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Inquiry into the role and potential of the National Broadband Network

House Standing Committee on Infrastructure and Communications

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Executive Summary

The Australian Government's National Broadband Network (NBN) aims to deliver broadband communications to Australians by connecting 100 per cent of homes, schools and businesses with advanced telecommunications infrastructure. A total of 93 per cent of premises will be connected using fibre to the home (FTTH) technology initially offering data speeds of 100 megabits per second (Mbps) and supporting future enhancements in excess of 100 Mbps. The remaining 7 per cent of premises in Australia will be connected using terrestrial fixed wireless or satellite wireless technology as appropriate. This will unlock previously impossible opportunities in communication, connection and instrumentation. In addition, major international scientific infrastructure projects such as the $2 billion future Square Kilometre Array site decision rests, in part, on the availability of broadband communications in Australia.

The high-speed telecommunications infrastructure will be transformative due to the high potential value in the services that will run across the network. CSIRO has recognised this potential and recently launched the Australian Centre for Broadband Innovation (ACBI) in partnership with the NSW Government and National ICT Australia (NICTA) to develop, trial and verify the value of new broadband applications and services. Whilst modest in scale, ACBI will serve as a focal point to investigate the delivery of broadband services to regional Australia.

The future transformative impact of broadband communications , including internet access, is, to some extent, unknown. Research programs can conduct pilot activities to evaluate broadband applications, particularly those that cannot run on existing broadband networks. These activities will help to identify new value propositions and business models built around high-speed, reliable, ubiquitous, 'symmetric' communications.

This submission will present a brief assessment of the technology being used in the deployment of the nation's new broadband infrastructure. It will suggest benefits that we believe will accrue from the infrastructure investment in areas of Government services (including health, education and social inclusion) and industry, and support these suggestions with current and past work that has been undertaken since 2000 by CSIRO using experimental broadband networks.

Technical background

The Australian Government's National Broadband Network (NBN) aims to deliver broadband communications to Australians by connecting 100 per cent of homes, schools and businesses. A total of 93 per cent of premises will be connected using fibre to the home (FTTH) technology, initially offering data speeds of 100 Mbps and supporting future enhancements in excess of 100 Mbps. The remaining 7 per cent of premises in Australia will be connected using terrestrial fixed wireless or satellite wireless technology as appropriate. It is likely that high speed broadband will offer a transformation at a scale similar to that which followed the introduction of the electricity grid and railway networks in Australia creating new business opportunities of considerable economic value.

Key benefits of the broadband infrastructure being deployed in Australia include:

- High speed access with connection speeds of 100 Mbps and beyond will enable a new high definition, immersive experience previously not possible on existing Australian public networks. This opens the way for **new methods of delivering services** including tele-presence for social and business purposes, enhanced entertainment, as well as interactive and meaningful delivery of eHealth, eEducation and eGovernment.

- The universal nature of the connectivity will support **inclusiveness and greater community participation** and real-time interactivity, irrespective of location, addressing the 'digital divide' between regional areas and cities. The ubiquity of access will allow for electronic delivery of services to all Australians and will address the nation's perennial challenge of the "tyranny of distance".

- The ubiquitous nature of the network connecting to homes, schools, hospitals, farms and public buildings has the potential for **new types of service and new business models** for education, healthcare, entertainment, electricity management, environmental management and many others.

- The 'symmetric' nature of the new network will allow people, irrespective of location, to **contribute to content and service creation.** This may range from simply being able to participate in high quality video conferences, to generating and offering content in entertainment, education, digital media, specialised skills training, management and many other areas including supporting home-based SMEs.

- These factors combined will allow people to contribute to, and benefit from, the growing range of 21st century services irrespective of where they live. By removing some of the barriers associated with living in rural and regional Australia, this in turn may **help to reverse the trend towards increasing urbanisation** in Australia

To allow the benefits outlined above, the network will have three important characteristics:

- High data rates
    - **FTTH (Fibre to the Home)** The service offered by the NBN Co has the potential to operate up to 1 Gigabit per second (1000 Mbps), compared with current Asymmetric Digital Subscriber Line (ADSL) technology that may operate up to 20 Mbps. This increase in data rate will enable more powerful applications that are data-intensive.
    - **Terrestrial wireless** - Technology decisions are yet to be made regarding the terrestrial fixed wireless (this is the direct wireless connection from a base station to the premises) technology to be used by the NBN Co. The NBN Co has stated that a minimum of 12 Mbps downlink (to the home) and options of 1, 2 or 4 Mbps in the uplink (from the home) will be possible. As this technology will be used to service areas beyond the fibre network which are typically in sparsely populated areas that may only have access to dial-up or mobile data services, this will represent a significant improvement in data rates currently available.
    - **Satellite** The NBN Co has indicated a 12 Mbps downlink and 1 Mps uplink will be possible for satellite users. Satellite technology will be used to provide

connectivity in remote areas and the data rate proposed will offer a significant improvement to telecommunications services. As a result, a greater range of applications and services will be available to users in remote and rural and Australia such as health, education, news and entertainment.

- Symmetry (relative data rates in the uplink and downlink)
    - Applications are becoming more interactive, however their scope and potential is effectively limited due to asymmetry of data rates of 'cable networks' such as ADSL and Hybrid Fibre Coaxial (HFC). In asymmetric networks, much higher data rates are provided for download than for upload. A typical connection may have a peak download data speed of 20 Mbps but only be able to upload data at a speed of 1 Mbps. The FTTP technology being offered by the NBN will provide up to 100 Mbps download and 80 Mbps upload. Greater symmetry will support applications with greater interactivity (particularly video-related applications for business, health, education, and entertainment). Greater symmetry will also allow greater community engagement as people will have a network that enables high quality video, audio and data to be sent from the home. In order to ensure all Australians benefit from the NBN, symmetry (or as close as possible) of data rates should be a goal for users of fibre, wireless or satellite connections.

- Ubiquity
    - The Government has announced it will connect 100 per cent of premises. The immediate impact will be to bridge the 'digital divide', supporting greater inclusiveness by making available a guaranteed level of broadband connectivity to all Australians. As a result of being able to reach all, or a greater part, of the population, new forms of service delivery become feasible. Government and industry will have the potential to reach all Australians using current and yet-to-be-developed electronic services. The NBN also has the potential to create the opportunity for all Australians to generate content a benefit that will support new businesses and enable greater sharing of information with the broader community.

Terms of Reference

The delivery of government services and programs

The electronic delivery of government services over a high-speed network would provide benefit in the following areas:

- Enhanced service and customer satisfaction while reducing costs through delivery efficiencies
- Delivery of a full range of electronic services in remote areas; and
- Improved 'on-the-ground' service delivery,

Enhanced service and customer satisfaction while reducing costs through delivery efficiencies

The term 'tele-presence' is used to describe high definition, high frame rate, low latency, immersive video conferencing facilities. The experience for the user is similar to being in the

same room as a person or group at the other end of the communication link. Such services typically cannot operate over ADSL links as they require high bit rate symmetric networks of the order of tens of Mbps.

A network that provides broadband communications will make the provision of tele-presence service between government offices, homes and other public locations (such as post offices and hospitals) possible and readily available. Multi-casting and the broadcasting from a central office to many sites also becomes possible. Early tele-presence systems were expensive costing over $300,000 per installation. Prices have fallen rapidly in recent years and we now see commoditisation of this type of technology to the point where it could support working from home, or 'tele-working', situations [Cisco].

As an example, in a government service setting, customers visiting a Centrelink office could talk with the expert for each specific customer case, anywhere in the country. Whilst this does not remove the need for the presence of the Centrelink officer, it does remove the need for the officer or the customer to travel, possibly substantial distances. It also allows people with different skills and experience to be connected to customers with particular needs anywhere in the network. The customer experience will be similar to having the customer and the service officer involved in a private face-to-face consultation. The involvement of an expert, regardless of the location, in solving the customer's problem will result in faster and better service quality. Better utilisation of government expertise and personnel around the country may also reduce customer service costs. Use of the broadband communications networks combined with tele-presence technology will allow government agencies to scale-up the quality and efficiency of service delivery at the front office and potentially in the customer's home, office, and other third party locations.

The NBN has the potential to enhance services in the health field. The network would allow the provision of expert medical specialist opinions to medical clinics that do not have the full suite of specialist services.

Tele-presence systems in the home could also support people working from home for part of the week. Such a change would have positive environmental impacts and may lead to productivity savings through reduced commuting.

Delivery of a full range of electronic services in remote areas

Many State and Federal government agencies provide electronic services via web-based portals that allow their customers to request and gain access to a wide range of services. Centrelink, for example, provides a selection of employment services via their website. Many remote areas in Australia lack an internet service that is sufficiently reliable and responsive to support such service delivery. Universal high-speed internet access could address this problem and, with its increased data rate, improve the range and depth of electronic services available in remote areas.

At present, many government services involve portal technology with text messaging and downloading of forms. High-speed internet access would allow this to be augmented with tele-presence as well as voice and streaming video to illustrate services and deliver information. These internet service improvements would allow electronic service delivery to become a viable and more satisfying alternative than travelling to the nearest government office.

High-speed, reliable communications also offer the opportunity to create a wider and broader set of on-line business services specifically for regional areas. For example, the banking industry is able to deliver many of its services online. This may be an effective strategy to address the implications of ongoing closure of regional branches and the reduction of face-to-face services.

Improved 'on-the-ground' service delivery

The NBN has the potential to operate offer important benefits for local service delivery. For example, typically health records and data are kept locally at hospitals and general practitioner (GP) clinics. With a more mobile workforce and population, broadband communications will allow health data to 'follow' patients. It will allow immediate data access, combining the customer records from all locations, resulting in better service delivery with fewer errors and better outcomes.

In addition, broadband communications could enable service delivery staff who are travelling in the field to access virtual office desktops with a full suite of software, service tools and information. This access could be provided from the customer's home, workplace or connected locations such as a kiosk or internet café. By allowing timely access to the right information and reducing paperwork, the NBN has the potential to offer the opportunity to improve the quality of service delivery.

Achieving health outcomes

It is possible that health services will be the largest beneficiary of high-speed broadband. Such networks will be a key enabler of the eHealth architecture that is currently being established in Australia. The combination of eHealth architecture with a high-speed network is likely to stimulate the development of innovative new services and healthcare solutions.

For the health service industry, high-speed networks will allow the provision of services into non-metropolitan areas which are currently not available. Some examples of innovation in healthcare currently being developed by CSIRO are described below.

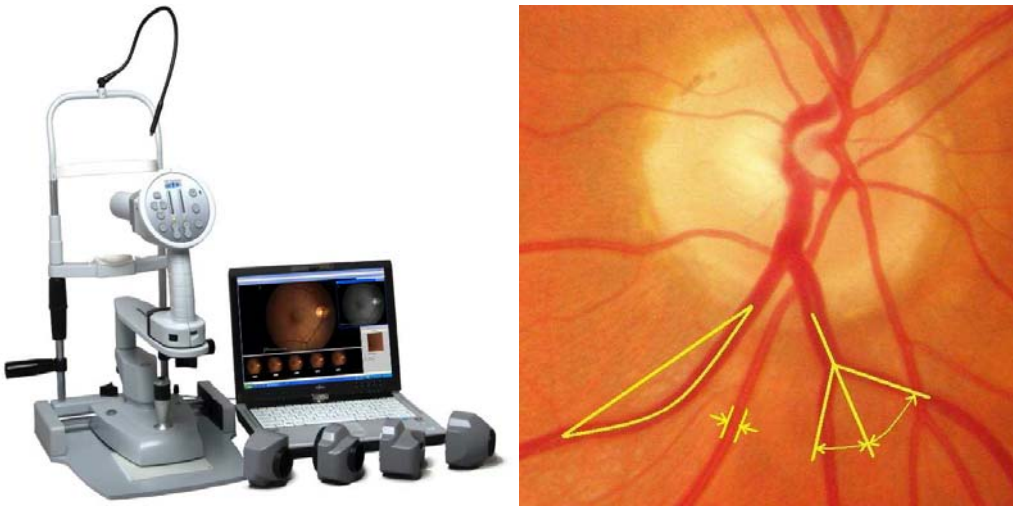
Remote eye-care

In 2009, almost 575,000 Australians were blind or had vision problems. Many of these people live in regional areas. Screening is a major contributor to disease prevention, and a national broadband communications network will support the delivery of telemedicine-based eye screening programs for sight threatening diseases such as diabetic retinopathy (DR) and Age Related Macular Degeneration (AMD).

A tele-ophthalmology service is currently being developed by CSIRO using leading edge, computer-aided ophthalmic diagnostic image analysis technologies as well as commercially available rental scanner devices. The system will allow healthcare professionals (nurses in the first instance) to perform screenings for eye disease in Port Hedland, Western Australia, and then seek specialist consultation as needed from an ophthalmologist in Perth who decides on the course of action. In addition to providing the remote ophthalmologist in Perth with a 'real-life experience' through an immersive video conferencing environment using 3D images and patient interactivity,, the system will enable the upload of images, videos and

medical history using a web-based diagnostic system (with Electronic Health Records) that can be read by other ophthalmologists.

This technology enables regular screening and will help to reduce the burden of crippling eye diseases. With broadband infrastructure, this type of service delivery model could be expanded nationally, and include more sophisticated eye diagnosis and other types of health service delivery.



Tele-ophthalmology has the ability to detect changes related to a range of conditions.

Tele-presence for remote specialist consultation

CSIRO has been active in the development of broadband tele-presence systems for healthcare for the past ten years. The Remote Immersive Diagnostic Examination System (RIDES) [RIDES] is just one example of a broadband application for tele-health.

Remote Immersive Diagnostic Examination System (RIDES) specialist and client suite

The RIDES system provides an immersive, high-definition specialist consultation overcoming the need for travel by a specialist or the need to pre-emptively transport patients long distances. Apart from high quality video and audio, the system allows high quality image exchange, data exchange and three-dimensional (3D) viewing of the patient. The

system also allows the specialist to project their presence by remote use of laser pointing and marking devices.

RIDES – use of remote laser pointing and marking devices

This system requires a symmetric connection of 30 to 50 Mbps to and from the patient. This is not possible with current ADSL or HFC networks. Costs for the equipment required for this type of system are falling and it is possible that, in future, this type of technology will either run on home entertainment systems or be a module that healthcare providers can deliver to a patient's home and connect to a high speed broadband network.

Such a development also has the potential to reduce the demand on aged care services. For example, the use of remote health monitoring and 'always on' high definition video, audio and data communication available in the patient's home may delay their need to move to full-serviced residential aged care.

In all trials of the RIDES technology, CSIRO has established its own broadband network (100 Mbps uplink and downlink). This is expensive and the costs of the broadband connections required for these systems restricted the deployment of specialist care especially in non-metropolitan areas where these solutions would have the greatest impact. For example from 2004 to 2006, CSIRO in partnership with NSW Health, developed the Virtual Critical Care Unit (ViCCU) [VICCU]. ViCCU was successfully trialled between Katoomba and Lithgow hospitals. In the 18 month clinical trial of the system, there were 443 documented activations. This trial was independently evaluated by the Centre for Health Informatics at the University of NSW.

The ViCCU system was an outstanding success, however, it was not rolled out across the state, due to the lack of a broadband communications network. A national high-speed network will reduce network connectivity costs and will stimulate the use of such tele-health technologies.

Care assessment and rehabilitation programs to the home

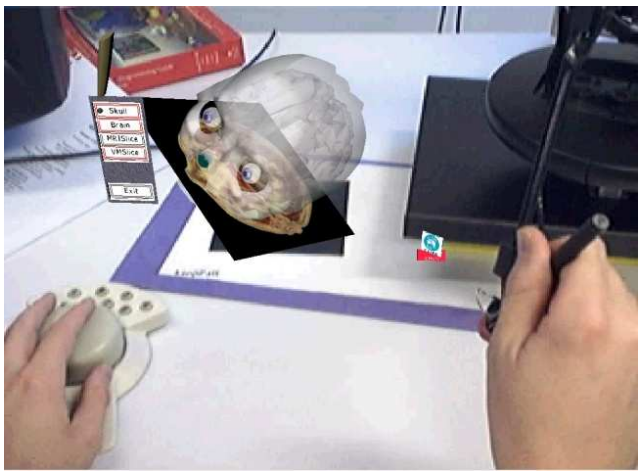
High speed communications will also provide opportunities for health service consumers to directly interact with the health providers from their home. For example, CSIRO has recently developed and trialled a Cardiac Rehabilitation Program which is delivered by mobile phones and through a web portal. The aim of offering the program in this way is to double the number of patients completing a rehabilitation program after a heart attack. This system has the potential to save $50 million per year in readmission costs alone in Australia [Deloitte]. The range of possible applications, similar to the Cardiac Rehabilitation Program, is huge.

This mode of health service provision could readily be extended to treat chronic illness, diabetes and support aged care. The key to the development of such applications is that they are interactive, this will require ubiquitous broadband communications connectivity to all homes.

Improving the education, resources and training available for teachers and students

The tele-presence technologies such as the Remote Immersive Diagnostic Examination System (RIDES) system are platforms that can be adapted for education purposes. This type of system would enable a specialist course to be available in rural areas where those courses are not offered due to availability lack of qualified teaching staff or demand for the subject. CSIRO is in discussions with the ANU Medical School to use the RIDES platform in the delivery of its rural GP medical program.

Tele-presence technologies will also be useful in vocational training for fields such as engineering, manufacturing and other related technical training that could benefit from using high definition video, shared images and data. CSIRO is working with mining and aviation companies on 'augmented reality systems' for the next generation of training systems. Augmented reality systems project additional computer-generated information into a training session. The augmented reality functionality is supplemented by haptic (a sense of touch) feedback. Augmented reality system being developed by CSIRO and others will become increasingly available but adoption of such system will be constrained by bandwidth limitations. Augmented reality systems require high data rates (typically 20-100 Mbps).



Augmented reality brain anatomy tutor, showing horizontal slice from the Virtual Human data set.

The management of Australia's built and natural resources and environmental sustainability

Sensor networks

The ubiquity of the broadband network will support the more wide spread deployment of sensor network across Australia.

Only value-intensive industries, such as mining, have been able to exploit the use of sensor networks for remote operations and remote analysis of day-to-day business, as well as the monitoring of long-term trends in remote locations. One of the large cost factors with such operations is the need for high bandwidth communication. As increased bandwidth becomes available and access ubiquitous, the concepts can be transferred to other industries and sectors, such as agriculture, infrastructure monitoring or environmental protection (including disaster warning and management). The increasing use of richer information sources, including audio and video, creates additional demand for high bandwidth access even for simple monitoring activities. The NBN could have significant benefits for sensor networks that can operate as early warning systems to alert communities about algal blooms, pest outbreaks, natural disasters such as floods and bushfires, environmental accidents such as contamination of drinking water; or terrorism events such as poisoning of a major water supply.

Agriculture applications

CSIRO has recently worked with dairy farmers in the South Esk region in Tasmania to continuously monitor soil moisture to improve irrigation. In this project farmers were able to optimally irrigate their fields to gain the best growth in pastures whilst minimising water usage. CSIRO has deployed sensors at Lake Wivenhoe Dam in Queensland to monitor water column temperature and catchment health. This project allowed the operators of the dam to control the quality of water supplied to the city of Brisbane. This type of sensing technology can be adapted to sense many other parameters such as water levels, temperature changes and video surveillance of traffic and other assets. With the addition of adequate network reach, remote control of valves, switches or other actuation devices will be possible.

Tele-operation and tele-farming

While Australia is blessed with abundant natural resources, our food production is particularly vulnerable to both environmental and social factors. Today there is already a shortage of fruit pickers, due to low wages and seasonality of requirements. Often our food production is in regional locations, where the mining sector is competing for the traditional labour force.

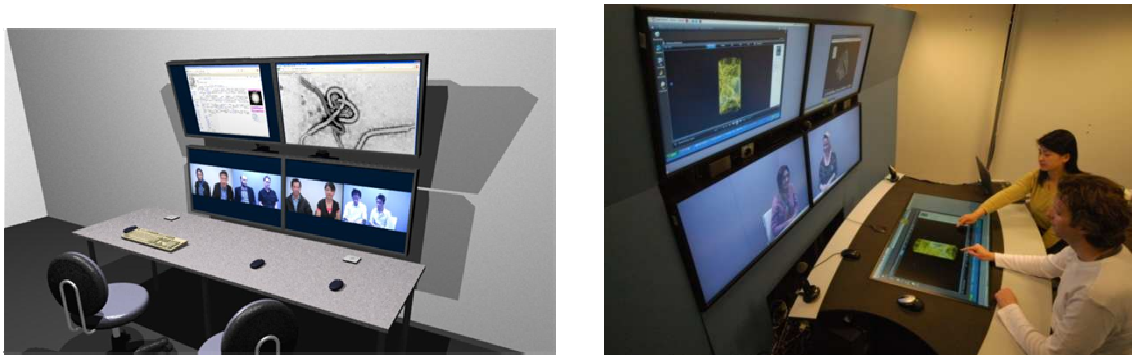
One possible solution is to use broadband communication networks to facilitate tele-farm workers to harvest fruit or other crops -that is, an 'at-home' workforce used to supervise semi-autonomous farm machinery. Agriculture is already using GPS-controlled farming machinery for tasks such as harvesting and ploughing. The provision of broadband will expand the possible applications that could be automated. Similar concepts have already been demonstrated in the mining industry with CSIRO Minerals Down Under Flagship completing successful trials of remotely-operated rock-breaking equipment and by remotely operating the loading of iron-ore into ships.

More connected farms

Food security relies upon arable land, suitable crops, availability of water, effective pest management and an ability to harvest the crop. High-speed network infrastructure could be used to provide the backbone of a whole-of-farm sensor network, providing an enabling environment to allow others to develop new methods for pest detection (and potentially control) and development of new harvesting techniques using robots or automated or semi-automated farming equipment. Additionally, it will also allow farms to access the latest government and industry information, such as weather and climate information and market data that will inform and improve decision- making on farms.

Broadband for biosecurity

Communication is essential for emergency responses. CSIRO Australian Animal Health Laboratory (AAHL) is a frontline biosecurity defence, helping protect Australia from the threat of exotic and emerging animal diseases. CSIRO has a developed a tele-presence system tailored for the needs of biosecurity scientists that supports the communication and sharing of information that was previously not possible [BIO]. This system will eventually be deployed around the country to monitor and manage disease outbreaks with high resolution communication, laboratory analysis and geospatial information. While this system will focus on exotic and emerging animal disease, such as the recent outbreak of avian bird flu, similar systems are envisaged for human health applications. With a ubiquitous high-speed network, this type of technology could be made more widely available to the agribusiness industry, not only for biosecurity, but to share information about methods for improving productivity.



Biosecurity Containment Platform

Energy applications

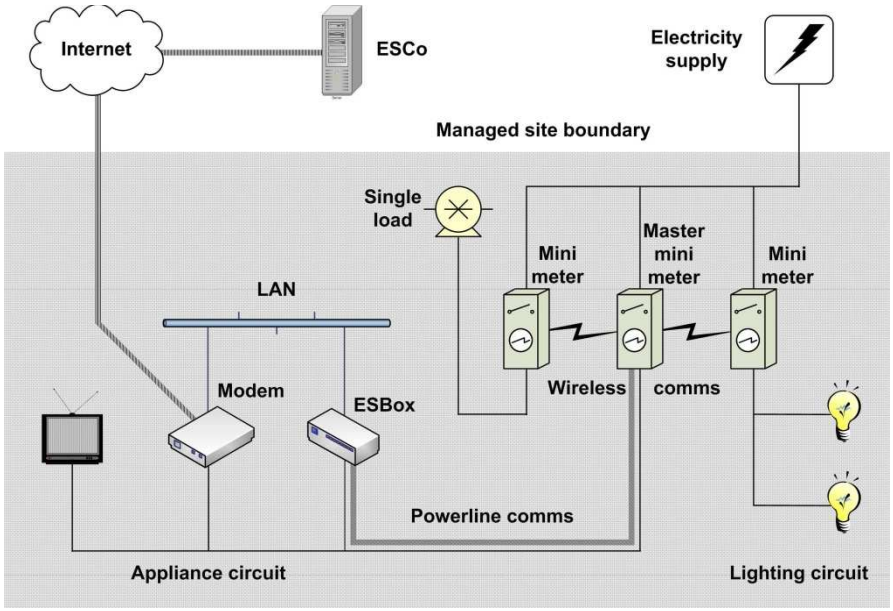
A ubiquitous broadband network can also improve energy management. This type of technology is commonly referred to as a 'smart grid'. Through a ubiquitous broadband network, all premises could be connected with a network interface device. This infrastructure provides a possible data connection via the wholesale network to the energy network companies.

CSIRO undertakes extensive research to solve energy challenges for Australia. This includes the integration of renewable energy into the electricity grid; using diesel, gas and other generation for small-scale distributed energy systems; local energy storage; electric vehicle integration; and home energy management systems. CSIRO is investigating systems that can switch high energy-use appliances in homes and small businesses on and off depending on the load on the network, price of electricity and preferences of the customer. Such a change

requires a whole-of-network approach, including integration with thousands of components in the grid that need to be monitored and controlled. Smart grids will become increasingly complex with high data flows. While the data required per site is small, when aggregated these data flows are significant and will require broadband infrastructure.

Creating a smart grid offers many benefits, including smoothing demand peaks, thereby minimising energy costs and blackouts; reducing the need for new infrastructure; and, ultimately, a reduction of greenhouse gas emissions.

CSIRO is also developing a Residential Scale Energy Management System [RSES] illustrated below. Energy Service Companies (ESCo) would work with large energy consumers to reduce costs through greater efficiency and by aligning consumption with market signals. Currently, small-scale consumers do not have the same opportunity as the financial benefit would not offset the costs. However, using common broadband internet connections, it is now possible to build and deploy a cheap, real-time platform to deliver energy services to individual dwellings. Consumers would sign-up to the provision of services by an ESCo, that would monitor and control energy demand within the home through a broadband network.



Energy Services – Simplified System Model

Impacting regional economic growth and employment opportunities

Faster and more ubiquitous broadband access will enable new technologies to be deployed in regional areas, providing the potential to stimulate economic growth and employment opportunities. Previously in this submission we discussed the delivery of services *into* regional and rural Australia in areas such as education, health and other government services. Broadband communications will also allow services to be provided *from* regional and rural areas to cities, other parts of Australia, or the world. For example, the delivery of distance

education services by universities, such as the University of New England, could be improved through high-speed broadband.

Tele-presence technology will also allow workers to operate remotely and feel as though they are in the same room as their co-workers. Files will be able to be shared, discussions held and resources such as storage and computing shared through 'cloud' resource sharing. For example, CSIRO has been developing technologies for remote operation of mining equipment from across the country and even to other parts of the world. This provides a safer working environment by moving the operator away from dangerous equipment and removing the need to support staff in remote locations. Tele-operation will not be limited to mining, but could apply in many other sectors. Skills can be applied from regional Australia wherever there is a need or market for them.

Mining applications

CSIRO has a long history of developing autonomous and remotely-controlled systems for mining operation, helping to improve safety and efficiency of mining operations. The long-term goal has been to develop a framework that links different, and potentially reconfigurable, mining equipment with minimal human operator intervention to accomplish major tasks in mining. The monitoring and direction of these systems depends heavily on high-speed, reliable communications. Applications have been developed in swing loader systems, dragline systems, excavator guidance systems, excavation systems, automated explosive systems for underground metalliferous mines, and long-wall mining automation [QCAT].

Researchers have also developed technologies that will enable the effective and safe tele-robotic control of mining equipment over distances of thousands of kilometres. As an example, Rio Tinto Iron Ore Automation Group commissioned CSIRO to design and install a tele-robotic control system to the primary rock breaker at the West Angelas iron ore mine, 110km west of Newman in Western Australia. The technology has been proven at the West Angeles iron ore mine, which was controlled by an operator over 1,000 km away in Perth.

The ability to remotely control mining equipment delivers benefits by removing people from hazardous and inhospitable working environments, as well as opportunities for increasing efficiency, productivity and profitability in mining. Traditionally, remote operation in this industry has involved video being transmitted to a remote operator who makes decisions based on the visual evidence and responds by commanding the equipment to take action (i.e. tele-operation). Unfortunately, for many mining applications, this type of interface does not offer the human decision-maker sufficient situational awareness to effectively maintain manual production levels. This means that there has been, until now, limited economic benefit for remote operation of mining equipment (remote mining) over traditional in-situ operation.

The feasibility project for Rio Tinto has now been completed, demonstrating a successful technology transfer from research to practice. This technology requires high speed broadband to operate effectively. A ubiquitous network will enable more innovative applications, and can move towards unmanned mining, which will have significant economic and safety benefits.

CSIRO's - Rock breaker solution in operation

The high-speed national network infrastructure will allow new levels of tele-work, as connections to the home will be similar to company network connections. CSIRO appreciates that there are social and management issues that must be considered, however, it is technically possible for staff in certain sectors to work productively remotely from the office. Tele-work may have an impact in regional areas. If productivity is similar, in- or out-of-the-office workers can be employed regardless of location. This implies that skilled workers can be part of rural communities without the need to relocate to the cities for employment and this may maintain or improve the communities in regional and rural Australia. .

Taking advantage of the 'cloud' - Impacting business efficiencies and revenues, particularly for small and medium business, and Australia's export market

High-speed communications infrastructure has previously been difficult and expensive for this industry sector to access. A ubiquitous high-speed network will allow for collaboration between SMEs and would contribute positively to national productivity growth.

High Speed Broadband will provide the infrastructure necessary for many Australians to take advantage of 'cloud' computing [CLOUD]. Access to symmetrical high speed networks will allow storage, computing and other business services to be accessed for a fee without the need for companies to purchase and maintain their own IT infrastructure.

While this will reduce the costs of business across Australia - particularly for SMEs - it will also allow regional and rural operators to compete using IT infrastructure that is up-to-date and at the same, or similar, price as city businesses.

For example, broadband tele-collaboration technology has proven to be highly effective when used by the motion picture post-production industry. During 2005 to2007, CSIRO trialled early versions of 'cloud' computing and resource sharing by connecting Australian SMEs involved in film post-production into a virtual community using CSIRO's high speed network (1 Gbps).

CSIRO worked with the companies developing technologies that enable dynamic collaboration with security to improve productivity. Typically, in the post-production motion picture industry, SMEs come together to collaborate on projects such as a particular film, that requires them to share data (motion picture clips) and collaborate to produce special effects by using common facilities such as computer rendering farms to produce 3D effects. The collaboration technologies that were developed allowed the SMEs to connect electronically and only share the data that was relevant to the project and restrict access to other data and systems.
There are issues that need to be considered with the implementation of cloud infrastructure including security, data ownership, business cessation issues, off-shore storage, and legal ramifications. Cloud computing, while providing a new computing paradigm, will also require a new legal and business framework..

CSIRO is investigating the issues and challenges associated with broadband-enabled cloud services, and is using an outreach program to communicate the insights to government, business and the general community.

The driving forces behind cloud services are:

- Significantly reduced Total Cost of Ownership (TCO) of the required IT infrastructure and software including (but not limited to) purchasing, operating, maintaining and updating costs and timeframes.
- Pay-As-You-Go (PAYG) based low prices.
- High Quality of Service (QoS) provided by cloud service providers such as availability, reliability and dynamic resource-scaling based on demand.
- Easy access to organisational information and services anytime anywhere.

The 'cloud' provides a new paradigm for delivering computing resources (for example, infrastructure, platform, software, etc.) to customers on demand, in a similar fashion as that provided by utilities (such as water, electricity, gas, etc.). The current cloud computing architecture and software infrastructure enables clients to interact with computing servers and storage by providing layers of services:

- Software as a Service (SaaS) provisions complete applications as a service, such as Customer Relationship Management (CRM), email, etc.
- Platform-as-a-Service provides a software platform for developing other applications on top of it. An example of such a platform is the as the Google App Engine.
- Infrastructure-as-a-Service (IaaS) provides an environment deploying, running and managing virtual machines and storage.
- Technically, IaaS provides incremental scalability (scale up and down) of computing resources and nearly unlimited, on-demand storage.

Integration with research and development, and related innovation investments

Real-time observation is transforming our knowledge of the environment and leading to new discoveries in many areas of science.

In modern science many discoveries are made by reinterpreting and/or merging existing data sets. To do this, scientists use broadband infrastructure to:

- download large data sets for local processing
- upload data to large national facilities
- access large scale facilities for computational analysis and processing; and
- download visualisation results

CSIRO is using a variety of sensor networks in environmental monitoring applications. The sensor networks have been deployed in remote locations, with the data traffic generated per sensor varying from a few bytes to gigabytes. Broadband networks will enable the transfer of data from the sensors back to laboratories.

The Federal government initiative, Integrated Marine Observing System (IMOS), provides an example of a facility that gathers and stores data that can be use for such discovery. IMOS gathers data about the oceans around Australia and makes this available to the Australian research community. Data is collected and stored in regional facilities around the country by the research partners. The data is used to develop and refine ocean and climate models using national super computer infrastructure that is located in Melbourne and Canberra. The IMOS system is highly dependent on broadband communications infrastructure.

CSIRO has 55 sites distributed nationally in urban and regional areas. CSIRO is dependent on broadband communications connectivity to support its centralised data centres, corporate business functions, and for connecting its staff in collaborative research activities. CSIRO and the Australian academic community has an excellent broadband infrastructure provided by the Australian Academic Research Network (AARNet) that connects major research institutions with multi Gbps broadband connections. A national broadband infrastructure will allow extensions to AARNet to connect regional research stations, sensor networks and scientists working in the field.

Australia and New Zealand are actively pursuing the opportunity to host the Square Kilometre Array (SKA), a $2 billion international radio astronomy facility in Western Australia. As part the Australian bid to host the SKA, the $152 million Australian Square Kilometre Array Pathfinder (ASKAP) is being constructed by CSIRO at Boolardy, Western Australia. ASKAP will be the fastest survey radio telescope in the world. It will also demonstrate the use of Boolardy as a world-class radio astronomy site, a wide-field of view technology, and long distance data transmission. The survey speed is determined by the high data rate of the telescope 24 Gbps (gigabits per second). The science processing for ASKAP will be performed at the Pawsey High Performance Computing Centre for SKA Science in Perth. Data will be transmitted from Boolardy to Perth over fibre. The Geraldton to Perth link will be provided by NBN Co. This continuous, long-distance (800km) transmission of large data volume is critical to ASKAP's success and also to the SKA.

The broadband communications capability is an important consideration in the selection of a site for the SKA telescope. Continuing the development of data transport capacity is a strong demonstration of the commitment to provide the infrastructure needed for the SKA, and for future scientific research generally.

Facilitating community and social benefits

No response.

The optimal capacity and technological requirements of a network to deliver these outcomes

Most advanced services in eHealth, eEducation, eGovernment and eEntertainment are video-centric, and need a symmetric user data rate from several Mbps to tens of Mbps. The most advanced of these services are beyond the speed and symmetry offered by the ADSL and HFC technologies currently available and described previously in this submission. These services will also demand symmetry and low latency (network time delay). Industry estimates indicate that, by 2013, the average data rate demand by every household will exceed 30 Mbps, and some advanced applications on the horizon will need a symmetric (uplink and downlink) data rate of 50 Mbps. A national infrastructure built for the near future, should support at least a symmetric user data rate of around 50 Mps.

Whilst this speed can be easily achieved by fibre, there are still great challenges in delivering such high performance services with fibre to premises on a guaranteed per user basis in some regional and rural parts of Australia. For example, deployment of fibre is impractical in some regions due to low population density or terrain/topography issues. An estimated 7 per cent of the population is not likely to be connected by a fibre to the premises approach and would need to be connected by alternative technologies such as a terrestrial wireless or a satellite solution. In order to ensure all Australians the full benefit form high speed broadband, symmetry of data rates (or as close as possible) is an important requirement for users of fibre, wireless or satellite connections.

CSIRO research and development for new fixed wireless technology

CSIRO is undertaking research into new wireless access and backhaul technologies (named Ngara) with the objective to offer an alternative for the wireless component of a high speed network in regional and rural areas. CSIRO has recently demonstrated the first stage of the Wireless Access technology in Smithton, Tasmania. This technology is proposed as an alternative technology for the wireless part of a high speed network in regional and rural areas. These initial trials achieved symmetric data rate speeds of 12 Mbps (simultaneous transmission and reception of 12 Mbps at the premises) with further field trials scheduled for late 2011 aiming to demonstrate a symmetric data rate of up to 50 Mbps from multiple premises simultaneously. CSIRO has briefed the NBN Co on this research program and has commenced discussions with telecommunication equipment providers. CSIRO is actively pursuing commercialisation opportunities for Ngara.

CSIRO research into applications and services for broadband networks

CSIRO is developing applications which utilise high speed network infrastructure. CSIRO has significant intellectual property and experience in advanced networking technologies, broadband applications development and wireless technologies (both terrestrial wireless and satellite). From 2000- 2007 CSIRO built and operated an experimental network similar to that planned for the NBN. This program of work, called the Centre for Networking Technologies for the Information Economy (CeNTIE), established a multi-gigabit metropolitan area fibre network in Sydney and Perth and connected to the two cities with a 10 Gigabit per second connection. Broadband applications were developed and trialled for education, health, banking and remote collaboration in the motion picture industry.

The Australian Centre for Broadband Innovation

In January 2011, CSIRO established the Australian Centre for Broadband Innovation (ACBI). Working in partnership with the NSW Government and National ICT Australia (NICTA) this activity will develop and trial new services and applications for the new high speed internet access being deployed in Australia. Through ACBI, CSIRO is collaborating with NBN Co to create an emulation (exact duplicate of functionality) of the NBN with connections to houses in the Sydney suburb of Parkbridge and to Armidale (NSW). While this activity is still in its establishment phase, the ACBI alliance will extend the test bed and development work to a number of other states in Australia. Working in partnership with local universities (such as the University of New England), it will demonstrate and evaluate applications in:

- Health tele-health to institutions and the home for chronic illness management and aged care
- Entertainment and media use of the television set-top box as an interface to the broadband network
- Infrastructure use of broadband network infrastructure for applications in residential energy management and traffic management
- e-Government broadband delivery of education and training. The use of broadband for delivery of government services

ACBI has capabilities to develop, trial and evaluate the technologies mentioned in this submission including:

- Tele-presence 10 years' experience in advanced video and data conferencing, augmented reality, virtual environment
- Cloud computing, storage and services security, privacy and trust technologies
- Web service delivery human computer interface, content tailoring, web services expertise, software engineering
- Human factors the ability to baseline productivity prior to the trial, establish appropriate metrics and conduct thorough evaluations to establish clear value propositions
- Wireless Broadband Network demonstrators such as Ngara.
- Stimulate the development of other advanced applications in agriculture, energy, mining and environment sectors.

CSIRO believes that the outcomes of this work will illustrate the social and economic benefits for Australia of broadband communications networks.

Summary

With this submission, we have attempted to highlight some of the expected benefits from a national broadband communications infrastructure as well as some of the ongoing activities which will be enabled by the infrastructure and so deliver benefits to Australians.

We believe the key benefits of the broadband infrastructure being deployed in Australia include:

- High-speed access with connection speeds of 100 Mbps and beyond, which will enable new, high definition, immersive experiences previously not possible on existing Australian public networks. This opens the way for **new methods of delivering services** including tele-presence for social and business purposes, enhanced entertainment, and interactive and meaningful delivery of eHealth, eEducation and eGovernment.

- Supporting **inclusiveness and greater community participation** and real time interactivity, irrespective of location, addressing the digital divide between regional areas and cities. The ubiquity of access will allow for electronic delivery of services to all Australians and will address the nation's perennial challenge of the tyranny of distance.

- The potential for **new types of service and new business models** for many areas, including education, health care, entertainment, electricity management, environment management. This is the result of the ubiquitous nature of the network connecting to homes, schools, hospitals, farms and public buildings.

- Allowing people, irrespective of location, to **contribute to content and service creation** as a result of the symmetric nature of the network

These factors combined will allow people to contribute to, and benefit from, the growing range of 21st century services, irrespective of where they live. By removing some of the barriers associated with living in rural and regional Australia, this, in turn, may **help to stabilise and possibly reverse the trend towards increasing urbanisation**.

References

[BIO] http://www.csiro.au/science/Biosecurity-collaboration-platform.html

[Cisco] http://home.cisco.com/en-us/telepresence/umi/

[CLOUD] http://www.csiro.au/science/cloud-computing.html

[Deloitte] ICT Centre E-Health Program Impact Evaluation, 28 January 2009

[Ngara] http://www.csiro.au/news/Broadband-coming-wirelessly-to-the-bush.html

[QCAT] CSIRO QCAT 2006 Annual Report: http://www.cat.csiro.au/images/QCATAnnualRep06.pdf

[RIDES] http://research.ict.csiro.au/research/labs/autonomous-systems/immersive-environments/rides

[RSES] http://research.ict.csiro.au/research/labs/tasictc/research-projects-1/energy-services/residential-scale-energy-services

[VICCU] http://www.csiro.au/science/ViCCU.html