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TOWARDS A NATIONAL VISION OF CONNECTIVITY FOR AUSTRALIAN SCHOOLS

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FIBRE CONNECTIONS TO SCHOOLS INITIATIVE DIGITAL EDUCATION REVOLUTION



FIBRE CONNECTIONS TO SCHOOLS INITIATIVE - TOWARDS A NATIONAL VISION OF CONNECTIVITY FOR AUSTRALIAN SCHOOLS

The Fibre Connections to Schools (FCS) initiative is an integral part of the Australian Government's Digital Education Revolution (DER) suite of initiatives. These initiatives recognise that Australian students need greater access to, and more sophisticated use of information and communications technologies (ICT). They need the best hardware, high speed broadband connections, quality digital content and well trained teachers to integrate technology into teaching and learning. This paper outlines a national vision of connectivity for Australian Schools as part of the consultations to support the FCS initiative.

Under the FCS, the Australian Government has allocated \$100 million to support the deployment of high speed broadband connections to Australian schools. This commitment recognises the potential of broadband technologies as enabling tools to improve educational opportunities, boost outcomes and energise the learning experience.

Background

In Australia and internationally, reliable and affordable broadband connectivity is recognised as having the capacity to transform the ways in which teachers, students and their families communicate, collaborate and access education resources across traditional boundaries. Countries including the United Kingdom (UK), the Netherlands, Greece and the United States of America (USA) have established national education networks that include schools and are based on high speed fibre broadband.

For more than a decade, Australian governments and school jurisdictions and sectors have been working to provide greater bandwidth to schools. As early as 2000, Australian Education Ministers adopted *Learning in an Online World: the School Education Action Plan for the Information Economy*. That work explicitly recognised both the transformational potential of ICT for education and the significant challenges to achieving that potential. Since then, there have been a number of vision statements and implementation plans to address bandwidth in education issues, including:

- The National Bandwidth Action Plan, endorsed by Education Ministers in 2003. The development of this plan was informed by national consultation, including a national forum;
- The National Bandwidth Implementation Plan, which was endorsed by Education Ministers in 2005;
- A bandwidth modelling tool for schools, which was commissioned in 2006 by the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA); and
- The National Bandwidth Statement of MCEETYA's ICT in Schools Taskforce, which was issued in December 2007.

In addition, major investments have been made by governments across Australia to roll out infrastructure, develop online resources and build teacher capability. But



while significant progress has been made, with fibre connections currently provided to about forty-seven per cent of Australian schools¹, it is uneven.

A significant number of schools continue to use non-broadband technologies or lower speed broadband solutions that are not capable of scaling up to higher speeds. And, in the case of those schools already on fibre connections, it is unlikely that they are actually using the technology to its full potential.

Together with the other elements of the DER, the FCS initiative is being progressed through the Council of Australian Governments Productivity Agenda Working Group. A vision for ICT in school education is being developed as part of that process. This paper suggests that as part of an over-arching vision, elements of a national vision of connectivity for schools should be explored.

In that context, this paper revisits the issue of affordability that has long been identified as a major barrier to high speed broadband uptake by Australian schools. In doing so, an objective of this paper is to develop and reach a shared understanding of the factors affecting bandwidth and data services costs faced by schools in the Australian communications market. The value proposition of high speed broadband services for schools will be influenced by these costs, and by the ability to progress and sustain all of the DER elements relating to the delivery of educational content and services over the short to medium term.

All jurisdictions and schools sectors agree that affordability and sustainability are the key principles to underpin a national vision of connectivity for Australian schools. They were explicitly recognised in the recommendations of the 2007 MCEETYA National Bandwidth Statement. Lack of affordability and sustainability act as disincentives to high speed broadband uptake by schools, and could impact on FCS implementation.

Other principles that have received support and provide the basis of a vision of connectivity for Australian schools are scalability and collaboration. Again, these terms are often used in statements about the role of ICT in education but are revisited in this paper because of their potential impact on the implementation of the FCS initiative.

The discussion of affordability, sustainability, scalability and collaboration outlined below has been informed, amongst other things, by conversations in May, June and August 2008 with education stakeholders. This paper also reflects feedback to a draft version that was circulated to education stakeholders including members of the Australian Information and Communications Technology in Education Committee in July 2008.

¹ This figure is based on the outcome of the first phase of FCS consultations and information received in response to the Department of Education, Employment and Workplace Relations (DEEWR) questionnaire about the availability of broadband in Australian schools distributed in May 2008 (15th August 2008).



Key Principles

1. Affordability

The ongoing affordability of any fibre connections supported under the FCS, particularly in regional areas, will impact enormously on their capability to contribute to education outcomes. Recurrent costs will be a major issue for schools. When looking at affordability over a period of time, we have been advised that the dominant costs are the human cost of technical support and operation and the recurrent elements of any network service charges. Typically, data network services are charged using some combination of:

- a connection or installation fee that is not necessarily directly related to the actual cost of providing the installation. In the case of fibre connections, this would include the cost of trenching;
- a recurrent access rental fee which is typically based on the speed of the connection but also varies according to the technology used (for example this charge is usually more expensive for ADSL1 than for ADSL2+ services); and/or
- a recurrent usage fee based on duration of use, volume of data transmitted and/or the distance over which data is sent.

In Australia, volume based charging of internet traffic is routine. While this is generally not the case overseas, there is no indication of change in the Australian market. These charges can have a significant impact on the affordability and useability of fibre connections to schools. Increased use of applications generating large data traffic volumes can lead to higher costs, budgeting uncertainty, use of download limits and throttling, all of which limit potential educational use. High costs for internet traffic pose a barrier to the use of the web for teaching and learning activities.

On the supply side, the cost factors involved in a fibre connection include:

- installation costs associated with the fibre and physical infrastructure (including the civil engineering works associated with trenching, cabling and ducting);
- costs of supplying the active components of the network. These include the optical and electric systems, such as switches and repeaters, that allow the network to send and receive signals and to be upgraded to 100 megabit per second (Mbps) or greater; and
- operational costs associated with providing the connection including transmission costs, management, network administration, billing, repairs and customer support.

The first two factors are largely sunk costs which can be amortised over several years, whereas operational costs are ongoing and are driven to a significant extent by geographical factors. The actual relationship between the costs of providing the network and what school jurisdictions and sectors pay for the service is, however, difficult to calculate.



State and territory jurisdictions, Catholic and independent school sectors and individual schools all have their own communications purchasing arrangements. In a number of jurisdictions and education sectors, demand aggregation has tended to result in more favourable commercial arrangements for the deployment of high speed fibre connections. But we are advised that differential recurring fees according to geographic location are, nonetheless, common and require a capacity for cross-subsidisation across a schools system. Where this capacity does not exist, the ongoing affordability of high speed fibre connections for smaller, especially regional, schools is currently uncertain and warrants further examination.

An alternative model for the charging of data network services exists in the Australian university sector. Australia's Academic and Research Network (AARNet), which is operated by AARNet Pty Ltd, connects universities and research institutes in all capital cities and many regional centres, as well as other isolated research facilities. AARNet also has significant international capacity, having established high bandwidth links to Europe, Asia and the west coast of the USA. This very high speed network operates at the 10 gigabit per second (Gbps) level and offers its university members a subscription based, predictable charge for academic and research data and communications transmitted across AARNet and many international research and education networks. Access to these international networks is provided through peering arrangements for which volume base charging does not apply. This service is currently only available to universities as a bundled service with commodity internet access.

A similar charging and business model is being developed by UQSchoolsNet, an initiative of the University of Queensland in its pilot phase. The UQSchoolsNet 'collaboration service' will be a subscription service that connects together member schools, the University of Queensland and other websites such as the Australian Broadcasting Corporation without accessing the general Internet thereby reducing recurrent usage fees. This will be available as a separate service and does not have to be bundled with commodity internet.

The Northern Territory and Australian Capital Territory government schools systems are the only ones currently connected to AARNet. While the Minister for Education, in her foreword to the AARNet Annual Report 2007, indicated an interest in exploring the potential role of AARNet in the DER that would appear to require:

- an adjustment of the AARNet business model; and
- a greater community of schools and more curricula available to optimise the market for a subscription service.

The vision of affordable high speed broadband connections for schools suggested here is one where schools can afford to use such connections to their full extent. This will be possible under charging models for data network services that are predictable and minimise the recurrent costs to schools, such as subscription based charging, or pricing that includes unlimited downloads. This approach requires a clear understanding of the drivers of costs and ways in which these costs can be reduced, for example, through encouraging aggregation of large volumes of education traffic and/or through a collaborative or collective services offering, at low or no cost,



similar to that provided by national research and education networks operating in Australia overseas (see discussion below).

2. Sustainability

As mentioned at the outset, the FCS is part of a suite of initiatives that, together, make up the DER, thereby recognising that safe, secure, sustainable high speed broadband connectivity to schools is likely to require a number of interrelated factors to apply – especially in the short to medium term. These factors include, but are not limited to:

The availability of an appropriate ratio of computers to students

Through the National Computer Secondary School Fund (NSSCF), the Australian Government aims to ensure that each student in Years 9 to 12 will have access to a computer at school. The outcome of the first funding round to 30 June 2008 is that 896 schools that have a computer to student ratio of 1:8 or worse can move to a target ratio of 1:2. The next round of funding will focus on moving all secondary schools to a computer to student ratio of 1:2.

It is recognised that the increasing use of mobile and other student personal IT devices as well as student generated content and social networks will also impact on bandwidth and data services requirements.

The development of online curriculum content that is readily accessible and can, amongst other things, be shared, locally stored and retrieved, as appropriate

Digital content will be drawn from a variety of sources and be aligned with the development of a national curriculum, as well as support online courses and classes of learners dispersed across sites.

In order for ICT infrastructure to be used well, action will be taken to ensure effective management and use of digital content and tools that will have improved online access, supported by the DER. This will include provision of relevant copyright compliant curriculum linked content, parent-school web based interaction and standards relating to the design, storage and cataloguing of online educational resources, so that these can be more readily found when needed and seamlessly integrated into lesson and course plans. Where there is sufficient bandwidth available, the use of caching and other technology such as WAN scalers, may be an alternative in terms of overall manageability.

The implications of expected increase in user generated Web 2.0 content may have an impact on the system requirements for storage, bandwidth, school level servers and content management. The development of flexible networks that are able to respond in a timely manner to these technologies will be important.

Support for teachers to make effective use of ICT in teaching and learning

It is recognised that many teachers are not using ICT for collaboration and communication and that capacity building in this area and in relation to using ICT for



curriculum design, planning and delivery in an online environment would be beneficial.

The Australian Government will work with the Deans of Education to ensure that teachers achieve competence in the educational use of ICT.

In addition to these factors, that are part of the DER suite of initiatives, broadband connectivity will only be supported and sustainable at the local level if it is reliable. This is why the Australian Government has expressed a preference for fibre technologies which are accepted internationally as delivering a more reliable data network service except in remote areas where non-fibre technologies are the only viable broadband options².

Sustainable broadband connectivity also requires a number of other factors that are the responsibility of school jurisdictions and sectors. These include robust Local Area Networks (LANs) and appropriate commercial arrangements for the backhaul of data.

The vision of sustainable high speed broadband connectivity for schools suggested in this paper is one in which the various and evolving elements that together build a value proposition for ICT in schools are all progressed. In this event, schools will regard their broadband connectivity as an integral tool in the delivery of their educational outcomes.

3. Scalability

One of the significant benefits of networks built on fibre is that bandwidth is almost unlimited and, as such, it is the most future-proof technological solution for data networks. Fibre to the premises, which is the objective of the FCS, is, according to *Developments in Fibre Technology and Infrastructure* (April 2008) a recent study by the Organisation for Economic Co-operation and Development (OECD), perhaps the most future-proof technology of all because it can best handle those bandwidth intensive applications such as high definition video-conferencing that are important in a contemporary educational context including in support of teacher professional learning.

The 2003 Broadband Advisory Group Report to the Australian Government, *Australia's Broadband Connectivity*, recognised that education users require significantly higher levels of bandwidth than residential or business users. It recommended that “schools and educational institutions should be connected to broadband internet services to facilitate research, support interactive learning and provide access to innovative and varied curriculum content.”³

² Fibre connections will not be able to be deployed to all schools in Australia. Consultations with education stakeholders in the first phase of the FCS have highlighted the issue of bandwidth for schools in remote areas. The DER policy states that schools in remote areas will receive a service which, depending on available technologies (eg. fixed-line, wireless and satellite), will be as close as possible to the standard to be provided by the National Broadband Network (i.e. 12 Mbps).

³ *Australia's Broadband Connectivity: The Broadband Advisory Group's Report to the Government – Recommendations*, p. 2



It seems that, once fibre infrastructure is installed, over-provisioning of ‘dark fibre’ and even installation of additional fibre is relatively inexpensive. According to the OECD study mentioned above, the costs of a fibre cable per kilometre are comparable to twisted pair and/or coaxial cables of similar lengths and similar number of strands. The capacity of fibre is, however, very significantly higher. And, once a site is connected to a fibre network, it is technically easy to upgrade to increasingly faster speeds.

Fibre networks also have technical advantages over other networks where the same physical network is shared, for example wireless and cable networks. The sustained rate that a connection can offer can positively or negatively influence the applications that can be used and how many can be used concurrently. If a network is shared for real time high bandwidth applications, the actual connection speed will depend on the contention ratio provided⁴. Any delays experienced due to slower connection speeds than anticipated can have an adverse impact in the classroom environment.

As noted above on page 3, on the basis of consultations with education stakeholders in the first phase of the FCS initiative, it seems that about 47 per cent of Australian schools are currently connected to fibre networks. The speeds of those connections generally vary from 2 to 20 Mbps with schools and school systems anticipating future upgrades according to timeframes that accord with their budgetary and other considerations.

The objective of the FCS initiative is to support the deployment of fibre connections to schools at speeds of up to 100 Mbps. Internationally, commercially available fibre networks currently reach speeds of up to 10 Gbps, with the latest technology at 40 Gbps and higher according to the OECD study mentioned above. Inevitably, over time, the bandwidth requirements of schools will grow as they increasingly integrate ICT, so that speeds in excess of 100 Mbps become commonplace. It will be important, however, that schools are able to manage the pace of that growth themselves. In this context, an early focus is likely to be supporting the transition of schools that are currently on non-fibre connections to have fibre so that they have capacity to scale up over time.

Another advantage of fibre networks is that they are better able to support symmetric communications that eliminate delays in communication exchanges. Symmetry is widely required in the contemporary education context to be necessary for adequate real time communications, such as high definition video-conferencing as well as end user created content and the sharing of multimedia. While symmetric bandwidth and services are becoming increasingly important, it is recognised that in the short to medium term, lower upload speeds are acceptable provided faster speeds can be achieved overall and the disparity between uploads and downloads is reduced.

The vision of scalability suggested here is one in which the architecture of fibre networks for schools minimises technical limitations on their use and supports ever faster speeds and increasingly bandwidth hungry educational applications.

⁴ The contention ratio is the ratio between the maximum amount of bandwidth needed if all users were to use the network at maximum speed and the actual bandwidth available.



4. Collaboration

The *Joint Ministerial Statement on ICT in Australian Education and Training: 2008-2011* provides a national framework for cross-sectoral collaboration on the effective and efficient use of ICT in education and training. Through this framework, Ministers of education and training have committed both to “national collaboration to share resources and expertise, and to leverage existing initiatives while recognising the importance of innovation and experimentation” and to “national, cross jurisdictional and cross sectoral approaches ... to address the ICT enablers of technology rich learning environments, ...including broadband”.

This commitment is important in the context of the FCS implementation as it recognises the benefits of collaboration to develop shared solutions to address shared challenges in the context of ICT in education.

There is support for greater collaboration at both a local and national level among education stakeholders.

Collaborative approaches have already been adopted to address common connectivity issues in an educational context. Such approaches both offer greater value for money through collective purchasing and build capacity to collaborate online for educational purposes. For example, internationally a number of national education and research networks (NRENs) have been established; driven by the requirements of higher education and research connectivity, including in Australia. These networks operate within agreed parameters combining high bandwidth connectivity often with ultra-resolution visualisation platforms. They run applications that do not require connection to the general internet thereby supporting more affordable bandwidth to members of these networks.

These sorts of networks offer the potential to transform the way the education sector collaborates nationally and internationally. In a country with a school population as geographically dispersed as Australia’s, the potential for collaboration throughout the education system, from early childhood development to postgraduate research are significant.

In a number of countries, notably the UK and USA, schools have been provided with access to NREN infrastructure, with the benefits arising from collaboration through these networks illustrated below:

- European *SchoolNet* has set up virtual communities for teachers in the 28 member countries to interact and share knowledge and resources. Teachers use these communities to find “partner classes”, which work together on single projects.
- The *K-20 school network* in the USA allows students nationwide to work together on projects for example, “Ice Stories”, where students interact with researchers working in the Arctic and Antarctica through blogs, video-conferencing, multimedia of their research and an archive of key resources in the fields of biology, geology and geography. In early 2008, the *K-20 network* launched Muse, a social networking site. This aims to allow schools to better connect with all others on the K-20 network, and to improve international collaboration.



- In the UK, *JANET Collaborate* has recently launched a programme that allows schools to find a partner school to video-conference with on any topic or by age group. Schools share educational opportunities and work collaboratively with partners including educational content providers across the UK.
- In the UK midlands parents can access an internal network, via mobile phone, to monitor their child's performance at school. Becta is developing plans to roll-out real-time reporting systems for parents to have access to regular updates on their child's progress.
- In the UK, students from seven secondary schools across London worked in partnership on a cross-curricular project on knife crime involving performance arts, business, media, art and design and health and social care. The students used 200 handheld devices to prepare and coordinate a presentation in which they presented the outcomes of their project in City Hall.

It is recognised that adequate bandwidth is not the only issue that impacts on the sorts of networks and collaborative approaches outlined above. Safe and secure connections between schools at the level of identity and access management are also important, as are the provision of data services.

The vision of collaboration that we are suggesting is one in which teachers, students and their families can safely communicate and collaborate in innovative ways that energise the learning experience, and where appropriate, collaborate with other education sectors such as higher education and vocational education and training. It is a vision of Australian schools networks that are interconnected so that teachers and students across traditional boundaries can access the same online curriculum and world class learning objects while retaining the ability to localise that content. And while interconnected – nationally and internationally – they are able to retain their community identity and to access a range of educational content that is affordable across schools networks for educational purposes.

Conclusion

The vision of connectivity for Australian schools is one in which they are affordably and sustainably connected through technologies that are scalable and integrated to optimise teaching and learning in Australia into the future. The vision encompasses connection of schools, as well as the building of networks and aspires to a social agenda which addresses educational disadvantage.

As outlined above, the vision of school connectivity suggested here is one which improves educational opportunities and facilitates quality teaching and learning outcomes by supporting:

- affordable high speed broadband connections to schools that can be used to their full extent;
- a value proposition for ICT in schools that regards broadband connectivity as an integral tool to the delivery of educational outcomes;
- fibre network architecture, where possible, that minimises technical limitations and sustains faster speeds and bandwidth intensive educational applications;



- safe and innovative communication and collaboration between teachers, students and families that energises the learning experience, and where appropriate, collaboration with other education sectors such as higher education and vocational education and training; and
- Australian schools networks that are interconnected so that teachers and students can access the same online curriculum and world class learning objects while retaining the ability to localise that content and retain community identity.

