



Cardiff University

“ARCCA HEC Tender”

Invitation to Tender (ITT)

Tender Ref: HWU/0573/02/K

OJEU Ref: 180908-2005

Specification: Lot 32

31 January 2007

Tender for the supply of a Cluster with Interconnect Fabrics and Management Nodes, Shared Memory Systems, Storage Services and associated Hardware and Software Tools.

CONFIDENTIAL DOCUMENT

Operational Requirements

Confidentiality

Cardiff University views this procurement as highly confidential. The Supplier must not divulge the nature of this procurement, or the content thereof, to any third party without the written permission of the University. All information supplied in connection with this invitation shall be regarded as strictly confidential.

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Definitions

Throughout this document:

The “University” means Cardiff University.

The “Supplier” means the firm or company who has been invited to respond to this ITT.

Glossary of terms used in this document

API	-	Application Programming Interface
ARCCA	-	Advanced Research Computing @ Cardiff
ASIC	-	Application-Specific Integrated Circuit
BIOS	-	Basic Input/Output System
CCTV	-	Closed-circuit Television
CE Mark	-	An assurance that an item meets all essential requirements of all applicable EU directives
CFS	-	Cluster File System
Cluster Management Node	-	A node providing infrastructural, management and administrative support to the cluster, e.g. resource management, job scheduling etc.
CMS	-	Cluster Management System
Compute Node	-	A node dedicated to batch computation
Core	-	One or more cores contained within a processor package
CPU	-	Central Processing Unit
CU	-	Cardiff University
CUBRIC	-	Cardiff University Brain and Repair Imaging Centre
DDR2	-	Double Data Rate Two
DIMM	-	Dual In-line Memory Module
EMC	-	ElectroMagnetic Compatibility
FBDIMM	-	Fully Buffered DIMM
FC	-	Fibre Channel
FPGA	-	Field Programmable Gate Array
Gb	-	Gigabit
GB	-	Gigabyte
Gbps	-	Gigabits Per Second
GCC	-	GNU Compiler Collection, as defined at http://gcc.gnu.org/

GEO	-	GEO 600 Gravitation Wave detection project. More information can be found at http://www.geo600.uni-hannover.de/
GFS	-	Global File System
Globus	-	An open-source software toolkit used for building Grids. More information can be found at http://www.globus.org/toolkit/
GPFS	-	General Parallel File System
GPU	-	Graphics Processing Unit
HEC	-	High End Computing
HPC	-	High Performance Computing
HPCC	-	HPC Challenge (Benchmark Suite)
HS	-	High Speed
HS-LL	-	High Speed Low Latency
HSM	-	Hierarchical Storage Management
INSRV	-	Cardiff University Information Services Directorate
IPMI	-	Intelligent Platform Management Interface
ITT	-	Invitation to Tender
kW	-	Kilowatt = 1000 Watts
LAN	-	Local Area Network
LDAP	-	Lightweight Directory Access Protocol
LIGO	-	Laser Interferometer Gravitational Wave Observatory. More information can be found at http://www.ligo.caltech.edu/
Linux	-	Any variant of the Unix-type operating system originally created by Linus Torvalds
Login Node	-	A node providing user access services for the cluster
LTO-3	-	A generation of the Linear Tape Open technology
Lustre	-	A software distributed file system, generally used for large scale cluster computing
MEG	-	Magnetoencephalography
MPI	-	Message Passing Interface
MTBF	-	Mean Time Between Failure
MTTF	-	Mean Time To Failure
MWE	-	Modern Working Environment - Cardiff University's full IBM portal technology stack
NFS	-	Network File System
NIC	-	Network Interface Controller

Node	-	An individual computer unit of the system comprising a chassis, motherboard, processors and all additional components
OR	-	Operational Requirements
OS	-	Operating System
PCI	-	Peripheral Component Interconnect
PCIe	-	PCI Express
PCI-X	-	Peripheral Component Interconnect Extended
Processor	-	A single IC chip package (which may be single-core, dual-core or quad-core)
QAA	-	Quality Assurance Agency for Higher Education
RAID	-	Redundant Array of Inexpensive Disks
RAM	-	Random Access Memory
SAN	-	Storage Area Network
SAS	-	Serial Attached SCSI
SATA	-	Serial Advanced Technology Attachment
SCSI	-	Small Computer System Interface
SIMD	-	Single Instruction, Multiple Data
SMP	-	Symmetric Multiprocessor
SOA	-	Service Oriented Architecture
SRIF3	-	Third round of funding from the Science Research Investment Fund
SSH	-	Secure Shell
Storage Node	-	A node providing access to the storage in Lot 3 for the cluster and shared memory systems
System	-	All of the equipment and software proposed by the supplier within the tender cost
TB	-	Terabyte
TCO	-	Total Cost of Ownership
TCP	-	Transmission Control Protocol
TFlops	-	TeraFlops = 10^{12} FLOPS (FLoating point Operations Per Second)
TOE	-	TCP Offload Engine
UK	-	United Kingdom of Great Britain and Northern Ireland
UNIX	-	An operating system conforming to the Single UNIX® Specification as defined by the Open Group at http://www.unix.org/ , and will also embrace those operating systems which can be described as Unix-like or Unix-type (or equivalent).

- UPS - Uninterruptible Power Supply
- USB - Universal Serial Bus
- VIRGO - A collaboration at the European Gravitational Observatory for the realisation of an interferometric gravitational wave detector.
- WEEE - Waste Electrical and Electronic Equipment Directive (EC directive 2002/96/EC)
- x86-64 - A 64-bit microprocessor architecture

1. Executive Summary

Cardiff University seeks to transform its research computing capability by engaging with a leading HPC supplier to:

- Procure a range of HPC equipment, including a large cluster, shared memory systems, associated hardware and software infrastructure.
- Assist with the development of a long term plan to enhance Cardiff University's research computing capabilities and services to the level of a world-leading institution.
- Develop a mutually beneficial partnership, to include possibilities for joint research and development with the capability for commercial exploitation.

2. Background on Cardiff University

2.1. Introduction

Cardiff University is recognised in independent government assessments as one of Britain's leading teaching and research universities. This reputation is maintained through a combination of impressive modern facilities, a dynamic approach to teaching and research, and a proud history of achievement.

Cardiff University is a member of the Russell Group, which is an elite association of 19 research-intensive universities. This group promotes research excellence and accounts for the majority of research income in the United Kingdom's universities.

There are 28 academic schools, each of which carries out research, and at any one time there are more than 1,000 research contracts in operation. Research expertise and excellence in research-led teaching at Cardiff University covers a wide range of areas, including:

- Engineering and technology
- Humanities
- Medical and dental sciences
- Natural, physical, health, life and social sciences.

This wide range of disciplines helps prepare students for a large variety of professions.

The international reputation of Cardiff University attracts students from around the world, with 30,000 applications annually for 4,500 places. The student population is approximately 26,000, including 21,000 undergraduates; and around 5,000 students graduate each year.

Cardiff University is one of the largest employers in Cardiff – the capital city of Wales - with more than 5,000 staff in teaching, research, technical or administrative roles. The University is also heavily committed to adult education and is the largest provider in Wales with several hundred courses in venues across South East Wales.

The University is spread over two main campuses as a result of the merger in 2004 between Cardiff University and the University of Wales College of Medicine. The

Cathays Park Campus is located in Cardiff's civic centre and the Heath Park Campus is north of the city centre. Teaching is also carried out in other sites across Wales. In recent years, substantial investment has been made in the University's estate, including the expansion of the life sciences facilities and the current developments of a new brain research centre (CUBRIC) and a new Optometry & Vision Sciences building.

The University is a large purchaser of goods and services, making a major contribution to the prosperity of the region. Industry, commercial partners, government bodies and other organisations also benefit from its academic expertise and research facilities. Cardiff University plays a very important role in promoting health and welfare via well-managed links to the National Health Service (NHS).

More information about the university can be obtained at:

<http://www.cardiff.ac.uk/about/index.html>

2.2.Vision, Mission and Aims (2006/07 – 2010/11)

Cardiff University's vision is to be a World-Class University.

To be among the very best in the world is the most challenging goal the University can set. It has done so because it is only through working to achieve the very highest international standards in research, teaching and other activities that it can realise the full potential of the academic community that is Cardiff University. The University's vision reflects its service to society and this vision is pursued in the belief that all stakeholders in the University should expect no lesser ambition.

Cardiff University's mission is to pursue research, learning and teaching of international distinction and impact. There are three main aims:

1. Research

To pursue research that is recognised as internationally distinguished in its quality and impact.

2. Learning, Teaching and Assessment

To pursue learning and teaching together with professional training and development that are recognised as internationally distinguished in their quality and impact.

3. Innovation and Engagement

To make a significant and sustainable contribution to health, economy, education and culture through the application of the University's strengths for the needs and good of societies throughout the world.

All the University's activities are directed to achieving the highest international standards in research, learning and teaching in a rich and varied research-led environment where all staff and students can achieve their full potential to the benefit of the wider community and society as a whole.

Tangible evidence that the University has gained recognition as a major player in UK Higher Education and can continue to move forward with confidence includes:

- The University's excellent results in the 2001 Research Assessment Exercise (RAE).
- Membership of the Russell Group of the UK's research-led universities.

- Rigorous mechanisms for reviewing the quality of teaching provision, strongly endorsed by the QAA Continuation Audit Report in 2000.
- Rising demand for student places.
- Rapidly increasing sponsorship of research.

2.3. Cardiff University Information Services (INSRV)

As a Directorate of Cardiff University, INSRV's mission is to deliver world-class information services that give staff and students an edge in realising their potential in research, learning, teaching and benefiting the wider community. INSRV works at the heart of the University's intellectual life and corporate operations, where it provides superior information resources, collaboration tools, discovery facilities, help, training and support. It is a large directorate with around 500 highly skilled staff who ensure that library, IT and media resources remain available to a user base of over 40,000 people. INSRV's development and operations teams collectively hold a vast body of knowledge and cutting-edge technical skills.

Scale of operations delivered by INSRV in Cardiff University:

- IT, Library and Media resources are made available to a user base of over 40,000 people.
- There are over 5,000 concurrent users of the IT services.
- There are well over 1,000 public access PCs in 60 locations, with hundreds being available 24 hrs. Networked computers offering a wealth of software applications are available to every student.
- There are currently 18 separate library sites with nearly 30 service points distributed across campus. Users make 2.5 million visits to these service points each year. There are over 1 million books and bound volumes to borrow from and there is access to upwards of half a million on-line digital and electronic resources.
- Users also make more than 45,000 logged IT support requests per year (with 3 times as many "quick queries").
- There are 200-plus major systems and software applications.
- Over 2,000 km of network cable is used to link in excess of 18,000 Gigabytes of additional information, which is stored on several hundred servers.
- Annual email traffic is now around 60 million messages and in addition to this each year INSRV will typically capture, stop and deal with (before they ever become visible to users) 70 million spam emails, as well as several thousand unsolicited network probes and attempted virus infections.

More information about INSRV can be obtained at:

<http://www.cardiff.ac.uk/schoolsanddivisions/divisions/insrv/index.html>

2.4. Advanced Research Computing @ Cardiff (ARCCA)

ARCCA is a new division within Information Services whose remit is to entirely transform the University's approach to advanced research computing:

- to bring together the advanced research computing community at Cardiff;
- to introduce and encourage the use of new techniques and technologies;
- to maximise returns and manage risks;
- to encourage and enable new user communities and new applications;
- to build and sustain a position which takes the University to the forefront of leading research universities in the UK and internationally in this field.

A central part of ARCCA's remit will be to develop and deliver new techniques and skills for existing advanced research computing users; but also, very importantly, to encourage new and interdisciplinary research using these techniques.

3. The HEC Vision for Cardiff University

3.1. The HEC Vision

To transform the contribution of advanced computing to the University's research agenda and, over time, to build and sustain a position which takes the University to the forefront of leading research universities in the UK and internationally in this field. A key enabler of this vision will be a new University-level high end computing facility.

3.2. Background to the Requirement

The new facility is intended to substantially improve the research computer systems infrastructure within the University. Example uses of the facility are:

- Astrophysics - numerical simulations of star and planet formation, in-house codes run on 4-, 8- and 16-core shared-memory machines.
- Biosciences - DNA assembly and phylogenetic analysis using in-house code on Cardiff's Condor system, which will require access to the procured storage solution.
- Chemistry - periodic DFT modelling of catalyst surfaces with VASP and SIESTA codes - 16 - 128 core through shared memory and/or closely coupled cluster.
- Chemistry - molecular modelling using Molpro on 16 and 32 core closely-coupled cluster and/or shared memory.
- Dentistry - biomechanics and mechanobiology - modelling of biological tissues and structures, using Finite Element Methods / Computational Fluid Dynamics, with in-house Fortran and C codes, and commercial applications: ABAQUS, LS-DYNA, MARC, MATHEMATICA and Fluent - to run on 8, 16, 32 cores.
- Earth Sciences - TERRA a fluid mechanics modelling code for Earth mantle convection - MPI code - running on tightly coupled clusters - with good scalability i.e. to very large processor numbers, also has high RAM and I/O requirements.
- Engineering - Coupled flow and deformation modelling, in-house finite element code to run on 8, 16 and possibly 32 core shared memory machines.

- Engineering - (Water Management) - Computational Hydro-environmental Dynamics, in-house code to run on 8, 16 and 32 core shared memory machines. CFD models used extensively by industry for flood inundation prediction and environmental impact assessment studies.
- Epidemiology
- Mathematics - computational fluid dynamics on shared memory machines.
- Medicine, including Pathology - systems biology/cancer research.
- Optometry - using distributed software and in-house software usually based on simulated annealing to study the relationship between order and disorder in biological macromolecules.
- Pharmacy
- Physics - galaxy formation and evolution - in-house code running on 8 and 16 core closely-coupled systems.
- Physics - real-time analysis of streaming data on loosely-coupled cluster nodes (experiments running continuously 24hr x 365 days for several years), from a network of Gravitational Wave Detectors within a high-profile scientific collaboration (LIGO/GEO/VIRGO).

It is expected that the increasingly coordinated and shared nature of high-end computing (HEC)-based research at Cardiff will also catalyse more interdisciplinary research opportunities in the above areas.

The academic schools that house these research groups almost all achieved the highest possible grades (5 or 5* i.e. research of international excellence) in the last UK Universities' Research Assessment Exercise (RAE). Overall, Cardiff University achieved 7th out of 106 universities in the UK RAE. It is expected that this investment will continue to enhance the University's reputation and prestige as a world-class research partner.

The University has identified the need to construct a new data centre to support its HEC Vision, and has now agreed a suitable location. This is expected to become available in Q3 2007.

3.3.Current HEC capabilities at Cardiff

There is currently a range of clusters (such as the Helix, Coma, and CUBRIC clusters) and shared memory systems (Cspace, Aztek) at Cardiff University funded by grants obtained by academic schools.

Support and systems administration for these systems is provided locally by schools, where each local system administrator is responsible for security, backup, and system administration.

It is anticipated that the new facility will be run as a University level service for the benefit of all HEC users.

4.Current Setup at Cardiff University

4.1.Cardiff University's IT infrastructure environment

Cardiff University has a large, centrally managed IT Infrastructure, with pervasive high speed networks to all major sites. Users are provided with limited, but fully

resilient SAN-based storage, accessed by centralised directory-based authentication. A new portal-based collaborative environment is being developed, based on the IBM product stack, and IBM's Tivoli Storage Manager product is used to provide backup and archival services.

4.2.HEC Equipment room

The HEC Data Centre will be a newly constructed, high quality machine room environment, comprising 150 m² space, which is more than adequate for the expected equipment and predicted future expansion. It will be on the ground floor, with options for a false floor and/or high level cable trays, if required.

The Data Centre will have a high standard of security features, including CCTV and key card access. It will also be equipped with smoke detection, and potentially water detection and automatic shutdown facilities.

Power supply to the Data Centre will have a separate bus-bar and meter for both equipment and cooling so that the power consumption of the individual parts of the facility can be closely monitored. No decision has been made regarding room-based cooling versus rack-based cooling, and Suppliers are invited to comment (in the response to Section 6.13) on this in their proposals.

The facility will also have sufficient office space nearby for more than 12 people. This could potentially include office space for Supplier's staff, if appropriate.

Suppliers are invited to comment (in the optional response areas of Section 6) on the specification of the above facility and suggest any additions that could enhance Cardiff's research computing capabilities and services to the level of a world-leading institution.

5.Procurement Procedure

5.1.General points

The purpose of this tender is to appoint a preferred HPC supplier for Cardiff University.

This procurement is being conducted according to the Restricted Procedure of the EU Supplies Directive. In the first stage of the SRIF3 co-ordinated procurement potential suppliers were invited to submit expressions of interest to Heriot-Watt University. A first stage evaluation was made on the basis of the expressions of interest, and a shortlist drawn up. Short-listed suppliers have been invited, in this second stage, to submit full responses to the ITT.

All formal communication with suppliers over the course of this procurement will be handled by Cardiff University.

Suppliers will be provided with clarification of our requirements in accordance with the EU directives on procurement.

5.2.Tender timescale

Suppliers should be aware of the following target timetable and must be available when requested:

Action	Date
Invitation to tender	31 January 2007
Supplier Open Day	15 February 2007
Supplier to perform Benchmarks	February & March 2007
Tender Return Date	Noon 28 March 2007
Evaluation / bid clarification, reference site visits / contract discussion	28 March – 22 June 2007
Anticipated contract award	End June 2007
Supplier delivers kit and begins installation and acceptance tests	End September 2007
Acceptance tests complete	End November 2007
ARCCA Service commences	1 January 2008

Cardiff University reserves the right to vary this timetable if the need arises, within the constraints of the EU Supplies Directive.

Initial ITT responses will be expected to remain valid until 30/11/07.

An electronic copy of this ITT will be available to Suppliers. Building plans, diagrams and other university documentation will be available to all Suppliers on request, if considered appropriate by the University.

5.3.Procedure for Bid Submission

Generally, the procedure should be in accordance with those of Heriot-Watt University, which is co-ordinating several similar procurement requirements in this case.

Specifically, for Cardiff University, the electronic copy must be in Word 2000 or Word 2003 format for the main ITT document and Excel 2000 or Excel 2003 format for the Cost Tables. Electronic copies can be submitted on CDROM or USB stick. Any non-standard fonts used in electronic submissions must be embedded in the document.

ITT responses submitted after the deadline will **not** be considered.

5.4.Instructions for response to requirements

PLEASE READ INSTRUCTIONS BEFORE ATTEMPTING TO WRITE RESPONSE

Suppliers are invited to respond to this Invitation to Tender (ITT) from Cardiff University for “a Cluster with Interconnect Fabrics and Management Nodes, Shared Memory Systems, Storage Services and associated Hardware and Software Tools”,

known as the "ARCCA HEC Tender". This tender process and subsequent contract will be managed by Cardiff University Information Services and ARCCA.

This ITT is in two main parts:

Sections 1 to 5 provide background information for the Supplier. These sections should be retained by the Supplier and do not require any response.

Section 6 is split into 5 Lots, which together form the Operational Requirements to which Suppliers are asked to respond. This section will require pricing using the cost tables contained in Section 7. Whilst the University would prefer a single supplier for all Lots, it will consider responses to any or all Lots. The responses will be evaluated and will form part of the contract. This section **must** be completed by the Supplier and returned to Cardiff University.

Section 6 requires specific commitments by the Supplier to functionality, power consumption and benchmarking results of the equipment that would be needed to satisfy the reference design. In Section 7, costings must be provided in the exact format requested. The ITT response must enable further implementations to be purchased under the same contractual agreement.

Suppliers are reminded that the University will only enter into contractual arrangements *for each lot* with one individual supplier or the lead supplier of a consortium (i.e. internal business relationships are the sole responsibility of the Supplier).

This document lays out Cardiff University's specific requirements in terms of hardware, software and implementation services in addition to providing details on the University's long-term strategic IT Vision of which this tender is a key component. In providing such information, Cardiff University wishes to emphasise that the successful Supplier will have demonstrated a willingness and capability to take a partnership approach to delivering a step change in the HEC environment available to staff, students and associates of the University.

Cardiff University expects to award the ARCCA HEC contract in the first instance for 3 years with subsequent annual extensions at the discretion of both parties. It is anticipated that the contract will be awarded in June 2007 and that work will start in September 2007. The University reserves the right to reject all offers or to accept any part, or all, of any ITT response at its sole discretion.

Suppliers are asked to include the following in their ITT response:

1. Completed responses to Section 6 and Section 7 using the document templates provided (5 paper colour copies and 2 electronic copies).
2. Executive Summary (10 bound paper copies and 2 electronic copies).

The above documents will be used to evaluate the Supplier's response. The operational requirements for the solution to be offered by the Supplier are laid out in Section 6. Section 6 contains all the requirements associated with the specified Lots and their implementation. This section will require pricing using the Cost Tables contained in Section 7.

When returning the response, Sections 1 – 5 should be retained as these sections are for information only and are intended to assist you in understanding the overall requirement. Where contradictions between Sections 1 - 5 and Sections 6 and 7 are found, Sections 6 and 7 will take precedence.

The Executive Summary should include, but not be limited to, the following points (in no particular order):

- The Supplier's understanding of the University's requirements.
- The Supplier's commitment to helping Cardiff University achieve its vision.
- Summary of costs
- Summary of implementation timescales
- Summary of how the Supplier will manage its aspects of the project.
- Innovative ideas for delivering early return on investment and achieving early buy-in by the initial user communities

The Executive Summary should be no longer than 3 sides of A4. It should be a free-standing, bound document of presentation quality written for an audience such as the Vice-Chancellor, Director of Information Services and other Senior Managers of the University.

Requirement Definitions

Each requirement has a notation indicating its importance to Cardiff University. Suppliers will be assessed against their capability to deliver against these requirements. The following terms and definitions are used in this document:

MR ***A Major Requirement***

These are considered to be very important requirements. When noting that a requirement is MR it is important to remember that if the overall solution does not meet this criterion then it may be deemed unacceptable. Suppliers should state how a requirement will be met, or show how it is not needed, considering the issues and the points raised. **A statement of the form 'this requirement will be met' will not be sufficient.**

It is strongly preferred that proposed solutions can be demonstrated to meet all the major requirements at the time of the ITT. Suppliers must provide satisfactory evidence of their ability to meet such commitments, and be prepared to enter into binding contractual arrangements.

HDR ***A Highly Desirable Requirement***

These requirements reflect functionality and capability that the University considers of importance. The ability of a Supplier to meet these needs within the available budget will form a substantial part of the evaluation of an ITT.

Where a proposal does not satisfy a particular desirable requirement, the Supplier must state on what basis it has decided not to meet that requirement.

IR ***An Information Requirement***

The nature of this procurement is such that it is vital that the Supplier provides full information on specific topics. These topics are identified as information requirements. Failure in an ITT response to provide full, relevant information in answer to information requirements may prevent the evaluation from being conducted properly, and hence lead to exclusion of the ITT response. Assessment of the quality of the ITT response will be based on the responses to these requirements, and will strongly influence the selection process.

PLEASE READ INSTRUCTIONS BEFORE ATTEMPTING TO WRITE RESPONSE

Instructions

- The Supplier must respond to all requirements in a Lot.
- All responses related to MR and HDR requirements must be associated with a brief explanation as to how the proposed solution meets that requirement and NOT a simple YES or NO answer.
- Responses should be placed in the box directly below the requirement to which it is responding.
- Answer text must be in blue. The blue text must be visible on both electronic and printed copies.
- A response to an individual requirement should not exceed 1 side of A4, except where it is otherwise stated.
- Where a response references other attached documentation, the University reserves the right to ignore it.
- All answers and any additional material appended should be succinct and relevant.
- The use of cross-referencing is unacceptable. If necessary the Supplier should repeat responses.
- The returned sections should remain in landscape.
- Questions and the successful Supplier's responses will form part of the Specification with which the Contractor will be required to comply.
- A bid which omits key information or fails to deal satisfactorily with any item or items may be considered non-compliant and may be rejected.

IMPORTANT: FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN YOUR BID BEING REJECTED!

5.5.Evaluation Criteria

- The evaluation criteria will be used to score the responses to Sections 6 and the Executive Summary. In evaluating tenders in accordance with the award criteria given in the Official Journal Notice 2005/S 183-180908, we shall pay particular attention to the following:
 1. Best Value for Money (60% Weighting)

This will take into account Total Cost of Ownership (TCO), including factors such as total power consumption, maintenance and service support quality, reliability, availability and serviceability, charges and management effort required. This will also include performance measurement (via benchmarking) and fitness for purpose, as measured by reference site evaluation and other supplier-provided information. Suppliers will be required to provide benchmarking and power consumption figures for the reference design. The successful supplier, as part of the negotiated contract, will be required to provide and commit to new benchmarking and power consumption figures for the agreed design, which will form part of acceptance tests.

2. Best Partnership Opportunities (25% Weighting)

The Supplier is expected to put forward a detailed range of options for joint working and exploitation of the new facilities, which should demonstrate the Supplier's technological innovation and commitment to the partnership with the University.

3. Best Flexibility for Unknown Future Needs (15% Weighting)

As evidenced by benchmarks, cluster management software, ease of upgrade and expansion and the range of supplier equipment options.

Evaluation Process

- An evaluation team will be formed by the University. This team will evaluate ITT responses and select one or more Suppliers with a view to reaching a contractual agreement subject to clarification of any outstanding matters.
- The evaluation team reserves the right to employ a multi-stage evaluation process with increasingly restricted shortlists drawn up at each stage.
- The evaluation team may offer Suppliers short-listed at any stage in the evaluation process the opportunity to attend the University in person to discuss their proposal. As part of the evaluation process, the University may contact or visit reference sites provided by the Supplier.
- After the short-listing stage, bid clarification talks will be held with one or more suppliers to finalise the details of the actual design to be delivered. At this point, the short-listed supplier(s) will be required to make specific commitments to performance, power consumption and operational behaviour for the finalised design. These will inform the evaluation process and subsequently become part of any negotiated contract, including acceptance tests.
- Further details on support contracts will be discussed during the evaluation process.
- After the final decision on the results of this Invitation to Tender has been taken, all Suppliers will be informed in writing whether or not they have been successful.
- The University does not undertake to accept the lowest priced ITT response or part of it.
- The acknowledgement of receipt of any submitted ITT response shall not constitute any actual or implied agreement between the University and the Supplier.
- The University reserves the right to accept any part, or all, of any ITT response at its sole discretion.
- The University reserves the right to reject all offers.
- Any contract that may be established between the selected Supplier and the University shall describe all agreed aspects of the arrangement based on:
 1. The Tender documentation;
 2. The Supplier's offer, including points of clarification from the subsequent evaluation;
 3. The Terms and Conditions included with this document, and any subsequent variations thereof by mutual written agreement

5.6.Delivery Requirements

The equipment will be expected to be delivered by the end of September 2007 and installed, commissioned and tested in October, November and December 2007, ready for commencement of service in January 2008.

The University will determine a genuine pre-estimate of the daily cost of any avoidable delay beyond agreed firm dates for equipment and/or system delivery, installation and/or commissioning where time is of the essence. This amount, that will not exceed £5,000 (Five Thousand Pounds) for every complete working day that the equipment or system is late or not functional, will be payable by the Contractor to the University as liquidated damages.

5.7.Support Contract Requirements

Your response to the points below should be addressed in Section 6.11.

- For each lot, the Supplier shall provide a single responsible person (Account Manager), with responsibility for delivering defined service levels, to deal with all contractual matters that either party may raise.
- Where necessary, to ensure speedy resolution of a particular issue and adherence to the support contract, this single point of contact should nominate a certified or otherwise suitably qualified third party support technical expert with whom the University can liaise directly. The Supplier's own single point of contact will however retain full responsibility for delivering the defined service levels.
- The Supplier's single point of contact must have the authority to authorise equipment replacement.
- The Supplier must provide on-site spares and/or a support contract for University staff to achieve immediate replacement to cope with whatever failure rate is being experienced under the contract.
- In the event of a failure rate causing more than 10% of a Lot's value to become unserviceable within any 12 month period, the supplier must either:
 - Expedite the repair work at its own cost as a matter of urgency, or
 - Where it is acknowledged that some of the repair work has to be carried out by the University, a pre-estimate will be agreed regarding the cost of work and parts involved and that agreed cost will be paid by the Supplier on receipt of an invoice from the University.
- The Supplier must provide a full description of the escalation routes in place to facilitate this Support Contract.
- The Supplier should state the level of support provided for up to 2 previous software releases.

5.8.Benchmarking Process

Suppliers will be required to benchmark their equipment as part of this tender process. Benchmarking will take place in three separate phases:

Phase 1 - Benchmarking for Tender Response

In this phase, suppliers should note that there are required benchmarks and optional benchmarks. Required benchmarks **must** be performed and include those specified in the Heriot-Watt tender documents as well as three Cardiff University-specific codes. Additional weight will be given to suppliers performing the optional benchmarks. Further details of these benchmarks can be found in Section 6.13.

All suppliers submitting a tender response must complete this Phase 1 benchmarking during February / March 2007.

Phase 2 - Post-shortlist Benchmarking

Following shortlisting of one or more suppliers, Cardiff University will require the shortlisted supplier(s) to perform a further set of benchmarks that are more specific to the University's requirements. The shortlisted supplier(s) will be given further information about these benchmarks during the bid clarification stage, but it is anticipated that they will include all Cardiff University-specific codes in Phase 1 above, plus an additional set of up to three applications used by major Cardiff University users.

It is envisaged that Phase 2 benchmarking will take place in May / June 2007. These benchmark results will form part of the contractual commitment by the successful supplier(s), which will be measured during Acceptance Testing.

Phase 3 - Acceptance Test Benchmarking

After contract award and delivery and installation of equipment, the benchmarks described in Phase 2 above will be performed again on the delivered equipment. This will ensure that the delivered equipment meets the contractual commitment given in phase 2 above and will form part of the overall Acceptance Tests.

It is anticipated that Phase 3 benchmarking will take place in October / November 2007.

5.9. Acceptance Tests

The successful supplier will be required to perform a series of acceptance tests. These will be split into two categories as follows:

1. Operational (basic correct operation, defined uptime with no failures, cluster re-configuration (to include provisioning and automated change of compute node operating systems), node re-imaging, resilience elements, mains power consumption of the overall solution, etc).
2. Performance (matches commitment of scale up or scale out from benchmarking of all applications, plus HPCC). The applications to be used during acceptance tests will include all CU-specific benchmarking applications as well as others, and will be agreed during the bid clarification and contract negotiation stages.

The detail of both categories of acceptance tests will be finalised during the contract negotiation phase. Without detriment to other contractual remedies, the University will incorporate provision for liquidated damages either for delayed, extended, or failed (by defined margin or ratio) acceptance tests. The calculated value of damages may be offset partly or wholly by agreed solutions such as:

1. Additional Staff resource funded by the Supplier and devoted to improving performance of delivered kit to an agreed level.
2. Enhancing cluster technology (software or hardware) to enhance performance.
3. Other pre-defined compensation which may be financial or of equivalent financial value as agreed between the parties as a condition of the contract.

5.10.Payment Information

Payment Schedule

The following payment schedule is proposed:

- 20% on delivery of ALL equipment (exceptions permissible by negotiation)
 - 20% on completion of installation and commissioning (all major elements agreed to be working by Cardiff University staff)
 - 40% on passing final acceptance tests (as defined in the OR and any subsequent negotiations)
 - 20% after completion of 2 months successful operation (as defined from successful acceptance test date)
- The University retains the right to negotiate a financial surety by way of a guarantee or bond from the Contractor, at the Contractor's expense, against any payment in advance of the satisfactory completion of final acceptance tests
 - The awarded contract will be valid for an initial period of 3 years with subsequent annual extensions subject to the written agreement of both parties.
 - The Supplier will be responsible for supply, delivery and acceptance of equipment on site, and subsequent installation, configuration, commissioning and the conduct of agreed acceptance tests with appropriate oversight by Cardiff staff.
 - Proving and defining acceptance tests will be carried out in conjunction with relevant Cardiff University staff.
 - Acceptance will be conditional on satisfactory completion of tests to ensure the solution meets the requirements and is in accordance with the contract.
 - The University reserves the right to retain an element of payment conditional upon successful acceptance of the total solution.
 - The University may consider a liquidated damages scheme linked to each successive stage of the acceptance testing.
 - In the event of an acceptance test consistently failing for which a satisfactory solution cannot be found within a reasonable defined period, the University, at its sole discretion, may cancel all or any part of the order, return all or any specific equipment and receive a full refund, without setoff, of monies paid to the Supplier up to that point.

5.11.Supplier Open Day

A Supplier Open Day will be held at Cardiff University on Thursday 15th February 2007. The purpose of this Open Day is to provide suppliers with an understanding of ARCCA's vision and this procurement and give suppliers an opportunity to clarify any points of uncertainty in the tender document. In doing so, the University wishes to facilitate suppliers in preparing highly targeted and appropriate responses to the ITT.

The event will begin at 1:30pm with an introduction to Cardiff University and ARCCA from the Director of Information Services. This will be followed by a presentation from senior Cardiff University researchers giving a description of some of the important research problems to be solved by the ARCCA facilities. Following a short refreshment break, the INSRV and ARCCA Chief Technology Officer will present a Lot by Lot introduction to the ARCCA HEC Tender and suppliers will be given the opportunity to ask questions about the tender in an Open Forum. The session will finish at 5:00pm.

Suppliers may send up to 3 individuals to the Open Day. The names of attendees must be registered by 12 noon on Tuesday 13th February 2007 via ARCCAtender@cardiff.ac.uk. An agenda and full details of the location will be issued prior to the Open Day. The University regrets that it cannot provide car parking for visitors so please allow plenty of time for arrival. Car parking vouchers can be purchased from INSRV Reception in 41 Park Place.

Questions for the Open Day should be sent in advance to ARCCAtender@cardiff.ac.uk. Questions will also be taken on the day. However, suppliers should be aware that responses to questions received on the day may not be as comprehensive as responses to questions received in advance. Note that Cardiff University retains the right to not respond to questions that it considers are inappropriate.

Questions after the Supplier Open Day

Following the Supplier Open Day, any further questions should be sent to ARCCAtender@cardiff.ac.uk. Issues which are points of tender clarification will be collated and communicated to all suppliers via email.

6. Requirements for the Offered Solution

PLEASE READ SECTION 5.4 'INSTRUCTIONS FOR RESPONSE TO REQUIREMENTS' BEFORE ATTEMPTING TO WRITE RESPONSE

General Conditions

1. The Contract must include provision for later (up to 3 yrs) enhancement at demonstrably competitive component cost without re-tendering [subject to any legislative compliance requirements on the University regarding competitive tendering]. Plus up to 2 annual extensions subject to the agreement of both parties.
2. The successful Supplier must deliver, install, commission, configure and prove (including running agreed acceptance tests) all hardware and software elements of the systems.
3. The successful Supplier is encouraged to offer partnership opportunities with real financial and other benefit for *both* parties. In responding to our requirements, please provide your suggestions concerning partnerships, architectures, tools, regimes, etc. appropriate for a research-led University like Cardiff. We are particularly interested in proposals that result in reduced workload for Administration / Operations personnel.
4. The successful Supplier must, subject to contract negotiation, commit to the ability to host the equipment at minimal cost for up to 3 months after scheduled delivery date (assuming Cardiff University is unable to host it at that time). The Supplier may offer up to 10% of facility during that time for use by other customers as compensation for hosting.
5. The system must include in the tender price all components needed to construct the complete system, including (but not limited to) all racking, cabling, keyboards, monitors, management hardware, switches, software and licences.
6. The equipment must be installed so as to be easily maintainable and potentially upgradeable. There must be no exposed cabling between cabinets – interconnecting cables must be gathered and appropriately labelled, using an acceptable cable marking system. All cabling must be in trays above the equipment.

7. The successful Supplier must provide a comprehensive documentation set for all major elements of the supplied solution, including 2 hard copies & 1 electronic copy. Updated versions must be made available on a regular basis.
8. The successful Supplier must provide access to user / vendor forums and / or bug tracking facilities.

6.1.Outline of Requirements

It is envisaged that the selected supplier(s) will be a large scale, experienced supplier of HPC clusters, and/or SMP systems and/or Storage systems, with the capability of providing long term support to the ARCCA facility. The Supplier will be willing to commit to specific delivery dates, and performance levels, with defined penalties for failure and will be able to offer opportunities for collaborative development of new services and facilities in the HPC arena.

This tender process will be used to select one or more partners to assist in the future development of ARCCA services. The Reference Design outlined in the tender is for the purposes of evaluating supplier responses only. It is expected that once a supplier has been provisionally selected, the bid clarification stage would refine the design further in the light of the tendered costs of the various elements, and the need to have both production and development environments.

The tender is currently split into 5 lots. The University may choose not to purchase Lots 4 and/or 5 under this tender, but Suppliers responses to these sections will be evaluated.

Lot 1. Cluster with Interconnect Fabrics, Management Nodes and Management Software.

Lot 2. Shared Memory Systems (8, 16 and 32-core SMP machines).

Lot 3. Storage Services for ARCCA facilities.

Lot 4. Specialist Hardware (FPGAs, accelerators, etc) with associated software.

Lot 5. Other software tools (compilers, applications, application profiling & system management tools, other software, etc)

Suppliers may bid on any or all lots.

6.2.Reference Design

The University has produced a reference design (Figure 1) in order to simplify the evaluation process. Suppliers are required to cost the reference design exactly 'as is' in the relevant spreadsheet sections. It is expected that, once a preferred supplier or suppliers has been selected, the bid clarification stage will lead to a final, derived design being developed and costed. Suppliers are also required to quote for specific variations on the reference design (e.g. more high speed interconnect) in the spreadsheets provided in Section 7.

Additionally, there are sections where suppliers can quote for different design possibilities that they think would be more appropriate for meeting Cardiff University's long term vision and goals. These options will be taken into account under the evaluation criteria relating to flexibility, and may be included in the final, derived design.

6.3.LOT 1 - Cluster with Interconnect Fabrics and Management Nodes

6.3.1.Requirements for Reference Design

Compute Nodes - A large, flexible Linux-based cluster of 512 Compute Nodes (each node to be dual CPU, dual core – CPUs should be chosen to deliver optimal price/performance), each to have dual 1 Gbps interconnect, 8GB RAM, >70GB SATA, SAS or SCSI boot disk. 50% of compute nodes to have an additional higher performance interconnect of very high speed and low latency. Suppliers must quote for an additional 4GB RAM per Compute node, RAID1 local disk config, additional nodes, and additional high speed low latency interconnects.

Cluster Management Nodes - 2 Management Nodes required, each with minimum 8GB RAM, >70GB resilient disk storage, dual 1Gbps Ethernet NICs. All local disk storage in the Management Nodes must be independent of single disk failure. The Management Nodes require high speed low latency interconnect to match Compute nodes with HS-LL interconnect. Appropriate UPS to be supplied to facilitate the powering down of all Management Nodes in a controlled fashion.

Login Nodes - 2 Login Nodes required to provide user access to the facilities, each with minimum 8GB RAM, >70GB resilient disk storage, dual 1Gbps Ethernet NICs . All local disk storage in the Login Nodes must be independent of single disk failure. Appropriate UPS to be supplied to facilitate the powering down of all Login Nodes in a controlled fashion.

Gbps Ethernet Interconnect Fabrics - Appropriate Ethernet switches to be supplied and integrated with the overall solution.

High Speed Low Latency Interconnect Fabric - Appropriate switches to be supplied and integrated with the overall solution.

Highly functional and easy to use cluster management and job scheduling software is required to facilitate efficient use of the cluster. All Nodes must provide an appropriate hardware management solution (e.g. IPMI). Supplier to consider offering a base cluster OS, with server virtualisation layer to facilitate different service OS distributions and libraries.

The Facility must have controlled power down and power up capability for compute nodes to manage gradual power loading/unloading.

Ref	Requirements	MR/ HDR/ IR
	For Compute, Management and Login Nodes:	
1.01	<ul style="list-style-type: none"> Dual Socket, Dual Core x86_64 Processor (EM64T or AMD 64) is required. Specify the chosen Processor manufacturer, model, and clock speed. 	MR
1.02	<ul style="list-style-type: none"> State which motherboard processor socket configurations (e.g. dual, quad, eight) the Supplier can commit to delivery of, during the period up to end 2008. 	MR
1.03	<ul style="list-style-type: none"> State which multi-core processors will be installable on the above range of motherboards. 	MR
1.04	<ul style="list-style-type: none"> Specify the Memory type e.g. FBDIMM or DDR2, and maximum RAM configuration for each node type. 	MR
1.05	<ul style="list-style-type: none"> Specify the size and rotational speed of the Hard Disk and its Interface e.g. SAS, SATA, SCSI. 	MR
1.06	<ul style="list-style-type: none"> Specify 1Gbps Ethernet Network Interface manufacturer, model, whether integrated or expansion card, and bus type (e.g. PCIe, PCI-X). 	MR

1.07	<ul style="list-style-type: none"> Specify 1Gbps Ethernet Network Switch manufacturers and models, topology, and interconnect methods. 	MR
1.08	<ul style="list-style-type: none"> Specify High Speed Low Latency Network Interface manufacturer, model, latency and bandwidth. 	MR
1.09	<ul style="list-style-type: none"> Specify High Speed Low Latency Network Internal Interface, whether integrated or expansion card, and bus type (e.g. PCIe, PCI-X). 	MR
1.10	<ul style="list-style-type: none"> Specify High Speed Low Latency Network external connection e.g. copper, fibre. 	MR
1.11	<ul style="list-style-type: none"> Specify High Speed Low Latency Network Switches manufacturers and models, topology, and interconnect methods. 	MR
1.12	<ul style="list-style-type: none"> Specify which distribution and version of Linux will be installed on all nodes. 	MR
1.13	<ul style="list-style-type: none"> Specify the method for Hardware Management for all nodes e.g. IPMI. 	MR

1.14	<ul style="list-style-type: none"> Specify the method for Power Management for all nodes to allow remote power up and power down. 	MR
1.15	<ul style="list-style-type: none"> Specify the method for controlling in a phased manner the powering up of all nodes (e.g. after a power cut). 	MR
	For all Management and Login Nodes:	
1.16.1	<ul style="list-style-type: none"> Specify RAID Controller manufacturer and model, RAID level, number of disks in array, disk manufacturer, interface (SAS etc) and rotational speed. 	MR
1.16.2	<ul style="list-style-type: none"> State what options are available for dual redundant PSUs. 	MR
	General	
1.17	<ul style="list-style-type: none"> Specify the number of racks required for 2048 Cores, making stated assumptions about the rack density which will achieve best value for money cooling. 	MR
1.18	<ul style="list-style-type: none"> Specify how all supplied software for compute nodes will be installed (and can be re-installed) by the Supplier and CU, including the time taken for one node, and all nodes. 	MR

1.19	<ul style="list-style-type: none"> All supplied software licences must be registered in the name of Cardiff University and not that of the Supplier. The GNU Compiler Collection (GCC) must be installed to produce executable code to run on the Cluster. This must include Fortran 77, 90, 95 & HPF, C/C++. The Supplier must list all supplied software here. 	MR
1.20	<ul style="list-style-type: none"> Management software must be provided to enable environmental interrogation of the cluster, for example CPU speed / temperature and fan speeds, and to enable shutdown procedures to be implemented and (optionally) automated should a node exceed a pre-defined limit. Alerts should be sent to defined recipients when such environmental limits are approached. The Supplier must specify here the capabilities of this software. 	MR
1.21	<ul style="list-style-type: none"> Failure of the power supply in a single node should not result in adverse effects to any other part of the Cluster. Specify how this will be achieved. 	HDR
1.22	<ul style="list-style-type: none"> Tools for profiling and debugging the execution of real applications on the cluster, including tools to aid in the identification of performance bottlenecks, must be provided. Suppliers should describe how these would be used to profile parallel and distributed memory codes running across several compute nodes. If these are third-party commercial products, the costs associated with licensing over 3, 4 and 5 years respectively, should be provided. 	MR
1.23	<ul style="list-style-type: none"> All software licences supplied should be appropriate for use in an environment where the research may be commercially funded. Specify all licences where this does not apply. 	HDR

1.24	<ul style="list-style-type: none"> Please describe what facilities exist within the equipment for logging errors and describe what action is taken to rectify equipment with unduly high rates of recovered errors. 	IR
1.25	<ul style="list-style-type: none"> A description including the make and model of the non-blocking switches proposed for the High-Speed Low latency Fabric and each of the Gigabit Interconnect Fabrics should be provided. This should detail the interfaces on each switch, their type, their latency and bandwidth performance and any other relevant technical information, such as stacking interconnects and performance of the same. 	IR
1.26	<ul style="list-style-type: none"> Please provide a description of the cabling (numbers and types) for all networks and interconnects and how they will be managed between compute nodes and Management nodes. 	IR
1.27	<ul style="list-style-type: none"> If the Cluster will be built off-site prior to delivery, please provide details of where it will be built and how it will be shipped to the University. 	IR
	For the Cluster Management System:	
1.28	<ul style="list-style-type: none"> A system for the re-integration of a failed node into the cluster, which may involve re-loading the Operating System and any configuration change, should be provided. The Supplier should provide details of how this would be achieved. 	HDR

1.29	<ul style="list-style-type: none"> Cluster Management and Performance Monitoring tools must be provided, which should be graphical, text and API accessible. The Supplier must describe this functionality. 	MR
1.30	<ul style="list-style-type: none"> The Supplier must state how all or groups of the compute or support nodes can be remotely powered on or off from within the Cluster Management System. 	MR
1.31	<ul style="list-style-type: none"> The University has a strong preference for nodes in which all management, down to BIOS console level, can be achieved from a support node, over the management network. The Supplier should state how this can be achieved. 	HDR
1.32	<ul style="list-style-type: none"> Specify how the system will authenticate users and specifically how the system would integrate with an existing LDAP directory. 	MR
1.33	<ul style="list-style-type: none"> Specify how the system will provision different OS images (for diagnostic and scientific purposes) on all or part of the Cluster and how that image will be delivered i.e. multicast, multi-boot, virtualisation, etc. 	MR
1.34	<ul style="list-style-type: none"> Specify how administrators will interact with the system, i.e. graphical user interface, command line interface, web and/or standards-based portlet interface, API. 	MR

1.35	<ul style="list-style-type: none"> Specify how administrators (and regular users) will monitor the system, i.e. graphical user interface, command line interface, web and/or standards-based portlet interface, API. 	MR
1.36	<ul style="list-style-type: none"> Specify how administrators will receive notifications of failures and how administrators can configure the circumstances under which those notifications are sent. 	MR
1.37	<ul style="list-style-type: none"> Specify how the system could be extended to manage existing Cardiff University Clusters. 	MR
	For the Job Scheduling System:	
1.38	<ul style="list-style-type: none"> A fully supported flexible job management, scheduling and submission system(s) must be provided and described here. The job management system should provide facilities for job output retrieval without requiring user login to batch nodes. Jobs should be able to be managed / prioritised according to configurable classes of their attributes. 	MR
1.39	<ul style="list-style-type: none"> The job manager should be able to constrain the resources (especially real time, memory and CPUs) used by wayward applications. The Supplier should describe how this is done. 	HDR
1.40	<ul style="list-style-type: none"> The job management system should provide accurate accounting data of the resources used by each job, including those resources used by all of the processors of MPI jobs. It should be able to both control and track usage by user, group or project attributes. The accounting data should be graphical, text and API accessible. Describe the relevant features here. 	HDR

1.41	<ul style="list-style-type: none"> The job management system should allow the definition of “interactive queues”, whereby duly authorised users can spawn interactive multi-processor tasks on several compute nodes that they cannot normally login to with SSH. The job manager must only allow such jobs to launch if the requested number of processors is free. Describe the relevant features here. 	HDR
1.42	<ul style="list-style-type: none"> Specify how the system will authenticate users and specifically how the system would integrate with an existing LDAP directory. 	MR
1.43	<ul style="list-style-type: none"> Specify how regular users (and administrators) will interact with the system, i.e. graphical user interface, command line interface, web and/or standards-based portlet interface, application programmer interface. 	MR
1.44	<ul style="list-style-type: none"> Specify how regular users can submit serial and parallel jobs to the system. 	MR
1.45	<ul style="list-style-type: none"> Specify how the Job Scheduling System and Cluster Management System will interoperate, paying particular attention to provision of different OS images. 	MR
1.46	<ul style="list-style-type: none"> Specify how the system will record job information and how that job information can be presented graphically. 	MR

1.47	<ul style="list-style-type: none"> Specify how the system will support advanced reservation jobs. 	MR
1.48	<ul style="list-style-type: none"> Specify how the system will support pre-staging of data files onto Compute nodes. 	MR
1.49	<ul style="list-style-type: none"> Specify how the system will support pre- and post-jobs, i.e. workflow dependencies. 	MR
1.50	<ul style="list-style-type: none"> Specify how the system will support job migration and rescheduling. 	MR
1.51	<ul style="list-style-type: none"> Specify how the system will support backfill jobs. 	MR
1.52	<ul style="list-style-type: none"> Specify how the system will interoperate with the Globus toolkit. 	MR
1.53	<ul style="list-style-type: none"> Specify how the system will support multiple queues. 	MR
1.54	<ul style="list-style-type: none"> Specify how the system could be extended to run jobs on existing Cardiff University Clusters. 	MR

	For both the Cluster Management and Job Scheduling Systems:	
1.55	<ul style="list-style-type: none"> Specify how security is achieved between users and jobs, such that no (non-administrative) user or job can alter or view details of another user or job. 	MR
1.56	<ul style="list-style-type: none"> Describe any innovative methods embedded in the software or hardware to minimise overall power consumption of the cluster. 	IR
	Specify how the Job Scheduling and Cluster Management Systems would cope with a single or multiple point failure whilst running the following jobs at the same time:	
1.57.1	<ul style="list-style-type: none"> A single parallel job that self-checkpoints running on 1024 cores on any Linux distribution for a period of 24 hours. 	MR
1.57.2	<ul style="list-style-type: none"> Multiple serial jobs running on 256 cores on a particular Linux distribution performing near-real-time data analysis. 	MR

6.3.2. Supplier Suggested Design

Suppliers are invited to propose and provide details (including all capital and recurrent costs) of alternative designs they think that Cardiff University should consider to achieve its vision and goals for HEC.

This section will be used by the evaluation team as a part of the assessment of the Supplier's ability to provide a workable solution that meets Cardiff University's goals.

Lot 1: Supplier Suggested Design

6.4.LOT 2 - Shared Memory Systems (8, 16 and 32-core SMP machines)

6.4.1.Reference Design

Cardiff University intends to purchase under this Lot a number of X86-compatible commodity 8-core, 16-core, and (fewer) 32-core SMP systems, with at least 2GB RAM per core. Consideration may be given to emulation of a single 128-core SMP system by appropriate methods (e.g. Cluster OpenMP). SMP machines in the reference design mount SAN storage via the Storage nodes. Options for high speed low latency interconnects should be costed in the relevant spreadsheet.

Cardiff University understands that X86-compatible commodity 32-core SMP systems may not be available for costing in the timeframe required at this stage of the tender. In this case, Suppliers should enter cost estimates in the spreadsheet, clearly indicating this, and also estimating when firmer costings will become available. However, during the bid clarification stage (April-June), one or more preferred suppliers may be required to provide fixed quotes for such systems.

Ref	Requirements	MR/ HDR/ IR
	For all Shared Memory Systems:	
2.01	<ul style="list-style-type: none"> Specify Processor manufacturer, model, and clock speed. 	MR

2.02	<ul style="list-style-type: none"> State which motherboard processor socket configurations (e.g. dual, quad, eight) the Supplier can commit to delivery of, during the period up to end 2008. 	MR
2.03	<ul style="list-style-type: none"> State which multi-core processors will be installable on the above range of motherboards. 	MR
2.04	<ul style="list-style-type: none"> Specify the Memory type e.g. FBDIMM or DDR2, and maximum RAM configuration for each node type. 	MR
2.05	<ul style="list-style-type: none"> Specify RAID Controller manufacturer and model, RAID level, number of disks in array, disk manufacturer, interface (SAS etc) and rotational speed. 	MR
2.06	<ul style="list-style-type: none"> Specify 1Gbps Ethernet Network Interface manufacturer, model, whether integrated or expansion card, and bus type (e.g. PCIe, PCI-X). 	MR
2.07	<ul style="list-style-type: none"> Specify which Operating System and version will be installed. 	MR
2.08	<ul style="list-style-type: none"> Specify the method for Hardware Management e.g. IPMI. 	MR

2.09	<ul style="list-style-type: none"> Specify the method for Power Management to allow remote power up and power down. 	MR
	General	
2.10	<ul style="list-style-type: none"> The Shared Memory Systems should have the ability to be integrated into the overall Cluster Management and Job Scheduling systems. Describe how this is to be achieved. 	MR

6.4.2. Supplier Suggested Design

Suppliers are invited to propose and provide details here of alternative designs (including non-X86 SMP systems), as for Lot 1 (Section 6.3.2).

Lot 2: Supplier Suggested Design

6.5.LOT 3 - Storage Services for ARCCA facilities

6.5.1.Reference Design

Storage systems - 50TB+ of usable, resilient, SAN-connected filestore (a mix of high and low speed disks), to be connected via 4Gbps FC to the 2 Storage Nodes. Options for prices of additional units of 10TB, to be called off over 3 years.

Storage Nodes - 2 Storage Nodes required, each with minimum 8GB RAM, >70GB resilient disk storage, dual-port 4Gbps FC cards (certified for compatibility with IBM SAN Switch Total Storage 256B), single 10Gbps NIC (TCP Offload Engine required). All local disk storage in the Storage Nodes must be independent of single disk failure. All of the Storage Nodes require additional high speed low latency interconnect to match the higher performance element of the Cluster. Appropriate UPS to be supplied to facilitate the powering down of all Storage Nodes in a controlled fashion.

Concurrent Cluster File System – the University may wish to purchase a Concurrent Cluster File System of at least 35TB.

Backup, Archival and HSM software - Software to control the backup, restore, archival, and optimal use of all four storage elements (high and low speed SAN storage, tape storage and Concurrent Cluster File System).

Cardiff University is currently implementing a large scale project called the Modern Working Environment (MWE), which is a full IBM portal technology stack, including Collaborative Tools, Enterprise Content Management, Application Integration, Data Integration and Business Process Management. The MWE is a disaster tolerant solution located over two sites, MWE Site 1 and MWE Site 2. The following information has been provided because suppliers may wish to consider integrating their design with the existing MWE technology.

Consideration will be given to the use and possible expansion of the existing IBM SAN Switch (Total Storage 256B) in MWE Site 2, and expansion of the MWE tape system. MWE Site 1 currently has two 4GB HS20 Tivoli Storage Manager (TSM) servers and a TS3310 library with 122 slots and 6 fibre LTO3 drives. The native capacity of the library is approximately 50TB. There are currently no TSM servers and no library in MWE Site 2. The University is licensed for Tivoli Storage Manager Extended Edition, including LAN licences, SAN licences, TSM for mail agents licences, TSM for databases licences, licences for TSM Production Centre (1-12TB), licences for TSM Production Centre (13-32TB), and licences for Tivoli Composite Application Manager for SOA.

Ref	Requirements	MR/ HDR/ IR
	For the Storage Nodes:	
3.01	<ul style="list-style-type: none"> Dual Socket, Dual Core x86_64 Processor (EM64T or AMD 64) is required. Specify the chosen Processor manufacturer, model, and clock speed. 	MR
3.02	<ul style="list-style-type: none"> Specify the Memory type e.g. FBDIMM or DDR2, and maximum RAM configuration for Storage nodes 	MR
3.03	<ul style="list-style-type: none"> Specify the size and rotational speed of the Hard Disk and its Interface e.g. SAS, SATA, SCSI. 	MR
3.04	<ul style="list-style-type: none"> Specify 10Gbps Ethernet Network Interface (with TOE) manufacturer, model, whether integrated or expansion card, and bus type (e.g. PCIe, PCI-X). 	MR
3.05	<ul style="list-style-type: none"> Specify the Dual Port 4Gbps Fibre Channel Network Interface manufacturer, model, whether integrated or expansion card, and bus type (e.g. PCIe, PCI-X). 	MR
3.06	<ul style="list-style-type: none"> Specify High Speed Low Latency Network Interface manufacturer, model, latency and bandwidth. 	MR

3.07	<ul style="list-style-type: none"> Specify High Speed Low Latency Network Internal Interface, whether integrated or expansion card, and bus type (e.g. PCIe, PCI-X). 	MR
3.08	<ul style="list-style-type: none"> Specify High Speed Low Latency Network external connection e.g. copper, fibre. 	MR
	For each Disk Enclosure:	
3.09	<ul style="list-style-type: none"> Specify RAID level. 	MR
3.10	<ul style="list-style-type: none"> Specify RAID Hard Disk quantity. 	MR
3.11	<ul style="list-style-type: none"> Specify RAID Hard Disk manufacturer and model. 	MR
3.12	<ul style="list-style-type: none"> Specify RAID Hard Disk Interface e.g. SAS, SATA, SCSI, FC. 	MR

3.13	<ul style="list-style-type: none"> Specify RAID Hard Disk rotational speed e.g. 7000rpm. 	MR
	For the Tape Storage (200TB):	
3.14	<ul style="list-style-type: none"> Specify Tape format e.g. LTO-3. 	MR
3.15	<ul style="list-style-type: none"> Specify Tape Library manufacturer and model. 	MR
3.16	<ul style="list-style-type: none"> Specify Tape Library quantity. 	MR
3.17	<ul style="list-style-type: none"> Specify Tape Drive manufacturer and model. 	MR
3.18	<ul style="list-style-type: none"> Specify number of Tape Drives per Library as supplied 	MR
3.19	<ul style="list-style-type: none"> Specify number of Tape Drives per Library maximum. 	MR

	For the Cluster Filesystem (35TB):	
3.20	<ul style="list-style-type: none"> Specify Filesystem format e.g. Lustre, GPFS, GFS. 	MR
3.21	<ul style="list-style-type: none"> Specify which Operating Systems and versions are supported by the filesystem. 	MR
3.22	<ul style="list-style-type: none"> State the sustained and peak throughput to the proposed Cluster Filesystem which the Supplier is prepared to commit to, and the conditions under which this will be achieved. 	MR
	For the Disk Storage (50TB):	
3.23	<ul style="list-style-type: none"> Specify RAID Enclosure manufacturer and model. 	MR
3.24	<ul style="list-style-type: none"> Specify RAID Enclosure quantity. 	MR

	For each Disk Enclosure:	
3.25	<ul style="list-style-type: none"> Specify RAID level. 	MR
3.26	<ul style="list-style-type: none"> Specify RAID Hard Disk quantity. 	MR
3.27	<ul style="list-style-type: none"> Specify RAID Hard Disk manufacturer and model. 	MR
3.28	<ul style="list-style-type: none"> Specify RAID Hard Disk Interface e.g. SAS, SATA, SCSI, FC. 	MR
3.29	<ul style="list-style-type: none"> Specify RAID Hard Disk rotational speed e.g. 7000rpm. 	MR
	General	
3.30	<ul style="list-style-type: none"> Licensing for the storage delivered must be for 3, 4 and 5 years from acceptance. Licences should not be “academic use only”. Describe the licence conditions here. 	HDR

3.31	<ul style="list-style-type: none"> A file system that provides resiliency and scalability in this usable, resilient, SAN-connected cluster environment should be provided. Describe the features of this system here. 	HDR
3.32	<ul style="list-style-type: none"> Describe how quota control of filestore usage will be implemented at various levels, for example by groups of related users or individual users. 	HDR
3.33	<ul style="list-style-type: none"> The Supplier should provide suitable storage management tools, preferably graphical, which may or may not be integrated with other cluster management tools supplied. Describe these tools here. Proactive warning of problems, for example by sending email to support staff, is highly desirable. 	HDR
3.34	<ul style="list-style-type: none"> Specify the method for Hardware Management e.g. IPMI. 	MR
3.35	<ul style="list-style-type: none"> Please provide here the ongoing licensing costs after the expiry of the licences purchased under the initial contract. These should include the licensing model, for example if licensing depends on the installed storage or other elements of the system. 	IR
3.36	<ul style="list-style-type: none"> Specify the hard disk MTBF hours and the manufacturers' duty cycle to which it applies, along with the MTBF for a 100% duty cycle. Using this, the annual rate of disk replacement for a 50TB file-store based on these disks must be computed and stated. 	IR

3.37	<ul style="list-style-type: none"> Please provide a description of the RAID units to be supplied for shared cluster storage and their properties. 	IR
3.38	<ul style="list-style-type: none"> Suppliers must state here the % availability of the disk storage subsystem to which they are prepared to commit for contractual purposes. 	MR
3.39	<ul style="list-style-type: none"> State any configuration options, for example different RAID levels, and any associated trade-off between higher levels of redundancy and reduction in useable space. 	IR
3.40	<ul style="list-style-type: none"> State the Mean Time To Failure (MTTF) of each RAID unit in the proposed configuration. 	IR
3.41	<ul style="list-style-type: none"> State the expected lifetime of the Storage system. The Supplier must state here that they will commit to supporting the system for at least 5 years after acceptance. 	MR
3.42	<ul style="list-style-type: none"> State the time for a system rebuild from a single disk failure and an array failure. Array failure may include failure of multiple disks in a RAID set or the failure of a RAID controller. 	IR
3.43	<ul style="list-style-type: none"> State the size and type of local disk in each type of node. 	IR

3.44	<ul style="list-style-type: none"> State the internal MTBF for a 100% duty cycle of local node disk. Using this, the annual rate of disk replacement for 256 nodes must be computed and stated. 	IR
3.45	<ul style="list-style-type: none"> State the software to be supplied (installed, configured, etc) to control backup, restore, archival, and HSM in an appropriate manner. 	MR

6.5.2. Supplier Suggested Design

Suppliers are invited to propose and provide details of alternative designs, as for Lot 1 (Section 6.3.2).

Lot 3: Supplier Suggested Design

6.6.LOT 4 – Specialist Hardware

Cardiff University is interested in researching the development and use of innovative application acceleration technologies and techniques. The University seeks to harness FPGAs and programmable ASICs to undertake a variety of data reduction, enterprise services and High Performance Computing tasks. These application accelerators should ideally co-exist with more traditional HPC and HEC past, present and

future investments, but provide a novel approach to the acceleration of some applications whilst avoiding some of the drawbacks associated with the total cost of ownership.

The aim is to address some of the computational needs of Cardiff University by seeking to establish aggressive application acceleration for a variety of end users using novel FPGA, Programmable ASIC and GPU implementations associated with High Performance Embedded / Tightly Coupled, Enterprise and High Performance Computing.

The University seeks to complement the more traditional approaches to HPC, as typified by Lots 1 and 2, by investigating a novel approach to HPC/HEC and utilising FPGAs, which can be reconfigured to accelerate certain applications. Quoted application speed-ups can range from x10 to x1000 making this a very effective strategy for certain applications. As well as utilising FPGAs, the University also wishes to investigate other programmable ASICs, such as the SIMD computing cells from ClearSpeed, and the increasingly powerful and flexible GPUs.

The effort associated with the porting of applications to run on these novel systems is likely to be of the same order of magnitude as porting applications to scale to many thousands of general purpose processors. The University wishes to procure associated development and profiling software and software tools to assist with this porting and application profiling to further improve the efficiency of this process. Finally the power consumption of the proposed systems will not be significantly more than the present school run multiprocessor systems.

Embedded, Enterprise and High Performance Applications

There are a number of end users in Cardiff University who could benefit from local HEC provision. Equally there are a large number of users who at present do not appear interested in pursuing traditional HEC routes. The University seeks to identify and assist end users in the three broad categories of:

- 1) Embedded / Tightly Coupled – placing FPGAs and programmable ASICs close to data sources to perform data processing and reduction operations at high throughputs. Potential applications include the processing of MEG signals arising from the CUBRIC brain recordings, the processing and fitting of 3D Photogrammetry data from the Human Performance Laboratory or gravitational wave data from detectors.
- 2) Enterprise – performing specialist services such as encryption and biometrics encoding across the entire campus for a variety of end users.
- 3) High Performance – some suppliers have recently introduced FPGA acceleration solutions into their product line. These products embed the FPGAs into the fabric of existing multiprocessor systems with high memory bandwidth interconnects. The University

seeks to augment Lot 1 and Lot 2 or provide a standalone solution to utilise these new systems as well as investigating more novel HPC solutions involving GPUs and SIMD arrays. Applications include surgical simulation and soft tissue modelling, image processing, bioinformatics and Monte Carlo / stochastic simulations.

Suppliers should itemise below (including capital and recurrent costs) any such software, hardware and services using innovative application acceleration technologies and techniques that will help Cardiff University achieve its HEC vision and goals. Other costs associated with the hosting and powering of the above systems should be made explicit.

Lot 4: Specialist Hardware

6.7.LOT 5 – Other Software Tools

Cardiff University recognises that achieving maximum value of Lots 1, 2 & 3 may require investment in other software tools not specified, including advanced compilers, libraries, optimisers, profiling tools, system management tools, parallel debuggers, etc.

Suppliers should itemise and detail here (including capital and recurrent costs) any such software tools that will help Cardiff University achieve its HEC vision and goals.

Lot 5: Other Software Tools

6.8. Knowledge Transfer

Suppliers should answer this section providing a comprehensive Knowledge Transfer package for all of the Lots on which they are bidding.

Ref	Requirements	MR/ HDR/ IR
K.01	<ul style="list-style-type: none"> To enable the University to get the best return for its investment, suppliers MUST in this section provide details of a comprehensive programme of Knowledge Transfer for each of the Lots that they bid on. This programme must deliver the appropriate business change to realise the full potential of the HEC facilities. Awareness and technical knowledge transfer could take many forms but needs to be of a quality suitable to allow Cardiff University staff to manage, monitor and maintain the Cluster. Costs should be detailed for each Lot in the separate spreadsheets. Suppliers should state whether this training can be delivered on-site, and using the delivered equipment. 	MR
K.02	<ul style="list-style-type: none"> Suppliers must also recommend additional knowledge transfer to Application Support Specialists to facilitate improved research outcomes for the University. 	MR

6.9. Project Management

Suppliers should answer this section for all of the Lots on which they are bidding.

Ref	Requirements	MR/ HDR/ IR
M.01	<ul style="list-style-type: none"> Suppliers must provide a sample Project Plan (of a recent similar contract) with their tender response here. 	MR
M.02	<ul style="list-style-type: none"> The successful Supplier will, within 2 weeks of signing a contract, be required to develop, agree and sign off with the University a Project Plan to cover all phases of the project. This must include delivery, installation, commissioning and acceptance tests. 	MR

6.10.Delivery Requirements

Suppliers should answer this for all of the Lots on which they are bidding.

Ref	Requirements	MR/ HDR/ IR
D.01	<ul style="list-style-type: none"> The supplier must describe here how they will satisfy the conditions laid out in section 5.6. 	MR

6.11.Support Contract Requirements

Suppliers should answer this section providing a comprehensive package for all of the Lots to which they are responding. This must include itemised support and maintenance costs (including upgrade protection, where relevant) for all major hardware and software components of the offered solution, for 3, 4 & 5 yrs from acceptance.

Ref	Requirements	MR/ HDR/ IR
S.01	<ul style="list-style-type: none"> The supplier must describe here how they will satisfy the conditions laid out in section 5.7. 	MR

6.12.Partnership Opportunities

Suppliers must provide an outline, of no more than 4 sides of A4, of the partnership opportunities they propose. Examples could include, but should not be limited to, potential areas of collaboration, research sponsorships, 2-way secondments, commercial networking opportunities and clear views of technology roadmaps.

Outline of Proposed Partnership Opportunities

6.13. Benchmarking, Power Consumption & Cooling

Suppliers should note that there are required benchmarks and optional benchmarks. Suppliers must perform **all** required benchmarks. Additional weight will be given to suppliers successfully performing the optional benchmarks. Suppliers are reminded that all benchmark results for the CU-specific codes must remain confidential between the Supplier and Cardiff University.

Ref	Requirements	MR/ HDR/ IR
B.01	<ul style="list-style-type: none"> System and individual compute node power consumption figures must be supplied in the spreadsheet provided in Section 7. The figures must be measured with the compute node running the CU-specific required (and optional, if performed) benchmarks. Figures for the average and peak power consumption during each benchmark run must be supplied. Please describe here the equipment used to measure power consumption. 	MR
B.02	<ul style="list-style-type: none"> Please provide peak and maximum realistic performance in TFlops of all computational units and the system as a whole. Details of the benchmark, computational unit size and configuration used to estimate this should be given. 	IR
B.03	<ul style="list-style-type: none"> Given the information provided in this tender document and your knowledge of Cardiff University's environment, the supplier should describe here the most appropriate cooling technology to achieve lowest TCO over 5 years, assuming constant electricity pricing. 	IR
B.04	<ul style="list-style-type: none"> Suppliers must state here their willingness to commit to actual power consumption figures for the finalised design to be agreed during the bid clarification stage. This will form part of the contractual obligations. 	MR

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Cardiff University understands that X86-compatible commodity 32-core SMP systems may not be available for benchmarking in the timeframe required at this stage of the tender. However, during the bid clarification stage (April – June 2007), one or more preferred suppliers may be required to perform the MOLPRO benchmarks (below) on a commodity 32-core SMP system.

Required

General benchmarks as specified in the Heriot-Watt Tender Documents and co-ordinated by Daresbury Laboratory, in addition to:

- Suppliers to perform CU-supplied TERRA benchmarking as defined by Cardiff University on 128 core cluster configuration with HS-LL interconnect.
- Supplier to perform CU-supplied MOLPRO benchmarking as defined by CU on 16 and 32 core cluster (with HS-LL interface) and 8 and 16-core SMP configurations.
- Supplier to perform CU-supplied Star Formation benchmarking as defined by CU on 8 and 16-core SMP configurations.

These benchmarks will be assessed in objective (CU-specific codes) methods, and subjective (i.e. assessment of flexibility as indicated by HPCC) methods.

Optional

- Suppliers to perform CU-supplied Gravitational Waves benchmarking as defined by Cardiff University on 128 core cluster configuration and Gbps interconnect.
- TERRA on 256 cores, HS-LL interconnect.
- TERRA on 128 and/or 256 cores, Gbps interconnect.

Contact Details for Benchmarking

Downloading benchmarking code: Suppliers must register to download codes at www.arcca.cf.ac.uk.

Subsequent queries about benchmarking should be addressed to ARCCAtender@cardiff.ac.uk.

6.14.Acceptance Tests

Ref	Requirements	MR/ HDR/ IR
A.01	<ul style="list-style-type: none"> Suppliers must indicate here their agreement with the acceptance test principles and conditions outlined in Section 5.8. 	MR
A.02	<ul style="list-style-type: none"> Suppliers should indicate here any other acceptance tests which they recommend should form part of the contract. 	IR

6.15.WEEE (Waste Electrical and Electronic Equipment) Directive

Ref	Requirements	MR/ HDR/ IR
W.01	<ul style="list-style-type: none"> Suppliers should specify what procedures they have in place for the collection, handling, treatment and re-use of WEEE. Responses should detail whether they have registered with the National Clearing House or with a compliance scheme. 	IR

W.02	<ul style="list-style-type: none"> Suppliers should state what information they propose to provide with regard to their products to assist with the reuse, recycling and recovery of types of new equipment in accordance with the Supplier's obligations under WEEE and how will this information be provided. 	IR
W.03	<ul style="list-style-type: none"> If Suppliers are not a member of a compliance scheme, they should specify how they select their authorised treatment facility. 	IR
W.04	<ul style="list-style-type: none"> Suppliers should detail their approach to product design to facilitate reuse, recycling and recovery of WEEE, its components and materials, and provide relevant examples. 	IR

6.16. Health & Safety Considerations

Suppliers are reminded of their obligation under the Health & Safety at Work Act 1974 and subsequent legislation. Particular attention is drawn to the requirements of the Act relating to equipment design and manufacture and to the installation, operation and maintenance of equipment.

Ref	Requirements	MR/ HDR/ IR
H.01	<ul style="list-style-type: none"> Suppliers must report here any particular requirements or special instructions relating to the proposed equipment and its consumable supplies necessary to ensure that they will be safe and without risks to health. 	MR

H.02	<ul style="list-style-type: none"> All new equipment to be delivered to the University must be tested for electrical safety in accordance with University regulations. Suppliers must confirm that standard electrical safety tests will not damage the equipment nor breach the conditions of the warranty or service agreements. Further details of the University's electrical safety testing requirements will be provided upon request. 	MR
H.03	<ul style="list-style-type: none"> Suppliers must state here that the equipment will comply with the European EMC Directive and will be marked with the CE Mark. 	MR

6.17. Customer References

Suppliers must provide details of three other clients with major contracts of a similar scope and value from which we may obtain a reference. These sites should be operational with preferably your most recent software release. References should demonstrate experience of implementing similar solutions preferably in other UK research-led universities. The University may contact or visit reference sites during the course of the procurement.

Ref	Reference Details
R.01	REFERENCE 1
	<ul style="list-style-type: none"> Name of Organisation:
	<ul style="list-style-type: none"> Address:

	<ul style="list-style-type: none"> Contact Name / Title:
	<ul style="list-style-type: none"> Contact Telephone Number:
	<ul style="list-style-type: none"> Contact email Address:
	<ul style="list-style-type: none"> Total Value of Contract and Duration:
	<ul style="list-style-type: none"> Project Description:
	<ul style="list-style-type: none"> Overview of Products / Services Provided:
R.02	REFERENCE 2
	<ul style="list-style-type: none"> Name of Organisation:

	<ul style="list-style-type: none"> • Address:
	<ul style="list-style-type: none"> • Contact Name / Title:
	<ul style="list-style-type: none"> • Contact Telephone Number:
	<ul style="list-style-type: none"> • Contact email Address:
	<ul style="list-style-type: none"> • Total Value of Contract and Duration:
	<ul style="list-style-type: none"> • Project Description:
	<ul style="list-style-type: none"> • Overview of Products / Services Provided:
R.03	REFERENCE 3
	<ul style="list-style-type: none"> • Name of Organisation:

	<ul style="list-style-type: none"> • Address:
	<ul style="list-style-type: none"> • Contact Name / Title:
	<ul style="list-style-type: none"> • Contact Telephone Number:
	<ul style="list-style-type: none"> • Contact email Address:
	<ul style="list-style-type: none"> • Total Value of Contract and Duration:
	<ul style="list-style-type: none"> • Project Description:
	<ul style="list-style-type: none"> • Overview of Products / Services Provided:

7. Cost Tables

The templates for the Cost Tables can be found in the accompanying Excel file “ARCCA Tender response spreadsheet.xls”

Where the spreadsheet states “Including Delivery, Installation, Proving and Acceptance”, the Supplier must interpret this to include **all** associated costs necessary, including Project Management costs, to achieve a fully-operational system, with all work being carried out by the Supplier. You may assume that Cardiff University will have relevant staff on hand to assist where necessary. The agreed Project Plan, referred to in section 6.9, must detail the effort required from Cardiff University staff at each phase of the project.