



CSIRO Submission 09/354

Inquiry by the Senate Select Committee on the National Broadband Network

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Executive Summary

CSIRO welcomes the opportunity to provide input to the Senate Select Committee's inquiry into the National Broadband Network. CSIRO has responded to Terms of Reference in areas where the organisation has appropriate knowledge and expertise.

This submission while primarily focused on **information and communication technologies (ICT)**, also provides input on the implications for the NBN on the provision of **eHealth Services**. CSIRO has significant expertise in this domain through the Australian eHealth Research Centre, a joint-venture between CSIRO and the Queensland Government.

CSIRO has developed a world leading research and development capability in core ICT and its application, with a proven track record to address requirements and develop innovative solutions for society that have commercial outcomes. The CSIRO pioneered the development of Wireless Local-Area Network (LAN) communications technology and standards that are now in use of over 1 billion computers and communication devices.

CSIRO agrees that high-speed broadband services will be critical for the economic and social growth of Australia. Government services in health, education, and energy, for example, will increasingly be delivered via the Internet. Business will increasingly use the Internet to both conduct business, and to deliver services to the customer. Individuals will increasingly use the Internet to communicate, access business and government services, in addition to accessing the latest on-line digital content.

As the global world becomes more data rich, there will be ever increasing demands on Internet infrastructure to quickly and efficiently transfer this data. CSIRO believes that the Government's plans for deploying *fibre-to-the-premise* (FTTP) to 90 per cent of Australian homes, schools and workplaces - with speeds up to 100 megabits per second (Mbps) – are both essential and achievable.

This submission focuses on the implications of the NBN for the 10 per cent of the Australian population that may not receive optical fibre access (the so called **last 10 per cent**). The provision of broadband services to the last 10 per cent remains both an economic and technical challenge. In particular, a data speed of at least 12 Mbps has been guaranteed for the last 10%, **providing rural and remote communities with speeds up to 100 Mbps** will enable the same quality of services for all Australians – and prevents the creation of two classes of digital access.

CSIRO specialises in addressing national challenges and has developed a world leading research and development capability in information and communication technologies.

It is a well understood fact that provision FTTP for **the last 10 per cent** of the Australian population is not economically viable due to the combinations of low population densities and the remote location of such population centres. Existing satellite and wireless communication technologies provide only part of the solution. CSIRO believes that:

- **Satellite-based** technology can only provide a practical solution for **the last 1-2 per cent** of the population with a data rate transfer of 12 Mbps. For the last 10

per cent, however, satellite technologies are not cost-effective when compared with wireless alternatives. Furthermore, satellite technology cannot support more than 50,000 household users and is unable to deliver data transfer of 100 Mbps.

- Third/Fourth Generation Wireless Technology (**3G/4G**) and **WiMAX** could provide a technical solution for the last 10 per cent with data rate transfer of 12 Mbps. This technology while more cost-effective than satellite, has significant financial and environmental constraints. Furthermore, wireless technologies cannot provide broadband services at the (desirable) rate of 100 Mbps.

Two new wireless under development by CSIRO solutions - **CSIRO regional access solution** and **CSIRO wireless backhaul solution** offer significant advantages over satellite, Third/Fourth Generation Wireless Technology (3G/4G) and WiMAX.

Specifically:

- By utilising the digital dividend of reusing the broadcasting towers and spectrum (**UHF** and **VHF**) currently allocated to **analogue TV**, and taking advantage of CSIRO's new patented technologies, the CSIRO regional access solution can deliver broadband services at 100 Mbps to sparsely populated communities at significantly lower costs than WiMAX or 4G - with estimated savings in excess of \$5.3 billion.
- The CSIRO wireless backhaul solution can provide up to 10 Gbps over 50 km at significantly lower costs than fibre, making it an ideal solution for the last 10 per cent - with estimated savings of \$1.4 billion. The CSIRO solution could also be used as a complementary cost-effective solution to fibre backhauls for regions provided with FTTP access.

Research conducted for the Australian Local Government Association¹ has indicated that delivering broadband services to the last 10 per cent will result in a \$2 billion per annum contribution to Australia's Gross Domestic Product. If CSIRO technology is developed and is deployed in the NBN, it is estimated that **capital savings of least \$5 billion** could be realised in the \$43 billion NBN rollout. Additionally, the commercial development of CSIRO technology could lead to new wireless communications technologies that could be worth **\$2-3 billion in exports**.

CSIRO would welcome an opportunity to address the Select Committee to further discuss this important government initiative in particular to provide an independent expert view on the strengths and weaknesses of technology options, and the potential for new electronic service delivery that the NBN will enable.

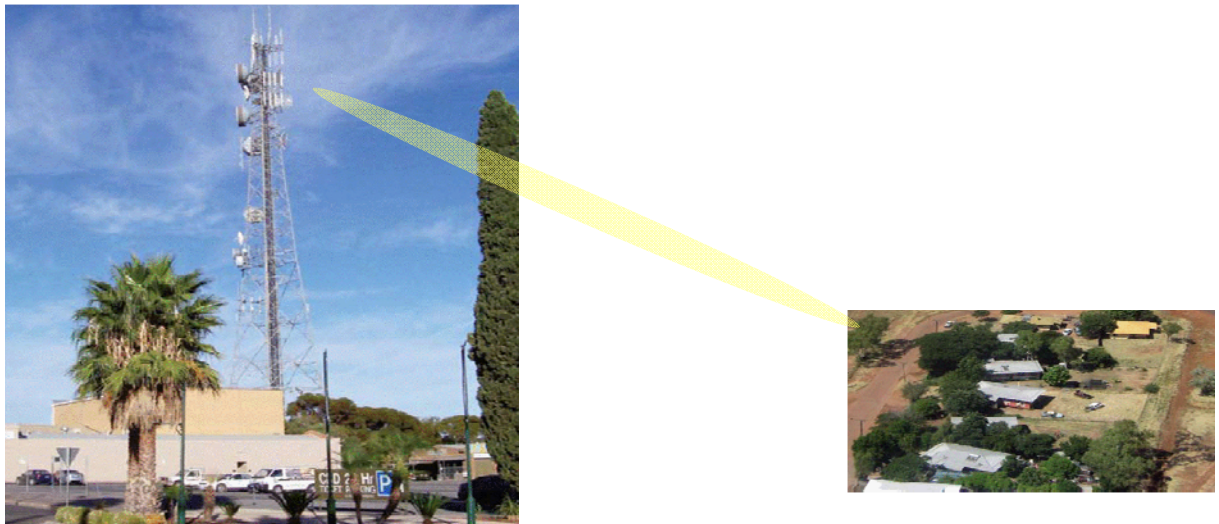
¹ http://www.infrastructureaustralia.gov.au/public_submissions/published/files/460_australianlocalgovernmentassociation_SUB.pdf

Specific Comments

This submission to the Select Committee addresses the following issues in *Terms of Reference 2d, 2e, and 2h* with specific regard to the implications for the NBN for **the last 10 per cent**.

Term of Reference (2d): Any regulatory changes pertaining to the NBN

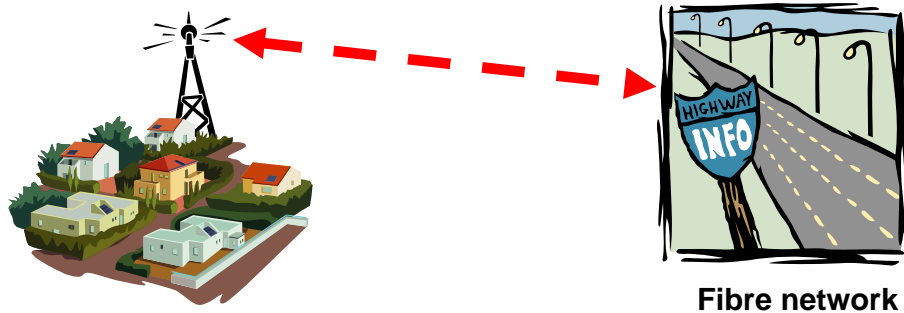
To deploy the **CSIRO access solution**, it will be necessary for ACMA to re-allocate at least some of the spectrum currently allocated to analogue TV. This is aligned with the Government's plan to switch over to digital TV². It is recommended that at least 35 MHz in the 400-800MHz frequency range is assigned for fixed wireless access for rural broadband. Furthermore, it would also be necessary for the Government to have access to the existing broadcasting towers. (The **CSIRO access solution** is illustrated)



With respect to the **CSIRO wireless backhaul solution** the most economical solution is to reuse the existing microwave towers. (Backhaul is the means of joining isolated sub networks to the BNB) To this end, the Government needs to have access to those towers. The CSIRO technology complies with the existing spectrum regulation for point to point microwave links³, so no regulation change is needed. (The **CSIRO wireless backhaul solution** is illustrated below)

² ACMA, Five-year Spectrum Outlook 2009-2013, March 2009.

³ http://www.acma.gov.au/webwr/radcomm/frequency_planning/frequency_assignment/docs/fx3/fx03.pdf



Terms of Reference (2e): *The availability, price, level of innovation and service characteristics of broadband products presently available, the extent to which those services are delivered by established and emerging providers, and the prospects for future improvements in broadband infrastructure and services (including through private investment);*

CSIRO is conducting on-going research into the communications demands of broadband systems, including high performance backhaul and a tailored solution for access technologies to meet the specific requirements of the Australian demographic. Over the last 6 months, CSIRO has successfully lodged patent applications for both backhaul and access technologies, and is now proceeding with prototyping of the access solution. Various prototypes for CSIRO's backhaul technologies are already available. However, prototypes are not yet finalised for the most recent patent in this field. In parallel to the development program, CSIRO has been considering the path to market, and discussions are now underway with potential equipment manufacturers and system integrators.

As the prototyping program unfolds over the next year, CSIRO will participate in the definition of international industry standards based upon CSIRO's approach, as well as collaborating with regional operators and industry suppliers for the proof-of-concept deployments. The manufacturing roll-out which will follow will concentrate on securing local investment in the development of a local Australian manufacturing capacity, supplying to Australia as well as identified international markets. The current market model is that local system integrators are likely to deploy the solutions in Australia, with supply to the international market through technology licensing and product export (where viable) to off-shore systems integrators.

Terms of Reference (2h): *Any technical, economic, commercial, regulatory, social or other barriers that may impede attaining the Government's stated goal for broadband availability and performance in the specified timeframe;*

The adoption of CSIRO communications innovations targeting **the last 10 per cent** will ultimately depend upon standards adoptions. However, early bespoke deployment may also prove to be commercially viable due to the prohibitive economics of rolling out existing technology options. Licensing by the Australian Communications and Media Authority for the prototyping phase has been approved. In addition, spectrum allocation associated with the digital dividend will be a key requirement for the proof-of-concept trials and system deployment of CSIRO's access technology. CSIRO has assessed the overall time table for the rollout and is confident that broadband availability will be available in the specified timeframe, and furthermore, is confident that the reach of broadband services will extend more rapidly, and to a larger proportion of the Australian population than would be the case with other technology options.

Implications of NBN for Delivery of eHealth Services

The Australian E-Health Research Centre (AEHRC), a joint venture between the CSIRO and the Queensland Government, has been asked to make a submission to the Senate Enquiry. The AEHRC is the leading eHealth research group in Australia. Rather than making a separate submission, it has been decided to include the contents of the AEHRC submission into the overall CSIRO document. This section focuses on how the NBN will enable novel health services, with the potential to simultaneously increase the reach of healthcare and reduce the costs of delivery.

The availability of ubiquitous and low cost broadband provides the ability to deliver many health benefits, for example bringing expertise to remote locations via tele-presence and remote training, providing enhanced community care and in-home monitoring for the elderly and chronically ill, reducing the social isolation that can lead to depression and other illnesses, and enabling improved techniques for analysis and standardisation medical data. The Health sector represents almost 10% of the national economy, and eHealth activities have long held the promise of enhancing productivity in healthcare delivery. CSIRO, through its significant on-going eHealth and Preventative Health research programs, is ideally positioned to take the lead in demonstrating novel IT solutions using the NBN that can turn this promise into reality.

Our view is that the NBN has the ability to deliver targeted benefits in several key areas of the national healthcare agenda, and help ensure the delivery of world-class medical care to all Australian citizens, regardless of their physical location. This submission will focus on the key areas:

This submission will focus on the key areas:

- **Telemedicine:** A high speed NBN would take telemedicine technology to the next level, out of the hospital into the home. This would enable better management of chronic diseases and the elderly from their home environment with patient-specific applications.
- **Health data management:** A high speed NBN would bring the vision of a national electronic health records system a step closer. The NBN will allow data records to be linked dynamically, providing virtual databases consisting of records securely linked from a variety of sources.
- **Diagnostic services:** A high speed NBN would enable a new generation of diagnostic services to be delivered on-line. The NBN could deliver advances in analytical techniques to clinicians wherever they are based, regardless of the availability of local expertise.

More detailed discussion of eHealth NBN application can be found in Appendix 2

Appendix 1: Indicative Analysis of NBN Solutions for Last 10 Per Cent

CSIRO has recently undertaken detailed investigations which compares the various technologies which might provide broadband Internet services to an urban centre in regional Australia. Based on these investigations, CSIRO estimates that the cost to provide broadband services to the **last 10 per cent** will be as detailed in Table 1:

Technology	Estimated Cost
FTTP	\$101 billion
3G/4G	\$13.6 billion
WiMAX	\$6.5 billion

Table 1: Cost estimates for extending NBN to last 10 per cent of Australian population using current technologies

Even ignoring the use of FTTP, these are expensive options that will not provide the same level of service that will be available to the 90 per cent of the population living in urban Australia. This is a national challenge that needs a national solution.

CSIRO has commenced a research program to address the challenge of providing broadband services to the **last 10 per cent** of the population living in non-urban regional Australia called **CSIRO regional access solution**. In simple terms, the **CSIRO regional access solution** proposes the use of existing broadcast infrastructure and broadcast spectrum in the new NBN. By using CSIRO technology (based on a recently filed patents), beams using new synchronisation and co-operative networking methods will form signals over the long distances to individual premises.

The CSIRO believes its technology is technically superior to 3G/4G and WiMax technology. In addition, because the CSIRO technology maximises the digital dividend by utilising current analogue television broadcast infrastructure, CSIRO believes that this higher quality of service can be delivered with fewer base stations at a significantly lower capital cost, and therefore worthy of being utilised strategically throughout the NBN program.

Satellite: It is understood that the new generation of Ka band satellites will provide up to 100Gbps capacity per satellite. Our initial analysis shows that this technology is attractive only for the **last one to two per cent** of sparse populations at the data rate of 12Mbps, and may cost more than \$1 billion for the overall infrastructure. This cost may be justified if 100% of Australia is to be connected with broadband. To expand access to the last 10 per cent using satellite communications is not considered to be feasible. In particular, the Ka band satellite technology is not suitable at all for high performance (100Mb/s) broadband services as one satellite can only support around 10,000 premises across Australia.

To our knowledge, some of the claims made about the deployment of satellite technology are based on a low broadband take-up rate. For example, if only one out of ten premises want to subscribe to the broadband services, one could employ one

satellite to cover the last 10% of Australia, but this is not sustainable. Also, the 50 contention rate quoted by some, which is the acceptable number of subscribers contending for the same channel at any given time, is too high, whereas a more acceptable number would be around 20. This would reduce the number of the subscribers that a satellite can support from 25,000 to 10,000.

There are also risks associated with deploying satellites. In particular, it is unlikely that one application will be allowed to occupy the whole Ka band spectrum, which means less available capacity. It is also unclear if the orbital slots required can be granted for NBN. Other risks are associated with satellite launching and failure in operation. (The review by CSIRO of the applicability of satellite technologies for wider-spread uptake is continuing.)

Wireless: A detailed review has been conducted of 3G/4G mobile telephone and WiMAX technologies. A detailed analysis for the inland city of **Griffith, New South Wales** is cited as an example. By way of background, Griffith is located in the centre of the Murrumbidgee Irrigation Area in south-western New South Wales. By road it is 620 km from Sydney, 450 km from Melbourne and 350 km from Canberra. Unlike many parts of Australia, Griffith was methodically planned from the very beginning. It is a busy, bustling regional city. It is also a typical region that will receive broadband Internet via FTTP to meet the needs of the urban centre (typically defined as a population cluster of more than 1000 residences) with wireless technology providing Internet access for residences outside urban centres.

Within a 60 km of the centre of Griffith, there are 3691 residences outside of the urban centre. The current 3G coverage around Griffith (as seen by the Telstra's NextG coverage map in Figure 1) is of the order of 20 to 30 km in range. However, CSIRO expects that this defines the coverage at the *minimum* data rate, and so expects the rural coverage at the *highest* data rate for 3G/4G to be in the order of 10 km on average. By utilising a higher base station and/or higher user antenna height, the coverage of WiMAX is expected to be larger than that of 3G/4G - which is assumed to be 30 km for the purposes of this analysis.

In both 3G/4G and WiMAX systems, the use of multiple-input and multiple output antennas (or MIMO) is often useful to improve the spectral efficiency (i.e. efficient use of the available spectrum). However, conventional MIMO techniques will not improve the spectral efficiency in rural areas. This is because MIMO takes advantage of the presence of severe multipath (which often occurs in built up areas), but multipath is not expected in rural areas where predominantly line-of-sight paths are utilised in order to increase the range.

Results of the CSIRO technology review are summarised in Table 2. The Table includes estimated area of coverage, maximum spectral efficiency, expected number of base stations required to be built for each technology to deliver wireless broadband to 3,691 residences based on a 10% usage factor (i.e. assuming 10 residences contend for internet access at any given time) outside the urban centre around Griffith.

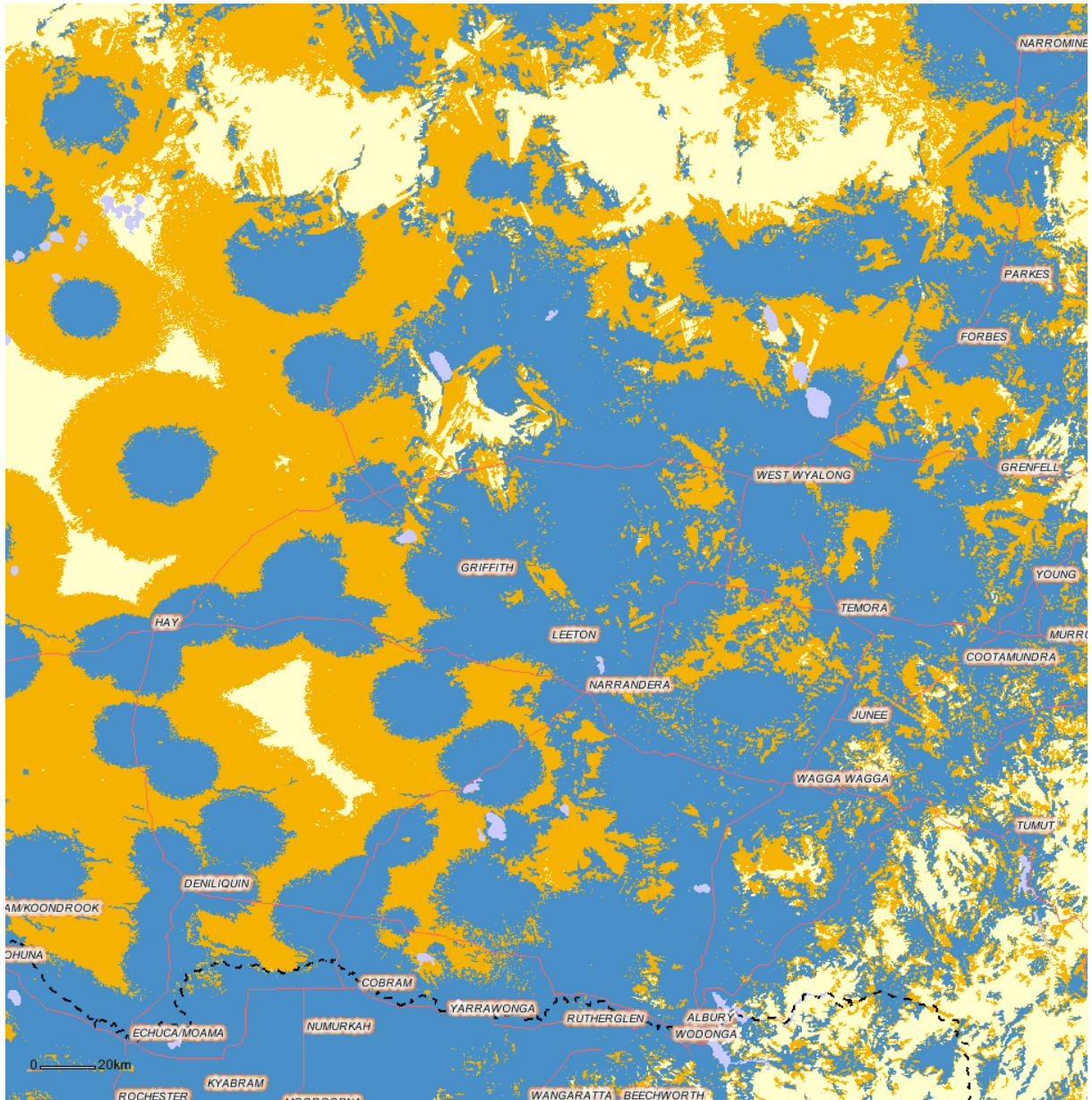


Figure 1: Current Telstra NextG coverage around Griffith (taken from Telstra’s web site)

CSIRO estimates that to deliver broadband services to the Griffith area at a rate of 100 Mbs would require 31 base stations using 3G/4G wireless communications technology, or 23 base stations using WiMAX technology. CSIRO further estimates that the cost of installing each base station is approximately \$300,000. Based on this estimation, the minimum capital cost of providing a basic level of broadband services to the area surrounding Griffith is estimated at \$9 million or approximately \$ 2,500 premises.

	3G/4G	WiMAX
Expected rural coverage at the highest data rate	10 km	30 km
Number of Base Stations required to cover 60 km radius	20	2.2
Expected maximum spectral efficiency in 5 years	6 bps/Hz	8 bps/Hz
Data delivered using 50 MHz frequency bandwidth	300 Mbps	400 Mbps
Number of Base Stations required to enable 4.4 Gbps (12 Mbps per user)	15	11
Data delivered using 200 MHz frequency bandwidth	1.2 Gbps	1.6 Gbps
Number of Base Stations required to enable 36.9 Gbps (100 Mbps per user)	31	23

Table 2: *Expected rural coverage, maximum spectral efficiency and expected number of base stations for 3G/4G and WiMAX technologies delivering broadband around Griffith.*

For Griffith: There are 3,691 homes located outside the urban centre which are located within 60 km of the urban centre; this non-urban area is not eligible for FTTP; and the current 3G wireless communications coverage of the non-urban area is patchy.

Using the **CSIRO regional access solution**, the current tower infrastructure in Griffith would support the delivery of broadband services at either the rate of **12 Mbps** or **100Mbps**. The corresponding estimated costs are displayed in Tables 3 and 4.

Technology	No. Base Stations	Cost
3G	20	\$6m (which includes the cost of new towers)
WiMAX	9	\$2.7m (which includes the cost of new towers)
4G	20	\$6m (which includes the cost of new towers)

CSIRO regional access solution	1	\$500k (no new tower is needed)
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Table 3: Cost to deliver 12Mbps to 100% of the Griffith region

Using the **CSIRO regional access solution**, the situation is somewhat better. Its coverage is similar to that for digital TV through the adoption of high tower high power transmission, low frequency transmission, and high gain user antenna. Figure 2 shows the existing ABC digital TV coverage which extends over a 60km radius.



Figure 2: Current ABC digital TV coverage around Griffith. (Taken from Telstra and ABC websites)

Technology	No. Base Stations	Cost
WiMAX	23	\$6.9M including the cost of new towers
3G/4G	31	\$9.3M including the cost of new towers
CSIRO regional access solution	2	\$2M including the cost of 1 new tower

Table 4: Cost to deliver 100Mbps to 100% of the Griffith region

Based on the example above, there are considerable cost savings to be made by the development and adoption of the **CSIRO regional access solution** to provide broadband services to the **last 10 per cent**. When compared with 3G/4G the capital savings are estimated to be \$12 billion; and when compared with WiMAX, the capital savings are estimated to be \$5.0 billion, with FTTP an order of magnitude greater costs than alternatives.

Technology	Estimated Cost
3G/4G	\$14.4 billion
WiMAX	\$5.3 billion

Table 5: Estimated savings achieved through the use of CSIRO regional access solution

A key feature of the CSIRO technology is the ability to efficiently manage the system's **backhaul requirements**. In places where there is a localised area served by any wireless communications system, there is a need to link this localised network to the main network; in this case the fibre based NBN. However, because of the large distances involved, these backhaul services could be provided cost effectively by point-to-point microwave radio relay. Conventional microwave relays employ a single narrow band to deliver up to 150Mbps data rate. In order to service a broadband network, a number of systems in parallel would be required to increase the overall data rates. This would result in significant cost increases.

In December 2006, CSIRO successfully demonstrated a 6Gbps wireless systems and 600Mbps MIMO demonstrator. This is a forty-fold increase over the capacity of current microwave systems. Based on further development of its wireless research, CSIRO can provide a wide bandwidth for gigabit link using a single system rather than the multiple systems required by using convention wireless backhaul technologies. We also believe that we can increase the range and decrease the costs of the backhaul equipment by developing and deploying reconfigurable and highly integrated transceivers based on new algorithms.

Technology	Estimated Cost
Fibre	\$1.65 billion
Multi-link microwave	\$850 million
CSIRO Technology	\$255 million

Table 6: *Estimated costs of providing backhaul services to last 10 per cent of NBN*

In addition to supplying the Australian market, there is a growing international market for wireless backhaul technology.

Regulatory Framework: In order to achieve the most from wireless communication technologies under development, the regulatory framework will need to evolve and develop with the technologies. CSIRO supports a strong and clear regulatory framework that provides certainty and clarity for all users and developers. It also supports a regulator framework that supports innovation i.e. the framework dictates regulatory outcomes, and is not technology or process-specific.

For example, adoption of the **CSIRO regional access solution** would require that part of the digital spectrum currently used for the broadcast of analogue television services. With the “switch-off” of analogue television currently scheduled for December 2013, regulatory action would be required to keep that part of the spectrum available for use.

Summary of Competitive Advantages of Technologies:

1. The next generation Ka band satellite will have up to a 100Gb/s capacity. Since the capacity must be shared by all the users in the satellite coverage area, and also because of the large size of each spot beam (around 200-350km diameter), it should only be used to support the last one per cent of the population living in areas remote from any wireless or fibre infrastructure. It cannot be used to support large clusters of users, such as an urban centre.
2. 3G/4G has the benefits of high data rate and mobility, but the coverage area shrinks when the data rate goes up. 4G promises 100Mbps data rate for mobile users. However, it is expected that the 100Mbps data rate will be shared by all the users in a cell. As 3G/4G is deigned as a mobile communications system, it is too costly to be used for fixed wireless access.
3. The fixed wireless access version of WiMAX (IEEE 802.16-2004) is designed for broadband wireless access for homes and offices. It can also be used for low capacity backhauls supporting up to 75Mb/s data rate. The main problem of WiMAX is the limited capacity up to 150Mb/s. For very low density areas, WiMAX is an attractive solution.
4. The CSIRO Rural Broadband Wireless Access is designed to be superior to WiMAX in that the cell capacity is increased by 5-6 fold. Consequently, it can accommodate higher data rate broadband applications and more users. Because CSIRO technology has much larger cell sizes; less base stations, less towers and less backhauls are required.

Appendix 2: Examples of eHealth applications enabled by the NBN

Our aim here is to give specific examples of the potential projects that can deliver impact in telemedicine for chronic disease management, enhanced access to healthcare data for practitioners and citizens, and new models for diagnostic imaging services.

1. *The NBN can deliver a step-change improvement in home-based care for the elderly and chronically ill, delivering similar levels of care to those in cities, towns, and remote and rural communities.*

Telemedicine has been used in medical settings for many years. Through the NBN, broadband will be available to all homes in Australia, and will allow these technologies to reach their full potential by extending them to the home environment. This can lead to improved systems for chronic disease management (via home based monitoring and mentoring) and improvements in the care of the elderly and socially isolated. For example, by using high resolution video systems and in-home monitoring, together with advances in secure remote interactions between patient and physician, it will be possible to use the NBN to enable the delivery of advanced healthcare interventions, education and coaching, and provide tailored social networking to reduce social isolation of the elderly and chronically ill.

We propose a system to deliver telemedicine tools, designed to allow in-home patient monitoring and remote consultation, regardless of geographic location, using secure remote identity verification. Services which will be made possible include secure doctor-patient interactions, care planning, health consultations and video-surveillance in acute distress situations in the home setting. These tools will also provide dual-use capabilities that will enable novel healthcare interventions such as remotely provided and monitored rehabilitation services, interactive education and coaching for health management, and social-networking for the elderly and bedbound to reduce social isolation – even if they are in a rural location.

This project will take advantage of CSIRO's expertise in ambulatory monitoring, integration of healthcare monitoring systems, experience in human-systems interactions, and our expertise in delivering real-world IT enabled healthcare interventions. CSIRO's early versions of the system allowed delivery of basic remote consultation and patient monitoring services, and provide simple social interaction capabilities through the use of video systems. Research activities will build on CSIRO's technologies in clinical interventions for rehabilitation, ambulatory monitoring (to determine and quantify the activity level of individuals), and health privacy services.

2. *The NBN can provide advanced on-line health services to provide improved access to medical data for health monitoring, clinical decision support and epidemiological studies.*

The National E-Health Transition Authority (NEHTA) has been established to accelerate the implementation of the eHealth agenda in Australia, with a primary focus on health data and medical records. A recent Access Economics study shows that investing \$6.3 billion in an integrated national electronic health records system will increase the NPV of GDP by \$6-13 billion over ten years; and create 12,000 jobs. NEHTA recognises the need for additional tools and research, and is working with the CSIRO's AEHRC to access our expertise in medical terminologies. It is our belief

that the NBN, combined with CSIRO technologies, has a role to play in accelerating this process.

The combination of CSIRO technologies, together with the bandwidth of the NBN, can be used to enable data records to be linked dynamically, providing virtual databases consisting of records linked from a variety of sources – and not requiring additional infrastructure. The health data services delivered will show the very real benefits of best-practice data linkage. The techniques developed for these services will not only help demonstrate the compelling reasons for Australia to move to shared electronic health records, but could also be extended to provide a framework for the state and federal health departments to offer citizens access to their electronic health summary data.

We propose a system that will build on CSIRO's internationally recognised work on secure integration of healthcare data, free text analysis for medical records, clinical terminology services, and the provision of systems for viewing medical records. The system will provide an extensible collection of software services that can be used by health organisations around Australia. Initially the services could include:

- A clinical terminology server. Uniquely this will allow agencies and disease-specific groups to extend the SNOMED CT clinical terminology for their particular speciality. This will place Australia as a world leader in defining standard terminologies, and can be used ahead of inclusion of the extension into the core SNOMED content by the International Health Terminology Standard Development Organization.
- A medical free-text analysis service providing a synoptic report. Initially focussed on analysis of pathology reports for cancer, the system will be based on the SNOMED CT system, allowing the medical community to expand the functionality as required.
- An entity resolution service. This will be based on CSIRO's HDI software for secure linking of medical databases, and will allow the collation of data relating to an individual from disparate medical data sources.
- An advanced, web-based system for viewing patient data, using a timeline of summary information. Through the use of the standard terminology server, various clinical decision support tools can be built based on this patient data.

3. *The NBN can provide a new, cloud-computing based system to provide standardised interpretation and quantification of medical images used for diagnosis and monitoring in key national priority areas such as Alzheimer's, cardiovascular disease and cancer.*

The NBN is being touted as allowing the transfer of medical data such as patient imaging studies, but the potential is so much more, leading to even greater productivity enhancements. For example, the NBN can be used to provide new diagnostic imaging services, delivering expertise to remote communities and instant turn-around of quantified imaging studies.

We propose a system ensures that the medical and medical research communities are provided with the latest advances in analysis techniques - as soon as these are approved and validated - wherever they are based and regardless of the availability of local expertise. The system will require the high-bandwidth capabilities provided by the NBN for delivery of image sets and return of results, and will use cloud computing

technologies to enable a scalable solution that constantly provides best-practice algorithms.

Currently, when patients require quantified imaging studies (MRI, CT, PET, etc), the areas of the image requiring analysis are subjectively examined by radiologists. This leads to variation in interpretation between clinicians, and is time-consuming and therefore costly. The NBN can solve this problem.

Research by CSIRO (and others) has demonstrated that many segmentation and analysis tasks can routinely be carried out by computer based algorithms, providing improved accuracy and enabling measurements that are not amenable to manual processing. However, to date the majority of these techniques remain in the research domain, due to computational requirements, and the proprietary nature of scanner data. CSIRO has developed significant technologies that will be of use to the community, and has strong collaborations with other institutions using CSIRO's open-access MILXView platform for image analysis and interpretation.

Building on CSIRO's active development programs, we are proposing to deliver a broadband portal where scanner images can be submitted for analysis using a standardised, open-access platform. This will enable the image analysis community to build on others work, helping to grow local expertise and stimulating the development and contribution of new analysis algorithms.