## 1 Context

1.1 The University of Edinburgh is a world-class research University, and one of its core strategic goals is "Excellence in research". The University aims to sustain and develop its position as a research and teaching institution of the highest international quality and to benchmark its performance against world-class standards.

1.2 Information Technology is used by most researchers as an integral part of their research. They are varyingly dependent upon desktop computers; small dedicated computers in combination with specific instruments; small, medium or large-scale data storage devices; high performance compute power; software of varying degrees of complexity and sophistication, and high bandwidth networks.

1.3 Simulation and other numerical methods now rank alongside theory and experimentation as a third strand of knowledge discovery, not only in the Colleges of Science and Engineering and Medicine and Veterinary Medicine, but increasingly also in the Humanities and Social Sciences. Individuals and teams model complex systems and acquire, store, manage and analyse data in a global environment.

1.4 In Science and Engineering, large scale computation and data management has become the norm. Examples include very large scale simulations, computational fluid dynamics, climate modelling, modelling of disasters such as fires or earthquakes, and management, analysis and manipulation of the vast quantities of data generated by international experiments. Access is needed to large computing and storage facilities, together with high speed networks with global connectivity.

1.5 In Medicine and Biology, much research depends on database technology and re-analysis of clinical and epidemiological data. This is fuelled by worldwide projects on the sequencing of more and more organisms, high-throughput experimental approaches and integration efforts. This has generated the need to collect, manage and analyse very large heterogeneous data sets from diverse sources spread throughout the world. Humanities and Social Sciences make substantial use of databases for example in English Literature and Law.

1.6 In the Humanities and Social Sciences shared access to data is starting to have dramatic effect in some aspects of research and collaboration by historians, philosophers, lawyers, musicians, and other disciplines. Numerical computation is very important to a few, for example economists, and manipulation of complex media such as 3-D models, video and audio is essential to others, for example architects and musicians.

1.7 Provision of software is found to be a limiting factor by both researchers and teachers. Some software is available free of charge, some is available only via research grants and is currently beyond the reach of doctoral students. Responsiveness and flexibility are needed to unpredictable research needs.

1.8 In the Humanities staff find it difficult to use their research in a teaching environment. They wish to teach innovative methods to their students, but find the standard undergraduate teaching environment a barrier to this.

1.9 Despite the differences in research computing noted above between Colleges and subjects, almost all members of staff and researchers store relatively small amounts of digital data which nevertheless are of critical importance to their work, for example research reports, papers, notes, book chapters, theses during production. For many, their entire research data collection may be contained within a few gigabytes.

1.10 Individual members of staff implement a range of different solutions to storage and computation needs. Funding for individuals and for central services alike can be a limiting factor to developing optimal solutions.

1.11 International collaborative research is common within the University of Edinburgh, spanning the range from large, long-term, funded projects to informal, short-term groupings with like-minded colleagues. Digital communications, data-sharing, and use of common workspaces are typical activities, with more specialised research also using remote access to instrumentation.

1.12 All staff and research students in all three Colleges need data services at some level to underpin and secure their research. Data services should include regular effective backup at a secure location with

effective recovery, and curation and preservation of data in such a way as to ensure availability for re-use by the creators or others. At present although there are some examples of good practice, there is a general insufficiency of both facilities and support, centrally and locally, resulting in varied practices across the University. Development of appropriately scaled data services and training in their use are therefore essential if the University wishes to maintain a high quality research environment.

1.13 The Report from the recent IT & Computing Review ('Kenway Report') also contained a comment about research computing support, stating:

*"Research Computing is inefficiently and insufficiently supported. The University is not fully exploiting its strengths in this area, which sit largely outside IS, e.g., in EPCC, the School of Informatics and NeSC. There is duplication and inefficient utilization of expensive resources (e.g., the recent acquisition of two Storage Area Networks), due to a lack of joined-up thinking and opportunism in exploiting time-limited sources of funds, which militate against good preparation and decision-making. Equipment has been procured without factoring in the full operating and support costs, or agreeing how these costs are going to be met over the equipment's lifetime. The devolved financial structure, and the difficulty in identifying all the stakeholders at the outset, impedes up-front agreement on sharing costs. Major research and other academic computing infrastructure projects are not owned centrally in the way that Estates & Buildings (E&B) owns building projects, which was noted as an example of good project management practice. "*

The Panel suggested a recommendation to ensure better management of this area:

***"Recommendation:** The CIO should take ownership from the outset of major research and other academic computing projects (similarly to E&B's ownership of building projects), adopting best practice project methodologies and involving all relevant stakeholders from an early stage. IS should provide support for planning, procurement, implementation, operational management and, where appropriate, transition into an in-house or well managed external service. Specialist procurement expertise will normally be essential to ensure a balance between strategic and opportunistic IT procurement strategies, and to ensure contractual issues are fully covered. All major projects should have a post-event review to evaluate benefits and lessons learnt. "*

## 2 Vision

2.1 The University of Edinburgh will offer an excellent research computing infrastructure that contains world-class facilities and services, including

- a high bandwidth network
- access to high performance computing
- data storage and services
- advanced and standard software
- support for all researchers to make the most of these services

The infrastructure will be robust and resilient and will keep pace with changing needs and technologies. Business continuity will be assured.

## 3 Strategy

3.1 Researchers will have access to world-class data services which will include storage, backup, sharing and access facilities to enable re-use, curation, and archive of data that they obtain through experimentation, observation and simulation or that is purchased or procured for use in research. It will be possible share data with groups both within and beyond the University.

3.2 Researchers will have access to world-class computational facilities which provide for agility and ease of access with capacity and capability. This may include advanced and standard software.

3.3 Researchers will have the skills and knowledge to make best use of the computational facilities available to them. Training will be available in order to ensure this is the case.

3.4 Research services will conform to the University IT security strategy which is currently being developed.

3.5 Flexible and timely support will be available for all researchers to help them to make the most of these services.

3.6 The needs of individual researchers will be addressed, taking account of the different needs of large well endowed research groups compared with those of the lone scholar.

3.7 There will be partnership at all levels. Research facilities and support will be part of a robust core infrastructure, and where possible will be shared rather than owned by individual research groups. Common solutions for provision of data and computational services will be agreed between all stakeholders, so that research groups, Schools, Colleges, and Support Groups can work together.

3.8 Advanced facilities require sophisticated procurement processes, and support will be provided for this activity in order to achieve best value for money and to comply with legislation. Best value for money will be achieved by selecting and acquiring facilities at the correct level in the University.

3.9 The need will be investigated to use research techniques as part of the teaching environment.

3.10 Flexible, composable services, which respect subsidiarity, will be available in recognition that ‘one size does not fit all’. The smallest number of solutions will be identified that will satisfy the community.

3.11 This strategy will be aligned to the annual plans of Colleges and Support Groups and will act as a guide when unpredicted opportunities or challenges arise.

3.12 Research facilities will be available to collaborators from different institutions and to independent visiting scholars and will support mobile researchers.

## 4 Strategic objectives

4.1 Research computing will be overseen by a high level strategic committee (IT Committee reporting to the Knowledge Strategy Committee) which will be responsible for the formulation, regular review and revision of the strategy. The committee will ensure that organisational barriers to implementation of the strategy are removed or reduced.

4.2 In addition there will be an oversight committee whose membership will include researchers who will set directions and ensure that research computing services deliver against need and are fit for purpose.

4.3 This strategy will be discussed at a senior level with Colleges and Support groups, and amended if necessary in order to align with their annual plans.

4.4 Data storage needs will be identified in terms of volume and types of data. Appropriate data curation systems and data storage infrastructure will be developed to satisfy these needs. Partnerships with external organisations will be recognised and facilitated.

4.5 Software requirements of research groups will be investigated and the possibility will be investigated of providing central licences, or facilitating licence sharing or licence exchange.

4.6 Good practice will be collected in different areas of research computing. There will be active promotion of sharing of ideas and information between researchers in different disciplines including use of online community technologies.

4.7 Support and consultancy will be provided to research groups in computational techniques and in data curation.

4.8 Single points of failure will be identified in the network infrastructure and where appropriate duplicate provision will be made.

4.9 Service level definitions will be available for all research services so that users will be able to have confidence in the services offered, and will understand the service ‘boundaries’.

4.10 Good practice will be publicized of procurement of research computing facilities in order to raise awareness across the University.

4.11 Green computing issues will be investigated and solutions trialled. The feasibility will be explored of exploiting compute cycles from the large number of machines around the university that are often left idle for long periods, with the aim of offering complementary services and potentially reducing power costs, for example by providing Condor pooling.

4.12 There will be charges for services where this is appropriate, and where charges will not deter innovation or good practice.

4.13 A sustainable model for funding will be made available in proportion to the volume of uptake expected for particular research computing services, encompassing compute as well as storage provision. Funding should be provided from an appropriate combination of IS core budgets, College research sustainability funds, and direct charges to research grants.

4.14 Support will be provided for IT professionals who work in research computing, including promotion of suitable career paths.