Meeting Australia's Research Workforce Needs

Submission from the
Australian eResearch Infrastructure Council
(AeRIC)

August 2010

<u>Table of Contents</u>

1. What is eResearch?

Just as in other facets of life, information and communication technologies (ICT) are radically transforming the way research communities across the world are operating.

Distributed high-performance computing, digital data resources and high-speed communications are just some of the developments improving the capacity of researchers to interact with their colleagues and share data worldwide in ways previously un-heard of.

Much of the research carried out around the globe is now conducted with the assistance of Information and Communications Technology (ICT) tools and services. Entirely new fields of research are emerging and researchers can now collect, move and manipulate large amounts of data, enabling new and much more complex problems to be addressed. It is important to equip Australian researchers, and institutions, for this new world of ICT enabled research, or 'eResearch'.

The term 'eResearch' encapsulates research activities that use a spectrum of advanced ICT capabilities and embraces new research methodologies emerging from increasing access to:

- broadband communications networks, research instruments and facilities, sensor networks, data repositories with their associated data standards and management tools, and high performance computing resources;

- software and infrastructure services that enable a trust and sharing relationship to be established between researchers and the wide variety of data repositories, computers, systems and networks on which they depend;

- ever greater computing power and ever larger scales of data that result in new research into phenomena previously un-researchable; and

- application and discipline-specific tools such as graphics intensive visualisation, simulation software, and interaction tools that provide the human interface allowing researchers to interact with each other and with their instruments, computational facilities and data resources.

These ICT enabled eResearch capabilities advance and augment, rather than replace traditional research methodologies. They also make some research possible that otherwise would not be possible.

These eResearch capabilities are enabling researchers in fields as diverse as medicine, genetics, chemistry, education, linguistics and finance to achieve world-class research outcomes and to disseminate knowledge gained from research through the use of advanced ICT.

The factors leading to an increasing ubiquity of ICT in every day life translate into the research sector as a growing dependence on eResearch capabilities to:

- discover knowledge, whether held in digital or physical forms;

- access data as well as the software services that are being made available to manipulate or analyse this data;

- synthesise, curate and disseminate new knowledge efficiently; and

- facilitate interactivity and research collaboration, allowing researchers to work seamlessly from desk-to-desk within and between organisations.

The amount and range of benefits from greater use of eResearch methodologies will vary between researchers and disciplines, according to their needs, awareness and skills, and the availability of the necessary support, expertise and physical resources. The main factors that enable researchers to increase their use of ICT are:

- their awareness of the full potential of ICT to enhance their research;

- the availability of an interconnected fabric of underlying shared service resources that facilitate access to diverse data sets, collaboration and interoperability, regardless of the discipline of the researcher, or computer platform being used;

- the ease of access to, and expert support of, ICT resources; and

- the skills and abilities of the researchers themselves, to make full use of the ICT services and facilities at their disposal.

eResearch has the potential to increase the efficiency and effectiveness of research endeavours across all disciplines. Greater interactivity between researchers and an increased ability to access research outputs will benefit industry, governments and the Australian community as a whole.

2. eResearch is an essential element of the national innovation system

A strong innovation system demands a high-quality research sector, equipped to adapt to complex challenges. In addition, today's big science and social questions are becoming increasingly global in focus and urgent in nature. To contribute, researchers need an environment that encourages and enables creativity in their work, in the way they work, and in the way their work takes effect.

There is no doubt that eResearch can be seen to be central to all stages of the innovation cycle, as it provides the necessary tools for advanced and collaborative problem solving, as well as platforms for the deployment of these findings and mechanisms for the rapid diffusion of ideas.

eResearch platforms encourage collaboration between researchers by providing the infrastructure to enable the pooling of research resources, including intellectual and

physical resources, to tackle large and complex problems. Bringing researchers closer together, across institutional and geographical boundaries, increases the collective accessible intellectual capital and hence creates a greater potential for breakthroughs in the pursuit of common research goals.

A failure to stimulate and coordinate the development and use of eResearch capabilities in Australia will result in:

- a less than optimal return on the Government's substantial investments in research infrastructure;

- Australian researchers and Australian research becoming less internationally competitive and relevant;

- the inability of Australian researchers to participate in those emerging fields of research that are only enabled by eResearch;

- the failure of industry to realise the benefits of improved collaboration with researchers and access to research outputs and innovation; and

- a failure to realise the potentially significant economic and social returns for the Australian community as a whole.

This will ultimately impact on economic growth and the Government's objective to capture a larger share of the global benefits of the information economy, for the benefit of all Australians.

In Australia, investments by successive governments in a number of programs have resulted in complementary projects and infrastructures that, taken together, enable significant advances in eResearch practice.

Investments in:

- High Performance Computing, visualisation and modelling;

- digital data Storage;

- advanced networks;

- data discovery and re-use;

- collaboration tools and services;

- authorisation and authentication systems; and

- simplification of rules of access including copyright

are all necessary elements in the creation of a comprehensive eResearch fabric. The Australian Government is currently addressing these requirements, to differing degrees, through the National Collaborative Research Infrastructure Strategy (NCRIS) and Super Science initiatives. Details of the projects supported under these programs can be found at Attachment A.

3. eResearch workforce needs

The difficulty in accessing appropriately skilled people has been identified as an important limiting factor in the deployment of eResearch and there is clearly a skills shortage in this area.

The report of the eResearch Coordinating Committee, *An Australian eResearch Strategy and Implementation Framework* (2006) identified skills as a key challenge for eResearch in Australia and nominated possible models to address the problem. Most recommendations made by the Committee, including the development of a central eResearch management body, dispersed training efforts and the provision of eResearch scholarships have yet to be addressed.

NCRIS and Super Science sponsored eResearch platforms have assisted in developing capacity in specific eResearch capabilities, attracting talented eResearch specialists through investments made in interoperability infrastructure, high performance computing and data management.

The potential for large-scale ICT research projects, such as the SKA, to bring high-skill, high-wage jobs to Australia will only increase the demand for skilled ICT and eResearch professionals.

However, providing for eResearch career pathways is an outstanding issue, as is the means for effective exposure to eResearch techniques and resources early in a researcher's career. Higher education and research institutions have a significant role to play in this endeavour and should be appropriately supported in this role.

4. Discussion questions

The following discussion questions were posed by the Research Workforce Strategy development team for consideration by AeRIC during the July meeting. Comments from AeRIC are outlined under each question.

4.1 Are the right policy levers and support mechanisms in place to support Australia's research workforce?

Many of the technologies that support eResearch are at the cutting edge of developments worldwide. Although Australia does have world-class leaders in some of these technologies, there is a nation-wide shortage of skills to support the rapid take-up of eResearch.

The current skills shortage indicates that the right policy levers and support mechanisms are not currently in place to support eResearch capabilities across the research workforce.

A wide range of diverse eResearch expertise is required to support Australia's research workforce in the effective conduct of cutting-edge research. The deficit of skills is across the spectrum, at the application level for scientists unfamiliar with eResearch technology, through to the generic ICT skills required for an eResearch

service provider. In between, there are domain specific ICT skills required to provide generalist ICT support and training.

Improving this situation will require a considerable short to medium-term increase of the number of researchers with the confidence, knowledge and technical skills to undertake eResearch, and in the number of IT specialists who can support or participate in eResearch projects with domain-based researchers.

The discussion at section 4.5 outlines specific actions that could be taken to better support the development of Australia's eResearch workforce.

4.2 What are the key areas that would benefit from future focus?

The following areas would benefit from future focus:

- practical skills for researchers who want to use eResearch applications;

- skilled professionals who can operate across research domains to help researchers use eResearch applications;

- experts in ICT and information management who can apply their high level knowledge and ability to particular research projects and to the research, development and deployment of eResearch enabling tools, services and methodologies; and

- The inclusion in Higher Degree studies of eResearch techniques and support.

4.3 What are the future directions and challenges for eResearch?

A challenge for the development of Australia's eResearch capabilities will be the development of a cohort of eResearch practitioners skilled at the higher degree level, who can initiate and carry out new eResearch projects, and apply eResearch methods to existing research programmes in their disciplines.

As well as providing a pool of eResearch expertise for the longer term, there is significant scope for this newly skilled cohort of eResearchers to be pioneers in their respective disciplines and stimulate other researchers to adopt and adapt these emerging methodologies.

Another challenge includes providing support for initiatives by educational institutions to remove domain barriers and introduce students to pertinent eResearch methodologies as soon as practicable in their undergraduate courses.

Vacation scholarships offered by universities and research institutions are a potentially useful 'pipeline strategy' to introduce bright undergraduate students to eResearch topics and to encourage them to pursue education pathways related to eResearch beyond their undergraduate courses.

4.4 What are the skills needed to support eResearch into the future?

As outlined, skills development activities are needed to provide a feedstock of capable eResearch practitioners for universities and industry, to train experts to assist researchers to use advanced ICT systems and tools in their research and to create a pool of professionals who can design, operate and maintain advanced ICT systems and platforms on which eResearch will depend.

There is a need for education and research opportunities to equip highly motivated students to choose careers in the technologies that support eResearch. A number of Australian universities have already introduced course modules that focus on aspects of eResearch into their undergraduate degree programmes. Universities should be encouraged to introduce conversion courses in this field and to provide opportunities in this area as part of the professional development of their staff.

To complement these emerging initiatives, scholarships and awards could be developed to provide a strategic flow of suitably qualified people to fill the skills gap. For example, support could be provided to institute one-year Honours Scholarships, which support students undertaking projects that incorporate eResearch problems; and three-year Post-Graduate Awards, with a particular focus on eResearch.

4.5 What specific actions might be taken through the research workforce strategy and among these, what are the highest priorities?

The research workforce strategy could support eResearch skills development though the implementation of:

- a broad outreach and awareness eResearch strategy;

- targeted transitional investments to build up the educational 'pipeline' that will populate these cohorts in the longer term; and

- eResearch skills development for early career researchers and existing practising professionals in the public and private sectors to make the transition to eResearch.

Outreach and awareness

The primary step to increase Australia's capability in eResearch is to raise awareness among the key participants. New and established domain-based researchers need to be made aware of the possibilities offered by ICT in their disciplines, and as an enabler of new forms of collaboration with other researchers and other sectors.

Researchers must be provided with the confidence, fundamental knowledge and technical skills to incorporate a variety of e- Research methodologies, facilities and tools into their existing research activities, and actively embrace the new technologies to pursue new research directions and collaborations.

Similarly, ICT professionals and information managers must be provided with new career pathways by which they can interact with domain-based researchers to enable eResearch projects and to participate as team members in domain-based eResearch collaborations. These functions should be addressed through a targeted outreach strategy to assist researchers and their IT collaborators to make the transition to eResearch.

Mechanisms to assist universities and research institutions to promote, participate in and coordinate their own awareness raising and training activities aimed at practising professionals will also need to be considered. Activities that could be better utilised include:

- professional exchanges such as visiting fellowships and overseas sabbaticals – these would stimulate visiting researchers from overseas research groups to bring valuable eResearch skills into Australian research communities, and would allow Australian researchers to visit and gain new insights into eResearch applications and methodologies overseas;

- summer schools, internships and immersion programmes for practising researchers – these initiatives could be targeted at both domain-based researchers and ICT researchers investigating the benefits of involvement in eResearch collaborations;

- international collaboration including workshops and seminar series on multidisciplinary areas such as bioinformatics, nanoinformatics and geoinformatics – such events would stimulate Australian researchers' awareness and involvement in state of the art eResearch, and would promote networking and international collaboration; and

- international collaboration on eResearch techniques and practices.

Education pipeline
Currently, the flow of students through the education pipeline is thin in some ICT areas, especially given the lack of 'industry pull' in Australia compared with other countries.

This may be exacerbated for the relatively new field of eResearch due to lack of community awareness of what it is all about. It may prove challenging, therefore, to attract sufficient numbers of students to take up study in eResearch areas.

The development of scholarship opportunities may prove to be an important part of the answer. Experience at many institutions has shown that even modest financial incentives at Honours level have proven very effective at attracting capable students to intrinsically interesting projects.

Universities may also consider it advantageous to restructure undergraduate courses to encourage more students to undertake cross-disciplinary electives that feed into eResearch scholarship opportunities.

eResearch skills development

On-the-job experience of researchers, IT professionals and information managers is also an effective method for acquiring important eResearch knowledge and skills.

It has become the practice of many universities to prepare postgraduate students for their careers through additional 'professional skills' development, integrated with their research training. Postgraduate training already encompasses important generic and transferable career capabilities in areas such as professional communications, project management or business skills.

With the growing importance of eResearch methodologies and ICT-enabled collaboration to discipline-based research, it is becoming imperative that domain-based research students are trained in relevant ICT and information management skills, for example, through short courses, and that IT research students have the opportunity to interact with domain-based researchers, for example through selective research placements or immersion programmes during their postgraduate courses.

For professionals already working in domain-based research areas, or in the support areas, such as IT departments, and libraries, professional development courses and conversion programmes will also be an important avenue for skills acquisition, or for introducing new capabilities. Incentives may need to be initially provided to academic teaching staff, ICT staff and information management professionals to encourage the development of courses and research projects involving e- Research.

Institutions themselves should be assisted in establishing effective incentives to academics to gain eResearch expertise, such as eResearch sabbaticals, teaching relief for 12 months while they gain new skills, seed funds for eResearch projects, and the provision of graduate diplomas or short 'conversion' courses for academics.

Institutional promotion and career advancement processes should render sufficient professional recognition to academics that choose to invest time and expertise in developing and supervising new cross-disciplinary eResearch projects and courseware. Similarly, formal institutional recognition and reward structures should encourage ICT staff and information management professionals to develop and implement systems and facilities for use by researchers.

----

eResearch Super Science & NCRIS Project Summary 2010

Collaboration Infrastructure:

Providing problem oriented virtual infrastructure and connecting research tools for research teams.

Name	Interoperation and Collaboration Infrastructure
Abbreviation	ICI
Lead Agent	Australian Research Collaboration Service (ARCS)
Collaborating Parties	TPAC, iVEC, eRSA, ANU, CSIRO, QCIF/UQ, Intersect
Funding	$22.5 million (NCRIS)
Project Objectives	Provision of technological services and support via interoperable and collaborative tools to enable Australia's researchers to remain at the forefront of their industries.

Name	eResearch Collaboration Infrastructure
Abbreviation	eRCI
Lead Agent	University of Melbourne (UoM)
Collaborating Parties	TBA
Funding	$47 million (Super Science)
Project Objectives	Provision of collaborative ICT infrastructure to simplify the combining of instruments, data, computing, and analysis applications and enable the development of research workflows based on access to multiple resources.

Data services:

An Australian Research Data Commons: combining and sharing research content.

Name	Australian National Data Service
Abbreviation	ANDS
Lead Agent	Monash University
Collaborating Parties	CSIRO and Australian National University (ANU)
Funding	$24 million (NCRIS)
Project Objectives	To support the discovery of, and facilitate access to, research data held in Australian universities, publicly funded research agencies and government organisations for the use of research.

Name	Australian Research Data Commons
Abbreviation	ARDC
Lead Agent	Monash University
Collaborating Parties	CSIRO and Australian National University (ANU)
Funding	$48 million (Super Science)
Project Objectives	To enable the construction of a range of ICT utilities to capitalise on and ensure greater use and re-use of existing data resources, as well as better management of new data generated in Australian research.

Name	Australian Social Science Data Archive Services for eSocial Science
Abbreviation	ASSDA (ASeSS)
Lead Agent	Australian National University (ANU)
Collaborating Parties	Australian Social Science Data Archive (ASSDA)
Funding	$3 million (NCRIS)
Project Objectives	Provision of a national service for the collection and preservation of computer readable data relating to social, political and economic affairs and to make these data available for further analysis.

Common Access Methods:

Name	Australian Access Federation
Abbreviation	AAF
Lead Agent	Queensland University of Technology (QUT)
Collaborating Parties	Council of Australian University Directors of Information Technology (CAUDIT)
Funding	$2 million (DIISR funds)
Project Objectives	Provision of a framework and support infrastructure to facilitate trusted electronic communications and collaboration within and between universities and research institutions in Australia and overseas.

Research Networks:

Name	Networks connectivity in the Northern Territory
Abbreviation	N/A
Lead Agent	AARNet Pty Ltd
Collaborating Parties	N/A
Funding	(just under) $3 million (NCRIS)
Project Objectives	Renewal of the NT connection to the AARNet network to enhance connectivity for research and education institutions

Name	National Research Network
Abbreviation	NRN
Lead Agent	University of South Australia (Uni SA)
Collaborating Parties	Expected to include AARNet, VERNet, possibly CSIRO and Aurora Energy
Funding	$37 million (Super Science)
Project Objectives	Extension and upgrade the Australian Research and Education Network to connect regional research data centres with each other, with new and existing high performance computing (HPC) centres, and all other high volume sources of primary research data.

Advanced Computing:

Name	Pawsey High Performance Computing Centre
Abbreviation	Pawsey
Lead Agent	CSIRO
Collaborating Parties	iVEC Members consisting of CSIRO, University of Western Australia, Curtin University, Murdoch University, Edith Cowan University
Funding	$80 million (Super Science)
Project Objectives	Construction of a National HPC facility to support SKA Science.

Name	National Computational Infrastructure
Abbreviation	NCI
Lead Agent	Australian National University (ANU)

Collaborating Parties	CSIRO, Bureau of Meteorology (BoM)
Funding	$26 million (NCRIS)
Project Objectives	Provision of high-end, capability computational services, to the Australian research community.

Name	Climate High Performance Computing Centre
Abbreviation	N/A
Lead Agent	Australian National University (ANU)
Collaborating Parties	CSIRO, Bureau of Meteorology (BoM)
Funding	$50 million (Super Science)
Project Objectives	Internationally significant HPC & Data support to priorities climate sciences.

Data Storage:

Name	Research Data Storage Infrastructure
Abbreviation	RDSI
Lead Agent	TBC
Collaborating Parties	TBA
Funding	$50 million (Super Science)
Project Objectives	To support a data storage infrastructure to enhance regional data centre development and to support retention and integration of nationally significant data assets into the national collaboration and data fabric.

Co-ordination:

Name	Australian eResearch Infrastructure Council
Abbreviation	AeRIC
Lead Agent	VPAC
Collaborating Parties	N/A
Funding	$1.5 million (NCRIS)
Project Objectives	Support for AeRIC and the Executive Director.