



24 February 2011

Mr Andrew McGowan
Inquiry Secretary
Parliament House
PO Box 6021
Canberra ACT 2600

Email: ic.reps@aph.gov.au

Dear Mr McGowan


RE: New Enquiry into the National Broadband Network

Thank you for your letter dated 9 December 2011, to our Vice-Chancellor, Professor Glyn Davis. On behalf of the University, please find attached the University of Melbourne response to the House of Representatives Standing Committee on Infrastructure and Communications Inquiry into the National Broadband Network.

We thank you for the invitation to provide a response to this inquiry.

If you require any further information please contact me on ph or
via email:

Yours sincerely

 Michael Beaton-Wells
Executive Director, Finance and Planning

Encl.

Finance & Planning Group

The University of Melbourne, Level 4, Raymond Priestley Building Parkville Victoria 3010 Australia

T: +61 3 8344 4597 **F:** +61 3 8344 8214 **E:** fpg-office@unimelb.edu.au

W: www.fpg.unimelb.edu.au



THE UNIVERSITY OF
MELBOURNE

University of Melbourne

response to the

House of Representatives Standing Committee
on Infrastructure and Communications
Inquiry into the National Broadband Network



Background

The University of Melbourne is a leading international university with a tradition of excellence in teaching and research. The University's outstanding performance in international rankings puts it at the forefront of higher education in the Asia-Pacific region and the world. The University of Melbourne is currently ranked number 36 globally according to the Times Higher Education-QS World University Rankings.

Established in 1853, the University employs over 7,000 staff, and has 30,632 undergraduate, 14,524 graduate and 4,823 research students. The main Parkville campus is recognised as a hub of Australia's premier knowledge precinct comprising eight hospitals, many leading research institutes and a wide range of knowledge-based industries.

The University of Melbourne aspires to realise the goals of its Growing Esteem strategy to be a public-spirited and internationally engaged institution, highly regarded for making distinctive contributions to society in research and research training, learning and teaching and engagement. The University is recognised nationally and internationally for excellence in research. The recent Australian Research Council reports of *Excellence in Research for Australia* (ERA) ranked the University as one of the top research universities in the country with over 99% of its research assessed to be at or above world standard.

The University offers a distinctive model of education known as the Melbourne Model. The new educational model is based on six broad undergraduate programs followed by a graduate professional degree, research higher degree or entry directly into employment. The emphasis on academic breadth as well as disciplinary depth and the new degrees ensure that graduates have the capacity to succeed in a world where knowledge boundaries are shifting and reforming to create new frontiers and challenges. In moving to the new model, the University is also aligning itself with the best of emerging European and Asian practice and well-established North American traditions.

Broadband services and applications are critical to the operations of the University today. However, the widespread availability of very high speed broadband services such as that offered by the National Broadband Network will enable the University to innovate in the way it delivers core service offerings including research, teaching and learning, and knowledge exchange, enabling it to retain its status as one of the world's leading higher education institutions. Ubiquitous, high speed broadband services will assist the University to:

- Improve the educational resources and training available for teachers, researchers and students;
- Attract research and development and related innovation investments; and
- Facilitate community and social benefits through outreach programs and public events.

This submission outlines The University of Melbourne's current reliance on broadband technologies, and highlights some potential future uses for research, teaching and learning, and engagement at the University and across the higher education sector. It should be noted that some research underway at The University of Melbourne directly relates to the development and usage of broadband services and applications in specific industry sectors, for example education and health. Some illustrative projects are outlined in the Institute for a Broadband Enabled Society's (IBES) submission to the House of Representatives broadband inquiry.

Teaching and Learning

Information and communications technologies, supported by broadband infrastructure, currently play a critical role in the delivery of teaching, learning and assessment in higher education. These technologies are used to support the management and administration of university teaching and also to greatly enhance students' access to scholarly resources and learning experiences, whether programs are offered primarily at a local campus or in distance or online modes.

Contemporary educational models such as inquiry-based learning, peer-based and collaborative learning, and simulation-based learning could all be greatly enhanced through the use of high speed broadband networks. Experiments conducted in a large chemistry lab can be beamed to students' personal computers; or experiments can be conducted virtually and interactively over the network. Resources and artefacts that are difficult to find and share can be sourced and displayed from anywhere in the world. Complex data can be captured, simulated, visualized and augmented for teaching and learning purposes through new display technologies. Experts from around the globe can contribute to the learning experiences of students at Australian universities via high definition video conferencing; reciprocally, Australian experts can contribute to the educational experiences of students in any part of the world. Peer-based group learning can cross national boundaries greatly enhancing students' educational understanding of diverse cultural phenomena. It is the student who is placed at the heart of many of these learning experiences and it is the technology that makes them possible.

A key component of these experiences is providing both teachers and students with access to resources (people, artefacts, data, environments) that would otherwise be unavailable. Broadband technologies can extend in novel ways the boundaries of teaching and learning both in and outside the classroom. Broadband technologies can enhance the educational experiences for a wider range of learners, no matter where they are located, and in this way, technology can overcome the tyranny of distance associated with the provision of education. In Australia, restrictions on access to educational opportunities are particularly felt by those located in regional and rural areas. Put simply, broadband technologies have the potential to remove proximity as a precondition for high fidelity interactive educational experiences. The consequences of this for Australian higher education are potentially profound.

Today's expectations

One contemporary driver for the use of technology in learning environments is the expectations of learners themselves. Most students who enter Australian universities, whether their prior educational experiences have been in Australia or overseas, expect to have access to a range of technologies to support their education. They expect access to an array of online services at anytime of the day, from any location, and through a variety of personal and mobile computing devices (e.g. desktop PC's, laptops and smartphones). The types of resources that students would currently access on a regular basis include:

- Communications technologies including email, instant messaging and social networking which are used to communicate with teachers and student peers;
- Course materials including lecture notes and audio-visual recordings made available through enterprise learning and management systems;
- Online assessment tools and computer assisted learning programs;
- Library services, including online materials such as academic journals and scholarly databases;

- Virtual collaboration spaces where students can connect with student peers and teaching staff; and
- A range of Internet based information resources and sources.

Potential for innovation in education

The capacity to offer rich interactive educational experiences in a way that is independent of distance is potentially transformative of higher education, both within Australia and abroad. Most immediately, this capacity provides the means to enrich the contemporary delivery of higher education, for example, by:

- Extending the reach and form of educational resources available to students as well as access to technology-enabled educational experiences;
- Overcoming regional disparities by providing the capacity for high-quality national access to educational resources and activities irrespective of location;
- Internationalising the educational experience, through the creation of international classrooms and collaborations, and access to real-time international events;
- Supporting the development of skills in global team-work through group projects involving culturally diverse and spatially distributed team members, preparing students to work in a global workforce, across geographical, disciplinary and cultural divides.

More fundamentally, though, this capacity is likely to lead institutions to change the way in which they deliver educational programs and in how they do so in partnership with others. The impact of such shifts is hard to predict, but it is likely that the effects will be felt globally. Australian institutions will be best placed if they can lead rather than react to the trends towards globalisation that are likely to follow. In recent years, Australia has led the provision of international education on a large scale; a high speed national broadband capacity will enable the Australian higher education sector to take the next major step towards an international education agenda.

As high speed broadband becomes more widely available outside Australian universities, it is also important to recognise the likely changes in students' expectations about the nature, quality and availability of services offered at universities. Students' expectations about the use of technology at universities are heavily influenced by what they are able to do with technology in their everyday lives. A challenge for the higher education sector will be to find innovative and effective methods for using technology in teaching and learning contexts in ways that build upon students' evolving skills and capacities. A high speed broadband network, therefore, will be a significant driver of innovation in teaching and learning in higher education. Moreover, high speed broadband capacity means that technologically-sophisticated educational resources are likely to have greater value at greater distances. Whether development of such resources leads to growth in commercial markets or open source communities of developers is not necessarily easy to predict but, in either case, participation in the development of such resources is likely to increase substantially the range of resources available to teachers and students and, as a consequence, enhance teaching and learning outcomes across a wide range of disciplines in the Higher Education sector. For example, potential uses for broadband applications and services in the higher education sector could include:

- Sophisticated, life-like tele-presence applications that connect learners and expert educators from around the world. For example, leading researchers from around the world could present an invited lecture to students at an Australian university and students could interact with others who are virtually or physically present;

- Virtual collaboration spaces with improved connectivity including enhanced visualization, text, voice and video capabilities;
- Visualization tools, including three dimensional video that can assist learners better understand complex structures, for example in molecular chemistry;
- Fully immersive 3D virtual reality learning environments with haptic (force feedback) capabilities that allow practice and rehearsal of complex procedures. For example, researchers at the MUVES laboratory at The University of Melbourne have developed haptic-enabled immersive environments that can be used to train surgeons so they can experience giving an operation prior to practicing on real patients;
- Highly specialised learning communities could be supported, facilitating collaborations across large distances, making effective use of scarce intellectual training resources in specialized fields and speeding the dissemination of innovative practice.

While these applications are available today, their use is limited in higher education. High speed broadband and ubiquitous broadband services will make these sorts of applications more widely available, not just on the University campus but also to workplaces and homes.

High speed broadband can also greatly enrich practical experience in professional fields through experience with a wider variety of situations and access to a broader group of specialist practitioners. In medical education, for example, high speed broadband can support deeper educational experiences through tele-health systems. Systems such as High Definition tele-presence will enable trainee practitioners to engage in a variety of clinical experiences, for example providing a medical consultation to a remote indigenous community.

High speed broadband will also facilitate growth in the higher education sector within Australia. It is very likely that online education offerings will play a far greater role in the global provision of higher education in the future. And these developments will allow Australian higher education providers to leverage high speed broadband to build capacity in the provision of online education offerings, thereby creating global export opportunities. Universal national access to high speed broadband and growth in broadband-supported delivery of higher education will also allow Australian universities to address existing educational disparities in Australian society.

Finally, it is worth noting that, with appropriate privacy and confidentiality provisions in place, NBN-enabled educational activities provide fertile ground for data capture to support higher education research, an area in which there is currently insufficient national or international investment.

Research

As a leading research institution, the University of Melbourne is involved in a broad portfolio of research initiatives both nationally and internationally. Almost all contemporary research endeavours are directly dependent in some way upon information technology and often are only possible through targeted computational infrastructure support. Uses include:

- Email and internet access for communications and research purposes;
- Library services, including access to academic journals and scholarly databases.
- Providing access to large-scale high performance computing (HPC) facilities;
- Supporting access to a wide range of heterogeneous domain specific or inter- and multi-disciplinary related data sets;
- Utilising High Definition tele-presence systems to enable researchers to efficiently and effectively conduct research projects with rural and interstate subjects
- Offering secure environments where inter-organisational collaborations can occur.

Many research disciplines are now producing increasingly large data sets with Petabytes of data and beyond not uncommon. This trend is expected to continue to increase exponentially, especially with automated data production now used extensively, e.g. in post-genomic life science research and future personalised e-health scenarios. HPC facilities are also growing in capacity with Petaflop supercomputers now increasingly common, with the potential to generate increasingly large data sets (and intermediate data sets). Visualisation of such data is often the only possible way to extract knowledge and understanding and given the distributed, collaborative nature of research, such visualisation will need to be delivered to the research desktop. In all of this, there are increasing demands and expectations being placed on the underlying network in that it will scale with the research capacity and demand – and that it will continue to do so.

ICT Research at the University of Melbourne

As an illustration of the depth and breadth of ICT-rich research in Australian universities, we enumerate here some of the major concentrations of such research occurring in the major research institutes and Centres of Excellence in and around the Parkville Precinct. Many of these research centres and collaborations rely on ICT infrastructure, and core research activities relate to broadband applications and services in some way. These centres, institutes and collaborators include:

- **Australian Urban Research Infrastructure Network** is developing national research infrastructure to increase our understanding of urban resources, use and management.
- **Centre for Energy-Efficient Telecommunications** focusing on a broad range of telecommunications network infrastructure and its elements and explores how those elements can be made more energy efficient.
- **Centre for Spatial Data Infrastructures and Land Administration** designs, builds, and tests land administration systems and SDIs in the context of developed and developing countries.
- **CRC for Spatial Information Systems** aims to accelerate the uptake of spatial information in key end-user domains, and spawn innovation and productivity advances in key industry sectors, including – agriculture, natural resources and climate change, energy and utilities, health, defence and sustainable urban development.

- **Department of Computer Science and Software Engineering** has research strengths span six major focus areas: Autonomous and Intelligent Systems, Computational Medicine, Declarative Languages, Knowledge Discovery, Parallel and Distributed Computing, and Software Engineering.
- **Department of Electrical and Electronic Engineering** has strong specialist research interests in Neuroengineering, Signals and Systems, and Telecommunications.
- **Department of Infrastructure Engineering** is dedicated to solving the major challenges facing societies around the world in the environment, physical infrastructure and spatial information.
- **Department of Information Systems** studies the interaction between people and technology. The departments research strengths are in interaction design, health informatics and the organisational and social aspects of information systems
- **Florey Neuroscience Institute** studies a variety of disease states such as stroke, epilepsy, Alzheimer's disease, Parkinson's disease, multiple sclerosis, Huntington's disease, motor neuron disease, traumatic brain and spinal cord injury, depression and addiction. The Institute is a world leader in imaging technology, stroke rehabilitation and epidemiological studies
- **Institute for a Broadband-Enabled Society** aligns research and industry interests to drive innovation in broadband applications to deliver seamless experiences for all Australians.
- **ARC Research network on Intelligent Sensors, Sensor Networks and Information Processing** works with researchers from around the world to address multi-sensor problems to develop intelligent, economically viable solutions of value to defence, critical infrastructure, health sciences and the environment.
- **Melbourne Brain Centre** is developing a deeper understanding of the brain, including neuro-imaging. Just one digital Magnetic Resonance scanner will generate 60Tb of raw data per annum.
- **Melbourne Systems Laboratory** has strong links with industry and other research organisations both within Australia and internationally. The laboratory has research strengths in signal processing, sensor scheduling, situation awareness, distributed sensor networks, adaptive sensor systems, and bandwidth constrained sensor fusion
- **National eResearch Collaboration Tools and Resources** objectives are to enhance research collaboration and research outcomes by providing ICT infrastructure that creates new information centric research capabilities, to simplify the combining of instruments, data, computing, and analysis applications
- **National ICT Australia Victoria Research Laboratory** research focuses on significant problems of national interest where ICT is a vital part of the solution. NICTA tackles complex problems in the areas of health, water management, transport infrastructure, and communications networks.
- **Peter Doherty Institute** brings together the expertise of leading biomedical scientists, public health specialists and educators focused on infectious diseases and immunity.
- **Victorian Life Sciences Computation Initiative** is a supercomputing program and facility that will lead to major improvements in public health outcomes in the areas such as cancer, cardiovascular and neurological disease, chronic inflammatory diseases, bone diseases and diabetes.

- **eResearch support at the University of Melbourne** provides high performance computing capacity; central research data storage; advanced visualisation through an OptiPortal, and direct involvement in a range of major eResearch projects
- **Health Informatics** improves health care by using information technology in innovative ways to collect, analyse and manage health information.
- **Victorian eResearch Strategic Initiative** is accelerating and coordinating the uptake of eResearch in universities, government departments and other research organisation and delivering embedded technologies and adaptable models that foster multi-disciplinary collaboration, lower barriers, and encourage the development of cross-institutional services
- **IBM Global Research and Development Lab** is combining research and development in the one facility and the first to be aligned with a university. The lab will ultimately bring together 150 IBM and University researchers and 40 PhD studentships.
- **Victorian Comprehensive Cancer Centre** will drive leadership and innovation in the fields of cancer treatment, research and education by having the largest concentration of cancer clinicians in the southern hemisphere, ranking it among the top ten cancer centres in the world.

Contemporary research produces a vast amount of data. High-speed broadband will enable research organizations to disseminate that data widely fostering collaboration and driving the next generation of scientific discovery. The University of Melbourne conducts strong research across a range of disciplines, including the life sciences. Below is a representative example of some of the research data demands within the life sciences:

- The **Bio21 Institute** maintains several high end and high throughput platform technologies for use by local and external research communities. These include a range of advanced analytical instrumentation that generate large amounts of data. For example, a single electron microscope can generate as much as 20Gb of data per hour when acquiring a tomogram. The Institute supports 27 laboratories from 7 institutions, as well as numerous industry partners. Bio21 plans to increase its research footprint by 50 percent in the coming years; part of this will be from the new Systems Biology Institute. By 2014, the expected data storage amounts will be over 400 Terabytes.
- The **National Metabolomics service centre** focuses on all areas of technology for small molecule analysis with the aim of providing access to world leading advances and technology for academia and industry across the country. Customers and collaborators include the Australian Centre for Plant Functional Genomics, the Australian Wine Research Institute in Adelaide, and universities across the country. The centre's storage demand is predicted to be 100 Terabytes by 2014.
- The **Parkville Precinct** around the University of Melbourne hosts a range of next generation gene sequencing platforms. These sequencing platforms provide the basis for international collaborations with major sequencing centers in the United States, United Kingdom and China. One of these platforms can generate around 500 Gigabits of data that needs to be analysed, doubling the data again.

The growth of data arising from research is both a local challenge and one that is placing increased demands on underlying networks. These national level projects involve research expertise across Australia. Without high-speed broadband the movement and transport of such data sets will become prohibitive in the foreseeable future.

Increasing demands are also arising from the international collaborations undertaken by researchers at the University of Melbourne. Examples include the ENSAT-CANCER project that is developing a complete virtual research environment for research into adrenal cancers with research partners in Europe and the AustralAsiaDS facility for research into disorders of sex development.

Numerous other major national and international projects such as the Human Variome project, the Large Hadron Collider, the Square Kilometer Array and the International Virtual Observatory produce vast amounts of data for researchers across the globe to analysts. These projects rely upon the timely delivery and transport of research data across high-speed broadband networks.

The University of Melbourne has recognized the local need for capability and support to cope with the data deluge facing many research disciplines - both now and in the immediate future. A \$2m centralized research data storage service has been rolled out to the University of Melbourne research base. This currently offers 400TB of research data storage however it has been specifically designed to be scalable. A further \$23m is being invested to build a research-focused high density data centre in Parkville, which will host many key Parkville Precinct and national initiatives such as the VLSCI. However it is fully recognized that these on-going efforts are dwarfed by the data storage needs facing many disciplines.

In addition to this, the University of Melbourne currently has an on-going \$30m network program to overhaul and modernize the local and wide area networks. This will deliver 10Gbps fibre core network across the university and beyond, e.g. a new 10Gb connection has recently been rolled out to the Austin Hospital. Such local/regional investments in the network whilst essential are a small part of the overarching challenge in supporting the national and international research demands of the university.

Potential for innovation in research

The University of Melbourne has the capacity to drive innovation in research through high-speed broadband. Some examples of how this can be achieved include:

- Tele-presence and video conferencing applications that enable collaboration between researchers. For example, leading researchers from around the world could present an invited lecture at the University or engage in discussion with research colleagues.
- Collaborative interactive visualizations of large data sets facilitating real-time data modeling and observation of emergent patterns within complex systems.
- Augmented reality applications based on high-resolution imaging to visualize complex structures, such as the unseen aspects of clinical environments enabling students to see through limbs and organs by overlaying biomedical features.
- Smart information systems that sense collect and integrate data to provide relevant information to end-users. For example, remote soil moisture monitoring systems.
- Dissemination and access to data sets, although it should be noted that some data sets for research purposes are too large to economically transmit over broadband infrastructure.

Engagement

The University of Melbourne is also committed to closer collaboration with industry and to public and community engagement at many scales and in many forms. Opportunities for engagement are threaded through many of the university's research and teaching and learning activities. And just as high speed broadband removes the dependence on proximity for high quality educational experiences, so it extends the reach and potential impact of outreach and engagement activities. We do not enumerate here the many ways in which such impacts could be realised, but note the potential step change that high speed broadband would provide in the capacity for Australian universities to reach across distances to create partnerships in the public interest. Such partnerships could be devoted, for example, to promoting health, connecting communities, supporting innovation and enhancing education.

Conclusion

As for many of Australia's research-intensive universities, the University of Melbourne's students, researchers and academics currently rely heavily on broadband technologies for communications, collaboration and learning. The availability of faster and more ubiquitous broadband services will enable the development of new applications, including a reliance on video distribution for the delivery of teaching services and collaborative activities.

Significant investment will be needed to ensure that the networking capabilities brought to bear by NBN are matched with investment in higher layer technologies that will enable the deployment of broadband applications for use in higher education.