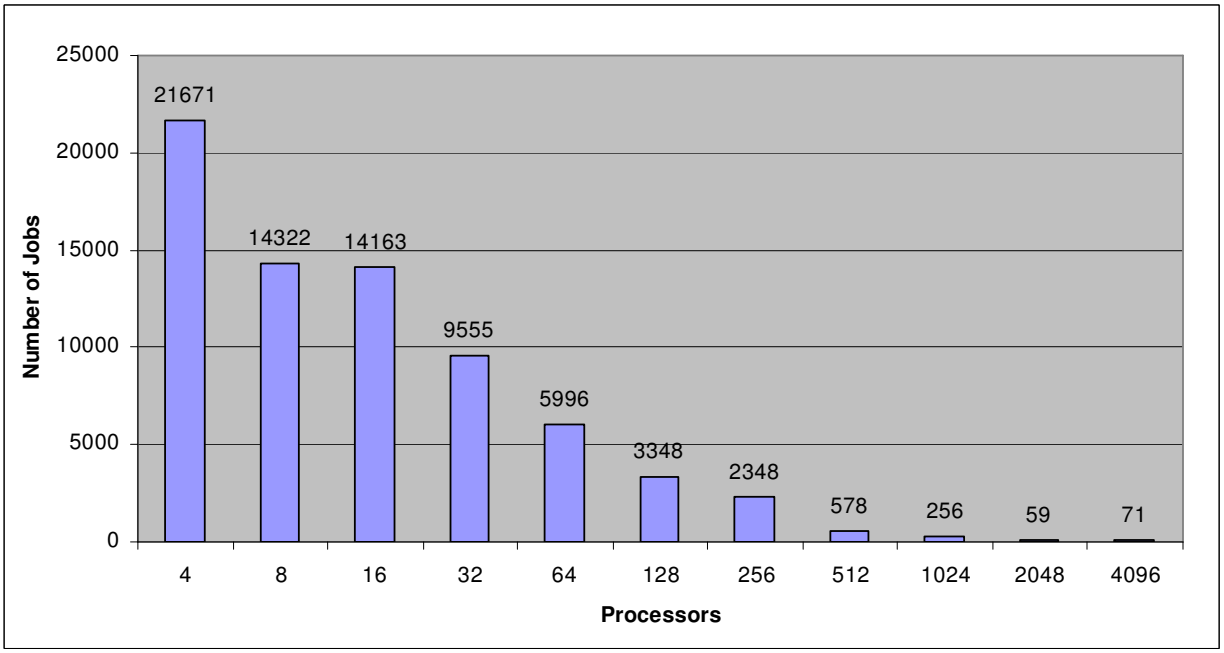
This was implemented on 7th October and we now await the results of this initiative.

EPSRC Resource Allocation Panel
The first call for the HECToR Resource Allocation Panel (RAP) is expected to be announced shortly.

3.2.1.1 XT Utilisation by Queue



3.2.1.2 XT Number of jobs per queue

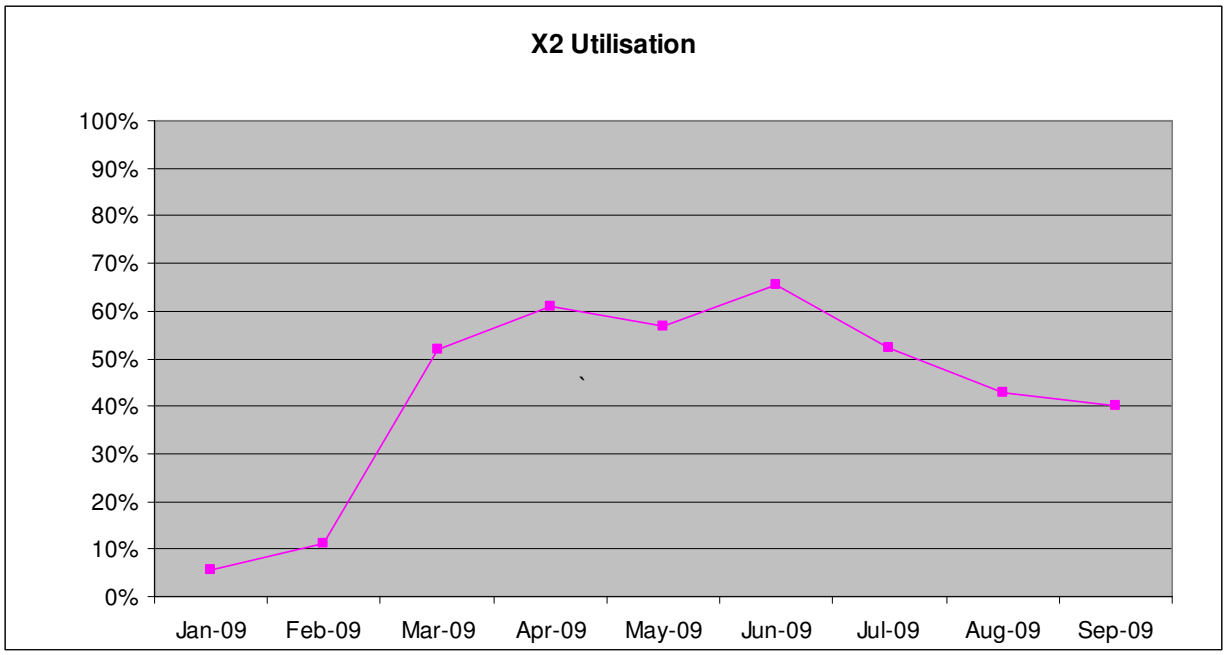


3.2.1.3 XT Utilisation by Consortium

Project	AUs	Raw AUs	Discounted AUs	Number of Jobs	%age of Use	Raw %age	Utilisation
y01	0	1,936	1,936	12	0.00%	0.00%	0.00%
y02	0	0	0	4	0.00%	0.00%	0.00%
y03	0	247	247	286	0.00%	0.00%	0.00%
y04	0	0	0	4	0.00%	0.00%	0.00%
y05	105,898	3,694,682	3,588,784	706	0.10%	1.60%	0.98%
y06	28	45	17	2319	0.00%	0.00%	0.00%
y07	0	379	379	66	0.00%	0.00%	0.00%
z01	156,567	984,190	827,623	1094	0.14%	0.43%	0.26%
z02	1	3,251	3,250	218	0.00%	0.00%	0.00%
z03	865,750	1,693,285	827,535	3219	0.79%	0.74%	0.45%
Internal Total	**1,128,244**	**6,378,015**	**5,249,771**	**7928**	**1.02%**	**2.77%**	**1.70%**
c01	1,022,811	1,268,170	245,360	2762	0.93%	0.55%	0.34%
e01	9,180	183,858	174,678	138	0.01%	0.08%	0.05%
e05	9,338,213	16,680,192	7,341,979	4298	8.48%	7.24%	4.45%
e10	55,644	70,044	14,400	94	0.05%	0.03%	0.02%
e101	190,912	225,982	35,070	273	0.17%	0.10%	0.06%
e102	1,132,785	1,509,890	377,105	542	1.03%	0.66%	0.40%
e107	2	2	0	6	0.00%	0.00%	0.00%
e109	0	0	0	1	0.00%	0.00%	0.00%
e110	2,108,173	2,600,234	492,061	422	1.91%	1.13%	0.69%
e112	102,500	107,594	5,095	100	0.09%	0.05%	0.03%
e113	9,891	9,903	12	92	0.01%	0.00%	0.00%
e116	77	77	0	4	0.00%	0.00%	0.00%
e117	247,664	247,664	0	72	0.22%	0.11%	0.07%
e122	4,306,929	10,275,143	5,968,215	913	3.91%	4.46%	2.74%
e124	148,409	2,425,355	2,276,947	780	0.13%	1.05%	0.65%
e125	252,826	8,235,497	7,982,671	77	0.23%	3.58%	2.20%
e126	341,124	609,739	268,614	136	0.31%	0.26%	0.16%
e24	6,295,694	8,789,358	2,493,664	1664	5.72%	3.82%	2.34%
e34	4,275	4,284	8	14	0.00%	0.00%	0.00%
e35	619,783	636,331	16,548	84	0.56%	0.28%	0.17%
e42	1,014,500	1,336,540	322,040	1537	0.92%	0.58%	0.36%
e59	0	85,194	85,194	3	0.00%	0.04%	0.02%
e63	2,418,123	7,805,971	5,387,848	601	2.20%	3.39%	2.08%
e68	976,003	22,410,741	21,434,737	2752	0.89%	9.73%	5.97%
e70	66,623	435,304	368,681	138	0.06%	0.19%	0.12%
e71	0	9,783	9,783	14	0.00%	0.00%	0.00%
e72	0	304,079	304,079	127	0.00%	0.13%	0.08%
e74	0	0	0	1	0.00%	0.00%	0.00%
e75	8,451	863,456	855,005	128	0.01%	0.38%	0.23%
e76	1,423,495	6,587,597	5,164,102	23	1.29%	2.86%	1.76%
e81	7	12,275	12,268	19	0.00%	0.01%	0.00%
e82	139	139	0	62	0.00%	0.00%	0.00%
e84	9,305	10,600	1,295	145	0.01%	0.00%	0.00%
e85	448,768	2,652,203	2,203,435	115	0.41%	1.15%	0.71%
e89	19,769,787	32,209,838	12,440,052	9718	17.95%	13.99%	8.59%
e90	750	809	59	18	0.00%	0.00%	0.00%
e99	1	1	0	1	0.00%	0.00%	0.00%
u03	8,172	11,388	3,216	144	0.01%	0.00%	0.00%
u10	51,918	52,896	978	221	0.05%	0.02%	0.01%
EPSRC Total	**52,382,935**	**128,668,134**	**76,285,200**	**28239**	**47.55%**	**55.88%**	**34.29%**

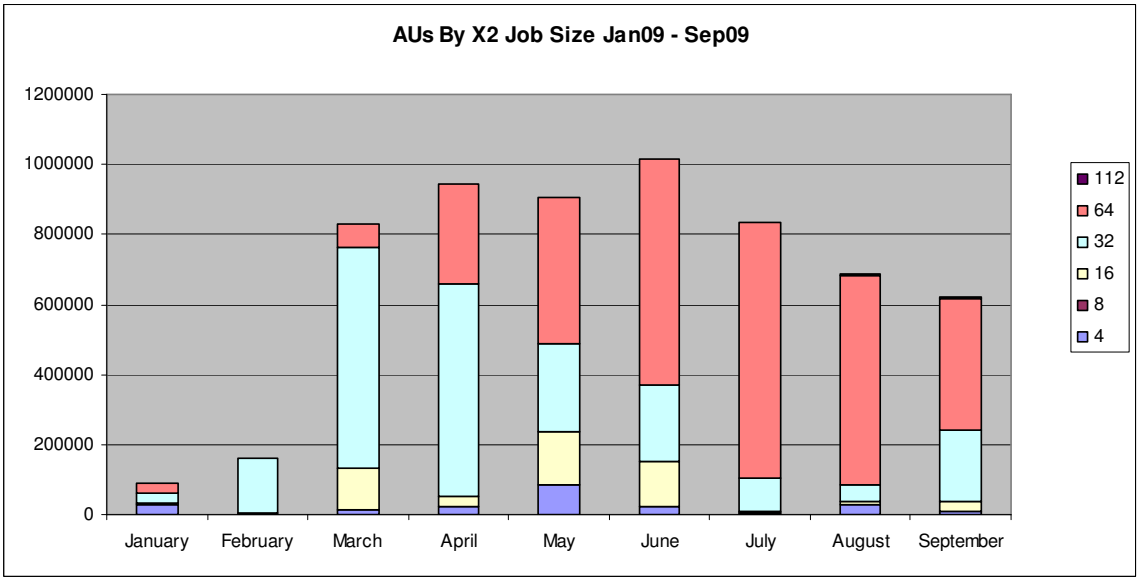
n01	1,168,257	1,724,958	556,701	2937	1.06%	0.75%	0.46%
n02	17,135,651	24,390,576	7,254,926	30444	15.56%	10.59%	6.50%
n03	15,403,229	40,590,883	25,187,654	5555	13.98%	17.63%	10.82%
n04	11,840,073	13,113,394	1,273,321	2062	10.75%	5.70%	3.50%
NERC Total	**45,547,210**	**79,819,811**	**34,272,601**	**40998**	**41.35%**	**34.67%**	**21.27%**
b08	1,601	1,604	2	20	0.00%	0.00%	0.00%
b10	4	4	0	54	0.00%	0.00%	0.00%
BBSRC Total	**1,605**	**1,607**	**2**	**74**	**0.00%**	**0.00%**	**0.00%**
T01	51,961	195,019	143,059	280	0.05%	0.08%	0.05%
x01	170,368	712,912	542,544	324	0.15%	0.31%	0.19%
x02	0	2	2	3	0.00%	0.00%	0.00%
x04	52,773	52,847	74	82	0.05%	0.02%	0.01%
External Total	**275,101**	**960,780**	**685,678**	**689**	**0.25%**	**0.42%**	**0.26%**
d03	281,981	684,634	402,653	768	0.26%	0.30%	0.18%
d04	24,923	709,568	684,645	2823	0.02%	0.31%	0.19%
d07	87,761	742,066	654,305	60	0.08%	0.32%	0.20%
d09	2,552	39,702	37,150	21	0.00%	0.02%	0.01%
d10	10,426,109	12,240,051	1,813,943	21	9.46%	5.32%	3.26%
DirectorsTime Total	**10,823,326**	**14,416,021**	**3,592,696**	**3693**	**9.83%**	**6.26%**	**3.84%**
Total	**110,158,421**	**230,244,369**	**120,085,948**	**81621**	**100.00%**	**100.00%**	**61.37%**

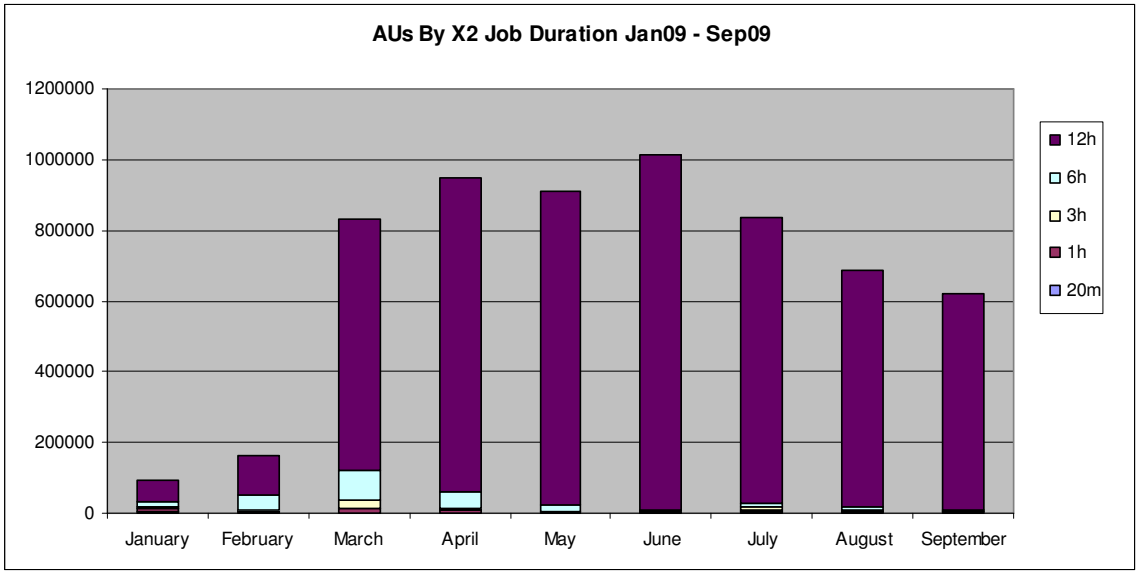
3.2.2 X2 Utilisation



X2 utilisation dropped in 3Q09 to 45% from 61% in 2Q09. Despite this, utilisation was still significantly higher than it was prior to the suspension of charging in March.

The decision was taken by EPSRC in August to extend the suspension of charging on the X2 through to the end of 2009.





3.2.2.1 X2 Utilisation by Consortium

Project	AUs	Raw AUs	Discounted AUs	Number of Jobs	Raw %age	Utilisation
y02	0	15	15	12	0.00%	0.00%
y03	0	4	4	7	0.00%	0.00%
y05	0	31	31	2	0.00%	0.00%
z03	0	69,529	69,529	37	3.25%	1.46%
Internal Total	**0**	**69,579**	**69,579**	**58**	**3.25%**	**1.47%**
e01	0	911,273	911,273	173	42.53%	19.19%
e05	0	404,409	404,409	53	18.88%	8.52%
e123	0	45	45	14	0.00%	0.00%
e24	0	39,375	39,375	30	1.84%	0.83%
e42	0	52	52	2	0.00%	0.00%
e69	0	8,920	8,920	3	0.42%	0.19%
e75	0	32,838	32,838	185	1.53%	0.69%
e85	0	14,752	14,752	1	0.69%	0.31%
e89	0	631,471	631,471	58	29.47%	13.30%
EPSRC Total	**0**	**2,043,134**	**2,043,134**	**519**	**95.36%**	**43.03%**
n02	0	7,872	7,872	66	0.37%	0.17%
NERC Total	**0**	**7,872**	**7,872**	**66**	**0.37%**	**0.17%**
d04	0	21,972	21,972	388	1.03%	0.46%
DirectorsTime Total	**0**	**21,972**	**21,972**	**388**	**1.03%**	**0.46%**
Total	**0**	**2,142,557**	**2,142,557**	**1031**	**100.00%**	**45.12%**

3.3. Performance Metrics

Metric	TSL(%)	FSL(%)	Jul-09	Aug-09	Sep-09	3Q09
Technology reliability (%)	85.00%	98.50%	99.4%	96.6%	99.3%	98.4%
Technology MTBF (hours)	100	126.4	183.0	183.0	146.4	168.9
Technology Throughput, hours/year	7000	8367	8124	8307	8198	8210
Capability jobs completion rate	70%	90%	96.3%	100.0%	100.0%	98.3%
Non in-depth queries resolved within 1 day (%)	85%	97%	100.0%	100.0%	98.3%	99.4%
Number of SP FTEs	7.3	8.0	9.0	8.4	9.3	8.9
SP Serviceability (%)	80.00%	99.00%	100.0%	100.0%	99.5%	99.8%

Colour coding:

Exceeds FSL	
Between TSL and FSL	
Below TSL	

4. Helpdesk

A total of 830 queries with a specified service metric were completed in this period.

Helpdesk Targets

Metric	Pass	Total	Fraction	Target
All queries finished in 1 day	666	670	99.4%	97.0%
Admin queries finished in 1 day	604	608	99.3%	97.0%
Queries assigned in 30 min	834	842	99.0%	97.0%
Technical assessments in 10 days	19	23	82.6%	97.0%

Queries by Service Metric

Service Metric	Queries	Percentage
Automatic	375	44.5%
Admin	233	27.7%
In-depth	149	17.7%
Technical	62	7.4%
Technical assessment class-1	18	2.1%
Technical assessment class-2	5	0.6%

Queries by Category

Query Category	Queries	Percentage
New User	102	12.1%
New Password	66	7.8%
Set user quotas	63	7.5%
Node Failure	62	7.4%
None	61	7.2%
Set group quotas	56	6.7%
Access to HECToR	53	6.3%
3rd Party Software	53	6.3%
Compilers and system software	41	4.9%
Disk, tapes, resources	38	4.5%
User behaviour	33	3.9%
Add to group	32	3.8%
Other	27	3.2%
User programs	26	3.1%
Login, passwords and ssh	21	2.5%
New Group	20	2.4%
Join Project	16	1.9%
SAFE	15	1.8%
Batch system and queues	15	1.8%
Courses	9	1.1%
Update account	7	0.8%
Static website	7	0.8%
Remove account	6	0.7%

Performance and scaling	3	0.4%
Delete from group	3	0.4%
Network	2	0.2%
Delete from project	2	0.2%
Create certificate	2	0.2%
Grid	1	0.1%

Queries by Handler Category

Handlers	Total	Admin	Automatic	Technical	In-depth	Technical assessment class-1	Technical assessment class-2	Percentage
USL	272	204		39	29	0	0	32%
OSG	434	25	375	20	14			52%
CSE	111	1			87	23		13%
Cray Systems	25	3		3	19			3%

5 System Hardware

5.1 HECToR Technology Changes

5.1.1 Phase2 Upgrade

5.1.1.1 Phase2a

The HECToR Phase2a acceptance tests were completed on 7th July 09. The 10-day availability trial was completed as planned on 18th July. In summary, the upgrade went very smoothly. Per the details in Section 5.2, the upgrade has had no significant adverse impact on the reliability of the service.

5.1.1.2 Phase2b

In 3Q09, the proposed solution for the HECToR Phase2b upgrade was agreed. A 20-cabinet 'Baker' system will be installed, with an early-user service available in March 2010. The system will comprise 44,544 cores (464 blades x 8 chips x 12 cores), delivering an estimated peak performance of 338 TFlops. Approximately 30 cabinets of XT4 will also be retained. The XT4 will formally provide the main service at this stage.

This will be followed by an upgrade to the Gemini network (by the end of 2010). The Baker/Gemini system will then provide the main service.

Detailed planning for Phase2b is now in progress. The transition to 12-core processors will be an interesting challenge for all!

5.1.2 Archive Solution

There is currently no means for users to back up, nor archive files from their working directory on HECToR. User code is backed up but data is not. In many cases, the ability to retain very large volumes of historic data is key to the research being conducted (e.g. ocean and climate modelling). An archive capability is critical for these users.

In 3Q09 a solution to the above problem was agreed. An archive mechanism will be provided in 4Q09 by CRAY based on Symantec's Enterprise NetBackup. This archive will have an initial capacity of 1300*800GB Tapes (1.02PB).

Two methods of archive will be supported

- Daily scheduled archive from special directories within the users work space.
- User initiated on-demand archive via a simple command-line interface.

Acceptance testing is scheduled for November. We are also planning an initial user trial in November with a sub-set of users. The early user groups have been identified as:

Project	*PI*
n01	Thomas Anderson/ Beverly de Cuevas
n02	Lois Steenman-Clark
n04	Richard Proctor
e01	Gary Coleman
e85	N. Swaminathan

The PIs from the early-user groups have been contacted and we are currently reviewing the archive quotas which they will require.

General availability of the archive will be dependant on the success of the acceptance tests and early-user trials.

5.1.3 Job Reservations

Job reservations are important to users as they can be used to support demonstrations, training courses and urgent computing. Reservations are available in PBS v10 which is installed on HECToR. In practice we have discovered a number of problems with enabling reservations. Work is ongoing to resolve these problems. This currently remains as our number one issue with Cray.

5.1.3 Pathscale Compiler

In July, SiCortex the company behind the Pathscale compiler ceased operations. This left some doubt as to the future of this widely used compiler on HECToR. It was later confirmed in August that Cray had acquired the Pathscale Compiler Suite, thus securing the future of the compiler on the service. Pathscale will now remain a fully supported product.

5.2 Severity-1 Incidents

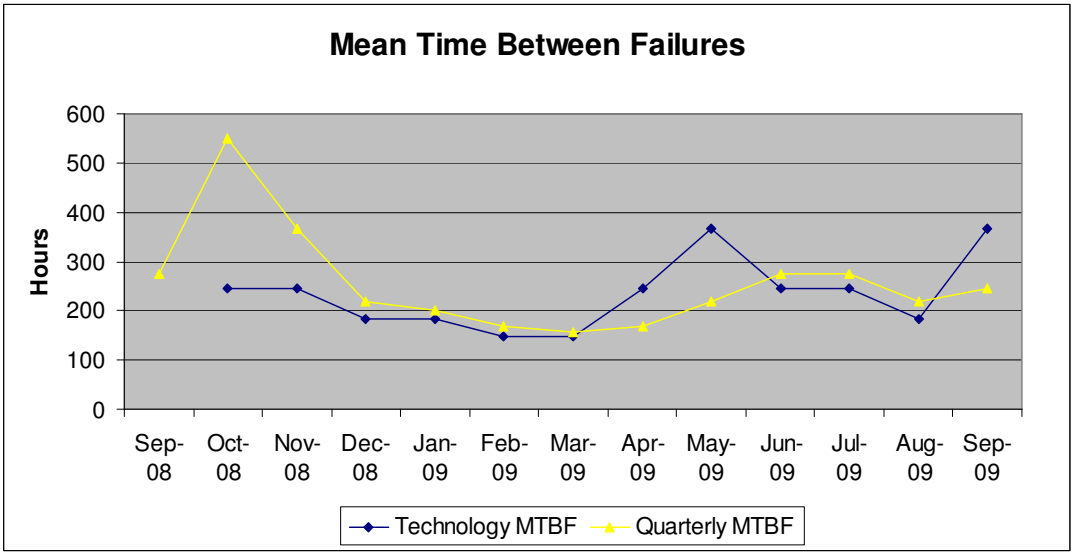
The monthly numbers of incidents and failures (SEV 1 incidents) are shown in the table below:

	July	*August*	*September*
Incidents	48	22	28
Failures	4	4	5

5.1.3 Technology Failures

Cray technology was responsible for nine of the thirteen Severity-1 incidents during 3Q09. Eight of these incidents were due to hardware failures; one incident was due to an overrun of a maintenance session. There were no Lustre related failures in 3Q09.

So far, reliability of quad-core is close to the long-term average for dual-core



5.1.3 Service Provision Failures

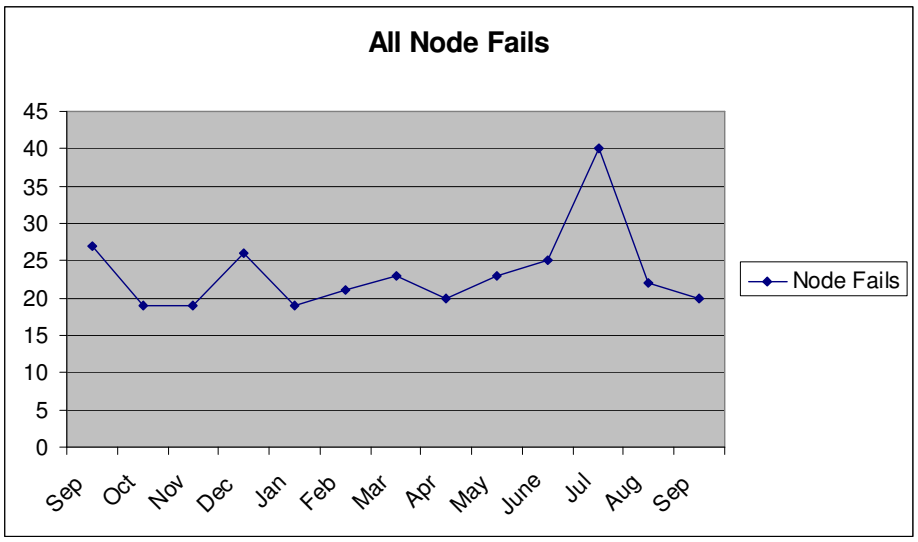
There were two service provision failures during 3Q09. In the first instance, a process error prior to a maintenance slot resulted in new users being unable to login for a short period of time. Existing users and batch jobs were unaffected. The second failure related to a failure of the SAFE. Users were able to access the HECToR website however the HECToR SAFE was unavailable. A third failure was attributed 50/50 between the service and external parties: a fault on the external power distribution network triggered a plant fault.

5.1.3 External Failures

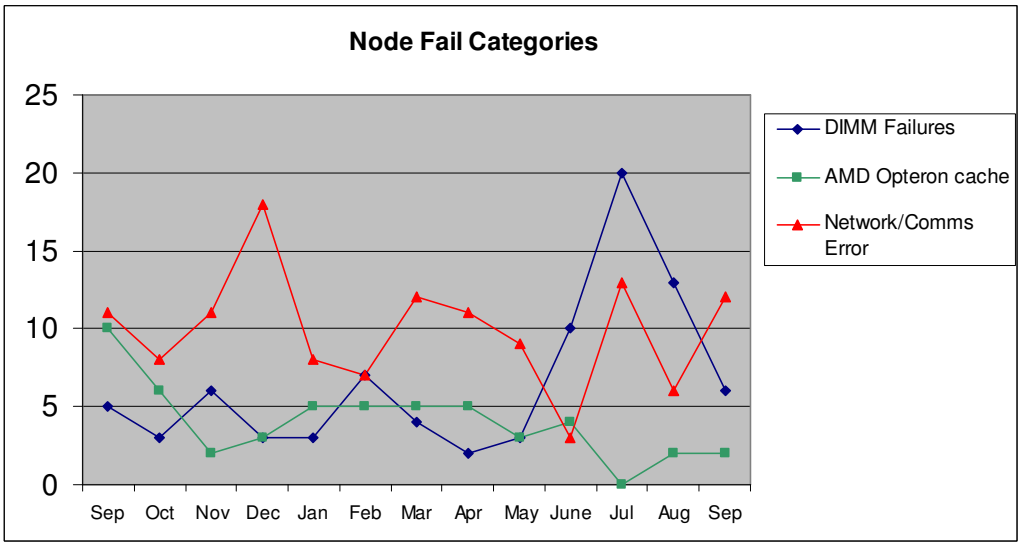
There was one failure in September as a result of a security alert. As above the failure due to a power distribution fault was shared between external and the service.

5.3 Single Node Failures

There were 82 single node failures in 3Q09 compared to 68 in 2Q09.



The number of node failures as a result of Un-correctable memory error (DIMM failures peaked in July. All 22,656 DIMMs were replaced during the Phase2a quad-core upgrade in June hence some initial failures were to be expected. The level of node failures has since dropped. More data will be required in order to gauge whether the upgrade to quad-core processors has had any long term effect on the volume of single node failures.



CRAY are continuing investigations into whether there are any patterns in node failures

Appendix A: Terminology

TSL : Threshold Service Level

FSL : Full Service Level

SDT : Scheduled Down Time

UDT : Unscheduled Down Time

WCT : Wall Clock Time

MTBF : Mean Time Between Failures = 732/Number of Failures

SP : Service Provision

SP Serviceability% = 100*(WCT-SDT-UDT(SP))/(WCT-SDT)

Technology Reliability % = 100*(1-(UDT(Technology)/(WCT-SDT))

Incident Severity Levels

SEV 1 — anything that comprises a FAILURE as defined in the contract with EPSRC.

SEV 2 — NON-FATAL incidents that typically cause immediate termination of a user application, but not the entire user service.

The service may be so degraded (or liable to collapse completely) that a controlled, but unplanned (and often very short-notice) shutdown is required or unplanned downtime subsequent to the next planned reload is necessary.

This category includes unrecovered disc errors where damage to file systems may occur if the service was allowed to continue in operation; incidents when although the service can continue in operation in a degraded state until the next reload, downtime at less than 24 hours notice is required to fix or investigate the problem; and incidents whereby the throughput of user work is affected (typically by the unrecovered disabling of a portion of the system) even though no subsequent unplanned downtime results.

SEV 3 — NON-FATAL incidents that typically cause immediate termination of a user application, but the service is able to continue in operation until the next planned reload or re-configuration.

SEV 4 — NON-FATAL recoverable incidents that typically include the loss of a storage device, or a peripheral component, but the service is able to continue in operation largely unaffected, and typically the component may be replaced without any future loss of service.

Appendix B: Projects on HECToR

Code	Title	Funding Body	Class	PI	Total AUs allocated	AUs used	AUs left
EPSRC Projects							
c01	Support of EPSRC/STFC SLA	EPSRC	Class1	Dr Richard Blake	12,803,723	12,922,424	-118,701
e01	UK Turbulence Consortium	EPSRC	Class1	Dr Gary N Coleman	426,219,876	1,925,849	424,294,027
e05	Materials Chemistry HPC Consortium	EPSRC	Class1	Prof C Richard A Catlow	1,129,327,228	23,150,884	1,106,116,344
e10	GENIUS	EPSRC	Class1	Prof Peter Coveney	9,257,856	5,513,732	3,744,124
e100	Large scale MD and quantum embedding for biological systems	EPSRC	Class2a	Prof Zheng X Guo	100,000	27	99,973
e101	Optimization of HPCx LES code	EPSRC	Class2a	Prof Michael Leschziner	334,701	231,233	103,468
e102	Numerical investigation of aerofoil noise	EPSRC	Class1	Dr Richard D Sandberg	5,000,000	2,519,210	2,480,790
e103	Micromagnetic simulations on HPC architectures	EPSRC	Class2a	Dr Hans Fangohr	100,000	0	100,000
e104	Fluid-Mechanical Models applied to Heart Failure	EPSRC	Class1	Dr Nicolas Smiths	2,400,000	0	2,400,000
e105	Joint Euler/Lagrange Method for Multi-Scale Problems	EPSRC	Class1	Dr Andreas M Kempf	1,300,000	0	1,300,000
e106	Numerical Simulation of Multiphase Flow: From Mesocales to	EPSRC	Class1	Prof Kai Luo	3,650,000	0	3,650,000
e107	Parallel Brain Surgery Simulation	EPSRC	Class1	Dr Stephane P. A. Bordas	6,000,000	7	5,999,993

e108	Unsteady Propeller Noise	EPSRC	Class2a	Dr Sergey Karabasov	100,000	0	100,000
e110	Computational Aeroacoustics Consortium	EPSRC	Class1	Prof Paul Tucker	39,100,000	3,865,817	35,234,183
e112	Assessment of the ONETEP code	EPSRC	Class2a	Mr Andrew J Scott	100,000	102,500	-2,500
e113	[dCSE] MRBV ? Massive Remove Batch Visualizer	EPSRC	Class2b	Dr Martin Turner	85,440	10,267	75,173
e114	[dCSE] OpenFOAM	EPSRC	Class2b	Mr Paul Graham	100,000	0	100,000
e115	Multiscale Modelling of Biological Systems	EPSRC	Class2a	Prof Jonathan W Essex	100,000	0	100,000
e116	Scaling and Benchmarking Spectral Codes	EPSRC	Class2a	Dr Benson Muite	100,000	941	99,059
e117	Getting started on HECTOR	EPSRC	Class2a	Dr Carmen Domene	100,000	247,664	-147,664
e118	Adaptive coupled radiation-transport and fluids modelling.	EPSRC	Class2a	Prof Christopher Pain	100,000	0	100,000
e119	Nanoscale Energy Transportation	EPSRC	Class2a	Dr Dongsheng Wen	100,000	0	100,000
e120	[dCSE] FF Transformations for plasma simulations	EPSRC	Class2b	Dr Colin M Roach	200,000	0	200,000
e121	[dCSE] Improving Performance using Wannier functions	EPSRC	Class2b	Prof Maria Merlyne DeSouza	1,700,000	590	1,699,410
e122	Multiscale Modelling of Magnetised Plasma Turbulence	EPSRC	Class1	Dr Colin M Roach	65,000,000	4,891,441	60,108,559
e123	Finger-jets and turbulent structures	EPSRC	Class2a	Dr David Ingram	15,040	0	15,040
e124	Compressible Axisymmetric Flows	EPSRC	Class1	Dr Richard D Sandberg	15,000,000	156,381	14,843,619
e125	Fermion Monte Carlo in Slater Determinant spaces	EPSRC	Class2a	Dr Ali Alavi	100,000	252,826	-152,826

e126	Clean Coal Combustion: Burning Issues of Syngas Burning	EPSRC	Class1	Dr Xi Jiang	9,984,000	364,748	9,619,252
e127	Alternative drag-reduction strategies	EPSRC	Class1	Prof Michael Leschziner	7,000,000	0	7,000,000
e128	Rate-Controlled Constrained Equilibrium	EPSRC	Class1	Dr Stelios Rigopoulos	6,230,000	0	6,230,000
e131	Direct Simulation of a Pure Plume impinging on a density surface	EPSRC	Class2a	Dr Maarten V Reeuwijk	100,000	0	100,000
e132	Parallel Version of a Design Sensitivity Tensegrity Code	EPSRC	Class2a	Prof Rod Smallwood	100,000	0	100,000
e133	Implementation of Established Algorithms to Extend HELIUM	EPSRC	Class2b	Prof Ken Taylor	200,000	0	200,000
e134	Numerical Simulation of Turbomachinery Flows	EPSRC	Class2a	Dr Francesco Montomoli	100,000	0	100,000
e135	DNS of unsteady turbulent flow over a smooth or a rough surface	EPSRC	Class2a	Dr Shuisheng He	100,000	0	100,000
e136	Modelling the UK Wind Power Resource	EPSRC	Class2a	Dr Gareth Harrison	100,000	0	100,000
e24	DEISA	EPSRC	Class1	Mrs Alison Kennedy	60,555,221	18,840,974	41,714,247
e34	Hydrogen vacancy distribution in magnesium hydride	EPSRC	Class2a	Prof Nora de Leeuw	100,000	22,357	77,643
e35	Non-adiabatic processes	EPSRC	Class1	Dr Tchavdar Todorov	3,000,000	895,274	2,104,726
e42	Computational Combustion for Engineering Applications	EPSRC	Class1	Prof Kai Luo	32,000,001	9,209,184	22,790,817
e59	Turbulence in Breaking Gravity Waves	EPSRC	Class1	Prof Ian P Castro	708,922	440,737	268,185
e63	UK Applied Aerodynamics Consortium 2	EPSRC	Class1	Dr Nick Hills	13,500,000	9,774,059	3,725,941
e68	Hydrogenation Reactions at Metal Surfaces	EPSRC	Class1	Dr Angelos Michaelides	50,000,000	25,532,673	24,467,327

e69	Simulations of a Subsonic Cylindrical Cavity Flow	EPSRC	Class2a	Dr Aldo Rona	125,001	125,273	-272
e70	Computation of Electron Transfer Properties	EPSRC	Class1	Dr Jochen Blumberger	960,000	324,242	635,758
e71	Simulating the control of calcite crystallisation	EPSRC	Class1	Prof John Harding	40,403,522	40,203,133	200,389
e72	Ultrascalable Modelling of Materials	EPSRC	Class2a	Dr Lee Margetts	8,622,547	8,459,578	162,969
e74	Quantum Monte Carlo Methods	EPSRC	Class1	Prof Dario Alfe`	30,008,735	32,477,320	-2,468,585
e75	Terascale DNS of Turbulence	EPSRC	Class1	Prof Christos Vassilicos	27,881,306	27,789,757	91,550
e76	HELIUM Developments	EPSRC	Class1	Prof Ken Taylor	6,058,305	7,481,798	-1,423,493
e77	Porting of DFT/GW Codes	EPSRC	Class2a	Prof Maria Merlyne DeSouza	160,000	60,676	99,324
e81	e-Collision experiments using HPC	EPSRC	Class2a	Prof NS Scott	200,000	614	199,386
e82	ONETEP: linear-scaling method on High Performance Computers	EPSRC	Class2a	Dr Peter Haynes	100,000	90,937	9,063
e84	Vortical Mode Interactions	EPSRC	Class1	Dr Tamer Zaki	9,600,000	11,364	9,588,636
e85	Study of Interacting Turbulent Flames	EPSRC	Class1	Dr N Swaminathan	5,588,610	643,920	4,944,690
e89	Support for UK Car-Parrinello Consortium	EPSRC	Class1	Dr Matt Probert	360,000,001	60,021,685	299,978,316
e90	Network modelling of wireless cities	EPSRC	Class2a	Prof Jonathan M Pitts	100,000	23,697	76,303
e92	Dynamo Action In Compressible Convection	EPSRC	Class1	Mr Paul Bushby	4,075,000	74,433	4,000,567
e93	ACE - Architecture Exercise	EPSRC	Service	Dr Lorna Smith	500,000	508,680	-8,680

e94	Porting the Linear Scaling DTF Code Conquest to HECToR	EPSRC	Class2a	Dr David Bowler	100,000	112,043	-12,043
e96	Materials Property Relationships	EPSRC	Class2a	Dr Shoufeng Yang	100,000	0	100,000
e98	Non-linear magnetohydrodynamic modelling of tokamak plasmas	EPSRC	Class2a	Mr Ian T Chapman	100,000	26,287	73,713
u02	Materials simulation using AIMPRO	EPSRC	Early use	Dr Patrick R Briddon	4,000,000	3,080,443	919,557
u03	DNS of NACA-0012 aerofoil at Mach 0.4	EPSRC	Early use	Dr Gary N Coleman	2,500,000	2,309,232	190,768
u10	Turbulent Plasma Transport in Tokamaks	EPSRC	Early use	Dr Colin M Roach	2,500,000	2,447,219	52,781
NERC Projects							
n01	Global Ocean Modelling Consortium	NERC	Class1	Dr Thomas Anderson	19,343,840	9,888,596	9,455,244
n02	NCAS (National Centre for Atmospheric Science)	NERC	Class1	Dr Lois Steenman-Clark	121,032,034	63,366,781	57,665,253
n03	Computational Mineral Physics Consortium	NERC	Class1	Prof John P Brodholt	150,618,316	88,852,778	61,765,538
n04	Shelf Seas Consortium	NERC	Class1	Dr Roger Proctor	39,009,435	19,171,283	19,838,152
u07	NCAS	NERC	Early use	Dr Lois Steenman-Clark	2,000,000	131,438	1,868,562
BBSRC Projects							
b01	Biomarkers for patient classification	BBSRC	Class2a	Prof. Peter Ghazal	100,000	300,794	-200,794
b08	Int BioSim	BBSRC	Class1	Mr Mark M Sansom	866,000	47,914	818,086
b09	Circadian Clock	BBSRC	Class1	Prof Andrew A Millar	2,000,000	0	2,000,000

b10	SPRINTing with HECToR [dCSE]	BBSRC	Class2b	Mr Terry Sloan	100,000	14	99,986
STFC Projects							
p01	Atomic Physics for APARC	STFC	Class1	Dr Penny Scott	3,020,000	0	3,020,000
External Projects							
x02	BlueArc (TDS)	External	Service	Mr M W Brown	1,000	0	1,000
x01	HPC-Europa	External	Class1	Dr Judy Hardy	2,183,338	1,311,272	872,066
x03	Prospect FS	External	Class1	Mr Davy Virdee	384,000	0	384,000
x04	Futuretec	External	Class1	Mr Davy Virdee	691,200	210,986	480,214
T1	NIMES: New Improved Muds from Environmental Sources.	External	Class1	Dr Chris Greenwell	4,113,669	242,844	3,870,825
Director's Time							
d05	Icon-DT	DirectorsTime	Service	Mr Paul Graham	320,000	322,097	-2,097
d08	Oncology	DirectorsTime	Service	Mr Paul Graham	35,000	25,531	9,469
d01	UKQCD-DT	DirectorsTime	Service	Dr Jonathan Flynn	3,968,929	3,968,926	3
d07	Thermal ellipsiods and proton transfer	DirectorsTime	Service	Dr Carole A Morrison	1,116,000	457,708	658,292
d09	ICHEC	DirectorsTime	Service	Dr Jean-Christophe Desplat	1,000,000	459,301	540,699
d10	d10	DirectorsTime	Service	Prof Ken Taylor	10,000,000	10,426,109	-426,109

d03	EUFORIA	DirectorsTime	Service	Mr Adrian Jackson	2,200,000	1,064,749	1,135,251
y09	Director's Time	DirectorsTime	Service	Prof Arthur S Trew	29,685,133	82,538	764,170
d04	MSc Projects	DirectorsTime	Service	Dr David Henty	93,500	58,151	35,349