ABSTRACT

If we examine what is required to position Australia in e-research, it is evident that much of the infrastructure required is already in place or under development. But do we have the right partnerships in place at a university level to ensure we maximise our opportunities and create the know-how we need?

University libraries have traditionally sought to build strong relationships with their research communities, often with mixed success. A later phenomenon was the development of high performance computing facilities in research-intensive universities, sometimes from within a central IT unit and sometimes as a discipline or Faculty-specific initiative, again with mixed success.

As e-research changes the focus from high performance computing toward the application of advanced information and communication technology for research across a broader range of disciplines, disciplines which are text and media-based, new know-how is required. Some of this know-how has traditionally rested with the IT community and some with the library community, yet rarely do they develop partnerships to support research.

This paper gives a brief account of the University of Melbourne’s Information Division’s history in research support and how we are positioning our University for e-research by building on past strengths and exploiting new opportunities, learning from the best of our experience in library and computing service research partnerships.

1 INTRODUCTION

The environment in which universities operate is rapidly changing as information and communication technologies enable the development of a global competitive knowledge and information economy, profoundly changing the nature of scholarly endeavour. A university’s core business is the creation, synthesis and communication of knowledge. Libraries have long been acknowledged as the ‘heart of the university’ but as we rapidly move into a digital environment this relationship extends to the information systems, technologies and infrastructure which underpin this core service. E-learning has led the way in providing new ways for information and IT professionals to collaborate with the academic community to achieve teaching and learning outcomes and now e-research offers new and exciting opportunities for information and IT professionals to partner with the research community to further leverage the power of information and communication technologies in the research process.

University libraries have traditionally been a key component of the research enterprise: building, preserving and providing access to scholarly research publications. More recently IT professionals have become involved in the research process through servicing the advanced computing needs of science-based researchers; in fact the Internet was spawned by the desire of academics to share high performance computing facilities.

Technologies, initially built for the sciences to share expensive science instruments, large scale computation, and access to massive datasets, are now having broader application as other disciplines recognize the potential for enhancing their existing research and for new research using the capability technology brings to the research process. E-research is moving beyond discipline-specific research projects to become an integral part of the research process. This will require new ways of working, new partnerships, and this is well recognized at a national and international level. But whilst we must ‘think global’ we must act local – strengthening existing partnerships and building new partnerships to enable our research community to gain the maximum benefit for the potential of e-research.
This paper outlines the context in which e-research is developing and describes how one university is responding to these new opportunities.

2 THE CHANGING NATURE OF RESEARCH- E-RESEARCH

Increasingly research is becoming more multi-disciplinary and more collaborative. Physicists and astronomers seek to leverage the large investments in specialist scientific equipment and collaborate on the analysis of massive data outputs whilst educationalists and ethnographers hope to share large multimedia research datasets for research collaboration. This has been made possible through rapid advances in information and communication technologies.

E-science is the term used for large scale science carried out through distributed, global collaborations and enabled by the Internet and related technologies (Distributed Systems Technology Centre 2004, p. 2). E-research is a broader term which includes non-scientific research but which still, in essence, refers to large-scale, distributed, national or global collaboration in research. It typically “entails harnessing the capacity of information and communication technology (ICT) systems, particularly the power of high-capacity distributed computing, and the vast distributed storage capacity fuelled by the reducing cost of memory, to study complex problems across the research landscape.” (Australian Research Council, 2005, p. 2). The ‘Grid’ is a collection of distributed computing resources (data repositories, specialized scientific equipment, computing power, knowledge services) that appears to users as one virtual system; (O’Callaghan 2004). It plays an important role in the development of e-research. As more researchers see the possibility of e-research the middleware, the software that ‘provides standard community tools and services for knowledge management, knowledge sharing, collaboration and interoperability between applications, computing resources, institutions, and individuals across the cyberinfrastructure’ (DSTC 2004, p. 2) becomes critical to an effective research process.

For Australian researchers, a great deal of the physical research infrastructure is in place through AARNet, AREN, APAC, the Synchrotron and related initiatives. The Federal government recognizes that good research requires good infrastructure and over $1 billion is being directed toward research infrastructure (Arthur, 2004). But despite this investment members of the Australian research community report that using existing resources across the cyberinfrastructure is time consuming and laborious (DSTC, 2004, p. 5). Whilst the physical infrastructure is well developed, the logical and intellectual infrastructure is a work-in-progress, including middleware, grid-enabling existing applications and data resources and solving the technical and organisational issues to enable international collaboration.

A great deal of effort is being directed at middleware development with the Middleware Forum and CAMP in late 2004 and the recently announced ARC E-research grant scheme. Such initiatives aim to develop a collaborative national approach to middleware development and ‘production-strength’ middleware tools which traverse discipline boundaries and provide broad value to research communities. The aim is to collaborate internationally and nationally to make existing middleware tools and services more robust and interoperable, to develop new tools where there are gaps, to make accessible large heterogenous research datasets and to develop a knowledge grid layer to add to the existing computational or data grids – a layer which integrates knowledge management services into the Grid environment (DSTC 2004, p. 6). But how do we unlock the know-how within the university sector to achieve this outcome?

As with much to do with technology, arguably the technology is the easy bit – the harder part is the human dimension, the fundamental issues and questions flowing from e-research relate to organizational issues rather than matters simply confined to middleware development, though this depends on your definition of middleware! If you take the JISC definition -which uses the term middleware to describe the process of helping institutions to connect people to resources (JISC Core Middleware Programme http://www.jisc.ac.uk/index.cfm?name=middleware_team) – and interpret it broadly then theoretically the organizational issues are arguably part of that middleware ‘glue’. These issues, at a national level, are best illustrated by a number of questions which are posed in the E-research middleware discussion whitepaper (DSTC 2004) including:

- What funding mechanisms can be drawn upon for middleware development?
• Who will be the champion for such an initiative in Australia?
• Who will coordinate the middleware program?
• How will long term research issues be determined/addressed/fed into middleware development?
• Should we set up centralized or virtual distributed organizations?
• What is the best way to implement and facilitate the research, development, deployment, user feedback cycle?
• How do we get domain specific research communities to adopt recommended standards?

These questions are just as valid at a local level for an individual university considering the whole e-research domain as they are for the national research community.

2.1 THE ROLE OF IT UNITS, LIBRARIES AND OTHER ‘SUPPORT’ UNITS

It is easy to see why access to shared ICT infrastructure and to the expertise of IT professionals is required to facilitate e-research endeavours. Yet the majority of the researchers typically employ their own IT professionals to develop tools and capabilities to meet their specific research project needs, though they are often required to seek out access to shared infrastructure. Responsive IT units within universities have been able to develop partnerships with their research communities to provide them with access to relevant infrastructure: bandwidth, advanced computing infrastructure, grid facilities, and to provide consultancy, advice and effective linkage points with relevant bodies such as APAC and AARNet. Researchers recognize that they require specialist IT know-how and access to sophisticated infrastructure.

Libraries have traditionally been central to the research endeavour, managing and preserving the scholarly record over time and making this resource accessible across scholarly communities. This has involved the development of partnerships and collaborations to make scholarly works accessible to the broader research community. Hence libraries have know-how not only in managing, making accessible and preserving scholarly data but also in forming federations and collaborations to share published scholarly work. But the nature of scholarly work is changing with interest in publishing research data and multiple versions of a scholarly work – no longer is it a discrete publication to be managed, made accessible and preserved (see Lougee 2002 for a full description of the changing roles of the research library). Some are suggesting that libraries risk fading from existence if they don’t respond effectively to the changing environment (for example Wheeler quoted by Goldenberg-Hart 2004). In e-research it is the raw research data which must often be managed, made accessible, curated. Lynch (quoted in Goldenberg-Hart, 2004) argues that the libraries’ role will shift from primarily acquiring published scholarship to a broader role in managing scholarship in collaboration with researchers who develop and use this data. Yet in the majority of existing Australian e-research projects the researchers, having the domain specific knowledge, have sought to perform these tasks of managing and making accessible the research data themselves. Unlike their recognition of their need for IT know-how the research community has rarely recognized the need for specialist know-how to manage, preserve and make accessible their research data.

James Dalziel (2004) has explored different support groups, specifically the library community (scholarly information), the Grid computing community, the IT services community and the e-learning community, and their possible contribution in the evolving middleware framework. He does so to demonstrate that other communities, not just the Grid community, have significant understanding and expertise in relation to the development of middleware. He draws particular parallels with the e-learning community’s relevant work. This approach is useful in drawing out the unique (and sometimes overlapping) specialist contributions that each group can make but at the same time it emphasises the traditional divide between different groups within a university context when clearly what is most needed is collaboration and partnership to achieve the e-research outcomes being sought. It would also be useful to map the know-how the researcher would bring to the partnership. He stresses the need for “significant collaboration across boundaries that are not normally traversed” (Dalziel 2004 p. 7) yet I suspect in a number of universities these boundaries have already been breached, even if initially for the purposes of facilitating e-learning (see for example O’Brien and Sidorko, 2001).
To place e-research within a university context it is possible to mirror the middleware questions raised above when identifying the issues for e-research generally:

- What funding mechanisms can be drawn upon within the university?
- Who will be the champion for such an initiative within the university?
- Who will coordinate the e-research program within the university?
- How will long term university research issues be determined/addressed/fed into e-research development within the university?
- Should we set up centralized or virtual distributed organizations within the university?
- What is the best way to implement and facilitate the research, development, deployment, user feedback cycle within the university?
- How do we get domain specific research communities to adopt recommended standards within the university?

Clearly these questions can only be effectively addressed through a strategic approach and strong partnerships between the research community and information, education and IT professionals. But effective partnerships require that there is an alignment of self interest among the collaborators (Atkins quoted in Goldenberg-Hart 2004). The champion must be able to develop this alignment of self interest if the partnerships are to be effective.

3 A CASE STUDY

3.1 THE UNIVERSITY OF MELBOURNE

The University of Melbourne is an international research and teaching university. Founded in 1853, the university commenced teaching its first students in 1855. Now, the university has over 40,000 students in a broad range of professional disciplines. Over 6000 students are higher degree research students.

The university is one of Australia's leading research based universities, with an international profile through its reputation for scholarship and teaching. It was ranked 22nd in the world by the Times Higher Education Supplement Study in 2004. It is a founding member of Universitas 21, an international federation of universities.

The university has more than 3,000 academic staff, with more than 1,000 being research-only with the remainder being teaching and research. The university has more than 4,000 research higher degree students. Total annual research income is in excess of $200 million AUD, making the University the second largest research organization within Australia after the CSIRO.

3.2 THE INFORMATION DIVISION

The Information Division brought together the Libraries, Information Technology Services and educational multimedia development four years ago into an integrated Division. The Division, and its predecessors, has long provided services for research staff and research students, but very much in ways separated across the IT-Library divide.

Library research services have included:

- Information desk services
- Research consultations to assist research staff and students in resource discovery, in developing effective searching strategies and using special features of online research databases
- Electronic gateways to provide researchers with enhanced access to specialised subject knowledge
- Resource provisions through developing and cataloguing the collection and through inter-library loan
- Research librarians were ‘embedded’ in some departments and also in the School of Graduate Studies
More recently work has been undertaken on a range of metadata harvesting, digital repository and preservation projects including participation in the Eprints Repository, the Australian Digital Theses project, Picture Australia, MusicAustralia and a trial of the PANDAS software for web archiving. Whilst this work has been valuable it has not been as part of a direct support program for the research community. The strongest partnerships with the research community have come through the librarians who have been ‘embedded’ within a particular department.

The educational researchers and educational technologists within the Division have built strong links with specific communities of research interest, specifically those interested in understanding the impact of information and communication technologies on teaching and learning.

On the IT side, the research support history is one of an emphasis on providing computational resources using large and expensive supercomputers and more recently High Performance Computing clusters. Much research computation takes place on researchers’ desktops and on facilities based in departments and faculties; conversely the University makes use of state and national resources through VPAC and APAC. The Advanced Research Computing group within the Division has computational and storage facilities under its management, filling the gap between local and external facilities. It provides free access to its own resources, and facilitates access to external resources. No matter where the computation is to take place, it provides advice on matters such as software selection and configuration, algorithms, and programming. It did not normally provide services such as managing the computation or developing code for researchers.

In recent years, a most important development has been the emergence of Grid Computing, the aim of which is to allow researchers access to computational and data resources sourced locally or remotely by using intelligent resource brokering software. A related development is the Access Grid and Access Grid Nodes, which provide a distributed environment for collaboration between researchers, including videoconferencing and remote control of instruments. The Division commissioned an Access Grid Node in 2004. Most clients for these services are from the numerical sciences. Despite limited resources, the advanced computing group within the Division has formed good, trusting relationships with certain departments and, critically, with certain research supervisors who are able to refer RHD students.

3.2.1 THE INFORMATION DIVISION RE-ALIGNMENT
A new CIO/University Librarian was appointed in March 2004 with a mandate for change. In the period since the Division’s creation there had been rapid change within the external environment and within the University itself. Reviews and stakeholder feedback over that period indicated that the University was not gaining maximum advantage from its information, education and communication systems and technologies and that the Division could be more effectively aligned with the University’s vision and mission. A process was undertaken to realign the Division so that it could add maximum value to the University’s vision by supporting world-class teaching, learning and research through leadership, innovation and quality in information and education services, systems and technologies. Key outcomes sought from the process were to ensure that the Division was well positioned to support world-class teaching, learning, research and administration through:

- effective University leadership in information and education services, systems and technologies;
- delivering innovative, responsive, high quality information and education services, systems and technologies and
- having the capability and flexibility to adapt and positively respond to external and internal opportunities.

The developments in e-research provided a perfect opportunity to demonstrate this new approach in action to achieve key outcomes for the University.

3.3 E-RESEARCH AT MELBOURNE
In April 2004 Professor Ah Chung Tsoi issued a discussion paper on e-research on behalf of the ARC (http://www.arc.gov.au/publications/arc_publications.htm#2004). This paper provided a catalyst for a number of the University of Melbourne’s prominent grid researchers to approach the relatively new CIO asking if they would champion the development of a strategic University-wide response to e-
research, in partnership with the Deputy Vice-Chancellor Research. There was recognition by the researchers concerned that collaboration in e-research needed to start at ‘home’. From this meeting an e-Research Working Party evolved, a working party which included researchers from across disciplines, and a representative of the Information Division. The Working Party released a draft report for comment in January 2005 and formally referred the report to the CIO in March 2005.

The report of the Working Party noted that “e-Research will become a key mode of carrying out collaborative research, across campus, and between institutions, both nationally and internationally. Belonging to a leading research institution with broad collaborative programs, University of Melbourne researchers are already participating in e-Research. The University will embrace the GRID and e-Research to enhance the ability of its researchers and students to better access data resources of all types from library collections to large data sets in the sciences and humanities, and to facilitate analysis and presentation of this data. The GRID and e-Research infrastructure will provide for better distribution of an access to existing and future IT resources, such as data storage and computing facilities.” (University of Melbourne e-Research Working Group, 2005, p. 2).

The report outlined what e-research projects were already occurring at the University and how these might be taken forward. A number of pilot projects were identified, some building on existing expertise in traditional areas of GRID research such as high energy physics and the Australian Virtual Observatory, as well as other emerging opportunities in medical imagery, ethnography and education.

The report made a number of recommendations to the University proposing they provide support for the proposed e-research projects and coordinate the University’s response to the call for ARC e-research project submissions. Specifically the report recommended that the University:

“2. Provide support to Departments and Faculties to develop applications in e-Research through the Information Division:

- Provide supported system software, based upon emerging standards (Globus/EGEE/GRID3), upon which University researchers can build applications.
- Facilitate communication between the University efforts and the major international programmes to ensure we work with emerging standards to more easily take advantage of these developments. This will allow local developments to be more easily incorporated into international developments.
- Maintain up-to-date “middleware” on the University of Melbourne central computing resources.
- Facilitate access for Melbourne researchers on central computers, as well as VPAC and APAC resources.

... 3b. provide personnel to facilitate sharing of the experience and expertise across the projects and, eventually, more broadly.

... 5. Establish and provide ongoing funding for a help-desk for e-Research participants.” (University of Melbourne E-Research Working Party, 2005, p. 4-5)

These recommendations begin to address the key issues for developing a strategic and collaborative approach to e-research at a university level. But more work was required to take this to the next stage.

Building on the opportunities offered through this report, and the call for ARC e-research submissions, the Information Division partnered with the Melbourne Research and Innovation Office to assist researchers with their ARC bids. The aim was to see how the Division might position itself, through its information and IT professionals and its existing and planned infrastructure developments, to support the e-research community in the most effective fashion. It enabled us to better understand their needs, and more importantly, to let them know what value (what know-how) we could bring to their research. A small group of staff, both librarians and IT professionals, met with the researchers who were seeking to put forward ARC proposals to see how we might assist them with their research. To prepare for this, interested staff were brought together from across the Division to discuss e-research and how we might work to support e-research. This session provided a great opportunity for people to
learn about the breadth of expertise and resources already available to the research community from different parts of the Division.

The staff identified that the Division is already offering/could offer:

- **Technical infrastructure and services**
  - ICT infrastructure including HPC, networks, data management and storage, repository management, grids, digitization, data mining, statistical support, data preservation, authorization and authentication mechanisms and help desks

- **Leadership and coordination**
  - broker the needs of academics, ie. be the ‘human middleware’ for example providing connections to needed support structures or expertise on campus
  - provide a ‘management’ structure for e-research across the University
  - collaborate with the other relevant bodies on campus to foster knowledge and resource sharing across campus communities.

The interviews with the researchers identified the need for:

- **Technical infrastructure and services**
  - terabytes of disk storage, network upgrades for handling large data volumes and video streaming, access grid nodes, middleware
  - friendly grid portal, technical support for integration and implementation of databases and software within a virtual organization environment, access to grid programming expertise, help in extending the tools, access to expertise in big databases

- **leadership and coordination**
  - need for an e-research champion to bring together a virtual team across the university and beyond, help researchers understand what’s possible with the grid, help people to work on their own.

What we found was a close correlation with the list developed by Markus Buchhorn (2004) of researchers’ e-research wants:

- Access to storage and computational resources
- Access to computational software and services
- Videocferencing and collaboration tools
- User friendly application specific web-based portals
- Shared access to large data repositories for searching, replication and updating
- Assistance with organising and managing their own research data sets
- Collaborative steering of remote research experiments & and ability to collaborate in international projects.

The notable exception is the recognition within the Melbourne research community of the importance of a champion at an institutional level to assist in achieving the outcomes sought. Surprisingly this need was echoed in the Division’s assessment of likely ways in which the Division may assist – a sure sign that there is a positive way forward.

### 3.4 E-RESEARCH: WHERE TO NOW?

In developing the new Divisional structures special attention has been given to how we might best work across the Division to support e-research, bringing together people with knowledge and expertise in data management, data access, grid technologies, authentication and authorization and other necessary expertise. The structures, and the ways of working, we are putting in place will enable the Division to partner with the research community to develop the services and infrastructure required to support e-research.

The University’s major planning and budget meeting occurs in June. A proposal will be presented, as part of the University’s broader Information Strategy. It will seek some additional funding, building on existing capability, to develop services and infrastructure which will broadly benefit the University’s research community. The proposal will target the recommendations from the E-Research Working Party and build upon what we have learned through consultation with the University’s research community about their needs. It will begin to address the questions posed toward the end of section 2.1 for the University of Melbourne.
4 CONCLUSION

The physical infrastructure for Australian e-research is almost in place (given current needs and IT capabilities); though much work remains to be done on the middleware, in the broad sense of that term, to enable e-research in national and international collaborations. But we must not ignore the challenge of partnering and change within our institutions, bringing various bodies of professional know-how together in new ways, as research is conducted in new ways. As in many things, thinking globally whilst acting locally will provide the best way forward in a complex and ever changing environment.

5 REFERENCES


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