KAREN: Opportunities and Challenges for New Zealand Libraries

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Abstract

The Kiwi Advanced Research and Education Network (KAREN) will transform New Zealand's research and education sector, in which libraries play a key part; however many staff in research organisations, including librarians, are not aware of KAREN and what it offers. This article introduces KAREN, suggests how research libraries could use KAREN to collaborate and deliver content and services, and explores some new professional roles and responsibilities.

Introduction and scope

The Kiwi Advanced Research and Education Network (KAREN) was launched in 2006. Although it offers significant opportunities for research organisations and the libraries that serve them, awareness of what KAREN is and what it offers is very low. This paper aims to raise awareness of KAREN amongst New Zealand library professionals, to demystify some advanced networking concepts, and to offer some prompts for engagement between research libraries and KAREN.

This article cannot cover everything about KAREN that is relevant to libraries. My focus is on research, rather than teaching and learning, and will be most relevant to research libraries within the current KAREN membership: i.e. university libraries, Crown Research Institute (CRI) libraries, and the National Library. Other kinds of libraries and cultural institutions (e.g. school libraries, public libraries, museums) may be connected to KAREN in future but are not currently members: their opportunities and challenges will need to be explored in future.

E-research is a much broader topic than can be explored here. Many key e-research technologies – such as high performance computing, grid computing, data visualisation, scientific workflows and the semantic grid – are out of scope. Selected references to introductory articles are provided for readers who wish to learn more about e-research from a library perspective (Gold, 2007a; Hey and Hey, 2006).

KAREN: some basics

Advanced research and education networks

The Kiwi Advanced Research and Education Network (KAREN) is a high-speed network that connects research organisations around New Zealand. A Crown-owned company, Research and Education Advanced Network New Zealand (REANNZ), owns and operates KAREN on behalf of the KAREN members.

KAREN provides a high-speed **backbone** (see Fig. 1) between a number of **points of presence** (also called **POPs**). This backbone is provided by Telstra Clear. Individual members must connect their internal networks to one or more POPs with **last mile connections**, which can be provided by a range of telecommunications suppliers.
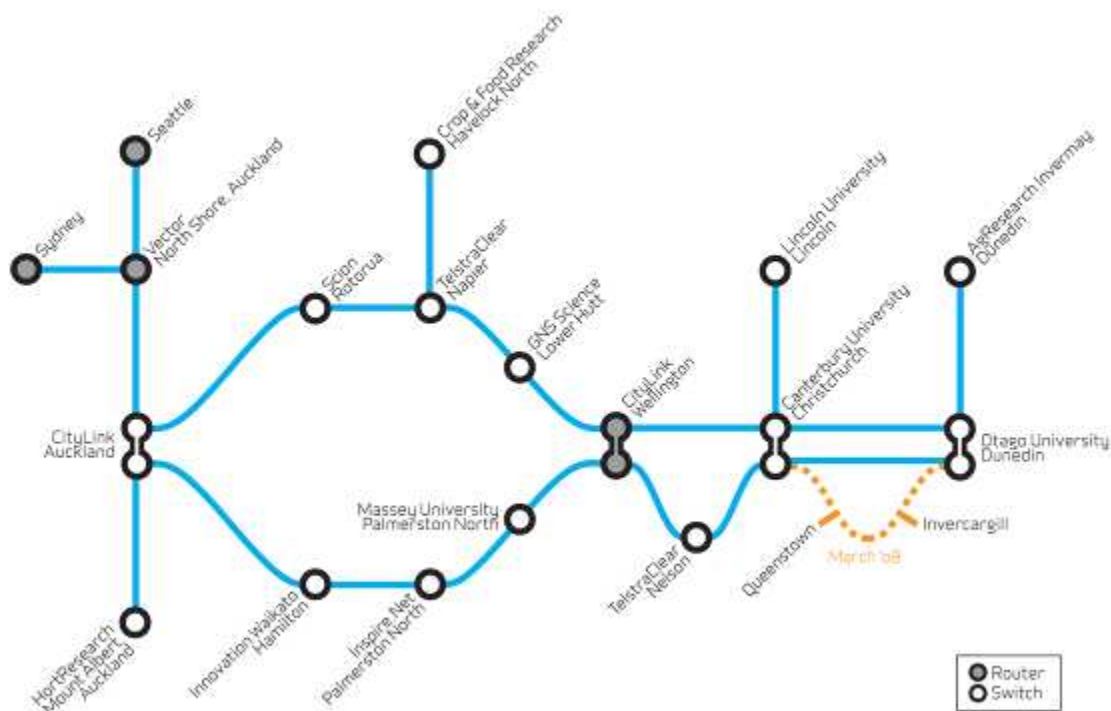

Fig. 1: Topology of the Kiwi Advanced Research and Education Network. Courtesy of Research Education Advanced Network New Zealand (REANNZ).

KAREN is a 'network' in the technical, not social, sense of the word; this is an important distinction. KAREN is not a network of people, for example, like the Humanities Research Network or the New Zealand Social Statistics Network; rather, it is physical telecommunications infrastructure.

KAREN is one of more than forty national advanced research and education networks (ARENs) around the world. Although KAREN is a national network, it also connects members to other ARENs overseas through a process called **peering**. This is achieved legally and politically through REANNZ's negotiation of peering agreements, and technically via international network connections from Auckland to Sydney and to

Seattle. From Australia and the US, traffic is routed to further destinations including Asia and Europe.

Peering can also happen locally. Work is underway on the Government Shared Network (GSN), and several school **loops** (local optic-fibre networks) are already in place in Nelson-Marlborough, Wellington and Auckland's North Shore. Over time, it is likely that some kind of peer connectivity between these different networks will be established.

Although technically similar in many ways, ARENs are quite distinct from commercial telecommunications networks. Advanced network professionals use the phrase **the commodity internet** to describe what most people understand as the internet. ARENs have very different mandates, governance structures and usage patterns from the commodity internet: in general, they are not seen as alternatives to the commodity internet, but rather additional networks for specialised activities that would not be technically or economically feasible using the commodity internet.

Networks, applications and middleware

KAREN is basically a 'pipe' that transfers data at very high speeds; up to 10 gigabits a second, or roughly 10,000 times faster than a standard broadband connection. KAREN is configured a little differently from the commodity internet so that high quantities of data can be transferred more efficiently but it is still, in essence, a pipe. This can come as a shock to researchers, educators and information professionals who expect KAREN to be able to *do* something; data processing, search and retrieval, visualisation, or some other research- or education-related activity.

These misunderstandings about KAREN's functionality seem to arise because of the seamlessness between networks themselves and the layers of content and services that we (as end users) access via those networks. When we say that we 'surf the internet', we make invisible the combination of hardware and software (e.g. browsers like Firefox and Internet Explorer) that supports our online activities. It can help to think of networks as similar to the electrical supply to our homes and workplaces: being hooked into the power grid is only useful if we have tools (e.g. lightbulbs and appliances) that transform that power and help us to achieve certain tasks (toasting bread, reading at night, watching a DVD). In the same way, the network – whether the commodity internet or KAREN - *enables* what we are doing, but must be combined with other tools specific to the task at hand.

Some tools are already available: KAREN can be accessed using existing applications like email clients and web browsers. There are also some communication and collaboration tools that can be (relatively) easily adopted: I discuss some of these later in this article. In many cases though, applications designed for ARENs are highly complex, reflecting the workflows, resources and computational requirements of specific scientific and scholarly domains. These kinds of tools may not be readily available in New Zealand: part of the process of building KAREN capability involves identifying, adopting/adapting and deploying tools and services that have been developed overseas, where ARENs have been in place in for many years.

There will also be a need to develop what is called **middleware**: "software that provides standard community tools and services for knowledge management, knowledge sharing, collaboration and interoperability between applications, computing resources, institutions, and individual" (DSTC, 2005, p.2). A full discussion of middleware is outside the scope of this article, but research libraries should be aware of developments in this area, particularly those relating to **identity and access management**. Adoption of standards, deployment of technologies like Shibboleth, and participation in **trust federations,** which provide legal and technical frameworks for sharing equipment and resources, will all be essential. In the long term, this type of middleware will have a positive impact on many library functions, but it requires non-trivial changes to systems, policies and processes across entire organisations, as well as in libraries.

Membership and access

Access to KAREN is governed by a Network Access Policy. KAREN was established for the purposes of research and education and is only available to members, associates and partners. The eighteen founding members are all of New Zealand's universities and Crown Research Institutes, and the National Library. Members pay an annual subscription; once this is paid and the organisation is physically connected, there are no further direct costs for the traffic over KAREN.

In future, KAREN may be available to other organisations such as schools, public libraries and other cultural institutions. These will be associate members, as their primary purpose is deemed to be research- and/or education-related. There is also provision for partners; commercial or other organisations that want to provide content or services to KAREN members, or that otherwise have a relationship with members that would benefit from limited access to KAREN. The New Zealand Supercomputer Centre is the first company in this category and will use KAREN to supply high performance computing resources to members.

Organisations become members and connect to the KAREN network at an institutional level. If your organisation is a KAREN member then you should be able to use KAREN. In fact, you may already be connected to KAREN and not realise it, since as an end user there is nothing special to see. KAREN is not an additional plug to your computer, or an icon on your desktop. Data is **routed** via KAREN or via the commodity internet automatically when you transfer data (e.g. send/receive an email or upload/download a file): the source and the destination of the data are automatically recognised as being part of the KAREN network or not.

KAREN's value: the paradigm shift to e-research

If KAREN is just a big pipe for transferring data, why is it so important? The answer lies in the activities that such high bandwidth enables; new types of science and scholarly work that have economic and other benefits. While KAREN will be used for a range of activities, research is a high priority: overseas ARENs have enabled a paradigm shift to what is becoming known as **e-research**. (This is sometimes referred

to as **cyberinfrastructure** in the US, and the term **e-science** was popular in the UK and Europe until recently, when this type of infrastructure began to be more widely adopted amongst the social sciences, and arts and humanities.)

Fig. 2 covers some of the salient points of this paradigm shift.

Characteristic	E-Research	Traditional Research
Participants	Diversely skilled, distributed research team	Individual researcher or small local research team
Data	Generated, stored and accessible from distributed locations	Locally generated, stored and accessible
Computation and Instrumentation	Large-scale, or on demand computation or access to shared instruments	Batch compute jobs or jobs run on researcher's own computers or research instruments
Networking	Reliant on the internet and middleware	Not reliant on the internet
Dissemination of Research	Via web sites and specialised web portals	Via print publications or conference presentations

Fig. 2: Traditional vs. e-Research Paradigms (Appelbe and Bannon, 2007, p.84). Reproduced courtesy of the Australian Computer Society Inc.

E-research is more than just research that utilises online resources and IT tools. Appelbe and Bannon from the Victorian Partnership for Advanced Computing make this distinction: "eResearch is not just about using new IT tools, such as teleconferencing or web publications, to *support* research projects… rather they are *reliant* on IT technology and organisational changes such as online collaboration to achieve the research outcomes." (p.84).

Emerging examples in New Zealand of e-research enabled by KAREN include:

- The NZ Biogrid, which will provide desktop access to public and shared bioscience databases and standardised workflows for bioinformatics analysis;
- A project for measuring poverty using high-resolution satellite imagery, which will involve accessing computers and datasets in the US and China;
- Earthquake engineering research into bridge design, which involves distributed testing between Auckland, Oxford, Cambridge and Bristol universities; and
- International radioastronomy involving ten universities and research institutes in New Zealand, Australia and Japan.

Challenges and opportunities for libraries

Collaboration & communication

KAREN's most immediate offerings are in the area of collaboration and communication. Tools are available or emerging, and these are generic enough to support a range of disciplines and activities, including e-research as well as other education-related functions like library services.

Videoconferencing is widely used in universities, CRIs and many other NZ organisations. Videoconferencing is a broad term that covers a range of tools that are useful in different situations. Many people are familiar with standard videoconferencing, and there is not scope in this paper to do more than note the cost savings that KAREN members can gain by ensuring that videoconferencing is routed over KAREN. There are two standard ways of videoconferencing: using the phone network (Integrated Services Digital Network, or ISDN) or using internet protocols (IP).Videoconferencing over IP can be routed over KAREN to members in NZ and to overseas R&E networks at no/low cost, while ISDN services are provided by commercial companies, often at a premium.

The Access Grid is an open source ensemble of collaboration tools that includes videoconferencing, but combines this with shared applications like whiteboards, presentations and browsers. It is well-suited to events with large numbers of participating groups. Access Grids are available at every NZ university; worldwide there are several hundred **nodes**, many of which can be accessed via KAREN for international collaborations. Ideally nodes are set up in dedicated rooms (see Fig. 3) so that participants can be projected at sizes that increase the sense of immersion, but nodes can also be portable (BeSTGRID, 2007).

Fig. 3. The HIT Lab (University of Canterbury) delivers a presentation to a group of school principals located in the Access Grid node at Victoria University of Wellington.

One of the exciting things about Access Grid is the development work taking place internationally: plug-ins for visualisation, data-sharing and remote control of instruments are being created. These kinds of tools enable researchers to undertake research that would be impossible without KAREN. Fig. 4 shows the Data Visualisation Laboratory for the New Zealand Network of Earthquake Engineers (NZ-NEES) project. The lab is being used to run a remote experiment on a shake-table in the United States: the researchers at the University of Auckland can talk to US colleagues, direct the staff setting up the shake-table, watch the experiment as it unfolds, and receive real-time data feeds of the results.

Fig. 4: NZ-NEES researchers at the University of Auckland use their Data Visualisation Laboratory to conduct an experiment in the US. Courtesy of BeSTGRID.

Access grids can be set up on individual users' desktops, and other tools are also available for this type of **desktop videoconferencing**. One product being piloted in New Zealand is EVO (Enabling Virtual Organisations): this was developed by Caltech for the high energy physics community but is becoming more widely used.

EVO is free and easy to access: a Java applet automatically downloads from the EVO gateway. The only cost involved is purchase of a webcam and headset. There can be firewall and configuration issues requiring some technical support, but in general, the process can be initiated by an end user. EVO offers text chat, video and sound, a shared whiteboard and desktop (see Fig. 5), and the ability to record sessions (Bonnington et al, 2007b).
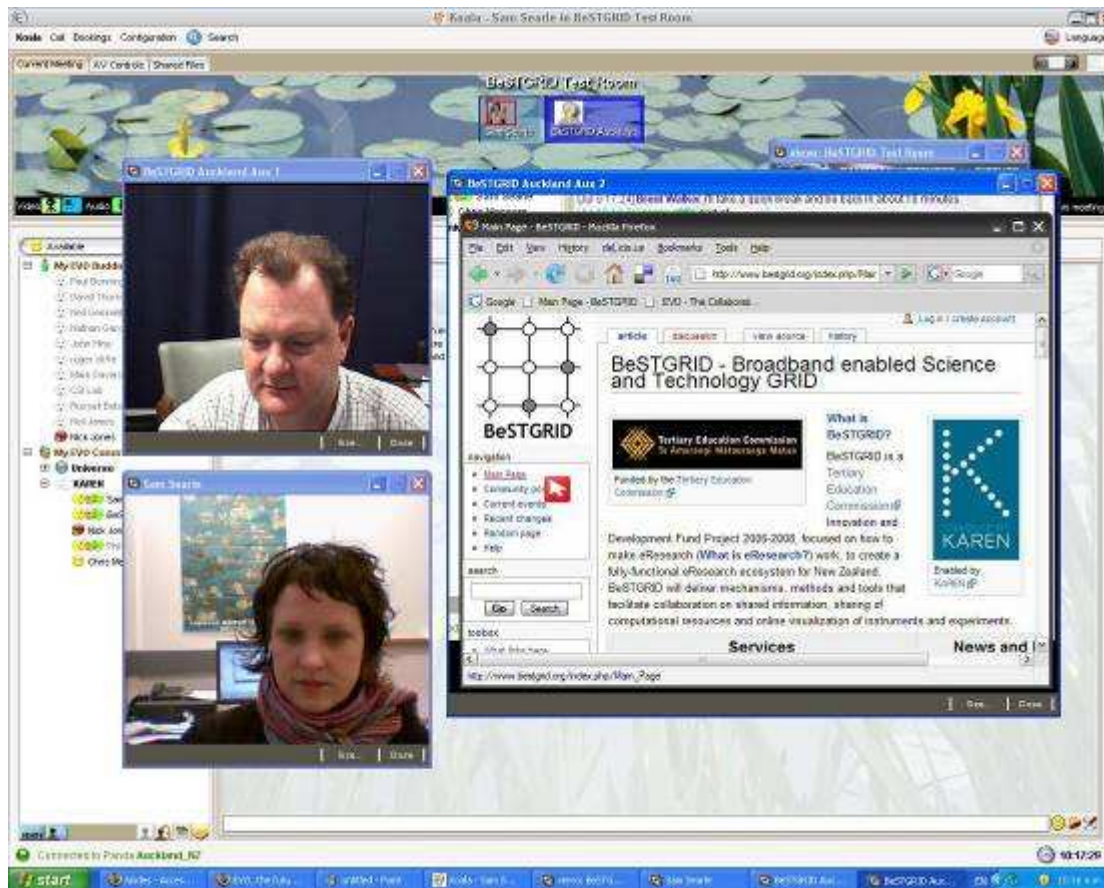
Fig. 5: An EVO screenshot. I am at my desk in Wellington videoconferencing with Paul Bonnington at Auckland University. Paul is sharing his desktop with me.

EVO is being used regularly in New Zealand for meetings with 10-12 participants, and a growing number of researchers use it on a daily basis to collaborate more informally. It has some advantages over similar tools (e.g. Skype): it has been developed specifically for use over ARENs, is more robust and secure, has higher quality sound and video, and can support more participants.

Collaboration can also be fostered through the development of **virtual research environments** (or VREs). At their most basic, these environments integrate tools for real-time communication (instant messaging, text chat, and less commonly, audio and video), asynchronous communication (email, bulletin boards), document sharing, and management functions (project schedules).

There is some overlap between the concept of a VRE and other tools and services: commercial groupware like Sharepoint and MS Groove; portal and content management systems; wikis and blogs; hosted web services like Google Groups; peer-to-peer filesharing and social networking sites; and learning management systems like Blackboard and Moodle. But unlike these products, VREs are developing in ways that will specifically support e-research. The long-term vision is that VREs will provide collaboration functions alongside more specialised tools: interfaces to hardware, scientific equipment and analytical software; repositories, library resources and knowledge management tools (e.g. personalised 'bookshelves with annotation and other functions); as well as common desktop applications (Bonnington et al, 2007a).

Sakai is a VRE being trialled in New Zealand. It was initially developed by Indiana, Michigan and Stanford universities, and is now widely used to support both e-learning and e-research. Auckland University's BeSTGRID project has established a Sakai Collaboration Server, which is available to the KAREN community. More than 500 registered users in 60 NZ-based research groups are currently using Sakai 'worksites' that integrate chat rooms, discussion boards, document sharing and wikis. Sakai offers these researchers an alternative to inefficient, unwieldy, and often insecure practices that are nevertheless very common: many researchers 'make do' with email and project websites, are not yet conversant with wikis, and share their data as email attachments and on CDs/DVDs, USB sticks and portable hard drives. Collaboration tools are established project-by-project: researchers end up with multiple log-ins and interfaces to contend with. While Sakai does not attempt to address all of these issues, it does offer the ability to easily create and join multiple groups, all of which are accessible via one site.

Sakai 'out of the box' does not require KAREN and much of its functionality is fairly standard, but this will change in future. The Sakai project is now linked with the US National Middleware Initiative and the UK Joint Information Systems Committee's Virtual Research Environments Programme: these injections of external funding will support development of specialised plug-ins for research that are likely to require more bandwidth. It is also important to note that while Sakai may not currently *need* KAREN, it is nevertheless contributing to the development of the culture and skills required for e-research by facilitating collaboration.

Libraries already adopt a collaborative approach, and there are clear opportunities for libraries to use videoconferencing and virtual research environments to support their work. Research libraries with access to KAREN can use tools like Access Grid and EVO right now for meetings, seminars and workshops; virtual reference would also be a possible use of these tools. VREs like Sakai can be used by project teams, committees and other groups: because these tools in their current form do not require KAREN, they can also be used to collaborate with libraries that are not KAREN members.

Content and services

As noted above, ARENs facilitate specialised activities; they are not generally intended to replace the commodity internet and their connectivity is restricted to members and their associates. This has important implications for libraries, since existing online services developed for the commodity internet and its large numbers of domestic consumers will not necessarily translate well to the KAREN environment. For example, while e-learning might benefit from high bandwidth, there is often a requirement to deliver e-learning to people at home, where they do not (and are extremely unlikely to ever have) access to KAREN.

So, while KAREN offers the opportunity to do some things *faster*, the challenges and the real benefits lie in the potential to do things *differently*. The question becomes: what might KAREN enable that the commodity internet cannot?

Digital collections are an obvious area where KAREN can provide value for libraries. At a basic level, existing digital collections will be delivered faster to members; this is of course a positive thing, but where ARENs really add value is in delivering content in rich media formats and of higher quality than what is usual right now. The availability of JANET, the UK equivalent of KAREN, has created an environment in which mass digitisation has moved beyond images and text to encompass important audio and video collections like NewsFilmOnline, the Independent Radio News Archive, and the British Library Archival Sound Recordings. Other archives of large files in rich media formats are emerging internationally: for example, the Digital Archive Network for Anthropology and World Heritage (DANA-WH) delivers high-quality 3-D representations of artifacts, fossils, and other objects.

With regards to quality, KAREN could enable delivery of digital objects that better meet researchers' needs, without the constraints of available commodity internet bandwidth. Using images as an example, there is no technical reason why very high resolution images from heritage collections like Timeframes could not be delivered to researchers via KAREN; of course, resolving the usage and rights management issues involved in this scenario would require significant effort. Similarly, KAREN would facilitate streaming and downloading of very large audio and video files (e.g. entire films, rather than just excerpts) for research purposes, if an appropriate technical and usage framework could be established.

Mirroring is another common use of ARENs: local copies of highly-used large databases or digital collections can be delivered quicker and with reduced traffic costs over ARENs. In Australia AARNet mirrors open source archives and other software and documents. Taiwan's TWAREN mirrors more than 150,000 open source software projects from SourceForge. In New Zealand, the University of Auckland Bioinformatics Institute recently launched the NZ BioMirror, which provides local access to DNA/protein sequence databanks required for bioinformatics research.

There is a natural fit between efforts to deliver local digital collections and the sharing of resources through consortial licensing schemes: New Zealand libraries have a strong history in this area (e.g. through EPIC) that could be leveraged to provide access to digital collections in new formats. REANNZ has recently appointed a Content and Services Manager, whose role will involve trials of desirable content across the whole KAREN community.

A further area of consideration for libraries is the provision of tools and services for working with digital collections. Digital libraries in New Zealand currently offer little functionality above searching and browsing; even personalisation options enabling the storage of personal subsets of objects remain uncommon. E-researchers will require the ability to mine textual and numeric data, process images, annotate resources, visualise datasets and use other tools with digital content. How will libraries respond to these demands from their researchers?

This change of focus – from understanding what researchers want to *find* to understanding what researchers want to *do* - will be critical in future. The challenge is one of integrating library content and services into research workflows. Lorcan Dempsey has described this challenge as one of *networkflows*:

> As more of our working, learning and playing lives moves onto the network we need better workflow support. One can state one of the major challenges facing libraries in these terms. Historically, users have built their workflow around the services the library provides. As we move forward, the reverse will increasingly be the case. (2006).

Sakaibrary is an early attempt in this area. This project is investigating building on the OpenURL standard to enable users to search library databases and easily import citations into the Sakai VRE, where they can be shared in a controlled manner (Indiana University Digital Library, 2007).

Some of the suggestions for content and services in this section do not require the high bandwidth of KAREN; however, just as VREs like Sakai are important in fostering collaborative work practices, these new modes of delivering content and services would be valuable in addressing the needs of scientists and scholars as they move from traditional modes of research towards e-research.

The data deluge

> No longer is scholarly communication a final discrete publication that is to be managed, made accessible and preserved. Libraries may even risk fading from existence if they don't respond effectively to the changing environment. In e-research, it is the primary research data that must often be managed, made accessible and curated. (O'Brien, 2005)

The data-intensive nature of e-research poses challenges to traditional models of the research lifecycle and scholarly communication. These challenges go beyond the now well-documented shift to open access journals and even the burgeoning institutional repository landscape: in future, researchers will seek open access to not just published outputs, but also the supporting datasets, parameters for data processing, automated workflow configurations that are produced over the life of a research project and are vital to understanding, validating and building upon the results of that research.

The quantity and complexity of research data is increasing at an alarming rate: in some disciplines, it is estimated to be doubling every year (UK Office for Science and Innovation, 2006). New processing and modelling techniques can produce vast datasets: a single astronomy simulation may contain up to 30 terabytes of data (Szalay, 2007): to put this in context, this represents more than 32,000 CD-ROMs! At the other end of the spectrum are large quantities of smaller datasets, e.g. spreadsheets and documents (e.g. interview transcriptions) that are manually created and managed by researchers or research teams, centres and institutes, usually without any input from information professionals.

At the same time that the data is expanding, requirements to provide access to data are becoming more common. Internationally, policy and funding agencies are beginning to mandate the sharing of research data obtained through publicly funded projects, and there is considerable public interest in free access to data. In 2004 New Zealand signed up to the OECD Declaration on Access to Research Data from Public Funding and it is likely there will be further moves in this direction: recent policy changes at the National Institute for Water and Atmospheric Research (2007) and Statistics New Zealand (2007) are a sign of the changes to come.

The scale of these issues demands urgent national action, with countries including the UK, the US, Canada and Australia embarking on major data-related work programmes (see, for example, Beagrie, 2007; Buchhorn and McNamara, 2006). The Australian government has allocated AUS$21M (universities and industry are expected to contribute a further AUS$24M) to develop the Australian National Data Service, which will establish technical and policy frameworks for making research data accessible (NCRIS, 2007).

Most information professionals are already aware that the long-term management, sharing and re-use of digital data raises issues around copyright, privacy and other intellectual property rights. The OAKLaw Project (Open Access to Knowledge) at the Queensland University of Technology is attempting to address some of these issues in the context of e-research and there is interest in licensing mechanisms like Creative Commons and its science-specific equivalent Science Commons.

The KAREN *Capability Building Roadmap* (REANNZ, 2007) has identified data storage, management and re-use as some of the most serious issues for New Zealand e-research development and KAREN uptake. The potential role of libraries in this environment is not yet clear. The Digital Content Strategy, ICT Framework for Education, and the National Library's National Digital Heritage Archive all promote the development of institutional repositories for research outputs and repositories of digital content, but the scope of these to date has been limited to published knowledge rather than datasets and other products of the research process.

Across the Tasman indicate, institutional repositories (IRs) are providing a good vehicle for discussions about **data curation**; the set of methodologies, skills and technologies required to manage research data. At a recent Australian e-research conference, IR managers held a workshop on "The researcher/librarian nexus: The challenges of research data management in institutional repositories" (2007). This workshop, under the auspices of the Australian Partnership for Institutional Repositories, highlighted that data curation can be seen as an extension of existing responsibilities; libraries are 'trusted', and can provide continuity of service, networks of useful relationships, and expertise in managing intellectual property. Unfortunately, workshop participants also expressed the common concern that libraries are not resourced at levels that would enable them to cope with the new demands of data archiving on top of their existing activities (Searle, 2007).

Roles and relationships

E-research offers librarians an opportunity to broaden their knowledge base and gain new skills. As noted above, IR management and support roles are emerging and the concept of data curation is gaining ground. These areas will provide interesting career options in future, and in such a fast-moving environment there are also likely to be other new roles that have not even been dreamed of yet!

The context for the expansion of our knowledge and skills must be new (or revitalised in some cases) partnerships with a range of other professionals. With scholars and scientists, our challenge is to meet them in their own spaces (both physical and virtual) and to understand more about how technology is driving, not just supporting, their

research. There will be new metadata standards to become familiar with: an array of schemas and ontologies are emerging for the description of scientific and scholarly data. Threaded throughout all this new activity are increasingly complex issues around copyright, licensing, privacy, and cultural property rights; librarians have a role in working to resolve these issues, and in encouraging best practice amongst researchers.

Greater cross-fertilisation with other information professionals, especially those with responsibilities for electronic records and archives, is urgently needed. With a few exceptions, NZ does not have a history of discipline-based data archives, and the skillsets required for this work (a combination of technical skills, archival expertise, and knowledge of the discipline/domain the data relates to) are very rare. There is also scope for greater cooperation amongst the libraries in the KAREN membership. Currently there is no SIG for research libraries within the LIANZA structure: university libraries have historically gravitated towards polytechnic colleagues within TEL-SIG while CRIs fall under the SLIS banner. Relationships between these groups and with the National Library will need be strengthened in future.

By its nature e-research will also require partnerships with a wide range of technical specialists: computer scientists who are at the leading edge of e-research; IT support staff and networking specialists; the managers of the videoconferencing suites, laboratories, supercomputers, visualisation centres and other venues and assets that form part of the network of shared resources that will be accessed via KAREN. Many of these locations and people may seem light years away from libraries and librarians; however, we need an open mind about new professional alliances if we are to meet e-researchers' needs for data, information and knowledge to be managed holistically throughout the entire research lifecycle.

Meeting the KAREN challenge: capability building

As this article has demonstrated, KAREN has the potential to transform our research and education sector, but there is significant work ahead for everyone involved, including librarians. The availability of KAREN is not enough: a process of capability building is now underway to address the enormous technical, professional and organisational developments that are required.

REANNZ has established an Advanced Network Capability Building Advisory Panel to advise REANNZ and agencies like MoRST on how to build the awareness, skills, tools and services that are needed to take full advantage of KAREN. The Advisory Panel guides REANNZ in the operation of a small fund (around $5M over 4 years) to help the KAREN community build capability. The KAREN Capability Build Fund supports travel and events, as well as exemplar projects that are deploying technology and building up an e-research workforce.

The Advisory Panel has overseen the development of the *Advanced Network Capability Building Roadmap 2007-2009* (REANNZ, 2007). The Roadmap provides a national framework for increasing KAREN uptake and developing e-research. This is a key document for all KAREN-related activities over the next few years and should be worthwhile reading for senior staff in research libraries and other information

professionals with an interest in the impact of new technologies on research and education.

Conclusion

As Victoria University of Wellington's E-Research Development Coordinator, I work with academic staff, particularly researchers, to increase use of KAREN. For the most part, this involves promoting not KAREN itself but the new kinds of services and activities that the network will enable. Many of these are familiar to information professionals: collaboration; management of data, information and knowledge; and the integration of communication tools and information services; all within an environment in which privacy, intellectual property and other rights management issues are serious concerns.

This article has suggested just some of the opportunities and challenges that KAREN brings. I hope it will prompt more New Zealand librarians to engage with KAREN and e-research as part of their professional practice. KAREN offers us the chance to better understand the crucial role that data, information and knowledge play in leading scientific and scholarly endeavours, and to work alongside other professionals to ensure that New Zealand makes the most of its advanced network.

Acknowledgements

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