chapter 1

INTRODUCTION

This report presents the results of an AIEAC Inquiry into the supply of, demand for and price of bandwidth, principally in backbone communications networks over the period 1999 to 2004 and the issues arising from that Inquiry.

1.1 why an inquiry into bandwidth?

A revolution in the information and communication technologies is at the very heart of the transformation now happening to the global economy. It is impacting on the nature and structure of business, throwing up new business models and making many kinds of transactions location independent.

The consequences for individuals and communities will also be profound, in terms of social interaction, education, work and entertainment. Already many new skills are in demand along with new ways of working.

The Internet fuels an increasingly large part of the growth and influences many of the changes that are occurring. Within the timeframe of this Inquiry it is expected that the transformation from discrete voice telephony and data communications systems to a fully integrated data based 'Internet' type of system will be largely complete.

For this to occur, Australians will need to be connected to the online environment. Currently, Australia ranks sixth in the world in terms of Internet users at 37 per cent of the population. This is just three percentage points behind the US which holds first place. Australian consumers and businesses have repeatedly demonstrated their willingness to be early adopters of new technologies and have done so again in this case.

To succeed in the new information economy and the global online environment which sustains it, will require that our communications system fully supports and encourages business to be internationally competitive.

In this regard, the availability of adequate, high quality and appropriately priced communications bandwidth is likely to be a key enabler of the emerging information economy while demand for increasing amounts of bandwidth can be expected to grow substantially over the next five years and beyond. The backbone, or trunk, network is of critical strategic importance in examining existing and projected capacity and demand. However, a network is only as robust as its weakest links. In examining backbone network capacity therefore, it is also necessary to look at other areas where bandwidth constraints might occur.

1.2 the inquiry

On 9 December 1998 the Minister for Communications, Information Technology and the Arts, Senator The Hon Richard Alston, announced his intention to ask the Australian Information Economy Advisory Council (AIEAC) to examine the issue of backbone bandwidth availability and pricing within, and to and from, Australia. The announcement realised the Government's 1998 election commitment to set up a National Bandwidth Taskforce to consider these issues.

The Minister's media release, and the tabling statement for the Digital Data Review report, which provides further details in relation to the National Bandwidth Inquiry, is at appendix 1. On 18 December 1998, the Minister announced the detailed terms of reference for the Inquiry. The media release is at appendix 2.

This Report is the work of AIEAC. It was produced under the guidance of a sub-committee of AIEAC with assistance from staff of the Department of Communications, Information Technology and the Arts (DOCITA). The sub-committee members are:

Dr Terry Cutler (Chairman)
Ms Mara Bún
Mr Peter Coroneos
Dr Wendy Craik
Mr Tom Kennedy

In addition, other members of AIEAC participated in the sub-committee's discussions from time to time, including Mr Don Mercer (chair of AIEAC), Professor Mark Sneddon and Dr Paul Twomey.

DOCITA staff who formed the NBI team consisted of Janelle O'Grady (Manager), Michael Moynihan, Garth Hartley, Bev McConnell, Anna Rudic, Brenton Thomas and John Street (CRU).

1.3 terms of reference

Under its terms of reference the Inquiry is to:

1. Report on the drivers of demand for bandwidth in a present and future Australian information economy, including:
    (a) the applications, in particular Internet-based services, which are most likely to drive demand for data communications on the network, especially the trunk network, from residential, business, community, academic and research and public sector users, including governments at all levels;
    (b) the likely take-up of these applications within the timeframe outlined above, including an indication of the likely price sensitivity of the potential markets for these applications; and
    (c) the likely levels of demand for telecommunications bandwidth within Australia and between Australia and key overseas markets.
2. Report on the constraints, if any, which exist on the ability of the Australian telecommunications network to meet the likely demand of an Australian information economy, including:
    (a) providing a 'stocktake' of Australia's existing trunk network, and planned changes to that network by commercial operators and state governments, with information disaggregated regionally, as far as practicable;
    (b) determining the current and reasonably anticipated data carrying capabilities of the trunk network;
    (c) outlining the technological changes, which are likely to affect the data capabilities of Australia's trunk transmission network;
    (d) analysing pricing for key high bandwidth services, including existing pricing structures, trends, and the benchmarking of current prices in Australia against those in comparable markets overseas;
    (e) outlining relevant market structure and commercial issues, including the current level and likely development of competition in relevant wholesale and retail carriage service markets within Australia;
    (f) determining relevant international market structure and commercial issues, including an assessment of the international settlement arrangements for Internet Protocol (IP) networking; and
    (g) analysing the implications of regulatory arrangements relating to the installation of trunk network infrastructure, in particular submarine cables, at all levels of government.

The above analysis should consider both present constraints and any future constraints that may emerge in the move to a full information economy in the primary timeframe for the report.

3. On the basis of the foregoing, and any other matters the Inquiry consider relevant, provide:

   (a) its assessment of the degree to which there is a risk of constraint on the availability of bandwidth in any significant part of the Australian telecommunications network, especially the trunk network, over the next five years which is likely to have a material effect on the evolution of the information economy in Australia; and consideration as far as practicable of the costs of such constraints to the wider economy; and

   (b) its views on the options open to the Government to address those constraints, including its preferred option (if any).

1.4 approach taken by the inquiry

The sub-committee first met on 17 February 1999 and had nine meetings in total. At these meetings, the sub-committee sought to address the issues arising from the Inquiry including specific issues such as pricing and rural matters. Guests were also invited to present different perspectives on a variety of issues.

Fundamentally, the Inquiry sought to determine if Australia's backbone communications networks would be in a position, over the next five years, to provide adequate bandwidth to support the new information economy.

The work of the Inquiry builds on previous work undertaken by the Broadband Services Expert Group in 1994,[1] the Communications Futures Project in 1995,[2] the Information Policy Advisory Council in 1997[3] and the Digital Data Review 1998.[4]

In September 1999 a discussion paper was circulated for public comment. In response, 29 submissions were received.

1 Broadband Services Expert Group, *Networking Australia's Future*, Australian Government Publishing Service, Canberra, 1994.

2 Bureau of Transport Communications Economics (BTCE), *Communications Futures Project—Final Report & Six Working Papers*, Forecasts of supply and demand for bandwidth by households, Canberra, 1995.

3 Information Policy Advisory Council, *Report of the Working Party investigating the development of online infrastructure and services development in regional and rural Australia*, Department of Communications and the Arts, Canberra, 1997, http://www.ipac.gov.au/report.ipac.htm.

4 Australian Communications Authority (ACA), *Digital Data Inquiry, Public Inquiry under section 486(1) of the Telecommunications Act 1997*, Australian Communications Authority, 1998.

In addition, two subject specific discussion papers were released for public comment in August 1999, *International Charging Arrangements for Internet Services* and *Regulation of Submarine Cables*. These discussion papers, the public comments and research together form the basis of this final report.

1.5 what is bandwidth?

Historically the term *bandwidth* was used by radiocommunications engineers to refer to the amount of radiocommunications spectrum available or necessary for carrying an (often analogue) signal for a particular purpose. For example, a telephone call normally uses in the order of four KHz of bandwidth while a television signal in Australia requires seven MHz of bandwidth. With the advent of digital communications systems, and in particular the Internet, the term bandwidth is a term capable of different meanings.

Bandwidth has been used more generally to refer to the measure of throughput capacity of a given communications network link or transmission protocol.[5]

In relation to digital transmission of data, the amount of bandwidth between sender and recipient determines how much data can be transmitted per unit of time. It is measured in bits per second (bps) or Kbps, Mbps and so on.[6] A typical residential modem for example, may transmit in the range of 28.8 Kbps through to 56 Kbps.

Assuming there were no other impediments this would determine the rate of flow for the data being sent.[7] In the case of larger businesses, their data connections might operate at two Mbps, ten Mbps or higher transmission rates. A table setting out common transmission rates in different parts of the world is at appendix 5 table AP5.1.

It is fairly common to talk about the size of the *pipes* available to carry data, with *larger* pipes having capacity to transmit higher volumes of data per second. While the analogy with, say, gas or water pipes is a useful way to depict flow rates, this

5 See Cisco Systems, *Internetworking Terms and Acronyms*, California, June 1999.

6 The measure of transmission capacity is in bits per second, (typically, mega bits per second written as Mbps or kilobits per second written as Kbps) whereas the usual measure of electronic memory storage capacity of a computer for example, is in bytes (typically megabytes written as MB or 106 bytes).

7 In practice, the nominal modem speed is not the actual data transmission rate and line conditions can further reduce data rates.

analogy can be misleading if it gives rise to the inference that data carrying capacity is somehow related to the physical size of the transmission medium. The size of transmission media such as copper wire, optical fibres and microwave radio transmission is not a relevant consideration in relation to data carrying capacity.

While the available bandwidth may be equal in both directions or symmetrical (as for example, in a voice call) this is not necessarily the case. Broadcast, for example, is essentially a one-way transmission system, while nominally 56 Kbps modems typically provide a higher data rate inbound than outbound (that is, asymmetrical bandwidth).

Bandwidth services can be provided in a variety of ways depending on the degree of value added. These range from transmission services such as private leased circuits, wholesale virtual networks to a variety of packaged wholesale services such as asynchronous transfer mode (ATM) and frame relay.

1.6 trunk network versus the customer access network

The terms of reference focus on the *trunk* network, on the basis that bandwidth issues in the customer access network were dealt with as part of the Australian Communications Authority's (ACA) Digital Data Inquiry in 1998.[8] This distinction turned out to be only partly relevant as:

- the ACA primarily dealt with bandwidth in the customer access network up to 64 Kbps which is the lower end of the broadband range;
- some network components such as satellites can be both trunk and customer access network; and
- network capacity, from a user perspective, is often determined by the capacity available in the customer access network.

For these reasons the Inquiry considered the customer access network where relevant. In addition, this report uses the expression *backbone* network instead of *trunk* network, as *trunk* has traditionally only referred to Telstra's network.

8 ACA *op. cit.*

1.7 consultation

The report has been developed from the work of the consultants, the Inquiry's consultations, submissions in response to the discussion paper, its independent research and ongoing input and advice from the AIEAC NBI subcommittee.

The Inquiry gratefully acknowledges the input and assistance it has received from the organisations and individuals with whom it has held discussions:

- the telecommunications carriers and network operators;
- focus groups organised by peak bodies such as the Australian Telecommunications Users Group, the Australian Information Industry Association, the Australian Multimedia Industry Association, the Internet Industry Association, Education Network Australia and the Screen Producers Association of Australia;
- a number of one-on-one interviews with representatives of the various industry categories;
- selected industry representatives as part of their address to the AIEAC sub-committee; and
- officials from State, Territory and Commonwealth Governments.

Appendix 3 contains a full list of the organisations and individuals with whom the Inquiry consulted and/or received submissions from.

The Inquiry wishes to give particular thanks to Telstra both for quantitative and other information made available to it or to consultants to the Inquiry and for its work in managing case studies relating to e-commerce. The case study firms were jointly selected by the Department and Telstra but the substantive work was undertaken by a consultant under the direction of Telstra.

chapter 2

THE BANDWIDTH ENVIRONMENT

The global communications industry is undergoing major changes, the most significant of which are:

- the shift from voice to data; and
- a spectacular growth in the demand for services and the capacity of networks to provide them.

This change is underpinned by significant developments in:

- communications technology to reduce the unit cost of carrying information;
- commercial and financial arrangements to facilitate e-business; and
- regulatory structures to promote competition.

2.1 introduction

Major changes are reshaping the communications industry worldwide. They herald a world of communications richness and ease largely unthinkable a decade ago, possibly even five years ago. To provide context for the discussion on supply, demand and pricing, this chapter sketches some of the more important forces driving the changes and explains what those changes are. Ranging from exponential gains in computing power and storage capacity through to massive international infrastructure investment, there is scarcely an area of the industry that is not being transformed in the process. With these changes are emerging new business models and new ways of doing business. Chapter 3 then takes up the implications of these changes in an attempt to clarify where they are leading. The discussion in both chapters should also make it abundantly clear why any attempt to 'guess the future' five years from now is no easy task.

2.2 shift from voice to data

The spread of business data networks and the burgeoning growth of the Internet, especially in the past five years, have seen digital data traffic rising to levels equal to, or nearly equal to, voice. One estimate is that data traffic is growing by a factor of three every five years while voice is growing by a factor of two over the same time interval and that, internationally, data traffic will overtake voice in two to three years.[1] For Australia, however, international data traffic exceeded voice traffic in 1998 with domestic data traffic expected to follow the same path in 2002.[2]

While the distinction is valid in illustrating the respective importance of voice and data, it tends to break down when considered in terms of traffic carried (or bandwidth required). Telecommunications carriers in most developed market economies are moving, or have moved, to digital transmission of voice. Hence, from a bandwidth perspective, there is data … and then there is more data.

The Internet is behind much of this explosion in data. Often characterised as a *network of networks*, the Internet is a set of protocols for enabling computers to connect and communicate with each other. Viewed in another way, it is like a communications platform that enables a range of other, Internet-specific programs to run.

1 McGinn, R.A., *A revolution in networking: toward a network of networks*, October 1998, *http://www.lucent.com/news/speeches/docs/mcginn1.html*, August 1999.

2 Telstra Corporation, *Telstra Annual Review, 1998*, p. 10.

A major stimulus to much of this Internet growth in recent years has been the development of the hypertext transport protocol (HTTP) and the easy-to-use web browsers that emerged to exploit it. Indeed, so ubiquitous is web-browsing based Internet usage that for many people the Internet and the World Wide Web are synonymous.[3]

2.2.1 FUNDAMENTAL TECHNOLOGICAL CHANGE

Complicating the picture further is the phenomenal rate of change and innovation in almost every area of communications. Processing speeds have been doubling every 18 months to two years since 1965, as predicted by Gordon Moore, a co-founder of Intel. At the same time, cost per unit of processing power has been halving every two years.[4] *Moore's Law* as it has come to be called, appears to have operated in many areas of the communications infrastructure and, in some cases is being outstripped by the rate of change.[5]

> 'In a way, it shows the trajectory of hope in business and has become a self-fulfilling prophecy because everyone now assumes that we should be able to double processing speed every 18 months. So, it was not only a fabulous forecast, it was also a fabulous inspiration.'
>
> (Paul Sappho, commenting on Moore's Law.)[6]

Improvements in information storage parallel those in information processing hardware.[7] Hard disc drives have been getting larger in terms of storage capacity and compact discs have been getting faster. Storage technologies affect virtually all information and communications products that involve almost any type of content. They can also affect the dimensioning of communications transport systems by providing buffering for non-time sensitive content.

The breadth of developments in transport technologies is on a par with those in information processing. Gilder argued in 1994 that, in the ensuing 20 years,

3 Given the ability of web-browsers to emulate a wide range of more function-specific client programs (for example, email), many other Internet programs have in fact been absorbed into browser-based functions.

4 McGinn, R.A., *op. cit*.

5 Bureau of Transport and Communications Economics, 1995, *op. cit.*, p. 23. Much of the discussion on technological change in this section is based on this report.

6 Sappho, P., *http://www.intel.com/intel/museum/25anniv/int/saffo.htm*, September 1999.

7 This paragraph and the following one, draw substantially on BTCE, 1995, *op. cit.*, pp. 22–28.

transport capabilities (notably bandwidth) were likely to exceed substantially the historic two-year exponential doubling associated with Moore's Law in information processing and the indications to date support this claim.

Another key area of change has been the rapid growth in communications mobility. Mobility is becoming an increasingly important feature of modern communications networks. Satellite services are increasingly providing ubiquitous mobile access, while the development of so-called two and a half and third generation mobile services are substantially increasing the data capacity of mobile services. Not only is mobile phone technology adding Internet functionality to phones, but new and smaller mobile devices like the evolving *palm top* computer, together with mobile telephony, will over time reduce the existing dominance of the fixed personal computer (PC) as the main entry point to the Internet. New types of personal communication devices are also under development that will allow remote, wireless communication with other electronic equipment, such as lighting and security systems in the home, PCs and facsimiles. One example of such technology is Ericsson's *Bluetooth* wireless technology, which is also expected to incorporate mobile phone and Internet access functions such as email and web-browsing.

Computing/communications devices, 2004

On present trends, computing devices in five years' time are likely to have:

- processor speeds of around 1.5 GigaHertz
- 300+ Megabytes of memory
- 40 Gigabyte storage capacity (or the equivalent of 8 feature movies)

Such devices will not necessarily resemble the existing PC:

'… although computer, telecommunications, and consumer electronics technologies will come together, the next generation of smart devices mostly won't …

The result is that there'll be a proliferation of smart, connected devices, from palm-sized and tablet PCs to Web-enabled phones and AutoPCs. Your files, schedule, address book, and everything else you need will automatically be replicated onto each of these devices, because everything that can think will link.'

Bill Gates 4 October 1999
http://www.microsoft.com/presspass/ofnote/10-04forbes.htm

2.2.2 E-COMMERCE

E-commerce, or e-business, is another area of spectacular growth. At the more visible end, e-commerce consumer transactions to send flowers, buy compact discs or book tickets have become fairly familiar to web users. Less visible are processes that go well beyond e-commerce in the *buy and sell* sense and which are likely to profoundly reshape doing business and running a business. In canvassing this more radical aspect of e-business, Matthew Symonds, writing in *The Economist* observed:

> The Internet is helping companies to lower costs dramatically across their supply and demand chains, take their customer service into a different league, enter new markets, create additional revenue streams and redefine their business relationships.[8]

Business-to-business electronic transactions are not of course limited to web-enabled transactions. Large corporations have been using electronic data interchange (EDI) systems to manage their supply chain relations for many years. However, in contrast with the inflexibility, limited range, expense and proprietary nature of EDI, Internet technology offers ubiquity, flexibility and ease of use. 'It is flexible enough to work either inside an organisation (intranet) or outside in open (public Internet) or secure (extranet) form. It is cheap to set up. And it is global.'[9]

The article goes on to note that business-to-business online trade in goods was valued at US$43 billion in 1998 and is expected to surge to US$1.3 trillion in 2003. By contrast, business-to-consumer transactions over the same period are forecast to rise from US$8 billion in 1998 to US$108 billion in 2003.

Online spending by Australian consumers is estimated at US$1 billion and projected to grow to US$7.6 billion within five years.[10] The same research found that annual business-to-business e-commerce spending in Australia had reached US$3.6 billion and would rise to around US$44.8 billion by 2003.

E-business also has the potential to restructure aspects of the supply chain itself, by obviating the need for intermediaries between suppliers and ultimate customers. This process of *disintermediation* could have major implications for conventional

8 Symonds, M., 'Business and the Internet', *The Economist*, 26 June 1999.

9 *Ibid*, p. 10.

10 Gartner Group, reported in *The Australian*, 24 August 1999, p. 34.

retailers, booking agents, auctioneers and others. At the same time, new forms of mediation are appearing: auction sites and exchanges have sprung up on the web in areas as diverse as road haulage and advertising space, effectively creating new spot markets for many services. Another significant aspect of many of these businesses is their *virtual* character—for example, businesses such as *amazon.com* that exist entirely as online entities with no retail premises.

While individual online transactions, whether business-to-business or business-to-consumer, may not involve large demands on bandwidth at present, the totality of these transactions can have substantial server-side capacity requirements.

In particular areas, however, there are more substantial bandwidth implications, even at the transaction level. Much of the growth in online transactions has been for physical goods (e.g. books, flowers) that are subsequently physically delivered. However growth in online transactions for intangibles can be expected to increase with online delivery of products such as entertainment and education. With the emergence of the MP3 audio compression protocol, and the rapid growth in online music, video and radio, more and more offerings are available to consumers via the web. In addition, businesses can be expected to integrate real time voice help desk services with their online transaction services as Internet voice telephony becomes more prevalent.

The development of e-commerce has meant that a great deal of business can be conducted with little regard for national boundaries. In the past the bookshop was mainly concerned about competition from the bookshop around the corner or across the city. With the advent of e-commerce, it is now potentially in competition with every e-commerce enabled bookshop in the world. While transport costs (in relation to tangible goods) and regulatory restrictions, where these exist, need to be taken into account, the emerging reality is one in which more and more economic activity is trade exposed.

2.2.3 INDUSTRY CONVERGENCE

Internet access providers and Internet service providers (ISPs) generally stem from a very different culture to that of the more traditional incumbent carriers, having sprung from the information technology industry rather than the telecommunications engineering industry. The telecommunications industry has typically worked with long (e.g. ten year) lead times, to high quality of service standards, backward compatibility and a reasonably predictable technological

environment. In contrast with the high service quality of telecommunications, the new entrants and ISPs come from an environment marked by rapid change and turbulence. In these circumstances the timeframe for innovation and bringing ideas to market tends to be in the order of 18 months to two years. In addition, the Internet world has typically had less predictable, *best endeavours* delivery, traffic congestion and transmission delays.

The Internet and telecommunications industries are converging. Around the world, many of the telecommunications carriers have moved into the provision of Internet services while in parallel, facilities based and non-facilities based providers have emerged to provide Internet and data services—and from there to voice services—that represent both an opportunity and a threat to the incumbent telecommunications carriers.

Part of the complexity of the emerging reality is that different content services (e.g. voice, radio and television) are capable of being delivered by a diversity of suppliers (e.g. telecommunications carriers, cable television operators and broadcasters). The emergence of digital terrestrial broadcasting (DTTB) will, for example, provide the opportunity for the broadcast of high quality television and large amounts of data (referred to as datacasting) in a television format to anyone who can receive the transmission signal.

Another level of complexity is introduced by the fact that most, if not all, of these services are either now able to be delivered, or in principle can be delivered, over the Internet.

There is also wide recognition that content—including multimedia content—is one of the keys to stimulating both consumer demand and revenue growth. As a result many new kinds of relationships are developing across the telecommunications, Internet service provision and media industries, among others.

One reflection of this convergence is the spate of corporate takeovers, mergers and alliances ranging across all sectors of the communications industry as organisations try to reposition themselves in an increasingly volatile and complex global market. Much of this activity has to do with vertical integration all the way from transmission through to content provision.

But underlying that activity are two distinct philosophies regarding network design and control. It has been expressed by many commentators as a battle for where

intelligence (and hence control) will reside: in the core network (the traditional telecommunications model) or at the periphery in the hands of the user (the Internet model).[11]

As David Isenberg has observed:

> IP terminates in a device at the customer's fingertips. Thus 'endpoints' are no longer owned or controlled by telcos. This simple fact has profound consequences for how telcos do business. Because IP is an Internetworking protocol, it makes differences between Networks irrelevant. So, no matter how much intelligence a telco Network has, or how many cool features the telco adds, in an all-IP Network, the only properties that matter are transport and connectivity. In an all-IP world, the network becomes the transport device for the customer's application; much like a disc drive is the customer's storage device.
>
> This means that new applications, new value, can be created at the edge of the network, without the permission, control, or involvement of the network owner. And when network ownership is de-coupled from value creation, telcos derive no benefit from the new value beyond the traffic it spawns.[12]

Thus, there is an underlying question as to whether the impact of the Internet will prove to be a *sustaining technology* or a *disruptive technology*, when viewed from the perspective of the traditional voice telephony carriers.[13]

2.2.4 CHANGING COST STRUCTURES

The rate of technological change and the blurring of the distinction between voice and data have implications for the cost structure of the telecommunications industry. As voice and data are increasingly carried in the same way over the same infrastructure, the cost of carriage for the two services will converge. As a result, the cost based justification for differential pricing arrangements of voice and data will disappear. In addition, the actual path travelled by the data in digital networks need not be related to the distance between the calling and called party. This, together with the potentially huge increases in available

11 Denton, T. M. Consultants, *Netheads versus Bellheads*, Final Report for the Federal Department of Industry (Canada), *www.tmdenton.com./netheads*, Ottawa, March 1999.

12 *Ibid*.

13 Christensen, C.M., *The Innovator's Dilemma*, Harvard Business School Press, Boston, Mass, 1999.

capacity, will mean that the marginal cost of the capacity required to carry a voice call will be largely independent of distance and will continue to fall, perhaps even approaching zero.[14]

This is not to say that a telephone service will cost nothing and therefore should be provided for free. The capital cost of infrastructure replacement and development will have to be recovered. This is a fixed cost, largely independent of the short term communications traffic requirements. Therefore the fixed component of voice call costs may rise while variable costs will probably fall. To the extent that pricing reflects costs, this would see a reduction in overall call prices with some re-balancing from the variable to the fixed component. It may be that telephone services will be bundled with other services in such a way that they may cease to be separately priced and developments such as the dialpad.com example, where call costs are recovered from advertising revenue instead of consumers, could lead to very different charging arrangements.

2.3 global bandwidth trends

Historically, the focus of governments has been on telephony (and broadcasting) services. In most countries telecommunications carriage has been provided by monopoly providers, who have generally been public sector organisations. This order has changed or is in the process of changing throughout the developed market economies. These changes are occurring in several dimensions.

First, many countries have opened their markets to competition, leading to substantial infrastructure investment, declines in prices, greater service diversity and product innovation. Markets have become more contestable. The US was the first to embark on this course with the introduction of competition in 1969. But the main growth in US competition is less than a decade old. As a recent *McKinsey Quarterly* noted in the US context:

> The new networks came into existence as a result of an ambitious rush by attacker telecommunications companies to exploit the capacity constraints of the early 1990s and to cash in on the data traffic boom set off by the rise of the Internet.[15]

14 US long distance call prices as low as 5c/minute have been reported, while Internet to conventional phone long distance calls are being offered free by one company (see *http://dialpad.com*)

15 McKinsey, *McKinsey Quarterly*, 1999, Number 2, p. 77.

Second, is the relative increase in data traffic as compared with voice traffic and the digitisation of communications networks. This has facilitated a change in the design philosophy of such networks, away from fixed path *circuit* switching, towards variable path *packet* switching.

Third, the traditional consortium approach to submarine cable investment and control is being eroded. As noted by Ovum:

> A new model for submarine cable is appearing, fuelled by the limitations of club cable [i.e. the traditional consortia] and the tremendous business potential in this area due to the unprecedented growth in bandwidth. Two new types of cable system are emerging:
>
> - carrier sponsored cables—privately implemented, but carrier maintained, for example, Gemini (jointly owned by MCI WorldCom and Cable & Wireless); and
> - private cable systems—privately funded and operated by an independent company, which sells capacity from the cable; for example Global Crossing.[16]

In many cases, these independent carriers have end-to-end customer access arrangements thus bypassing the need for inter-carrier settlements. Thus the fairly well understood rules for international settlements in voice telephony will become increasingly less well adapted to the emerging environment.

While most of these developments are focussed primarily on North America and Europe, developments are occurring elsewhere. An example is the recently announced joint venture between Global Crossing, Softbank and Microsoft to build a US$1.3 billion broadband East Asia network connected back to the US. The Asia Global Crossing network will include Japan, China, Singapore, Hong Kong, Korea, Taiwan, the Philippines and Malaysia with terrestrial links and city rings as well as undersea cables and will provide web hosting, e-commerce and Internet services as well as low cost telephony.[17]

While new investment in international infrastructure between Australia and other countries is occurring, it is a matter of some concern that major investment projects like Asia Global Crossing can occur without including Australia within their

16 Ovum, *op. cit.* p. 122.

17 *http:www.globalcrossing.bm/pressreleases/pr_090899.asp* September 1999.

reach. It points to an ongoing danger that Australia's international connectivity could continue to be less abundant and the market less aggressively competitive than elsewhere even in the East Asian region. Developments in Australia's international capacity are discussed further in chapter 5.

Fourth, there have emerged new wholesale markets for communications capacity. Where formerly wholesale and retail markets were for practical purposes indistinguishable, in the new environment bandwidth has become a tradeable commodity. This can be seen in the emergence of carriers laying optical fibre cable and then on-selling unlit (dark) fibre to other carriers; companies laying fibre (sometimes referred to as *carriers' carriers*) with the sole purpose of on-selling to carriers and service providers; and in the growth of spot markets for bandwidth.

The new generation carriers—Qwest

Qwest Communications is the fourth-largest long-distance operator in the US. It is also expanding internationally. Qwest's principal aim is to provide adequate bandwidth for the increasing demands of the advancing digital age, supporting the seamless delivery of new multimedia traffic. It has been at the forefront of the rise of the new 'bandwidth barons' in the US—that is, the emerging carriers building new high-capacity coast-to-coast infrastructure optimised for data.[18]

There are two kinds of bandwidth market intermediaries: bandwidth exchanges and bandwidth brokers. The former basically facilitate contact between buyers and sellers of bandwidth. The latter operate their own facilities to which buyers and sellers connect their networks.[19] Commenting on the rise of bandwidth exchanges (or *Telecommunication capacity markets)* the Organisation for Economic Co-operation and Development (OECD) concluded that 'It is …undeniable that, where alternative infrastructure is available from different providers, they assist in bringing down the cost of the communication infrastructure underpinning electronic commerce.'[20]

18 Young, S., Flanigan, B., *The Bandwidth Explosion*, Ovum Pty Ltd, 1999, pp. 410-411

19 Young, S., Flanigan, B., 1999, *op. cit.*, p. 111; OECD, *Building infrastructure capacity for electronic commerce leased line developments and pricing*, DSTI/ICCP/TISP(99)4/FINAL, Paris, 1999, p. 18.

20 OECD 1999(a), *op. cit.*, p. 19.

Bandwidth exchanges—Band-X

In July 1997, Band-X launched the first ever independent virtual market for international wholesale telecom capacity—that is, bandwidth and minutes. The Internet-based exchange provides registered users with screens for placing bids and offers for bandwidth, minutes, co-location facilities and recruitment. Since it was launched, Band-X has more than 4 500 members from 110 countries. These range from tier 1 carriers, large resellers, 'carrier's carriers', ISPs, backbone operators, switchless resellers and large and small corporate customers.[21]

The massive investments now occurring in infrastructure capacity—particularly in the northern hemisphere—together with the degree of turbulence, technological innovation and uncertainty tend to undermine the market demand/ investment planning process. Each new generation of cable and switching can provide more potential capacity than the sum of all existing capacity and at substantially lower unit cost. Industry responses to this situation range from rational planning and investment to an almost apocalyptic belief that demand will expand to match supply—a *build it and they will come* reaction. The latter sort of response is to some extent captured in the following comment (in relation to memory capacity) from Andrew Gove of Intel:

> You never know until you get there—supply comes in big chunks. Build the capacity, counting on the demand, and then work like a dervish to make sure the demand comes about.[22]

The US currently exerts a dominating influence over much of international communications, especially in relation to the Internet and associated data markets. This is true in relation to massive investment in global communications infrastructure, in product and service development and diversity, and in Internet content and e-commerce. The pace of investment has accelerated sharply with frequent announcements of new capacity roll-outs, whether terrestrial landlines, wireless or satellite-based services, and some US carriers are looking to build economies of scale by going global. The rapid development and infrastructure rollout of the US market drags in significant amounts of capital, which Australia

21 Young, S., Flanigan, B., 1999, *op. cit.*, p. 257.
22 Gove, A., quoted in Young, S., Flanigan, Ba., 1999, *op. cit.* p. 158.

must compete with to further develop our network. In the case of the global networks the decision to invest in the US or Australia is often made at its US headquarters. These issues are again taken up in subsequent chapters.

The main exception to US dominance is in the area of voice traffic where the flows tend to be more balanced and not critically hubbed on the US. Even in this area, however, the US has been a leader in competition and innovation (e.g. the introduction of overseas call-back services) and reductions in long distance and international call costs.

2.3.1 TEST-BEDS

There is a widely shared perception that new applications will be spawned in the bandwidth-rich environment that is already emerging, particularly in the Northern Hemisphere. Organisations in a number of countries—with or without government assistance—have taken initiatives to create high bandwidth experimental networks to stimulate research and the development of new applications.

Notable amongst these high performance networks are Internet2 in the US, CANARIE in Canada and, to a lesser extent, the European TEN-155 network. In each case the networks are built around the involvement of the academic research communities. In the US and Canadian examples the networks also involve assistance and participation from a range of information and communications technology corporations.

Internet2 is the most developed of the projects identified here. The project began in 1996 with the explicit goals of creating and sustaining a leading edge network capability for the American research community and enabling the development of a new generation of applications to fully exploit the capabilities of broadband networks.

2.3.2 OTHER MODELS

Municipalities and/or utilities have also entered the communications business, either directly or by having facilities managed on their behalf. The city of Stockholm is one of the longer-established models of the later. In 1994 the city chartered a company called Stokab to lay a fibre optic network, which was

completed within two years. Stokab basically focuses on supplying dark fibre to other carriers and resellers, who terminate and light their own fibre and supply all services above that layer. Because of the relationship between Stokab and the City, rights of way and ducting issues either did not arise or were quickly resolved, while the availability of fibre to other parties has obviated the need for others to lay separate infrastructure.[23] The City of Palo Alto Utilities, in the San Francisco Bay area, is essentially going down a similar path with fibre to the home. Again, fibre is available to third party services on either a lit or unlit basis. In the City Manager's report to the Palo Alto City Council, specific mention is made of the cost advantages involved in being able to access the City's conduits and poles. The report goes on to say:

> Such a project could be completed at less than a third of the cost competitors would incur to bore underground and install new conduit. This is the City's most significant competitive advantage.[24]

Similar developments are occurring in Australia. ACT Electricity and Water (ACTEW) has completed trials for an ACT-wide broadband digital network called TransACT. The network consists of fibre to within 300 metres of every home and copper from there to the home/office. Services include telephony, video and high speed data services (including Internet) to residential, business and government markets. The full commercial rollout of the network currently awaits the sign-up of commercial investors.

2.4 implications

Emerging from all of this is clear evidence of a major paradigm shift. This ranges all the way from network design philosophies to the way services are packaged and delivered. During the time-frame of this Inquiry, for example, the shift from a voice to a data environment will be largely completed in most developed economies. The changes present both significant opportunities and threats to Australia. The way in which the transition is managed will determine how dislocating the changes will be, but it is unlikely to be played out without there being both winners and losers.

23 See Isenberg, D., *A tale of two cities: municipal nets show new models for local competition*, *http://www.americasnetwork.com/issues/98issues/981001/981001_edge.html*, October 1998.

24 City Manager's Summary Report, *The Palo Alto Fiber Backbone*, *http://www.cpau.com/fiberservices/phase4.html*, August 1996.

There are also some serious timing lags and discrepancies involved, country to country, between city and rural, and the technologically rich and poor. The US ascendancy in infrastructure investment, globalised e-commerce, content creation and its substantial time lead in the online world could have a major impact on the economic performance of other countries. In Australia's case, the US timing advantage has been estimated to be about one to two years.[25] Given the exponential growth of, say, e-commerce in the US, this sort of lead means the absolute difference in performance is almost certain to widen rather than remain constant or decrease—particularly given that it has a tendency to draw new investment to the US rather than Australia. The implications of this situation will be taken up again elsewhere in this report.

At a more general level, the globalisation of markets and the globalised communications networks supporting them have major implications for Australia. While Australia remains the *island continent* in geographical terms, it is important this does not also represent our economic, cultural and policy mind-set. In addressing the issues of bandwidth and globalisation this Inquiry has attempted to distinguish between those problems and issues that are likely to be transitional and hence self-correcting and those problems which appear to be systemic and call for substantive policy responses. What is at issue here is not whether we are part of a globalised economy and communications infrastructure but how quickly and effectively we respond to the threats and opportunities represented by this global environment in order to maximise the national benefits from participating in it.

Nevertheless, the emerging global information economy presents significant opportunities for Australia and Australians. The new world will be one of bandwidth richness with more and more commercial, educational and entertainment services migrating to the online environment. Consumers can expect to have greater choice over services, networks and greater mobility of access. These themes are explored further in chapter 3.

25 The NBI Discussion Paper suggested that the gap between Australia and the US might be two to five years. In the light of further advice that timing appears to be unduly pessimistic and one to two years is a more realistic assessment.

chapter 3

TOWARDS A VISION FOR BANDWIDTH

This chapter aims to make sense of the forces affecting bandwidth markets, by proposing a simplified, three-stage evolutionary model:

- within the context of this model, a bandwidth vision for Australia is articulated.

The key challenges raised by that vision and the paradigm shift identified in chapter 2 are further developed.

These challenges, together with the market analysis in chapters 4-9, form the basis of the issues canvassed in chapter 13.

3.1 introduction

Chapter 2 described the forces which are making, and will continue to make, massive changes to communications markets in Australia and globally. That chapter concluded that these changes meant that over the period of the Inquiry's investigation (1999–2004), the paradigm shift from essentially independent analogue networks carrying mainly voice, to data networks carrying substantially data traffic would be largely complete, in the major developed economies. This chapter attempts to provide a broad framework for thinking about these changes, and to draw out some of the implications for bandwidth markets, by proposing a simplified three-stage schema of the legacy, transitional and future bandwidth worlds.

Within the context of the third stage of this schema, the chapter proposes an idealised vision of what Australia might strive to achieve in that emerging environment. This is intended to assist in identifying policy aims, and to highlight some of the tensions, constraints and possible pitfalls in achieving the kinds of changes that would be required to realise the vision. This is subsequently taken up in chapter 13 which addresses more specific issues.

3.2 the evolution of communications markets

Communications markets are complex and inter-related. As described in chapter 2, they are also currently the subject of very rapid change in the structure of both supply, demand and market structure. It is not easy to capture the nature of this change simply, however it is worth making the attempt, because the bandwidth future is likely to depend to a considerable extent on the way we manage the transition to the data future. The following simplified discussion places Australia and most developed nations in the second phase of a three phase transition.

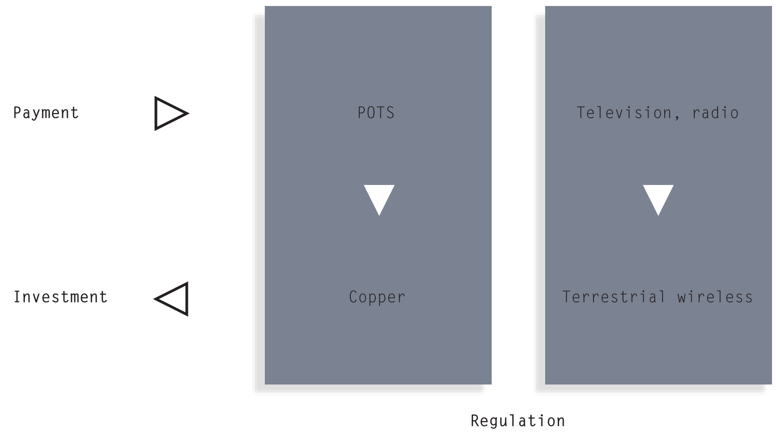
3.2.1 STAGE 1: THE LEGACY WORLD

Until the early 1990s the bandwidth market in Australia could be crudely characterised by the diagram in figure 3.1. The traditional model was based on the vertically integrated supply of what was essentially a single product based on an exclusive relationship between service, supply and end-use. A monopoly telecommunications carrier developed the copper (and then optical fibre) infrastructure and support systems and was able to capture all the revenue from supplying an essentially commodity application—the plain old telephone service

(POTS) to end users. Similarly, broadcasters supplied a vertically integrated television and/or radio service based on their ownership and exclusive use of infrastructure. This vertically integrated world provided a clear business model supporting investment in infrastructure which could have long pay back periods: suppliers could invest, reap the returns from that investment and reinvest as the need arose. This entire scheme was underpinned by regulation which was built on, and reinforced, the technology based model. While this model is a simplification of a more complex reality (it does not, for example, incorporate mobile phone, print media and video, or postal services), it nonetheless summarises the underlying business model as it relates to infrastructure investment.

Figure 3.1
TRADITIONAL COMMUNICATIONS INTEGRATION[1]

Stage 1 — 1990, the legacy



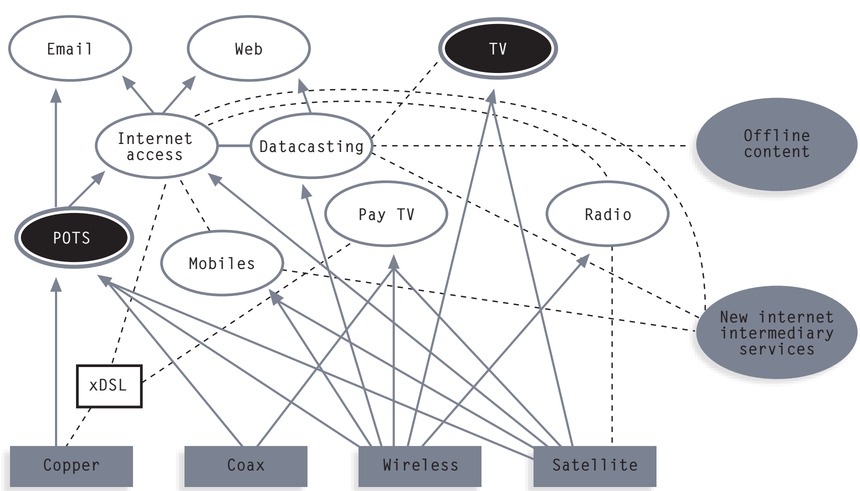
1 Derived in part from unpublished concepts from Dr David Clark, Massachusetts Institute of Technology (MIT).

3.2.2 STAGE 2 — COMPLEX TRANSITION

This strong, vertical integration of the technology with the end service is breaking down, largely as a result of the forces described in chapter 2. As shown in figure 3.2, there are now many more services in addition to POTS, television and radio (although these three remain for the present the most important). Also, this wider range of end services can now be provided by a wider range of technologies, with new possibilities still emerging. In the case of POTS, for example, telephony services can be provided via traditional copper pairs, by hybrid fibre coaxial networks as an adjunct to pay television and other online services, via satellite, over the Internet, and increasingly, as a mobile service competing with the fixed public switched telephone network (PSTN). Even in the case of goods that require physical delivery, the Internet is increasingly becoming an online option for ordering and payment, with new intermediaries appearing to offer business billing and payment services.

Figure 3.2
TRANSITIONAL COMMUNICATIONS ENVIRONMENT

Stage 2 — now, transitional



However, as discussed in chapter 2, there is both a convergence occurring between voice and data and a discontinuity. For example, there is guaranteed bandwidth for the existing circuit-switched network, high quality of service, and sophisticated time/distance charging arrangements and billing systems. By contrast, at present the Internet largely provides a *best endeavours* technology with no explicit service quality guarantees, but simple, cheap, distance independent charging. In the present Internet world, congestion and transmission delay are dealt with in a variety of different ways through usage constraints. These range from time-based and volume-based (megabyte) charging, to time-based disconnection with reconnection constraints, through to accepting congestion, packet loss and degradation of service. As IP becomes more mainstream, however, this can be expected to change if businesses and people are to put mission and even life critical applications onto wholly IP-based systems.

3.2.3 STAGE 3 — THE DATA WORLD

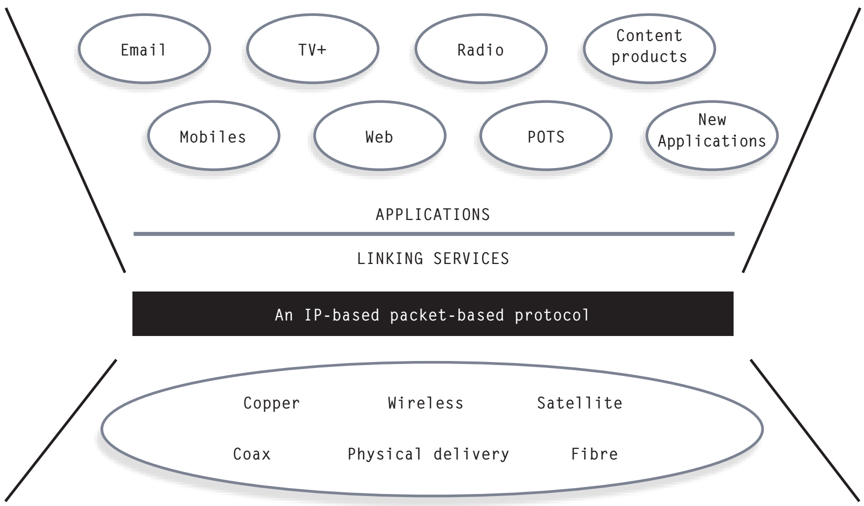
Over time however it seems likely that a new order will emerge, along the lines shown in figure 3.3. What that diagram attempts to represent are all the different communications carriage technologies, all working through the medium of a packet-based protocol, probably one based on IP which currently underpins the Internet.[2] In one sense, it would be appropriate to call this the *Internet* model of communications, except that the Internet is currently associated with a range of particular applications such as the World Wide Web and email, or alternatively with Internet access services. As data networks evolve, it is likely that the underlying data protocols will become increasingly *invisible* to end users and applications providers alike.

Sitting between the carriers and the range of existing and new applications an IP mediated environment is likely to facilitate a range of linking or facilitating services. These could include, for example, billing and certification (e.g. using public key technologies) services, bundled e-commerce *platform* services, auction, spot market and price watch services across a wide range of goods and services.

2 Again, this represents a simplification of a more diverse and complex reality. There is likely to be a need for switched capacity for broadcast video transmission, given specific quality and continuity of service considerations, as pointed out by the Federation of Australian Commercial Television Stations in their submission, *Bandwidth Availability and Pricing within, and to and from Australia,* p. 9, October 1999.

Figure 3.3
FUTURE COMMUNICATIONS ENVIRONMENT

Stage 3 – the future



This environment is likely to involve significantly different underlying incentive structures for infrastructure investment and bandwidth supply, because the simple vertical integration in supply has largely been removed. (There may be new forms of vertical or horizontal integration, however.)

If this is a broadly correct representation of the main directions of change, then there are certain features of this environment that will need careful consideration. Those countries that can manage the transition to a substantially data-based communications environment smoothly and quickly are likely to be well placed to exploit the increased efficiency and opportunities for innovation presented by this new environment.

3.3 the bandwidth vision

Against this background, the Inquiry considers that it is important to articulate a guiding vision of what Australia should be striving to achieve in the emerging environment of bandwidth abundance. The emergence of the information economy represents a turning point in the development of the world economy and has profound implications for a small country like Australia. While large companies have been internationalising over many years, there is now an opportunity for even small businesses to expand into global markets providing they can operate efficiently.

In light of this, the Inquiry believes that it is important to create the conditions under which the technological promise of cheap and abundant bandwidth can be realised, largely because of the value in the services delivered over it. We see a society in which communications becomes the truly enabling technology it has the potential to be, not simply for technological elites but for society generally, continuously enhancing the knowledge, power and control of individuals over their personal, social and working lives. At the same time, the range of applications will grow, together with their ease of use and effectiveness through improved interfaces and intelligence.

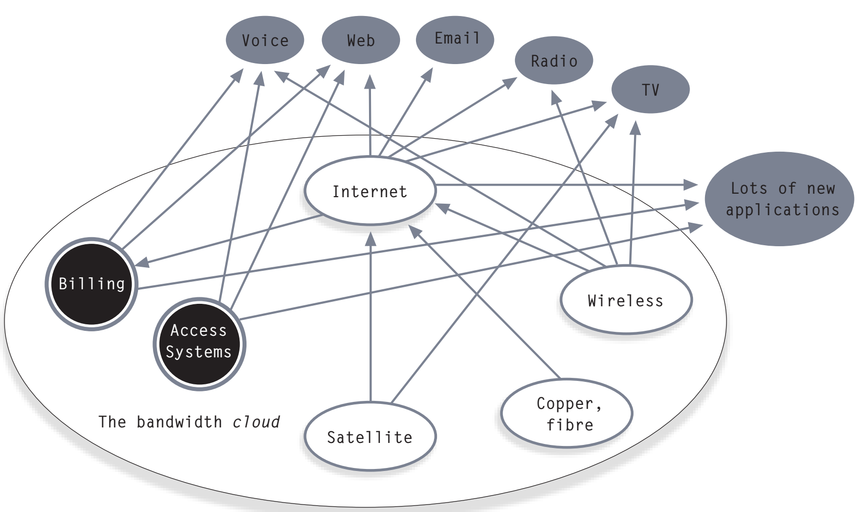
Our current conception of an ideal future is one in which bandwidth is truly a commodity and:

- is ubiquitous and accessible;
- is cost-effective;
- is highly and easily scalable;
- is characterised by high levels of customer control;
- is capable of working seamlessly between networks;
- gives consumers choice in both price/quality terms;
- gives consumers choice of supplier;
- provides all Australians with broad equality in the available choices; and
- is internationally competitive in terms of:
  - supporting Australia as an e-commerce supplier,
  - being capable of fostering a vital and growing local content market,
  - helping to drive data flows which redress international imbalances,
  - assisting with the balance of trade,
  - maintaining the integrity of Australia's cultural identity and projecting it internationally.

One metaphor which may be useful in conveying these ideas is that bandwidth appears to users as being, essentially, a *cloud*[3] which simply connects users in a way which is cheap, ubiquitous and abundant with connectivity instantly available anywhere at any time. This cloud would enable supply of a range of intermediate wholesale services supporting a range of applications across a range of different types of networks and services. Of course, this requires networks which are highly scalable, seamlessly integrated and robust. They will also offer quality of service and delivery guarantees that at least match the existing circuit-switched networks. Incremental supply will increase as demand increases with no timing lags either domestically or internationally. This 'bandwidth cloud' is perhaps best represented in figure 3.4, which is essentially an alternative version of the stage 3 diagram previously shown in figure 3.3 (the billing and access systems are examples of *linking applications* which are also available to applications users across the *cloud*).

Figure 3.4
THE BANDWIDTH *CLOUD*

Stage 3 – the vision, a bandwidth cloud



3 The term is also used in relation to work of the Internet Engineering Task Force and its Working Groups. See various drafts at *www.ietf.org*

In any environment where such a vision is likely to be seen, there is likely to be a number of important *instrumental* features. These include:

- the existence of sophisticated, efficient and responsive wholesale markets for bandwidth;
- a culture of innovation among providers of bandwidth;
- sophisticated content and e-commerce applications providers who can work with bandwidth providers, or indeed can provide bandwidth themselves;
- substantive location independence of services across Australia with parity of service and price;
- symmetrical rather than asymmetrical bandwidth; and
- regulatory arrangements which assist, and certainly do not hinder, the achievement of these objectives.

3.4 from here to there

As noted above, the Inquiry considers that the management of the transition to stage 3 is a critical issue for national competitive advantage: those countries that manage this transition well will be very well placed for the future. Those countries which manage the transition poorly cannot simply shut their borders but will suffer in both economic and social terms.

It is against this background that the Inquiry sees the key underlying questions to be addressed as being:

- what needs to be done to encourage and accelerate the transition to the IP world;
- conversely, what are the pitfalls and risks in the current transitional phase which could impede that process;
- how do we ensure that there is still sufficient incentive for continued investment in infrastructure and content as business models change in the move to stage 3;
- how can we foster a culture of innovation in the provision of bandwidth; and
- how can we equitably address the needs of regional Australia, and those consumers who may have difficulty accessing bandwidth, in a way which does not cause difficulties for longer term investment and the kind of competitive bandwidth market that the wider Australian economy will need in order to be globally competitive?

While the need for continued investment in infrastructure and across the communications industry more generally is a central imperative in achieving our national communications and trade goals, the solution set is complex and multi-faceted.

The issues raised by these questions, against the background of the market realities in Australia, are taken up in chapter 13.

chapter 4

THE BANDWIDTH MARKET OUTLOOK
A FRAMEWORK FOR ANALYSIS

There is no single market for bandwidth

- markets vary on a geographical and hierarchical basis.

The markets are likely to become increasingly complex due to the interplay of factors outlined in chapter 2.

A number of models were developed to estimate future bandwidth demand and supply which, while not providing the answers, indicate a range of issues to be considered.

4.1 introduction

The terms of reference provide for an investigation of the:

- present and future capabilities of the Australian telecommunications network, and especially the trunk network, to meet the likely needs of the information economy; and
- a comparison of bandwidth prices in Australia against those in comparable markets overseas and how prices may change; and

4.1.1 FORECASTING

To undertake this study it was necessary to forecast the supply, demand and pricing of bandwidth. The difficulties in forecasting in communications markets were extensively canvassed in the Bureau of Transport and Communication Economics *Communications Futures Final Report*. It is worth quoting at some length because these observations remain valid.

> Medium-term forecasting of structures and trends is difficult, even for stable, well understood products. The problems become particularly acute for industries as new, as complex, and as global as those dealing with information and communications products.
>
> … neither the economic nor the marketing literature offers many pointers to identify ways of testing future market developments … Indeed, a review of the forecasting and diffusion literature as it relates to communications, conducted for the BTCE by Lamberton …, demonstrates that the dynamic processes shaping the evolution of communications markets remains little understood, despite considerable academic and business interest. Two specific difficulties which confront researchers into new communications markets are described below.
>
> Predictive bias
>
> A central problem for forecasters is that the very activity of thinking about the future of new products has an inherent bias in favour of market success. This is particularly marked in the case of new products based on new technologies.

> This phenomenon, and the reason for it, are perhaps most persuasively demonstrated and discussed by Schnaars … in a wide-ranging and perceptive survey of technological predictions that have gone badly wrong over the last 50 years … Schnaars' warnings about optimism are particularly strong for technological predictions which are related to the Zeitgeist or 'spirit of the age' …, for which the 'information superhighway' is surely the strongest current contender … Schnaars concludes that the most successful forecasting is normally generalised rather than specific, conservative, and based on market fundamentals.
>
> Complexities in communications markets
>
> A specific problem for analysts trying to assess likely developments in communications markets is the particularly fluid state of many of the market fundamentals. Most of the 'standard' uncertainties inherent in predicting future market structures are present in communications. Among the more obviously problematic areas of interest are:
>
> - very rapid technological developments, on a range of fronts, which affect cost structures, entry conditions, products, and demand conditions (as technologies are put to new uses);
> - significant changes in the structure of demand, through demographic shifts, growing information intensity and sectoral change in the wider economy, and lifestyle developments;
> - significant regulatory change as competition is introduced, or intensifies, in telecommunications and broadcasting markets around the world, the nature and time of which depend on political processes; and
> - the sometimes unpredictable strategic behaviour and judgements of key market participants, responding to all of the above.
>
> So, while this research recognises that these forecasting problems are intrinsically insoluble, it nevertheless seeks to demonstrate that it is possible to make some progress in a way that helps rather than hinders informed policy discussion and debate.[1]

For this reason, the Inquiry has sought to use several methodologies to estimate future supply, demand and pricing for bandwidth. While none of these

1 BTCE *op. cit.*, pp. 57–59.

methodologies is likely to provide all the answers, or raise all the issues, each one contributes to developing a more complete picture of the future. To this end, six principal consultancies were let.

The Communications Research Unit (CRU) within DOCITA also developed a model based on Australian Bureau of Statistics data relating to expenditure on communications to derive demand in a range of industry sectors.

In a fully competitive market, supply and demand dynamically adjust through the pricing mechanism. In markets where there is less than full competition, however, suppliers may have scope to control supply, price or both, in order to match supply and demand. In order to cover the range of market conditions, therefore, the Inquiry commissioned separate studies on supply, demand and prices and examined market structure issues relating to international and the Australian domestic markets.

In general, prices will tend to reflect what is happening to costs and communications unit costs have been falling for many years. The extent to which prices trend downwards with costs will of course depend upon the competitive conditions. In order to get some sense of what might be occurring in relation to costs, the Inquiry also commissioned a study on the current costs for the construction of a backbone network. The results of that study are presented in chapter 8.

International charging arrangements for Internet services and submarine cable regulation are discussed in chapter 12.

4.2 general aspects of the market for bandwidth

Before studying each of supply, demand, pricing and market structure it is important to examine some of the main features of the communications market. This draws on a supplementary consultancy undertaken for the Inquiry by Ovum.[2]

2 Ovum Pty Ltd, *National Bandwidth Inquiry: Consultancy Co-ordination Report*, a report to DOCITA, September 1999(b).

4.2.1 WHOLESALE AND RETAIL MARKETS

Bandwidth is a product for which there is derived demand. The market for backbone bandwidth is essentially a wholesale market in which infrastructure carriers provide capacity to retail carriers and service providers as input into the latter's retail services. Raw bandwidth is rarely retailed *as is* to the end user, except perhaps in the case of some large corporate users with special needs and the ability to manage their telecommunications requirements from their own resources. It is instead sold as some form of *service* which requires bandwidth for delivery to the customer.

At its simplest this service involves little more than the provision of carrier managed bandwidth. An example is leased line services for providing dedicated capacity between nominated locations. In its more complex form it could involve a virtual private network. Most retailing of bandwidth is intended to support other applications that are valued in the market place. The reliance of those applications on backbone bandwidth is an important matter for carriers and service providers, but not of direct interest to the end customers.

This wholesale/retail distinction is a very significant factor to be constantly borne in mind in the analysis of bandwidth markets.

4.2.2 NO SINGLE MARKET

There is no single market for bandwidth. In consequence there is no single price point, level of demand or amount of bandwidth supplied. The studies commissioned as part of the Inquiry reveal that there are a range of markets, which differ significantly on a geographic or industry basis in terms of:

- demand growth and potential;
- aggregate demand;
- existing capacity;
- access to existing capacity;
- sources of supply;
- cost to serve; and
- customer buying power and negotiating leverage.

It follows that the notion of *a market* is a construct used for convenience of reference, and *price* and *capacity* in that *market* refers to an average or typical outcome around which a range of values must be assumed.

4.2.3 DYNAMISM

The market for bandwidth is dynamic. Market factors and the relationships between them are changing, including:

- product and service innovation;
- nature and cost of underlying technologies;
- demand patterns;
- usage patterns;
- user demographics;
- supply margins;
- cost relationships in service delivery;
- user expectations;
- user reliance on the service; and
- business culture and lifestyle factors.

These complexities and dynamics have implications for the types of models that might usefully be used to study future developments of the bandwidth market.

4.3 supply

The amount of bandwidth supplied in the future is a function of the amount of bandwidth currently supplied and how this may change over time. *Current* bandwidth is based on infrastructure already installed plus bandwidth which can be brought on line quickly by the application of appropriate technology. Future bandwidth will be provided by new infrastructure that might be installed over a longer period (up to five years) and the technological changes that are likely to impact on the capacity of new and existing infrastructure. These issues are discussed further in chapter 5.

Consultants were engaged to conduct a stocktake of Australia's existing backbone network and any planned expansion, to determine its current and anticipated traffic carrying capabilities, including an assessment of the effects on capacity of technological changes.

Amos Aked Swift (AAS) was asked to compile a detailed inventory of capacity based on the actual and planned investments of major carriers and other organisations with transmission infrastructure. AAS's methodology involved a survey of the utilised and spare capacity associated with existing installations. In order to provide information on a regional basis and in a form that protected the

carrier's commercial interests, data was collected by sampling 223 towns in all States and Territories in five population ranges. From the information collected, AAS was able to determine the extent to which installed capacity was utilised and the potential traffic carrying capabilities of the network with the application of new technologies.[3]

Consultel was retained to assess the utilisation and potential capacity of current communications networks based on generally available information, and on information that might be known to Consultel in its capacity as a specialised consultant in this field. This approach differed from that of AAS in that it did not involve a survey of major carriers and other organisations. Consultel constructed a picture of current utilised bandwidth capacity and of spare and potential bandwidth capacity based on the known provisioning and traffic loading practices of infrastructure carriers.[4]

4.4 demand

Future demand for bandwidth is a function of:

- the applications demanded;
- the number of users that demand those applications;
- the intensity of use in terms of time and bandwidth required to run the applications; and
- the geographic areas they are demanded from.

On this basis, there is no single question and corresponding answer for demand but rather a matrix of questions and answers. These are discussed in chapter 6.

To assist in addressing these questions consultants were retained to develop empirically based estimates of demand for bandwidth over the next five years. The estimate of demand could be based on analysis by industry sector, by type of application, by type of services or any combination of these.

3 Amos Aked Swift, *Report on the Capacity and Current Utilisation of Communications Bandwidth*, a Report for DOCITA, Sydney 1999.

4 Consultel, *Bandwidth in the Future*, a report for DOCITA, 1999.

4.4.1 JUDGEMENTAL MODEL

Network Strategies employed a model based on the development of typical usage patterns for users in various sectors of the economy for the years 1998, 2000 and 2005. Examination of total usage patterns in a number of differently sized communities was based on the aggregation of individual patterns represented in each community. Network Strategies' model was concerned with the requirements of typical users for bandwidth aggregated into sectors and regions. This model relied on expert judgements to support the usage assumptions employed for each of the yearly *snapshots* involved.[5]

Network Strategies employed a logistic diffusion curve to represent *likely* future take-up, and adopted pessimistic and optimistic alternatives based on earlier or deferred take-up. In the absence of other inputs on the average price of retail applications, a retail price reduction was assumed to apply in each year of the period under study. Specifically, no assumptions were made of step function increases in the take-up of bandwidth intensive applications during the period before 2005. Therefore, although some implementation of broadband access technologies might be implicit in the Network Strategies approach, there was no assumption of mass take-up of a particular technology that might generate very sharp increases in usage of bandwidth in the backbone network.

4.4.2 ECONOMETRIC MODEL

Communications Economics Research Program's (CERP) approach is based on an econometric model with emphasis on the model's internal relationships, rather than on expert knowledge and assumptions. CERP considers that its model is capable of incorporating a wide range of different input values.

CERP's model is a continuous model, rather than the aggregation of demand or supply characteristics into a *snapshot*. It is driven by intensity of use, forecast take-up by users based on American experience with Internet services, and peak traffic to average traffic relationships.[6]

5 Network Strategies, *An Investigation of Future Demand for Bandwidth*, a report for DOCITA, 1999.

6 Communications Economics Research Program, Curtin University, *The Investigation of Future Demand for Bandwidth*, a report for DOCITA, 1999.

4.4.3 JUDGEMENT MODELS WITH PRICE ELASTICITY RESPONSE

The Communications Research Unit (CRU) employed a model based on the break-down of Australian Bureau of Statistics data on expenditures by Australia New Zealand Standard Industrial Classification industry classes into the amount spent on usage and that spent on access. The current level of household bandwidth demand is estimated by aggregating profiles of average users of various applications.

Demand forecasts are driven by assumed relationships with demand drivers such as contestable expenditures, cost savings and prices of bandwidth, computers and access. The model also incorporates estimates of the rate of diffusion of new technology. A gravity model is used to relate bandwidth demands to population in regions and the distance between population centres.

4.5 pricing

Pricing is a major driver of demand and supply and as such an important consideration for this study. However, it is an extremely complex variable, changing from supplier to supplier and by application, region, distance, time of day, volume, and quality. The issue of pricing is further complicated by the practice of providing undisclosed discounts to some customers.

As outlined in chapters 2 and 3 there are some major changes occurring within the bandwidth market which have a significant impact on the underlying cost structures and as such the prices. The impact of these changes on prices has been examined and the issues arising are discussed in chapter 7.

Ovum was retained to analyse and report on likely trends and issues for pricing of bandwidth over the next five years. The analysis was also required to look at the factors influencing those trends such as geographic locations, access to technology, the rate of investment in infrastructure, underlying cost structures and levels of competitive pressures in the market.

Ovum developed a model which enables an index of price movements over five years to be constructed, based on the identification of the scenario best describing a particular geographic market at the beginning of the period and the scenario best describing that market at the end of the period. Removal of legacy policies associated with uniform pricing is also factored into the model.

4.6 cost estimates — network construction

A further consultancy was commissioned to estimate the costs, in 1999 prices, of constructing a fibre backbone inter-city and intra-city network. Consultel developed a hypothetical fibre network linking Brisbane, Sydney, Melbourne and Adelaide, as well as a Sydney network connecting the CBD, North Sydney, Crows Nest, Chatswood and Parramatta. While the networks do not provide end-to-end user connections they do illustrate both the range of network components and their approximate costs, and the aggregate costs for installing such a network. Chapter 8 provides a fuller discussion of the models and associated costings.

4.7 market structure

While the underlying unit costs of providing bandwidth are decreasing, the effect this is having on prices depends on the level of competition in the market. The Australian telecommunications market was opened up to full competition in 1997. However, competition has developed unevenly across Australia and as a consequence there is not one market for bandwidth but a number of markets with different characteristics. The level of competition in these markets is expected to change at varying rates over the period of this Inquiry. Chapter 9 discusses the factors affecting those changes and how market structures may develop.

4.8 coordination of studies and preliminary conclusions

To assess whether there is sufficient capacity to meet demand for bandwidth, the stocktake of infrastructure and the demand studies must be broken down into the same geographic areas. The level of competition in each area will influence the level of pricing and hence supply and demand.

Conclusions resulting from the consideration of supply, demand, pricing and market structure are at chapter 9.

4.9 international comparisons

The above paragraphs outline the methodology for providing a view of bandwidth availability and pricing within Australia and between Australia and other countries. However, it does not provide a view on how Australia compares with other countries.

The Internet has little regard for national borders and this may have a significant impact in relation to trade. The trade in many goods and services, which has in the past often been mainly a domestic concern, is now, because of the Internet, potentially open to any country. This represents both an opportunity for, and a threat to Australian businesses as it may open up markets for exports while also providing a greater level of competition in existing markets. It is therefore critical that Australia succeeds in the fast emerging world of e-commerce. The take-up of e-commerce depends on, among other things, a world class communications network that is capable of supporting and stimulating e-commerce now and in the future.

However it is very difficult to obtain a clear picture of how Australia compares with the rest of the world in this regard. Not only are clear indicators of the bandwidth situation in Australia required, but data in a similar format that is directly comparable is required for other nations where a comparison is sought. In relation to bandwidth availability and demand there is very little information from other countries. The main source of comparison is price. However, as mentioned above, price is an extremely complex issue determined by many variables and it is very difficult to make international comparisons that match all the variables. Some of these difficulties are outlined in chapter 7.

Some aspects of the market structure in other countries are also examined to see how they compare with the Australian market.

4.10 implications

As outlined above this is a very complex issue making it extremely difficult to provide forecasts over the next five years to 2004. Nonetheless, the influences affecting the issues are further developed and discussed in chapters 5, 6, 7, 8 and 9 and the overall conclusions are summarised in chapter 10. The results of the consultants' investigations are also outlined. Copies of the consultants' reports are on the compact disc inside the back cover of this report.

chapter 5

SUPPLY OF BANDWIDTH

The results of the stocktake of installed and potential capacity in the backbone domestic and overseas communications networks are presented, based on two approaches:

- a survey of domestic network operators; and
- an existing data model.

The results suggest that the:

- potential backbone capacity to the towns surveyed is very large;
- installed capacity to a few of the towns sampled is quite low; and
- the ownership of the backbone network is highly concentrated.

Developments in optical fibre technology are the major factors contributing to the high level of potential capacity.

5.1 introduction

Term of reference 2 of the Inquiry provides for an investigation of the constraints, if any, which exist on the ability of the Australian telecommunications backbone network to meet the likely demand for communications bandwidth. One of those potential constraints is the current and estimated future supply of bandwidth.

To determine the *amount* of network which is or will be available to supply bandwidth two consultants were commissioned and the Inquiry undertook its own research so as to:

- conduct a *stocktake* of Australia's existing trunk network, and planned changes to that network by commercial operators and State Governments, with information disaggregated regionally, as far as practicable;
- determine the current and reasonably anticipated data carrying capabilities of the backbone network; and
- outline the technological changes, which are likely to affect the data capabilities of Australia's backbone transmission network.

The supply of bandwidth is considered under these three broad headings.

5.2 the stocktake

Consultants were engaged to conduct a stocktake to determine the present and future (1999 to 2004) capacity of backbone communications networks to carry data between major locations within Australia, between Australia and selected overseas destinations, and to determine the current level of utilisation of that capacity.

5.2.1 CAPACITY

The term *capacity*, when used in relation to the amount of information that may be carried on a backbone communications network, can have a number of interpretations. The stocktake was particularly interested in *available* capacity and for the purposes of this report available capacity is further divided into *installed* or *potential* available capacity where:

- capacity is measured in bits per second; and
- available capacity is either *installed* or has the *potential* to be installed:
  - *installed* refers to capacity which is being utilised by a customer (and hence has been sold) and, except for the existing data model estimates (see below),

also includes capacity used by the carrier or network provider as backup capacity or to manage the network;

– *potential* refers to capacity which could be brought into use at low marginal cost relative to the cost of the facility on which it is implemented and this includes spare capacity.

Capacity described in this way is independent of the technology used to provide it. In practical terms this means that the capacity data cited in this report includes optical fibre, satellite and terrestrial microwave based systems unless otherwise stated. In addition, capacity which is available in the backbone network does not necessarily relate to the availability of capacity to the end customer. In this regard, and in line with the terms of reference, the stocktake did not examine the capacity in the customer access network nor did the commissioned research investigate the *provisioning* of capacity to the customer.

5.2.2 METHODOLOGY

The true capacity of the various domestic communications networks is highly sensitive commercial information and is therefore not readily available from the network operators. Further, the capacity information which can be derived from the data which is available is often subject to a number of caveats which may impinge upon its accuracy. For this reason, consultants were engaged to develop two different and independent estimates of backbone domestic communications network capacity. One approach was to survey carriers and network operators, and the other involved estimating capacity based on existing available information. The consultants also investigated the capacity available between Australia and overseas destinations, for which existing information is more readily available.

5.2.2.1 survey of domestic network operators

Telecommunications carriers and other network providers were surveyed directly about the capacity of their networks terminating at a particular town or city, based on the meaning of *capacity* set out above. To protect the confidential nature of the information, capacity was sought for a representative sample of towns and cities (the names of which were known only to the carrier and the consultant) divided into five cohorts based on population in each State and Territory and,

where appropriate, the information from the various capacity providers was aggregated. A detailed description of the town sampling technique is presented in appendix 4.[1]

Based on the survey, the consultant considered[2] that:

- the ownership of the backbone network is highly concentrated. There are ten operators of trunk networks within Australia, of which six are licensed carriers;
- oversupply of capacity is a characteristic of the backbone network within Australia. There is a significant surplus of spare, or potential capacity terminating in all the population centres reviewed in this report which could be commissioned at relatively low marginal cost;
- the *potential* capacity exceeds the *installed* capacity by between 100 and 100 000 times;
- trunk routes between Australia and major international destinations are also characterised by large amounts of spare capacity;
- optical fibre cable is the most heavily utilised technology in the trunk network, particularly on all the inter-capital routes and along most major routes on the eastern seaboard;
- microwave technology is used to a much lesser extent in south eastern Australia and in selected rural and remote areas around the country;
- satellite technology is used primarily and increasingly as a broadcast medium. Major operators indicate that the economic viability of satellite technology for point-to-point communications is marginal;
- carriers have adopted short-term planning processes which appear rigorous in ensuring that capacity is provided in response to demand. None of the carriers approached by the consultant has a five-year capacity plan as they consider that both supply and demand cannot be predicted confidently over this period; and
- dense wave division multiplexing (DWDM) technology is a developing technology and the upper limit of its capacity is not known.

5.2.2.2 existing data model for domestic capacity

The alternative method of determining the supply of backbone network capacity was to develop an estimating model based on available data sources. The model

1 Amos Aked Swift, *op. cit*.
2 *Ibid*, p. 4.

used two estimating methods, one for major, large and medium sized urban centres, with populations above 5 000 inhabitants, and another for small urban centres and localities, with populations at or below 5 000 people.

For the larger centres, a picture of the history, engineering philosophy and current practice in relation to the dimensioning of transmission systems by the major bandwidth providers was developed. Particular emphasis was placed on the factors which determined where optical fibre cable was laid, how many optical fibres were installed in a given cable system, how many systems were likely to be in service, and the resulting bandwidth yield from the application of particular transmission technologies. From this and detailed but incomplete data from the major carriers, a model was developed to estimate current bandwidth for major routes, and make future estimates of bandwidth.

For small urban centres and localities estimations of bandwidth were made taking into account the centres' lack of access to optical fibre cables and the available alternative transmission technologies.

5.3 network capacity

The results of the two approaches to estimating backbone capacity in the domestic and international networks are presented below, together with information on capacity to Australia's external territories. The figures represent an aggregate of the capacity of optical fibre networks, terrestrial microwave networks and satellite networks. The contribution to the total backbone capacity provided by satellites is very small. This is the case because:

- the capacity of satellites is small when compared to optical fibre; and
- satellites are more cost effective when used as a broadcast medium or in specialised customer access networks, such as remote areas, rather than point-to- point backbone capacity.

A more detailed discussion of satellite capacity appears later in the chapter and in appendix 5.

5.3.1 RESULTS – PRESENT DOMESTIC CAPACITY

Table 5.1 lists the ten organisations with appreciable amounts of backbone capacity. Only the first six in the list are licensed carriers and by far the greatest proportion of all the available capacity is owned by Telstra. Based on the survey responses provided by these network owners or operators, table 5.2 provides aggregated average, minimum and first quartile, installed capacity for towns in a number of population ranges. To more easily compare centres of different sizes, a statistical installed capacity per head is also presented. A number of graphical representations of existing networks were developed and are presented in the three national maps at the end of the chapter.[3]

The survey results for installed capacity per head (table 5.2) vary considerably. In particular the minimum values for towns with populations between 1 000 and 9 999, and between 10 000 and 29 999 suggest that the current capacity in the smaller towns within these population ranges may be a little low. However, the average installed capacity per head increases as the size of the towns decreases. The potential capacity per head is large for all the towns surveyed.

Table 5.1
MAJOR AUSTRALIAN TRUNK NETWORK OWNERS OR OPERATORS

Name of operator	*Primary technology*	*Location*	*Carrier licence (Y/N)*
Telstra	Optic fibre	Ubiquitous	Yes
Optus	Optic fibre	Major cities	Yes
PowerTel	Optic fibre	QLD, NSW, VIC	Yes
Macrocom	Microwave	QLD, NSW, VIC	Yes
Soul Pattinson Telecommunications	Microwave	NSW, VIC	Yes
Horizon	Microwave	VIC	Yes
Rail Access Corp	Optic fibre	NSW	No
Victorian Rail	Optic fibre	VIC	No
Reef Networks (Queensland rail)	Optic fibre	QLD	No
AARNet[(a)]	Microwave	QLD, NSW, VIC	No

Note: (a) AARNet does not make capacity available to the marketplace. Under the terms of its current arrangements, the capacity is shared and sold within its community of interest.

3 *Ibid.*

Table 5.2

SURVEY RESULTS OF NATIONAL TERRESTRIAL BACKBONE CAPACITIES

Population range	*Sample*	*Installed capacity (Gbps)*[(a)(b)]	*Potential capacity (Gbps)*[(a)(b)]	*Installed capacity per head of population (Kbps)*	*Potential capacity per head of population (Kbps)*
100 000 and above	Minimum[(c)]	8.124	8 205	74	74 646
100 000 and above	First quartile[(d)]	14.587	13 040	66	59 339
100 000 and above	Average[(e)]	33.777	39 558	39	46 089
30 000 to 99 999	Minimum	0.831	1 041	27	34 349
30 000 to 99 999	First quartile	5.354	3 744	156	109 249
30 000 to 99 999	Average	8.818	8 038	185	168 494
10 000 to 29 999	Minimum	0.066	480	7	47 933
10 000 to 29 999	First quartile	1.446	2 231	116	179 522
10 000 to 29 999	Average	3.740	5 171	218	301 892
1 000 to 9 999	Minimum	0.006	160	6	159 046
1 000 to 9 999	First quartile	0.055	640	42	493 066
1 000 to 9 999	Average	1.200	2 477	421	868 136
Less than 1 000	Minimum	0.004	160	20	800 000
Less than 1 000	First quartile	0.012	480	43	1 715 818
Less than 1 000	Average	0.208	1 223	425	2 495 784

Notes: (a) Carriers agreed to provide information on network capacity only in terms of *installed* or *potential* capacity.

(b) The information on installed and potential capacity represents an aggregate of the capacity of all network operators sampled and includes optical fibre, terrestrial microwave and satellite capacity.

(c) The *minimum* value in each population band represents the town with the lowest population in that band.

(d) The *first quartile* is a measure of capacity of a town within each population band such that 25 per cent of towns within this band have a capacity less than the first quartile and 75 per cent have a capacity greater than the first quartile.

(e) The *average* value represents the mean of all sampled values in the population band.

Table 5.3 presents estimates of installed[4] capacity for links between the larger cities based on the existing data model. The model estimate for the average installed backbone network capacity for smaller cities and towns with populations between:

- 20 000 and 199 999 people is 40 Gbps;[5]
- 5 000 and 19 999 people is comparable to that of the larger centres (up to 40 Gbps), but reduced in practice by the smaller number of direct fibre routes and the greater sharing of the intermediate capacity;[6]
- 1 000 and 4 999 people is up to 2 Mbps as such towns are likely to be served by a microwave link; and
- 200 and 999 people is, in most cases, a number of analogue 64 Kbps voice channels based on the digital radio concentrator service (DRCS) or the newer high capacity radio concentrator (HCRC).[7]

Table 5.3 provides an estimate of available capacity for major urban centres (nominally above 200 000 inhabitants),[8] based on the existing data model.

5.3.2 RESULTS — ESTIMATED FUTURE DOMESTIC CAPACITY

It can be seen from Table 5.2 that the capacity figures from the stocktake support the earlier statement that potential capacity exceeds installed capacity by between two and five orders of magnitude. However, capacity figures derived from the existing data model paint a somewhat different picture, in that given the likely technological developments, low, medium and high estimates of domestic backbone capacity in 2005 (for the same list of towns used to estimate the present capacity—Table 5.3) are:

- twice the present capacity for a low growth scenario;
- between four and eight times the present capacity for a middle growth scenario; and
- between 30 and 35 times the present capacity for a high growth scenario.[9]

4 *Installed* capacity figures generated by the existing data model exclude capacity allocated to restoration or backup and network management functions.

5 Amos Aked Swift, *op. cit.*, annexure B.

6 *Ibid,* p. 16.

7 In many cases towns in the 200 to 999 population range are connected to point-to-point microwave systems, see Consultel *op. cit.*, p. 16.

8 Consultel, *Bandwidth in the Future,* 1999, p. 7.

9 Summary of tables in annexures C, D and E in Consultel *op. cit.*

Table 5.3

MODEL ESTIMATES OF PRESENT BACKBONE CAPACITY AVAILABLE IN MAJOR URBAN CENTRES[10]

Major urban centre	*Persons*	*Estimated capacity in 1999 (Gbps)*									
		Sydney	*Melbourne*	*Brisbane*	*Perth*	*Adelaide*	*Canberra*	*Gold Coast*	*Newcastle*	*Central Coast*	*Wollongong*
Sydney	3 276 207	-									
Melbourne	2 865 329	550	-								
Brisbane	1 291 117	363	363	-							
Perth	1 096 829	363	363	183	-						
Adelaide	978 100	363	363	183	183	-					
Canberra	322 723	363	363	183	183	183	-				
Gold Coast	311 932	363	363	183	183	183	183	-			
Newcastle	270 324	363	363	183	183	183	183	180	-		
Central Coast	227 657	363	363	183	183	183	183	180	180	-	
Wollongong	219 761	363	363	183	183	183	183	180	180	180	-
Hobart[(a)]	126 118	363	363	183	183	183	183	180	180	180	180

Note: (a) Hobart has fewer than 200 000 people but is shown here because it is linked by a major synchronous digital hierarchy loop to the capital city network.

5.3.3 DISCUSSION OF DOMESTIC CAPACITY DATA

The orders of magnitude of difference between installed and potential capacity presented in table 5.2 can be explained by:

- the large potential increase in capacity of existing optical fibre which is made possible through the application of DWDM technology; and
- the current conservative dimensioning philosophy adopted by the carriers in optical fibre cable construction and operation.

10 *Ibid*, annexure A.

Table 5.4

UTILISATION OF OPTICAL FIBRES WITHIN A CABLE[11]

Single cable path between urban areas[(a)]	*Total fibre pairs per cable*	*Direct working pairs[(b)]*	*Indirect working pairs[(c)]*	*Unused pairs[(d)]*
Major capital cities	27	3	2	22
Other major centres	18	3	2	13
Large centres in south east Australia	12	2	1	9
Other large centres	9	2	1	6
Medium sized centres	6	2	1	3

Notes: (a) Represents a single cable between two or more locations which would typically be one leg of a ring cable system.

(b) Cable serving end point population centres, for example Sydney and Melbourne.

(c) Cable serving intermediate population centres, between the end points, for example Albury-Wodonga.

(d) Unused fibre pairs are most probably left as dark fibre.

The first point is discussed later in this chapter. In relation to the second point, the existing data model estimated that the utilisation of optical fibres within a particular cable is as set out in table 5.4.[12] The high level of unused fibre pairs would be intended to provide for system redundancy in the event of the failure of any of the pairs in use and/or to provide for potential future increases in capacity.

The differences in the backbone installed capacity data derived from the network operators' survey and the existing data model may be explained as follows:

- the bandwidth estimates based on the model are conservative and can be taken as a minimum with the true values being almost certainly higher;[13]
- the survey measured capacity into (and out of) a town while the model estimated capacity directly between towns and this excludes capacity which is allocated to intermediate minor sites along a cable route;
- the survey measured installed capacity as that which is currently in service, while the model estimated installed capacity currently used by clients which excludes capacity allocated to restoration and network management functions; and

11 Consultel, *op. cit.* pp. 16–18.

12 For confidentiality reasons, Telstra was unwilling to provide direct information on the level of optical fibre utilisation within its network, and the other carriers were not approached for this information.

13 Consultel, *op. cit.*, p. 18.

- the survey measured total installed capacity which could be available at a location, ignoring other network requirements, while the model estimates the likely installed capacity, given the relationship of the location to other sites in the network and the current dimensioning philosophy.

These factors combine to produce the differences of between one and three orders of magnitude which can be observed from the data presented above.[14] This serves to highlight the difficulties of measuring the dynamic nature of capacity typical of a meshed network employing technology which can assign available network resources to peak traffic loads as and when they occur.

5.3.4 RESULTS — PRESENT AND FUTURE INTERNATIONAL CAPACITY

The installed and planned future capacity between Australia and overseas destinations is provided by satellite and submarine cable systems and is summarised in table 5.5. Even allowing for the optimistic nature of the prediction of future capacity, the table suggests that there is likely to be a considerable increase in capacity to overseas destinations in the next five years, based on optical fibre cables rather than satellites.

Table 5.5

EXISTING AND PLANNED INTERNATIONAL CAPACITY[15]

Year end	*Installed and planned future overseas capacity (Gbps)*			*Comments*
	Satellite	*Cable*	*Total*	
Installed	11	7.5	18.5	-
1999	11	27.5	38.5	SEA-ME-WE 3 cable in service
2000	11	147.5	158.5	Southern Cross cable in service
2002	14	787.5	801.5	SkyBridge satellite & Australia Japan Cable in service[(a)]
2003	18	3 347.5	3 365.5	Teledesic satellite and Oxygen cable in service[(a)]

Note: (a) SkyBridge, Teledesic, the Australia Japan Cable and Project Oxygen are all proposals in 1999 and it must be considered unlikely that all of them will provide their scheduled capacity in the timeframe stipulated, so 3 365.5 Gbps total overseas capacity in 2003 is an optimistic figure.

14 *Ibid*, p. 19.

15 Developed from Consultel *op. cit.*, Amos Aked Swift *op. cit.* and DOCITA research.

5.3.5 CARRIER PROVISIONING POLICY

The survey also revealed that none of the licensed carriers have a five year future provisioning plan, as neither supply or demand can be predicted with sufficient accuracy over that period. Carriers adopt a three months to two year planning cycle, based on a *just-in-time* provisioning model. This is a viable approach to future provisioning as available technology can provide for huge capacity upgrades of existing optical fibres within a relatively short time, should this be warranted by demand.

The Inquiry has some evidence[16] of unreasonable delays in providing communications services, particularly in country areas. This evidence is supported by the findings of the regional Western Australian communications audit.[17] While in some areas this may be due to a shortage of backbone capacity, based on the evidence of the survey, it is more likely the result of provisioning problems on the part of the carriers.

5.3.6 AUSTRALIA'S EXTERNAL TERRITORIES

Australia has four external territories with permanent inhabitants:
- Norfolk Island;
- Christmas Island, Indian Ocean;
- Cocos (Keeling) Islands, Indian Ocean; and
- Antarctic Territories—bases at Casey, Davis, Mawson and Macquarie Island.

The communications arrangements vary considerably between the external territories, depending on their location.

5.3.6.1 Norfolk Island

Under the *Norfolk Island Telecommunications Act 1992,* Norfolk Telecom, which is part of the Norfolk Island Government administration, is the sole provider of telecommunications to the Islanders. Norfolk Island is not covered by the Commonwealth *Telecommunications Act 1997* and therefore the universal service obligation (USO) does not apply. While there is a local ISP, access to adequate bandwidth is restricted by the limited data rate and very high charges imposed by

16 Material provided by the National Farmers Federation.

17 Boshe Group, *Communications Audit—The Needs of Regional Western Australians*, (10 vols), Perth, May 1997.

Norfolk Telecom. The ISP is charged $98 000 per year for a full time 64 Kbps link via the ANZCAN oceanic cable, and is not permitted independent access to cheaper satellite services.[18]

The ANZCAN is an analogue copper coaxial undersea cable that connects Norfolk Island to Australia and Fiji and has an equivalent total capacity of 24 Mbps.[19] A consortium (of which Telstra is a member) owns the cable and they lease a small part of its total capacity to Norfolk Telecom. ANZCAN is planned to be in service until 2005 and may continue beyond that date. Telstra and Norfolk Telecom are investigating the provision of satellite services to the island well before the potential closure of ANZCAN and this could provide for higher bandwidth services.

5.3.6.2 Indian Ocean Territories

Christmas and Cocos Island have a cable customer access network capable of delivering 9.6 Kbps. Backbone connections are provided solely by satellite. The islands are outside the footprint of the Optus satellites and on the fringe of the PanAmSat 2 (PAS 2) satellite footprint. PAS 2 can provide 64 Kbps services, but requires a 6 metre dish for each service.

Telstra provide a 64 Kbps symmetrical dedicated full time connection to the mainland backbone network via Intelsat in order to meet its digital data requirement under the USO.[20] A number of these services are already installed on the islands, including to a local ISP. Telstra suggest that cheaper alternative satellite services may be available from other international carriers or service providers utilising Asiasat, however it would be unnecessarily expensive for Telstra to negotiate and provide such services itself.[21]

ISDN services are not currently available to the islands because of technical limitations in relation to the Intelsat satellite, however such services are expected to be available by 2002.[22]

18 Joint Standing Committee on the National Capital and the External Territories, *Islands to Islands: Communications with Australia's External Territories*, Commonwealth of Australia (Federal Parliament), March 1999, Canberra, p. 42.

19 Consultel, *op. cit.* p. 20.

20 This costs $56 000 per year plus a set up cost of about $13 000 for each circuit.

21 Briefing provided by Telstra to DOCITA and the Department of Transport and Regional Development, October 1999.

22 *Ibid.*

5.3.6.3 Antarctica

Because of its unique circumstances and extreme isolation, the Australian Antarctic Division of CSIRO has responsibility for the cost and maintenance of the entire communications infrastructure of the Australian Antarctic Territories. The Territories are not subject to the USO and each base has a dedicated 64 Kbps ISDN line and five voice channels, provided by Intelsat.[23]

5.4 technology and network capacity[24]

The following pages examine the backbone and customer access networks and briefly explain how advances in technology are likely to influence the capacity of networks in the future.

Given the rapidly increasing demand for bandwidth, much of the research and technological developments have been targeted at reducing costs while increasing the available network capacity. The emphasis on cost reduction has seen the cost of transmission capacity falling by an average of 30 per cent per annum for the last 25 years and this trend is likely to continue in the foreseeable future.[25] Economic issues affecting network capacity are developed in some detail in later chapters of this report.

5.4.1 CAPACITY

The capacity of a communications network can be increased by:

- installing more or different physical links from place to place; and/or
- enhancing the capacity of the existing network links.

The technical issues influencing the size and nature of potential increases in capacity are examined in relation to the backbone and customer access network.

23 Joint Standing Committee on the National Capital and the External Territories, *op. cit.*, p. 86.

24 A full discussion of technological issues may be found in appendix 5.

25 Ovum 1999(a), p. 36.

5.4.2 SPECTRUM ALLOCATION PROCESS

For wireless links, either in the backbone or customer access networks, the most significant determining factor for capacity is the availability of radio frequency spectrum. As a limited natural resource, spectrum is not freely available and is the subject of a detailed allocation process.

The spectrum allocation processes take into account a large number of factors including the technical characteristics (carriage capacity) of different parts of the spectrum, the presence of incumbents in some bands, competition between telecommunications carriers and the needs of the Australian community. The development of planning and allocation policies is conducted on a national and international basis by the Australian Communications Authority (ACA) and Government, through consultation with industry, interested persons, government agencies and international bodies such as the ITU. The process is a dynamic one, with the Government, and in particular the ACA, continually refining the spectrum allocation system to improve the delivery of services.

The main purpose of spectrum planning, prior to the allocation of spectrum, is to minimise interference between devices, and to effectively ration spectrum in certain bands where demand exceeds supply. Under the *Radiocommunications Act 1992*, the ACA is required to regularly prepare the Australian Radiofrequency Spectrum Plan which broadly sets out what types of services (e.g. mobile or radiolocation) that can be allocated in each band and determines how much spectrum or bandwidth is available for each type of use. The ACA also prepares individual band plans which indicate in detail what types of services will operate in each band and how much spectrum can be allocated for each service. For example the 900 MHz band plan sets out the spectrum allocation for 900 MHz cellular mobile services.

Most spectrum is allocated through:

- apparatus licensing, which requires specific types of equipment to operate on certain frequencies with set licence fees; or
- class licensing, which generally requires specific types of equipment to operate within certain frequency bands with no licence fees.

Under the apparatus licence system there are 16 transmitter licence types and four receiver licence types. The main backbone services for which apparatus licences are allocated are fixed services such as point-to-point microwave systems or satellite links.

The *Radiocommunications Act 1992* also enables the ACA to allocate certain bands through spectrum licensing. This process permits a wide range of uses in such bands at fees usually based on market prices achieved at auction. As such, spectrum licences are a tradeable spectrum access right for a fixed non-renewable term of up to 15 years. They were awarded for the first time in 1997, following the auction of the 500 MHz band. Allocation of spectrum licences in the 800 MHz and 1.8 GHz (generally used to provide mobile services) followed in 1998. An allocation of 28/31 GHz licences occurred in 1999.

5.4.3 BACKBONE NETWORK

5.4.3.1 infrastructure duplication

The installation of increased physical capacity in the backbone network has occurred as new network providers install capacity independent of, but largely parallel to, the existing Telstra network. This occurred when Optus installed its capital city optical fibre network after the establishment of duopoly competition in 1992. Since the telecommunications market was made fully competitive in 1997 a number of carriers have or are installing additional capacity in selected locations, for example Macrocom has installed a microwave link between major centres in New South Wales and Victoria.

Infrastructure duplication has tended to occur on routes where existing communications traffic is heaviest and, as a consequence, the existing network has the greatest capacity. This is one of the contributors to the considerable over-supply reported in the survey. However, new market entrants who install additional capacity must consider that the costs of network construction are justified and that they can compete effectively with the existing carriers. In the future, the oversupply of capacity may be a disincentive for further infrastructure investment. The majority of carriers that provide national and international long distance services are leasing capacity rather than investing in their own infrastructure. This situation is unlikely to change in the period 1999–2004.[26]

Telstra is also installing more physical capacity as part of the ongoing process of upgrading their network. For example, the number of fibre strands in a typical optical fibre cable has increased from six or twelve in the late 1970s to a situation

26 Amos Aked Swift, *op. cit.*, p. 5.

where country routes are now often being equipped with 60 fibres.[27] This upgrading is occurring in all areas of Telstra's network, sometimes in response to competition, but more usually to replace obsolete facilities and maintain an acceptable quality of service. This trend is occurring largely because, at the time when new optical fibre cable is installed, the marginal cost of installing additional fibre strands is small compared with the overall installation cost.

5.4.3.2 enhancing the capacity of optical fibre

The information carrying capacity of one optical fibre strand is undergoing a revolution. In the mid 1980s one Telstra fibre strand between Sydney and Melbourne could carry either 140 or 565 Mbps (equal to 0.14 or 0.565 Gbps).[28] Today the same fibres routinely carry 40 Gbps[29] and could easily be upgraded to 80 Gbps. One manufacturer, Fujitsu, has announced a 320 Gbps system based on one fibre, available in 1999. In May 1999 Nortel announced a 1.6 Tbps (1600 Gbps) system for release in 2000 and while this report was being produced they announced in October 1999 the successful demonstration of a 6.4 Tbps (6400 Gbps) system planned for commercial release in 2001.[30]

This extraordinary increase in capacity has been brought about by increasing the optical pulse rate in the fibre and by DWDM. DWDM is a multiplexing technology whereby an optical beam on a single fibre strand is divided into its component colours, just as ordinary sunlight can be divided into the colours of the rainbow. Each colour can be made to carry as much information as could be carried by the original fibre. This produces a capacity multiplier effect of 16 times, as currently used by Telstra, and up to 160 times by 2000.

DWDM can usually be installed on existing in-ground fibre without digging it up and at a cost which is only a fraction of installing new fibre.[31] Telstra and Optus have indicated that the upper limit of potential capacity using DWDM technology cannot be quantified confidently.[32] This technology has lead the network providers to use a new *just-in-time* capacity provisioning model. For example, one fibre pair

27 Consultel, *op. cit.*, p. 9.

28 *Ibid*, p. 8.

29 *Ibid*, p. 10.

30 See *www.nortelnetworks.com*, October 1999.

31 The cost of installing DWDM equipment tends to be higher as the age of fibre increases and some of Telstra's pre 1987 fibre cannot carry DWDM.

32 Amos Aked Swift, *op. cit.*, p. 4.

on an older 12 pair cable can be upgraded to 16 colour DWDM and carry more capacity than the whole original cable. As and when demand increases, a second pair could be upgraded to more than double capacity again. The lead time for such upgrades is a few weeks to a few months, meaning that network providers can be assured that on optical fibre routes, a large excess of capacity can be made available in a relatively short time and at relatively low cost.

5.4.3.3 undersea cables

Theoretically, the same capacity enhancement technologies can be applied to undersea optical fibre cables as those on land. However, installing the necessary hardware upgrades in undersea optical amplifiers to provide for higher factors of DWDM, for example, is often not technically possible and very rarely cost effective. As a consequence undersea cables are often over provisioned at the time of construction and usually remain at their initial capacity for their working life. The Project Oxygen network is an example of a proposed undersea cable development with a high initial capacity of 2.56 Tbps on trans-oceanic segments.[33]

5.4.3.4 satellites

Satellites are not widely used to provide backbone network capacity as they have limited total capacity in relation to optical fibres. For example, the capacity of each Optus satellite covering the whole of Australia is 0.6 Gbps (from table AP5.2 in appendix 5) compared with the average potential capacity from all sources into individual small towns of 160 Gbps (from table 5.2). This trend should continue for the next five years as the potential future capacity of optical fibre links is likely to increase significantly faster than future satellite capacity.

5.4.3.5 point-to-point microwave

The installation of point-to-point microwave backbone networks is sometimes comparatively cheaper per unit of capacity than installing a new optical fibre network or launching satellites. This is particularly the case if existing towers, perhaps used for broadcasting or cellular telephony, can also be used to support the microwave equipment. However, the capacity of such systems is limited by the availability of spectrum and their reliability can be at risk from adverse weather conditions and/or malicious damage.

33 See *www.projectoxygen.com*, August 1999.

While the capacity of microwave systems is likely to expand over the next five years as the result of technological developments, the rate of that expansion will be very small in relation to the likely rate of capacity increases available on optical fibre networks.

5.4.4 CUSTOMER ACCESS NETWORK

The stocktake identified considerable amounts of transmission capacity available in the backbone communications network.The bandwidth available to the end user is also dependent on the optical-electronic conversion (between the optical fibre and the copper network) and the capacity of the customer access network (also known as the local loop).[34] Many of the submissions identified the often low data transfer rates provided by parts of the current customer access network which can restrict the bandwidth available to the end user.[35] For this reason, technological developments which are likely to provide end user access to backbone networks at rates in excess of 64 Kbps are discussed below. The report of the Digital Data Inquiry also discusses a number of technological options for providing communications services in the customer access network,[36] with its main focus being the provision of access at or below 64 Kbps.

5.4.4.1 terrestrial

In recent years a number of alternative technologies have been, or are being, developed to increase the bandwidth capacity of the customer access network. These technologies include the various forms of the digital subscriber line (xDSL) transmission technique over the existing copper,[37] new fibre networks deployed in a hybrid design with coaxial cable or xDSL, microwave point to multipoint distribution systems such as local multipoint distribution systems (LMDS), datacasting and cellular mobile networks. These systems are outlined below[38] and all have the potential to provide a varying level of broadband services to the end user.

34 See the Telstra submission to the Inquiry—attachment C.

35 See submissions from AAPT, Optus, Australian Photonics Pty Ltd, Australian Telecommunications Users Group, Council of Australian University Directors of Information Technology, CSIRO-Telecommunications & Industrial Physics, Commonwealth Department of Education, Training and Youth Affairs and Tasmanian Department of Education.

36 Australian Communications Authority, *Digital Data Inquiry: Public Inquiry under section 486(1) of the Telecommunications Act 1997*, Australian Communications Authority, Canberra, 1998. For a discussion of narrowband customer access technology see chapter 5.

37 Other copper based multiplexing systems are also in use such as *pair gain*, however they do not provide broadband capacity.

38 See appendix 5 for a more detailed discussion of these technologies.

xDSL

Digital subscriber line technology uses specialised modems to carry high bandwidth over the existing copper twisted pairs (or newly installed copper pairs) in the customer access network. The amount of capacity the technology can carry decreases as the length of the copper wire increases (reflecting the customer's distance from the exchange or remote multiplexer) and as the electrical quality of the copper decreases.

Asynchronous digital subscriber line (ADSL) technology is capable of operating at 6.3 Mbps to the user over distances up to four kms, while very high digital subscriber line (VDSL) technology, such as that recently trialed in the ACT, will deliver 51.8 Mbps over 330 metres. The return data speed from the user to the network is much lower, varying from 0.64 to 2.3 Mbps over the same distance ranges.

The technology has the capacity to provide high bandwidth to all end users connected by less than four or five kms of copper wire to their nearest telephone exchange or remote multiplexer (effectively the end of the optic fibre cable). The cost of this technology should be reasonable as it is widely used in the US and Europe, ensuring economies of scale in its manufacture.[39]

Telstra is about to conduct extensive trials of ADSL which are expected to be complete by July 2000. A rollout beyond the trial period will be based on demand. The first trial will involve about 100 selected wholesale and retail customers on 10 exchanges in Brisbane, Melbourne and Sydney. The next phase will extend to approximately 1 000 customers.[40]

hybrid networks

In the capital cities on the eastern seaboard, the hybrid optical fibre and coaxial cable (HFC) networks of Telstra and Optus pass millions of homes and businesses. These networks already offer pay television, cable modem access and, in the case of Optus, telephony as well. To date, the cable modems have each been based on a different proprietary standard resulting in relatively small numbers being manufactured at a comparatively high cost which in turn has served to reduce the demand for modem access to the HFC networks.

39 The provision of xDSL services in the future is likely to be influenced by the recent decision of the ACCC to require Telstra to allow access by other carriers to their customer access network. This issue is discussed further in chapter 9.

40 See Telstra media release of 20 September 1999 at *www.telstra.com.au/press/recent.html.*

Both carriers have indicated that they are moving to implement the new internationally recognised cable modem standard known as the data over cable service interface specifications or DOCSIS. Access to the large number of modems manufactured to the DOCSIS standard overseas should reduce the price of cable modems and stimulate demand.

The ACT trial of a VDSL network mentioned above is another example of a hybrid broadband network. It used optical fibre in the street and twisted copper pair for up to the last 300 metres to the home with VDSL compression technology.

LMDS

LMDS is a broadband wireless technology used to deliver voice, data, Internet and video services at up to ten Mbps in the frequency ranges above 25 GHz. Due to the propagation characteristics of signals in this frequency range, LMDS uses a cellular like architecture to provide fixed services in a point-to-point or point-to-multipoint configuration directly to residential and commercial customers in a line of sight range of up to five kms from the transmitter.

AAPT has purchased spectrum throughout Australia in the frequency ranges 27.5 to 28.35 GHz and 31.0 to 31.3 GHz and intends to roll out 120 nodes (transmission points) by December 2001. These will provide coverage to:

- all key metropolitan areas with high concentrations of business customers;
- all capital city CBD areas to complement existing and planned AAPT optical fibre cable; and
- over 20 selected regional centres.[41]

datacasting

Datacasting is defined in the *Television Broadcasting Services (Digital Conversion) Act 1998* as a non-broadcasting service using spectrum set aside for broadcasting services. This is a subset of a wider group of services referred to as broadcast data transmission (BDT), which includes all data services directly linked to radio frequency point to multipoint television and radio transmissions delivered by any terrestrial or satellite means.

41 AAPT submission to the Inquiry, October 1999.

Broadband BDT service may be provided over a number of existing and anticipated carriage platforms:

- existing geo-stationary satellite systems such as the Optus and PanAmSat satellites;
- non-geostationary wide bandwidth satellite systems such as SkyBridge or Teledesic;
- coaxial cable, pay television systems;
- local microwave distribution radio based systems (MDS);
- broadcasting band datacasting services;
- data broadcasting within a terrestrial broadcaster's potentially spare capacity;
- third generation cellular mobile systems; and
- broadband customer access network using technology such as ADSL.[42]

The services available range from simple text based information services, such as stock market information or sports results, to advanced Internet style services.

Narrowband analogue BDT services currently available in Australia include teletext (*Austext* available on the Seven Network), *Stocktext* (up to the minute stock market quotes on the Seven Network), some Internet services (Seven Network and the Special Broadcasting Service—SBS) and captioning. Teletext and captioning have significant audience reach, with around 2.3 million teletext viewers[43] and 22 per cent of all free to air televisions programs including closed captioning,[44] targeting the estimated 1.7 million Australians with significant hearing loss.[45]

The more efficient use of spectrum in digital television transmissions enables broadband data services to be delivered via BDT. Broadcast digital television services are currently available through the pay television operator Austar using its own MDS infrastructure or the Optus B3 satellite. Free to air digital terrestrial television broadcasting (DTTB) services are scheduled to commence in 2001 in metropolitan areas and 2004 in country areas with analog still to be provided at least eight years after commencement.

42 See appendix 5 for a more detailed discussion of some of these technologies.

43 Budde, P., *1999/2000 Information Highways in Australia*, Paul Budde Communications Pty Ltd, 1999, p. 28.

44 Closed captioning refers to embedding captions in a television signal which can only be accessed with a special decoder, while open captioning refers to captions (often called subtitles) available to all viewers.

45 Budde, *op. cit.*, p. 31.

Broadband BDT service can be provided through a number of existing and anticipated carriage platforms:

- satellite using the existing geostationary satellite systems such as the CW Optus and PanAmsat satellites;
- non-geostationary wideband satellite systems such as Skybridge or Teledesic;
- coaxial cable (Pay TV) systems;
- MMDS and LMDS radio systems;
- broadcasting band datacasting services;
- data broadcasting within a terrestrial broadcaster's digital multiplex using spare capacity;
- advanced digital mobile phones (IMT 2000); and
- ADSL over telephone lines.[46]

BDT has the potential to provide significant asymmetric bandwidth to a very large audience in metropolitan and rural areas because of its point to multipoint nature. The services are provided via an ordinary television (with an appropriate set top box), usually have a television *feel* (as distinct from a computing *feel*) and are very simple to access. User interaction can be provided via a back channel, often through a PSTN link or sometimes another wireless based connection.[47]

broadband cellular mobile

Broadband cellular mobile or third generation mobile as it is referred to has the potential to provide a 2 Mbps data stream to a hand held multimedia communicator. Such devices are not expected to be in widespread use until at least 2005. The services provided by the technology are still the subject of considerable debate, but include remotely operating and monitoring household devices, video telephony and information and entertainment services. Given the huge popularity of the existing cellular mobile telephone, third generation mobile communicators are likely to be widely used in the future.

5.4.4.2 satellite

The distinction between backbone and customer access network is more difficult to make with respect to satellite capacity, as one satellite can provide both services. By their very nature, satellites are best suited to point-to-multipoint broadcast

46 Federation of Australian Commercial Television Stations (FACTS), *Bandwidth Availability and Pricing within, and to and from Australia*, p. 6.

47 See discussion of *Audience interaction* under *Datacasting* in appendix 5.

type applications. They also have a significant niche application as part of the customer access network, in situations where alternative terrestrial technologies are not cost affective or not available, such as many rural and remote areas and areas where xDSL technology is not practicable. These are likely to remain the most significant satellite applications in the customer access network over the next five years.

The capacity available from satellite technologies is limited by the available spectrum. They are not be able to service large numbers of users in one location as they depend on the sharing of a relatively limited bandwidth between all the users. However, in sparsely populated areas or perhaps as fill in for terrestrial cellular systems they will provide good service coverage.

Many satellites have some coverage over Australia, but Optus and PanAmSat have geostationary satellites with Australian dedicated footprints. Based on these footprints, Optus and Telstra are beginning to provide broadband services direct to the user, usually in 64 Kbps steps. However, as satellite transponder capacity is limited by spectrum availability, Optus and PanAmSat are capable of serving perhaps only tens of thousands of customers with an equivalent 64 Kbps dedicated link.

The proposed low earth orbit systems such as *SkyBridge* should provide up to 10 Mbps to limited numbers of domestic customers in most land based locations throughout the world.[48]

Optus satellites

Optus currently operates three satellites, two from the B series and one older A3 series satellite which provides a restoration capability for the B series satellites. A third type, the C series, is in the process of being procured.

The three satellites provide beams covering the Australian continent, North Eastern, South Eastern Australia, Central Australia, Western Australia, South West Pacific, Papua New Guinea and New Zealand. These are used primarily by commercial, free to air television broadcasters and pay television operators with B3 being the preferred satellite for digital direct to home services. The B series spacecraft include a transponder which provides the *MobileSat* voice and data service.

48 More detail about low earth orbit satellite broadband services is presented in appendix 5.

The B1 satellite provides analogue services and may be used for networking, point-to- multipoint or point-to-point communications, may be accessed using fixed antennae and is currently used by free to air television operators, carriers and large corporate organisations, providing 80Mbps per transponder. The B3 satellite is dedicated to direct to home broadcast and its performance has been optimised to serve small, fixed antenna dishes ranging in size from 0.6m to 1.5m with capacity to deliver video and Internet services typically of 4 Mbps.

The C1 satellite currently being procured is planned to be launched in early 2002 and will replace the B3 satellite as the new digital satellite optimised for direct to home services. The commercial payload on the satellite will provide an enhanced capacity to deliver direct-to-home television, Internet, telephony and high bandwidth data communications throughout Australia and into Asia.[49]

PanAmSat satellites

PanAmSat currently operate 19 satellites of which PAS 2 and PAS 8 have dedicated footprints over Australia. As for all satellites, their capacity is limited by the available spectrum. In addition, PAS 2 and PAS 8 have switchable transponders that can be allocated to the Australian footprint or other Asia Pacific footprints. Therefore, the available capacity over Australia is in part determined by the demand for capacity in other parts of the Asia Pacific region.

PanAmSat tend to market their satellite capacity on a wholesale basis, to global television networks or other communications carriers. Most of the PAS 2 and PAS 8 capacity has already been sold in this way and the total capacity on the satellites which is still directly available is small. However, those, such as Telstra, who have purchased capacity for resale are marketing satellite services to clients typically with poor or no terrestrial broadband services.[50]

5.5 backbone capacity versus capacity available to the customer

Following the structure presented at the beginning of this chapter, available capacity is either installed or potential capacity. These categorisations refer to capacity in the backbone network and do not necessarily translate to capacity

49 More detail about Optus satellites is presented in appendix 5.

50 More detail about PanAmSat satellites is presented in appendix 5.

available to the customer residence or place of business. In addition, potential capacity is that capacity which can be made available in the backbone network by the carrier at a small marginal cost in relation to the total cost of the link. Installing potential capacity could take the carrier some time, perhaps weeks or even months.

Installed backbone capacity may translate to capacity provided to the customer subject to:

- the limitations of the customer access network;
- provisioning issues at the local exchange, such as the availability of the necessary connecting equipment; and
- market factors such as product definitions, billing and price.

Factors affecting the marketing of capacity are discussed in some detail in subsequent chapters.

5.6 implications

Survey and modelling results suggest that in all but a few exceptions there is considerable existing backbone network capacity available. Recent technological developments would appear to ensure that there will also be very large amounts of backbone capacity available in the future. This appears at odds with substantial evidence of capacity shortages experienced by some end users, particularly in rural areas.

This suggests that the cause of most capacity shortages at the point of sale, may be due to provisioning problems independent of the backbone capacity. These might include: bandwidth limitations in the customer access network; the availability of the necessary resources to actually connect up customers; or poor internal communications between the carriers' engineers and marketers.

OPTIC FIBRE NETWORK COVERAGE

OPTIC FIBRE TO OVERSEAS

MICROWAVE NETWORK COVERAGE

chapter 6

DEMAND FOR BANDWIDTH

Seven main drivers of demand were identified: voice communications, Internet access, corporate networking, business to business communications, e-commerce, collaborative working and video services.

Four key industry segments have a particularly high demand for bandwidth: retail trade, property and business services, health and community services and education.

Modelling of demand for telecommunications bandwidth indicates that peak usage in Australia, including international incoming and outgoing traffic, is currently in the order of 300 Gbps:

- of this demand, about 15 per cent can be considered to be backbone bandwidth, that is international, inter-city and inter-regional demands.

Usage is generally less than one per cent of current bandwidth capacity.

Demand is growing rapidly and most of the growth is in data traffic. Forecasts of growth in bandwidth usage by the year 2004 range from an increase of two and a half (CERP and Network Strategies) to four and a half times (CRU).

6.1 introduction

Term of reference 1 of the Inquiry calls in part for an analysis of the following issues:

- the applications, in particular Internet-based services, which are most likely to drive demand for data communications on the trunk network, from residential, business, academic and research and public sector users, including governments at all levels; and
- the likely levels of demand for telecommunications bandwidth within Australia and between Australia and key overseas markets.

To assist the Inquiry to address these issues, two consultants were contracted to undertake demand modelling and projections.[1] In addition, the CRU provided modelling assistance and advice on the consultants' results. Aggregate wholesale market demand estimates for the period 1999 to 2004 were also developed by a consultant in the course of their work on future bandwidth prices.[2]

6.2 applications that may affect the demand for bandwidth

In terms of generic user applications, consultants to this Inquiry identified the following as likely to be the main drivers of demand:

- voice communications;
- Internet access;
- corporate networking;
- business to business communications;
- e-commerce applications;
- collaborative working; and
- video services.[3]

In addition, the Inquiry notes that entertainment services are already having a major impact on network load as more audio and video is transmitted across the network. Online gaming is a major user of bandwidth: trends in the game market are towards online play and it has been experiencing very substantial growth.

1 Communications Economics Research Program at Curtin University (CERP) and Network Strategies.

2 Ovum Pty Ltd, 1999(a), *op. cit*.

3 Network Strategies, *op. cit.*, p. 3 and Communications Economics Research Program, *op. cit.*, p. 13.

6.2.1 VOICE COMMUNICATIONS

Independent broad estimates have voice steadily increasing by around 15 per cent per annum, that is, doubling every five years.[4] Competition in long distance and international as well as increasing network efficiencies have resulted in dramatic reductions in prices and some operators are observing growth in traffic per user.[5] Much of this growth is occurring in mobile services.[6] It is unclear to what extent voice will migrate from the existing circuit switched networks to end-to-end packet switched networks within the timeframe of this study, but it is likely that some traffic will move in this direction. This issue was not covered by the consultancies.

6.2.2 INTERNET ACCESS

As noted earlier in this report, advances in information technology have led to a doubling of computer power every 18 months to two years and thus to a widening array of computer applications from basic data manipulation and word processing to multimedia and virtual reality.[7]

Access to the Internet requires that the user connect to an ISP, with the connection type usually depending upon the amount of traffic generated, the response times required and the cost of the service.[8] Low volume users usually connect over a standard copper pair PSTN line, allowing communications of up to 56 Kbps, using a standard modem.[9] Those with higher traffic requirements have a number of options:

- switched connection via an ISDN service;
- digital leased lines;
- cable modem (only where the broadband hybrid fibre coaxial network is installed); and
- satellite.[10]

4 Ovum Pty Ltd, 1999(a), *op. cit.*, p. 6 and McGinn, R.A., *A revolution in networking: toward a network of networks*, October 1998, *www.lucent.com/news/speeches/docs/mcginn1.html*, September 1999.

5 Network Strategies , *op. cit.*, p. 4.

6 Ovum Pty Ltd, 1999(a), *op. cit.*, p. 4.

7 Communications Economics Research Program, *op. cit.*, p. 12.

8 Network Strategies, *op. cit.*, p. 5.

9 Actual connection speeds are likely to be lower than the nominal capacity of the modem.

10 Network Strategies *op. cit*.

Almost all large businesses are connected to the Internet, with over 90 per cent of businesses with at least 100 employees having Internet access as at June 1998.[11] Small and medium sized enterprises (SMEs) have been slower to adopt the Internet. Fifty seven per cent of medium-sized businesses (20–99 employees), 33 per cent of small businesses (5–19 employees) and only 26 per cent of micro businesses (1–4 employees) have Internet access.[12] However, the take-up is growing with an additional 14 per cent of small businesses and 17 per cent of medium businesses connecting to the Internet[13] in the twelve months to February 1999.

Around 50 per cent of one major ISP's residential and SME customers currently access the Internet using a 56 Kbps modem, with the remainder being a mix of 28.8 Kbps and 33.6 Kbps modems. While ISDN or cable modem access is available from this service provider, the higher costs of utilising additional bandwidth is not seen as offsetting the benefits of faster access.[14]

In the residential market, as at May 1999, 47 per cent of households had a computer, with just over 22 per cent having home Internet access, an increase of 553 000 or nearly 57 per cent over May 1998.[15] While capital city penetration (at 26 per cent) is higher than other areas (17 per cent), the take up rates in metropolitan and rural areas are similar.[16]

In terms of accessing the Internet (whether from home, work or elsewhere), 5.5 million adults or 40 per cent of the adult population had access at some time in the year to May 1999, compared with 3.6 million, or 26 per cent, a year earlier.

These figures mask some important differences among the age cohorts. Table 6.1 summarises adult access by age range. It shows that the 18–24 cohort who accessed the Internet has grown to a massive 74 per cent. As this group matures they are likely to continue to fuel demand for Internet access, while those entering this age-range can be expected to increase the overall percentage still further.

11 Australian Bureau of Statistics, *Business use of information technology, Australia, Preliminary,* ABS Catalogue No 8133.0, 1999 quoted in Network Strategies, *op. cit.*, p. 6.

12 *Ibid*.

13 Sweeney, Brian and Associates, *Yellow Pages, Small business index*, February 1999.

14 *Ibid*, p. 7.

15 Australian Bureau of Statistics p. 5, ABS (1999), *Household use of information technology, Australia*, ABS Catalogue No 8146.0; ABS (1999), *Use of the Internet by householders, Australia,* ABS Catalogue No 8147.0.

16 Australian Bureau of Statistics (1999) *Use of the Internet by householders, Australia,* ABS Catalogue No 8147.0.

Table 6.1

ADULT INTERNET ACCESS[17]

Adult age range (years)	*Year to May 1999*		*Year to May 1998*	
	Number of persons (millions)	*Percentage of age range*	*Number of persons (millions)*	*Percentage of age range*
18–24	1.3	74	0.9	49
25–39	2.3	53	1.4	34
40–54	1.5	39	1.0	28
55 and over	0.4	10	0.2	5
All adults	5.5	40	3.6	26

The above figures only address adult Internet access. If the age range is extended to all persons aged five and over, then the total population of Internet users is probably close to 6.5 million.[18]

Subscriber growth rates for the Internet appear to be in the order of six to eight per cent a month.[19] When taken together with the fact that existing users are spending more time online or using the Internet more intensively, this is broadly comparable with other estimates that Internet traffic is growing by two and a half to three times each year.[20]

6.2.3 CORPORATE NETWORKING

The demand for data services, such as frame relay, ATM and leased lines is overwhelmingly driven by the need for local area network or wide area network connectivity, with businesses routing not only data traffic but also voice and video over their networks.[21] Intranet access for geographically distributed sites can be a critical resource for sharing corporate information on matters ranging from corporate planning and policies, to financial management and training

17 *Ibid*.

18 Derived from Australian Bureau of Statistics (1999) *Household Use of Information Technology, 1998* ABS Catalogue No 8146.0

19 *Ibid*.

20 Ovum Pty Ltd 1999(a), *op. cit.*, p. 6.

21 Network Strategies, *op. cit.*, p. 7.

programs. In addition, as discussed in chapter 2, e-commerce and e-business usage is rising dramatically. In the case of e-business, this involves contracts and tenders, inventory control, exchange of data sets as well as business-to-business trading.

For many large corporate organisations, existing electronic data interchange arrangements, with their upstream suppliers or downstream customers, remain important communication channels. These arrangements are expensive to put in place and are difficult to change where a company wishes to move to a more open, Internet/extranet structure. But given the greater flexibility and ease of use with web based networks, this migration is likely to occur increasingly over the next few years. At the same time, as business supply lines become increasingly integrated these relationships can be expected to become deeper and more communications intensive.

Business-to-consumer e-commerce, while not on quite the same scale of dollar value as business-to-business transactions, is nonetheless increasing exponentially. Taken at the level of the individual transaction, e-commerce transactions may not use much bandwidth. When usage is aggregated at the site level, however, they can impose large demands on server capacity and communications network capacity. This sort of server-side demand growth is likely to be very significant as the sophistication of e-commerce increases (e.g. animation, audio, voice and more complex interactive scripts) and the total volume of transactions and site visits increase.

6.2.4 COLLABORATIVE WORKING

To an extent, this area of usage could be seen as a subset of corporate networking. It is treated separately here because of the range of technologies it can involve. In essence, collaborative working (also known as virtual teamwork), allows people working at different sites, and even in different countries, to work together without the need to travel or exchange data on physical media. Such arrangements may involve a combination of voice, video and data with the bandwidth requirements varying with the needs of the user.[22]

There are some 50 Internet telephony programs available currently on the Internet and many of them are free. New services have sprung up, particularly in the US, which enable users to connect, via the Internet, to PSTN telephone subscribers.

22 *Op. cit.*, p. 8.

The first round of these services were fee based. More recently, however, a US service provider has offered Internet to conventional phone services anywhere in the US without charge, recovering costs from associated advertising.[23]

In addition to voice telephony, there are combined Internet telephony, video, white board and file exchange programs such as Vocaltec's *Internet Phone* and Microsoft's *NetMeeting* that operate over relatively low bandwidth to facilitate collaboration. By contrast, specific uses like telemedicine real-time diagnosis requires a high quality of service and very high bandwidth (155 Mbps) because of its need for voice, video and high resolution graphical images.[24]

6.2.5 VIDEO SERVICES

Video services, such as video telephony and video conferencing, are at present mainly limited to large corporate organisations or government and some smaller specialist businesses. It is expected that take-up will continue to grow as the costs of terminal equipment and bandwidth decline and processing power continues to increase.[25]

Common existing video conferencing systems use 384 Kbps bandwidth, with a compression factor of 240 to one. Voice accounts for 64 Kbps, while file transfer and *whiteboarding* use part of the remainder and video accounts for the rest.[26] On packet switched networks it is generally expected that video conferencing will use between 200 and 400 Kbps, though bandwidths as low as 64 Kbps are possible with a compression of 1 400 to one.[27]

A more major source of video (and audio) usage and bandwidth demand however, is likely to come from video and music streaming, in terms of both on-demand and live content. There are growing numbers of sites that are offering archived and live shows.

23 See *www.dialpad.com*

24 Network Strategies, *op. cit.*, p. 8.

25 *Ibid*.

26 *Ibid*.

27 *Ibid*.

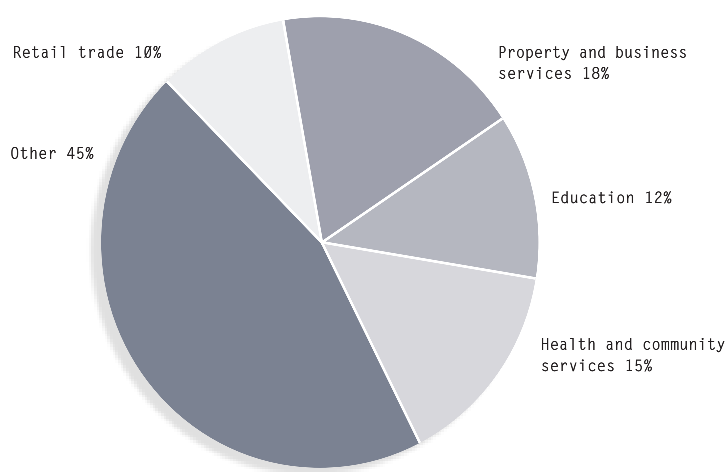
6.3 industry sectoral demands for bandwidth

Commissioned research for this Inquiry has identified four key industry segments as having particularly high demand for bandwidth:

- the retail trade;
- property and business services;
- education; and
- health and community services.

Demand from these sectors will continue to grow or remain high over the next five years with education and health and community services increasing their share of total demand relative to industry (inclusive of the government sector) as a whole.[28] Figures 6.1 and 6.2 show estimated bandwidth usage in 2000 and 2004 respectively.

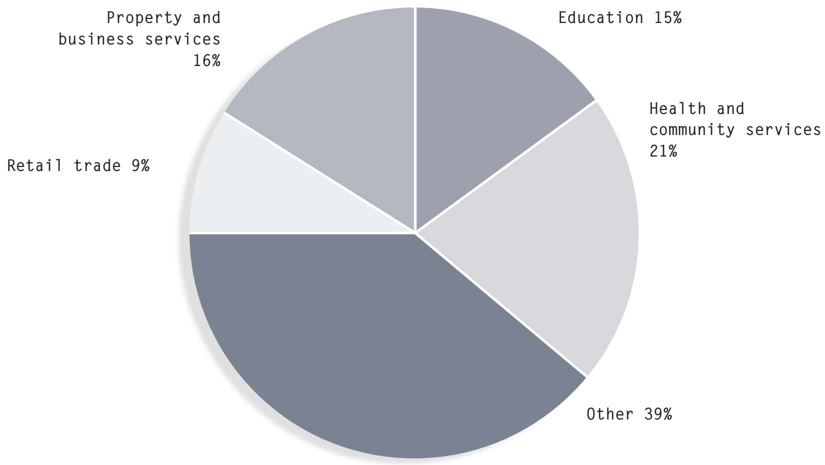
Figure 6.1
ESTIMATED INDUSTRY BREAKDOWN OF BANDWIDTH USAGE, AUSTRALIA, 2000[29] (LIKELY SCENARIO)



28 Network Strategies *op. cit.*, p. 27. As indicated earlier in this chapter, the Inquiry has also been advised that online entertainment services are undergoing very substantial growth, though it was unable to find quantitative data to substantiate this view.

29 *Ibid*, p. 23.

Figure 6.2
ESTIMATE INDUSTRY BREAKDOWN OF BANDWIDTH USAGE, AUSTRALIA, 2004[30] (LIKELY SCENARIO)



6.3.1 EDUCATION

An indication of potential growth in the education sector is provided by the expected growth in higher education's demand for bandwidth. Services to higher education are provided by the Australian Academic Research Network (AARNet). The Council of Australian University Directors of Information Technology (CAUDIT) have indicated that traffic is currently growing at around 50 per cent a year but has more typically doubled every nine months (250 per cent a year). This slowdown has come about as universities have consciously sought to limit the cost of Internet traffic. Nonetheless, they estimate that demand will grow from 155 Mbps in 2000 to 1.2 Gbps in 2004.[31]

However, potential demand is constrained by bandwidth cost and quality of service considerations. Much of this demand relates to utilising new technologies and tools for flexible delivery of education. As CAUDIT note, there is an increased availability of tools to digitise music, images, video, photographs and audio and rising expectations among students and teachers to utilise these media in the preparation of instructional materials.

30 *Ibid*, p. 24.

31 CAUDIT, *Submission to the National Bandwidth Inquiry*, October 1999, p. 8.

6.3.2 HEALTH

Much of the demand in the health sector is expected to come from the increasing adoption of new communications-based management and delivery tools. The broad use of information technology in the health industry to achieve better medical and economic outcomes, has developed from a combination of related trends:

- providing health care at a distance using telecommunications;
- the storage, retrieval and communication of health related data; and
- electronic business transactions and management or e-business.

Providing health care at a distance or *telehealth* is the most visible use of information technology for health purposes in that it usually directly involves the patient. This could include for example *teleradiology*, *telepsychiatary*, direct advice to a patient or conferences between medical staff about the most effective treatment for a particular condition. The bandwidth currently required for such services varies from an ordinary telephone call at the least up to video conferencing, at perhaps 384 Kits/s or higher depending on the resolution required.

Such services have the potential to use considerably higher bandwidth if services such as real time, high definition, three dimensional colour imaging became a commonly used medical diagnostic tool. Such imaging techniques are beginning to be developed, but it may more than five years before they become a significant component of telehealth.

6.3.3 MULTIMEDIA

While not specifically identified as an area of high growth and potential demand by the consultants, or currently significant in terms of *overall* demand for bandwidth, the multimedia industry in Australia has particular needs for high bandwidth. *Multimedia* refers to their combination of skills in photography, animation, graphic design, digital imaging and audio engineering (or some combination of these) to produce, for example, film or video sequences.

Often these processes involve the transfer of images and sound through a number of production stages carried out collaboratively and/or sequentially by geographically separate organisations. This is ideally suited to high bandwidth data transfer. This industry is a potential consumer of competitively priced high bandwidth services within Australia and to overseas locations and, given the right circumstances, could well compete effectively in the US film and video post production market.

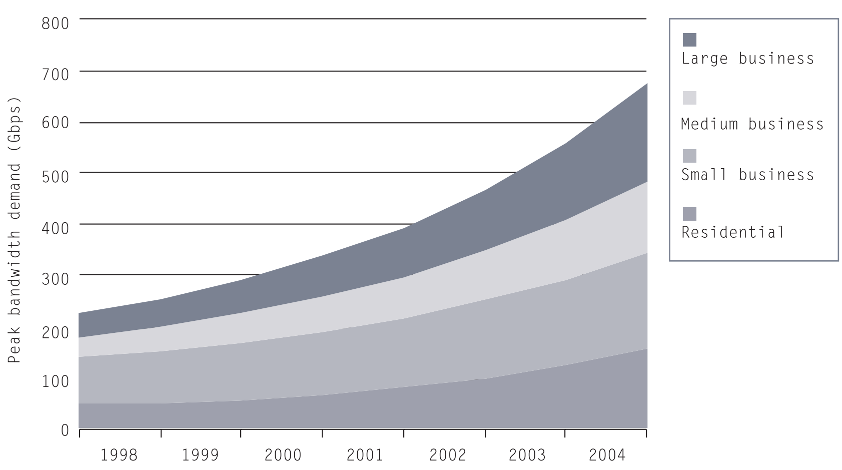
6.4 modelling the demand for bandwidth

6.4.1 MODELLING RESULTS

The CRU model finds that in 1999, total peak bandwidth usage in Australia, including incoming and outgoing international traffic, was of the order of 300 Gbps. This accords broadly with the findings of the other two models. Although the Network Strategies' estimate was somewhat lower, at around 250 Gbps, this did not include all business-to-business traffic. The CERP estimate was based on average traffic and did not include leased lines, and therefore was expected to be lower than the peak traffic estimates.

All of the modelling work agrees that demand for bandwidth is growing rapidly, with variations in expected outcomes arising from differences in the degree of optimism attached to how quickly prices for bandwidth and access will fall and how quickly will broadband access to homes be rolled out. Graphs of various scenarios from the three models are shown in figures 6.3, 6.4 and 6.5.

Figure 6.3
RESULTS FROM NETWORK STRATEGIES MODEL (LIKELY SCENARIO) 1998-2004[32]



32 Network Strategies, *op. cit.*

Figure 6.4

OVERALL RESULTS FROM CRU MODEL, 1999-2005[33]

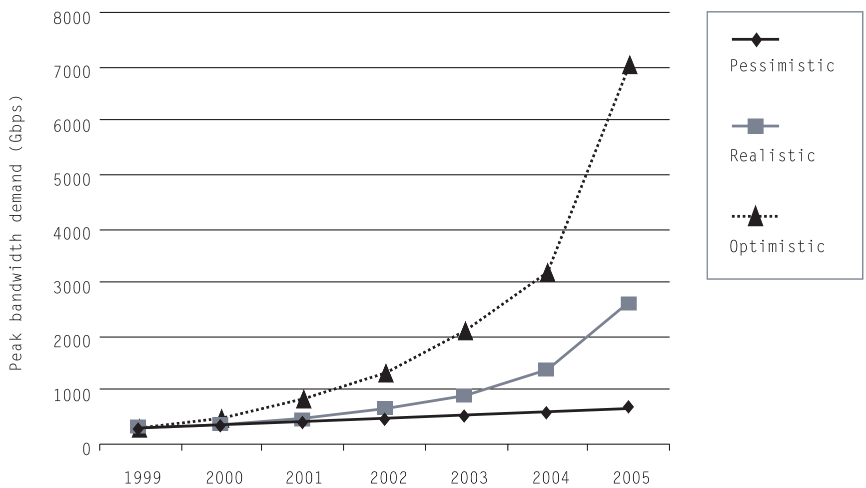
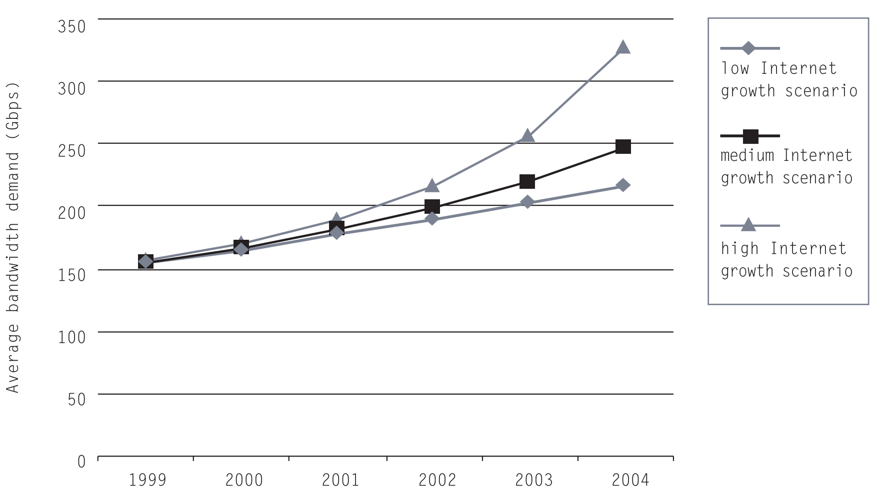


Figure 6.5

OVERALL RESULTS FROM CERP MODEL, 1999-2004[34]



33 Street, J., *Modelling Telecommunications Bandwidth for Australia*, Paper presented to the Communications Research Forum, Canberra, 27–28 September 1999.

34 Communications Economics Research Program, *op. cit*.

Around 80 per cent of bandwidth demands are attributable to business and government usage, and 20 per cent to households. These estimates are made on the basis of who initiates the calls, so it may be inferred that traffic between households and business or government are also estimated to be a relatively minor part of the total traffic at this time.

Differences in forecast growth rates can be explained by differences in scenarios as follows:

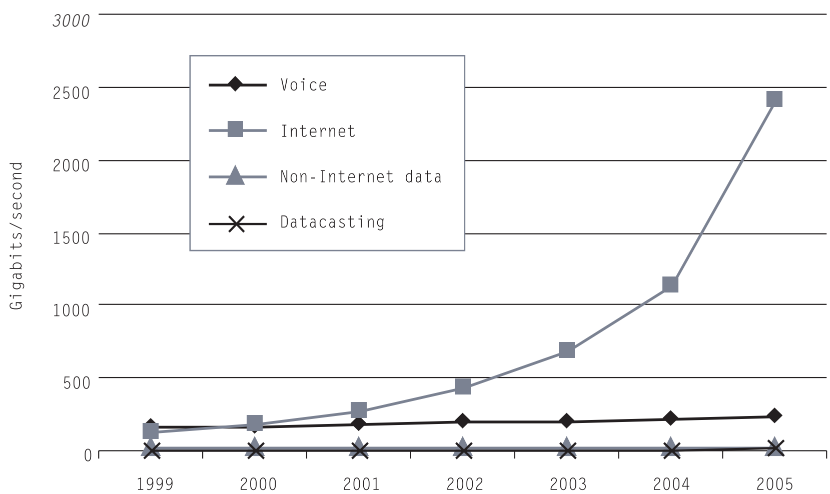
- Network Strategies adopted conservative scenarios in which demand was constrained by the use of existing access technologies (and implicitly, relatively small reductions in price of usage);
- CRU adopted a wider range of scenarios—from highly pessimistic, in which demand growth was severely constrained by almost no reduction in prices—to relatively optimistic, in which demand was forecast to grow 24 fold in the six years to 2005 as a result of prices falling almost one third of what they are today on international, inter-city and intra-city routes. (By implication, this scenario assumes significant roll out to businesses and households of high bandwidth access technology such as ADSL.); and
- CERP forecasts were applied to a much lower base than the other two models because only PSTN and home use of the Internet were analysed (see the discussion below that compares the three models). In addition, even the most optimistic forecast of growth in Internet hosts was for a lower growth rate than has been experienced to date.[35]

A further finding, which accords with worldwide industry experience, is that whereas voice and data demands are currently about equal, by far the greatest growth in bandwidth demands is for interactive, packet switched data services, typically for Internet applications. Although demands for other services such as circuit switched voice applications are also growing, there are significant differences in rates of growth. Internet demand is growing rapidly and exponentially whereas voice demand is growing relatively slowly and linearly, as depicted in figure 6.6 below which shows the break-up in forecast growth between voice, Internet, non-Internet data applications and datacasting.

35 *Ibid*, p. 48.

Figure 6.6

FORECAST GROWTH IN BANDWIDTH DEMANDS BY CATEGORY[36]



6.4.2 DIFFERENCES IN MODELLING APPROACHES

The three groups commissioned to model the demand for bandwidth each took different approaches to the problem.

> Network Strategies took a judgemental approach as outlined in the following excerpt from their report:
>
> [Network Strategies] identified the following applications that will drive future bandwidth demand:
>
> - voice;
> - Internet access;
> - corporate networking;
> - collaborative working; and
> - video services.
>
> Network Strategies' methodology for estimating demand relied on matching the above applications with profiles of average users by market segment. Using a straightforward judgemental forecasting approach, we estimated take-up of

36 Communications Research Unit model (likely scenario).

applications from the addressable market. We calculated peak bandwidth per user, and this, together with take-up, enabled us to determine total bandwidth requirements. Network Strategies' data was gathered using a combination of interviews with industry players, and desk research. Our assumptions are supported by in-depth expert knowledge and judgement of the Australian market, technological trends and developments in applications.[37]

The Communications Research Unit also took a judgemental approach, but differed from Network Strategies as follows:

- in the CRU model, business and government base case demands are estimated by breaking down ABS data on expenditures by ANZSIC industry classes into the amount spent on usage and that spent on access. The expenditure on usage is divided by an assumed price for bandwidth to estimate the quantity of aggregate usage. In turn, peak usage is calculated as the product of aggregate usage and a factor that relates aggregate usage to peak usage;
- the CRU estimates the current level of household bandwidth demands similarly to Network Strategies by aggregating profiles of average users of various applications;
- the CRU model distributes demands across six point-to-point regions: International, Inter-capital, Intra-capital, Inter-regional, Remote to everything else, and Intra-regional and Intra-remote using a 'gravity' model that relates bandwidth demands to population in regions and the distance between them. This distribution shows that, of aggregate peak demand, only about 15 per cent can be considered to be *backbone* bandwidth, that is, international, inter-city and inter-regional demands; and
- in the CRU model, demand forecasts are driven by assumed relationships with demand drivers such as contestable expenditures, cost savings and prices of bandwidth, computers and access. Diffusion of new technology is estimated using 'S'-shaped mathematical relationships known as Gompertz curves.[38]

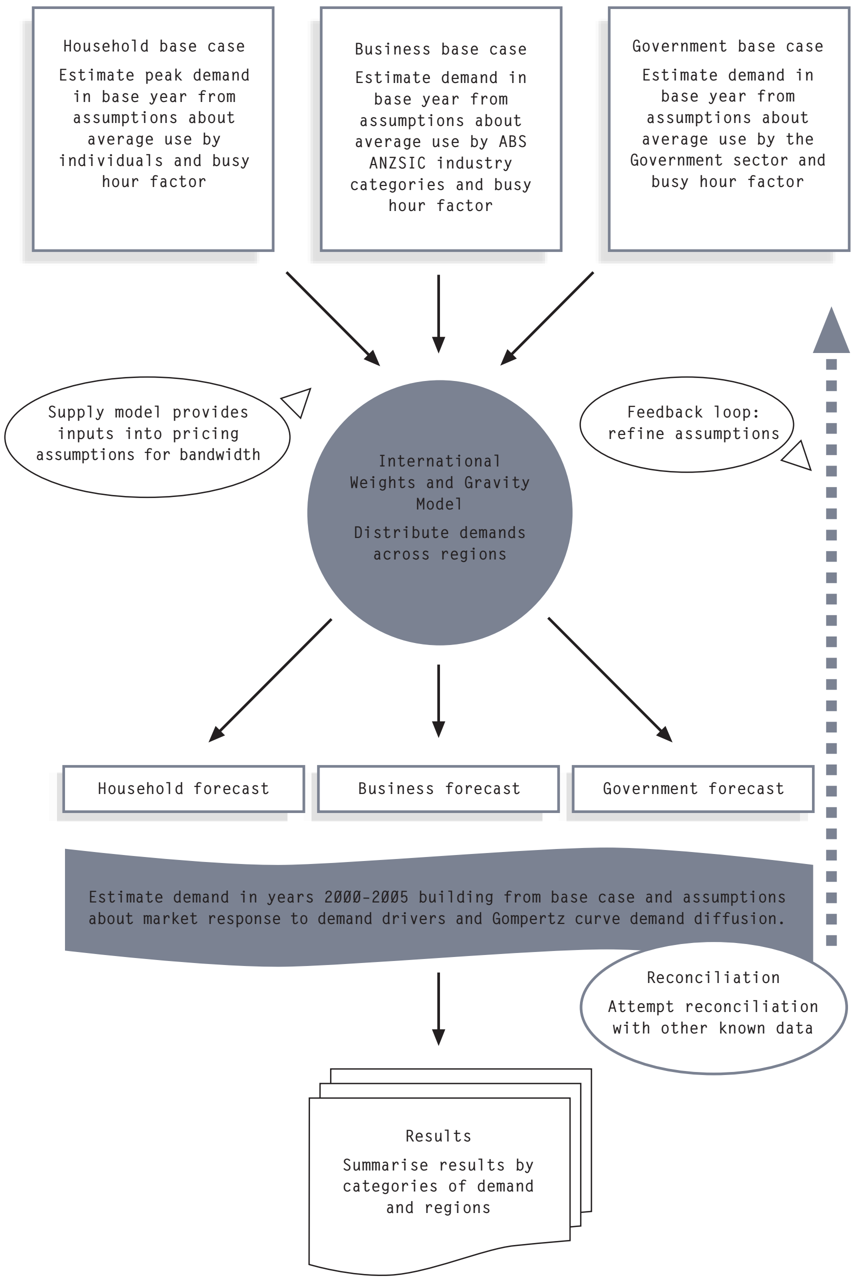
A flow chart of the CRU model is at figure 6.7.

37 Network Strategies, *op. cit.*, pp. i–ii.

38 Gompertz diffusion curves are described in Bureau of Transport and Communications Economics, *Work in Progress Paper No. 4 - Networked Communications Services to the Home*, 1995, p. 67 and Chow, G., *Technological Change and the Demand for Computers*, *American Economics Review*, Vol 57 (December) 1967 pp. 1117–30.

Figure 6.7

FLOW CHART OF CRU BANDWIDTH MODEL



The CERP took an econometric approach as outlined in the following excerpt from their report:

> To overcome data limitations, the forecasting methodology is based on the 'one-world model'. The one-world modelling approach assumes: the rate of Australian Internet host growth continues to mirror that of the US; the flat-rate pricing option introduced by AOL in 1996 continues to dominate in the market to 2004; a fixed relationship between hosts and the number of users; ISDN subscription is a good proxy for network reach; computer prices continue to decline at two to four per cent per half year; ISDN rates will continue to grow at between 2.5–10 per cent per half year; and megabytes per user is a reasonable Internet traffic metric.
>
> The one-world model generates Internet host growth forecasts which can be applied to Australia. A user per host factor is calculated, and applied to host forecasts to obtain the total Australian persons accessing the Internet. Intensity of use, measured by bytes per Internet user, is then estimated and multiplied by the number of Australian users to provide total Australian Internet traffic forecasts at 2004.
>
> Another major component of bandwidth demand is PSTN traffic. A time-series model is used to forecast local, long-distance, mobile and international PSTN traffic. PSTN traffic forecasts are converted from minutes to bits per second and aggregated to obtain Australia-wide demand for PSTN traffic. These projections are summed with Internet traffic projections to obtain bandwidth demand from 1999 to 2004.[39]

The particular difficulty with constructing forecasts using an econometric approach in this instance, is that there is no history of bandwidth demands upon which to build a relationship with demand drivers. Relationships with underlying drivers are highly fluid and are likely to remain so for some time to come, as new technologies are invented, are brought to the market place, and as consumers and businesses learn and become accustomed to what can be done with them. Therefore, all of the models incorporate, out of necessity, a high degree of judgement as to how demand for bandwidth is likely to unfold.

In summary, the models differ in a number of dimensions, for example in terms of how the base case is constructed, the forecasting technique and what is actually modelled, as outlined in table 6.2.

39 Communications Economics Research Program, *op. cit.* pp. 1–2.

Table 6.2

COMPARISON OF MODELS

Factors	*Network strategies*	*CRU*	*CERP*
Model type	Judgemental	Judgemental	Econometrics/ One world
Drivers	User profiles and take-up per cent	Prices of bandwidth, computers and access, incomes, cost savings, diffusion shapers	Econometric forecast of Internet hosts. Users per host used to estimate users and intensity of use used to estimate usage
Categories of end uses modelled	All except business to business file transfers (under development)	All: Internet, Circuit-switched voice, Non-Internet data, broadcasting (datacasting)	PSTN (Telephone) and Internet only
Base case	Peak demands 1998: 224 Gbps 1999: 252 Gbps	Peak demands 1999: 300 Gbps	Average demands June 1999: 155 Gbps
Diffusion method/ forecasting technique	Interpolated from estimates in 1998, 2002 and 2005	Constant elasticity demand relationship and Gompertz curve	Econometric forecast using log-linear demand relationship with constant elasticities. Linear trend for PSTN traffic
Busy hour/ network dimensioning	Number of simultaneous users in busy hour	Peak to aggregate usage factor	Annual traffic in bits is divided by 31 536 000 seconds to calculate average bits per second
Scenarios	Optimistic, likely, pessimistic	Optimistic, mid-range, pessimistic	High, medium, low scenarios for growth in users and intensity of use
Sectors modelled	Households and ANZSIC industry classes including govt. administration and defence X small, medium and large businesses	Households, government and ANZSIC industry classes	Total Australia
Regions modelled	By locations: Australia, States, capitals and generic cities	Point to point: international, inter-capital, intra-capital, inter-regional, remote to everything else, and intra-regional & intra-remote	Australian States and Territories by metropolitan, provincial and remote

6.5 internationalisation effects

The Internet (and the World Wide Web as a subset of it) has enormous implications for international trade. It represents both an opportunity and a threat to Australian businesses. It is also likely to have a significant impact on the demand for bandwidth. This aspect has not been specifically taken up in the models, however, it is implicit in the judgemental models which consider the take-up of e-commerce in various industry sectors.

6.6 other estimates

In addition to the modelled estimates shown above, Ovum, in the context of their pricing consultancy (see chapter 7), estimated that overall demand for bandwidth was growing by 30 to 60 per cent annually, primarily in and between capital cities. They estimated that wholesale bandwidth prices in capital city and thick route markets would decline by 30-50 per cent over the five year period.

Applied to the Network Strategies 1999 estimate of 252 Gbps peak usage at the 30 per cent growth rate, this would generate a 2004 peak demand of 936 Gbps and 2 642 Gbps at the 60 per cent growth rate level (that is, just under four fold and just over ten fold growth respectively).

For growth of these magnitudes to be feasible, several related things need to occur. First, the substantial falls in capital city and inter-capital market prices projected by Ovum would need to occur (with some of the benefits flowing through to retail market prices). Second, there would need to be faster adoption, and demand for, broadband applications. On this point, a recent report from Merrill Lynch listed what it saw as the top ten *rich media* applications that would develop:

- pure video on demand;
- e-commerce, notably goods, travel, share dealing and event booking;
- email;
- music, pay per view and downloading;
- interactive advertising;
- games;

- gaming;
- information like listings and directories;
- e-banking; and
- news.[40]

Third, existing bandwidth *chokepoints* like the local loop will need to be at least partially relieved.

40 Blackley, N., Sullivan, P., *Broadband Interactive Services*, Merrill Lynch, July 1999. While email is not *per se* a broadband application there is a growing tendency to use it as essentially a file transfer device with attachments ranging from modest documents to video clips of many megabytes.

chapter 7

PRICING ISSUES

Forecast changes to price in 1999-2004 are:

- reductions of 30-50 per cent per annum in the price of wholesale bandwidth, being most significant on intra-capital, inter-capital and other thick route markets, with a flow on effect to high bandwidth services; and
- future data pricing models are likely to be less distance and time dependent, however areas without competition may not receive the full benefits of reduced costs.
- regional pricing disparities are likely to widen due to lack of competition, although customers in rural areas served by thin routes could gain the benefits of reduced prices by fostering demand aggregation and using it to attract service providers with alternative delivery technologies.

Australian prices for leased lines and switched data services are generally higher than prices for comparable services in the US and Europe:

- although, there is some variance depending on capacity and distance.

Major influences on price trends are underlying cost structures and the levels of competitive pressure in the market.

7.1 introduction

This chapter examines how Australian prices for bandwidth compare to some other countries, how prices may change over the period 1999 to 2004, and the main influences on price trends.

The terms of reference call for the Inquiry to report on the:

- constraints, if any, which exist on the ability of the Australian telecommunications network to meet the likely demand of an Australian information economy, including analysing pricing for key high bandwidth services, including existing pricing structures, trends, and the benchmarking of current prices in Australia against those in comparable markets overseas; and
- drivers of demand for bandwidth in a present and future Australian information economy, including the likely takeup of these applications within the timeframe outlined above, including an indication of the likely price sensitivity of the potential markets for these applications.

To assist the Inquiry address these issues a consultant was contracted to analyse and report on likely trends and issues for the pricing of bandwidth over the next five years, and to explore the influence on future trends by a range of factors including geographic location, access to technology, the rate of investment in infrastructure, underlying cost structures and levels of competitive pressures in the market.[1] A literature search has also been undertaken by the Inquiry.

Unless indicated to the contrary the forecasts and modelling in the rest of this chapter draw on the work undertaken by Ovum.

7.2 future trends — elasticity, price movements and structures 1999-2004

7.2.1 TRENDS IN PRICE ELASTICITY OF DEMAND

Chapter 6 identified and modelled the likely drivers of demand for bandwidth. The demand growth projections depend on expected price movements. The relationship between demand and prices is known as the price elasticity of demand. This measures the per cent by which the demand for a service changes in response to a one per cent change in price.

1 Ovum, 1999 (a), *op. cit*.

Although it is generally accepted that reduced bandwidth prices will stimulate demand, it is impossible to accurately predict when, where and by how much this will occur. Empirical evidence on the elasticity of demand for bandwidth is equivocal, as seen by contradictory results from different overseas studies and carrier surveys.[2] Evidence at this stage is anecdotal, rather than statistical.

The market for bandwidth is believed, by one overseas carrier, to be more elastic in the wholesale sector than in the retail sector.[3]

7.2.2 FORECAST PRICE MOVEMENTS – METHODOLOGY

Noting the difficulties posed by the use of deterministic models of supply and demand to forecast bandwidth prices, the consultants have constructed a model on the basis that price in any geographic market will reflect cost plus a margin, which in turn are functions of technology and competitive effects. The consultants sought industry views on the extent of cost reductions resulting from technological developments. The cost reductions were converted to price reductions as a function of competition and market effects.

A forecasting model of route characteristics and scenarios was constructed based on the identification of the scenarios best describing that market at the beginning and at the end of the period. The scenarios range from:

- high costs and low competitive effects, producing high prices in the *traditional PTT*;
- low costs and low competitive effects, producing medium prices in the *exclusive club*; and
- low costs and high competitive effects producing low prices in c*onsumer heaven*.

7.2.3 FORECAST PRICE MOVEMENTS – ROUTE CHARACTERISTICS AND SCENARIOS

The model at table 7.1 suggests that wholesale bandwidth prices will fall in all market scenarios over the next five years. The largest price reductions are in the order of 82–87 per cent and are spread across major and minor inter-capital, major and minor regional, CBD to metropolitan, intra-CBD and metropolitan to

2 *Ibid*, p. 35. Research by British Telecom supported the case for elasticity, whereas a study by the US Federal Communications Commission did not.

3 Young, S., Flanigan, B., 1999, *op. cit.*, p. 237.

metropolitan routes. Similar price reductions are predicted on international routes from Australia to Japan, US and New Zealand respectively. Market outcomes are also expected to improve over five years in these high demand, international and domestic routes, reflecting low cost and high competitive effects.

In contrast, prices for remote routes such as Broken Hill to Whyalla and minor regional routes such as Townsville to Cairns are forecast to fall between 69 and 80 per cent over the five year period. Only remote routes will be adversely affected by de-averaging and are likely to see the rate of decrease get smaller, from 76 to 69 per cent. This is due to the predicted lack of competition on these routes.

7.2.4 PRICE MOVEMENT FORECASTS 1999-2000

7.2.4.1 domestic prices for bandwidth

Wholesale prices have fallen by around 30–50 per cent over the past year on major inter-capital routes. This rate of decrease is likely to continue for each year of the next five years. Prices of bandwidth should fall faster in high demand, low cost areas due to the effect of competition. Regional pricing disparities are likely to widen, although customers in rural areas served by thinner routes may be able to reduce prices by fostering demand aggregation and using it to attract service providers with alternative delivery technologies.

Retail prices for a range of bandwidth using applications are considered to be 30–50 per cent above those for equivalent services in Europe and the US. These differences are expected to decrease over the period, as bandwidth costs as a proportion of total service cost should reduce. However a decrease compared to other countries will only occur if the bandwidth prices in Australia fall by more than the other countries.

7.2.4.2 international bandwidth prices

International prices are expected to fall by 50 per cent per year, and to continue to fall by that amount for each year of the next five years. However, Australia as a long, low traffic route in global terms, could continue to be disadvantaged to some extent by distance. Strategies adopted by carriers to offset this include the establishment of Internet exchange operations in locations selected to improve peering leverage, mirroring and caching.

Table 7.1

ROUTE CHARACTERISTICS AND SCENARIOS

Route characteristics	*Examples*	*Current scenario*	*Forecast scenario after 5 years*	*Price change (%)*	*Route thickness*[(a)]	*Factor and revised index 5 yr*[(a)] *(%)*	*Amended price change*[(a)] *(%)*
Major inter-capital	Sydney to Melbourne	Exclusive club(W)	Consumer heaven(M)	-82	Very thick	-30(M)	-87
Minor inter-capital	Perth to Darwin	Traditional PTT(W)	Exclusive club(W)	-84	-	0(W)	-84
Major regional	Melbourne to Geelong	Exclusive club(W)	Consumer heaven(W)	-81	Fairly thick	-20(W)	-85
Medium regional	Hobart to Launceston	Traditional PTT(W)	Exclusive club(M)	-84	Mod. thin	+10(M)	-82
Minor regional	Townsville to Cairns	Exclusive club(W)	Exclusive club(S)	-77	Mod. thick	-10(S)	-80
Remote	Broken Hill to Whyalla	Traditional PTT(W)	Traditional PTT(W)	-76	Very thin	+30(W)	-69
Intra CBD	Melbourne CBD to Melbourne CBD	Exclusive club(S)	Consumer heaven(M)	-81	Very thick	-30(M)	-87
CBD to metro	Sydney to Chatswood	Exclusive club(W)	Consumer heaven(W)	-81	Fairly thick	-20(W)	-85
Metro to metro	Parramatta to Ryde	Exclusive club(W)	Consumer heaven(W)	-81	Mod. thick	-10(W)	-83
International A	Australia to NZ	Traditional PTT(W)	Exclusive club(W)	-84	Fairly thick	-20(W)	-87
International B	Australia to Japan	Exclusive club(S)	Consumer heaven(M)	-81	Fairly thick	-20(M)	-85
International C	Australia to US	Exclusive club(S)	Consumer heaven(M)	-81	Very thick	-30(M)	-87

Notes: (a) Amended for price de-averaging; S = strong; M = medium; W = weak in each scenario category.

Source: Ovum Pty Ltd. *Future Pricing Trends for Bandwidth*, August 1999, p. 45.

7.2.4.3 regional price disparities

Disparities between the price of wholesale bandwidth on high and low traffic routes are expected to increase, even though customers on both routes should benefit from price reductions arising from reduced technology costs. Full cost reductions are unlikely to be available in regional areas as long as competition continues to be minimal.

7.2.4.4 negotiated prices

Negotiated prices based on applications and specific customer network configurations are expected to become increasingly common in the corporate and government sector. Negotiated prices could pose problems for smaller organisations that do not have the negotiating skills and/or the economies to obtain deep discounts.

7.2.4.5 impact of bandwidth market complexities

The market for bandwidth is becoming more complex. A range of prices can therefore coexist at any given time or place for services offering similar bandwidth. A trend towards trial and error pricing has arisen from the imperfect view of the wholesale market held by most participants. This trend is likely to continue.

7.2.4.6 price de-averaging trends

There is likely to be a move away from uniform, averaged, distance dependent pricing structures in the future. Price de-averaging is discussed elsewhere in this report.

7.2.5 PRICE STRUCTURE FORECASTS 1999-2000

7.2.5.1 wholesale market – alternative funding

As bandwidth becomes a commodity, service differentiation and *financial engineering* will become more common, enabling carriers to gain competitive advantage.[4] A greater range of contract terms and payment options is already available:

- including rental, lease, indefeasible rights of use contracts (previously used exclusively by international cable consortia), and futures contracts and options;

4 *Ibid*, p. 253.

- including pre-sale, lump sum, fixed and declining payments; and
- non-price funding structures including fibre swaps and service exchange agreements (such as undertaking billing and maintenance in exchange for capacity).

However, compared with retail markets, the commodity market provides fewer opportunities to trade equivalent value, and therefore non-price settlement is less common. Many of these alternatives have yet to develop in the Australian market.

Indefeasible Rights of Use (IRUs) are the most common way to control bandwidth on international submarine cables. IRUs are attractive to investors in infrastructure because they enable the recovery of set-up costs within a short time period and relieve the cable investor or owner of responsibility for running costs. In turn, IRU holders acquire the right to use the cable until the end of its life (about 25 years), and effectively act as owners of a portion of bandwidth.

The New Business Tax System (Capital Allowances) Bill (the Bill) contains provisions which specify that IRU holders may claim a tax depreciation deduction on the acquisition of an IRU. These provisions are consistent with overseas practice and have been welcomed by the telecommunications industry. The Inquiry also welcomes these provisions which will increase incentives for investment in telecommunications infrastructure.

While, historically, IRUs have only been used in relation to international cable systems, they are increasingly being applied overseas to domestic cables and there is some evidence in Australia of private infrastructure investors looking to utilise the IRU approach domestically. The Inquiry notes, however, that the provisions in the Bill relate only to "international telecommunications submarine cable systems".

Just as it had for international cables, the lack of a tax depreciation write-off may adversely impact on the growing interest in IRUs for domestic cable systems and may stymie potential new infrastructure investment models in Australia. There appears to be no reason for differential treatment of international and domestic IRU arrangements. The Inquiry considers, therefore, that a consistent approach to the tax treatment of IRUs be applied to both domestic cable systems and international cable systems.

7.2.5.2 retail markets — alternative funding and price relativities

As discussed in chapter 2, the convergence of the Internet and telecommunications industries will impact significantly on cost structures, especially in retail markets. The merging of data and voice on IP based networks over the next ten years will remove the justification for differential pricing arrangements for voice and data. Service provision is also both converging and expanding rapidly as a result of competition and deregulation—telecommunications carriers are moving into the provision of Internet and broadcasting services, and Internet and data providers are offering voice services traditionally provided by carriers and broadcasting services.

The complex dynamics of retail value added markets is seen in the development of new price structures, which reflect changes to pricing relativities between usage, connection and rental.[5] New pricing models are developing such as:

- flat rate pricing, where connection costs become a greater proportion of the total cost. This model is growing in popularity with consumers, but has the potential to cause congestion, which may in turn create a higher cost premium service that minimises the effect of congestion;
- pricing for *indigestion*, which is a variation of the flat rate model in which usage costs based on bits per second are introduced with a premium on peak times; and
- priority scheduling pricing and realtime pricing, which are full usage models.

There are clear anomalies between wholesale and retail market pricing practices. Wholesale pricing is traffic and usage based (bits per second traffic), while retail markets use both usage and flat rate models. These anomalies stem from:

- cost based pricing practices, which are far more widespread in the wholesale market, due to the effects of competition;
- the free Internet legacy, which is a strong influence on consumer attitudes;
- price controls at the retail level; and
- the inadequacy of existing telephony billing and customer support systems in that they are large, complex and rigid. The migration to flexible, scalable and responsive IP compatible systems involves a high level of investment, and will be gradual.

5 Fixed charges are the prices for connection to the network and rental of a line to a local exchange. Usage charges are the prices for local, long distance and international calls.

7.3 current prices for high bandwidth services in Australia compared to those overseas

7.3.1 METHODOLOGY

Current domestic telecommunications prices for a range of high bandwidth services were compared to similar services in overseas countries. The services selected include digital leased lines and switched data services (frame relay and ATM). Their prices are compared at various bandwidths, over various distances, between Australia (Telstra), US, United Kingdom and selected European countries, and between different regions within Australia.

Case studies were compiled from interviews with a carrier, a large corporate national user, a regional utility and a government department.

Any price comparison analysis is inevitably qualified by negotiated prices and by the complexities of the bandwidth market generally. These influences on price trends are discussed earlier in the chapter. Data sources available for analysis are largely confined to published or list prices. In practice, actual market pricing varies because of negotiation between carriers and business customers over price and other conditions.

For example, a national large corporate user interviewed by the consultant noted that 'in relation to leased services it pays less than 50 per cent of the rates outlined in the Telstra Standard Form of Agreement'.[6] Similar considerations apply to overseas list prices which can also be deeply discounted.

Different network configurations can also distort price comparisons because of differences in underlying cost structures, as can different ways of bundling the services sold. Different market conditions can also have an impact on prices.

7.3.2 CURRENT PRICE LEVELS IN AUSTRALIA AND INTERNATIONAL COMPARISONS

The consultants found that current Australian digital leased line prices are competitive with some European prices in some price and bandwidth ranges although European prices appear to be quite variable. US prices tend to be significantly lower than Telstra's prices.

6 Ovum *op. cit.*, p. 53.

Current Australian frame relay prices are about double comparable US prices at lower bandwidths (to 128 Kbps) and more than double at higher bandwidth. Within Australia, significant variations exist between the prices of service providers and in their relative competitiveness over different bandwidths.

Australian (Telstra) ATM prices are also significantly higher than United Kingdom (BT) prices although less distance sensitive. BT's prices are approximately 30–50 per cent of Telstra's at lower access speeds (512 Kbps to 1 Mbps) and less at higher speeds (34 Mbps).

Recent benchmarking pricing studies by the Productivity Commission and the OECD[7] show that:

- for *national leased line charges* (64 Kbps and 1.5/2.0 Mbps) Australia ranked in the middle of 30 countries in a basket constructed by the OECD in August 1998; and
- for *business digital mobile services* Australia ranked equally with the US, Finland, Sweden and Canada in a Productivity Commission price index comparison over nine countries.

7.3.3 PRICE REDUCTIONS IN THE CENTRAL BUSINESS DISTRICT AND MAJOR INTER-CAPITAL ROUTES

Infrastructure based competition has contributed to the development of a wholesale market for bandwidth services between carriers and service providers in the CBDs and major inter-capital routes leading to substantial price reductions in these markets.

Prices for wholesale two Mbps services are estimated to have fallen by about 60 per cent on the Melbourne, Canberra, Sydney, Brisbane route over the past eighteen months. There will soon be four operators (Telstra, Optus, Macrocom and PowerTel) competing on this route.

In the profitable CBD areas, corporate data traffic has provided a strong incentive for operators to install their own access infrastructure into major buildings. It is estimated that up to eight infrastructure providers have installed fibre optic rings in the Sydney and Melbourne CBDs.

7 OECD, *Communications Outlook*, Paris 1999 (b), p188; Productivity Commission, *International Benchmarking of Australian Telecommunications Services*, Research Report, March 1999, p. 149.

In contrast, there has been a far smaller reduction in wholesale prices on other inter-capital routes, such as Melbourne to Perth, which currently supports only two operators.

7.3.4 PRICING ON REGIONAL ROUTES

The absence of competition on most regional routes in Australia has meant that price reductions have been correspondingly low. In addition, the underlying cost structures influencing prices on regional routes are affected by both distance and amount of traffic carried. In the absence of competition the main determinant for wholesale bandwidth prices is the telecommunications access regime, which is discussed further in chapter 9.

The consultants concluded that US and European prices are comparatively less dependent on distance and traffic, although BT's (United Kingdom) prices for ATM were more distance dependent than Telstra's.

7.3.5 INTERNATIONAL PRICES

The level of competition on international routes is increasing due to the broad participation of Australian carriers in cable consortia such as Southern Cross. Also, although individual satellites have significantly less capacity than cable, there are a number with footprints over Australia. However, the volume of traffic and number of operators means international bandwidth into Australia is unlikely to become as competitive as the North Atlantic and even North Pacific routes.

7.4 major influences on price trends

There are a number of different forces driving changes to current pricing trends and structures. Ultimately however all of these pricing factors are dependent on underlying cost structures and the levels of competitive pressure in the market. Government and regulatory policy, the impact of historical factors on domestic pricing trends, including competition, and the development of wholesale markets, are explored elsewhere in this report.

7.4.1 CHANGING COST STRUCTURES AND TECHNOLOGICAL INNOVATION

The increase in data traffic, combined with the digitisation of communications networks has been accompanied by a trend towards variable path packet switching, from fixed path circuit switching. Transmission technologies such as DWDM are unleashing a massive increase in capacity on optical fibre links. These technologies are causing the costs of providing bandwidth transmission service per unit of bandwidth to decrease dramatically. The cost of bandwidth transmission has fallen at an average of 30 per cent per annum for the past 25 years, and costs are expected to continue to fall at this rate. Due to economies of scale, these effects are accentuated on routes carrying higher traffic.

The costs of data traffic switching and routing are also falling although at slower rates than transmission. The move to IP packet switching provides a significant compression factor for digital voice, creating a more efficient use of network infrastructure. ATM switching technology is also being deployed widely in many trunk networks. This involves a significant capital cost, but provides a high level of flexibility to the network operator to tailor services more closely to the customer's requirements.

The falling real costs in provision of wholesale bandwidth resulting from technological innovation are reflected in the strong downward pressure on price in competitive wholesale markets, as discussed in the previous section.

7.4.2 COMPETITION, REGULATION AND GOVERNMENT POLICY

While underlying cost and customer expectations influence price, the full impact is determined by the level of competition in the market. Where competition is effective, cost reductions will be passed on to customers as suppliers vie to service customers.

Competition effects can also be simulated through regulation such as access arrangements and price caps. However, in the longer term these mechanisms can also hinder the introduction of competition.

7.5 implications

The uneven impact of competition on pricing has led to the development of differing prices for bandwidth throughout Australia. Higher prices, particularly in regional areas, are a potential constraint on the ability of people in those areas gaining the full benefits of the information economy. These issues are further discussed in chapters 9 and 13.

chapter 8

COSTS

The costs of a basic Brisbane, Sydney, Melbourne, Adelaide optical fibre data network with CBD rings in each capital would be in the order of $300 million.

This cost is based on a network design model taking into account typical values for major network cost components, but excluding the costs for significant inter-capital redundancy (meshing), telephony switching and customer access.

8.1 introduction

The preceding chapters have examined supply, demand and pricing issues in order to arrive at broad conclusions about bandwidth availability both now and over the time-frame of this Inquiry. The present chapter attempts to assess the costs of installing a new optical fibre network with inter-capital and capital city components. It is based on a report prepared for DOCITA as part of the present Inquiry.[1]

Two caveats need to be set in place at the outset. Firstly, the hypothetical networks developed here for the purposes of analysis are not operational in the sense of providing end to end customer connections and do not in that respect provide fully costed network services. Nonetheless it does throw some light on what a *dark fibre* network might cost to build and some feel for the distribution of costs amongst the different network components. The second qualification concerns the relationship between costs and prices. While declining costs will tend to be reflected in prices in a fully competitive market in the longer term, structural issues and historical effects can to some extent reduce the capacity for competitive pricing outcomes to occur.

8.2 scope

The hypothetical networks discussed below cover an:

- inter-capital network between Brisbane, Sydney, Melbourne and Adelaide; and
- intra-city network within Sydney between Chatswood, Crows Nest, North Sydney, the Sydney CBD and Parramatta.

8.3 general network model

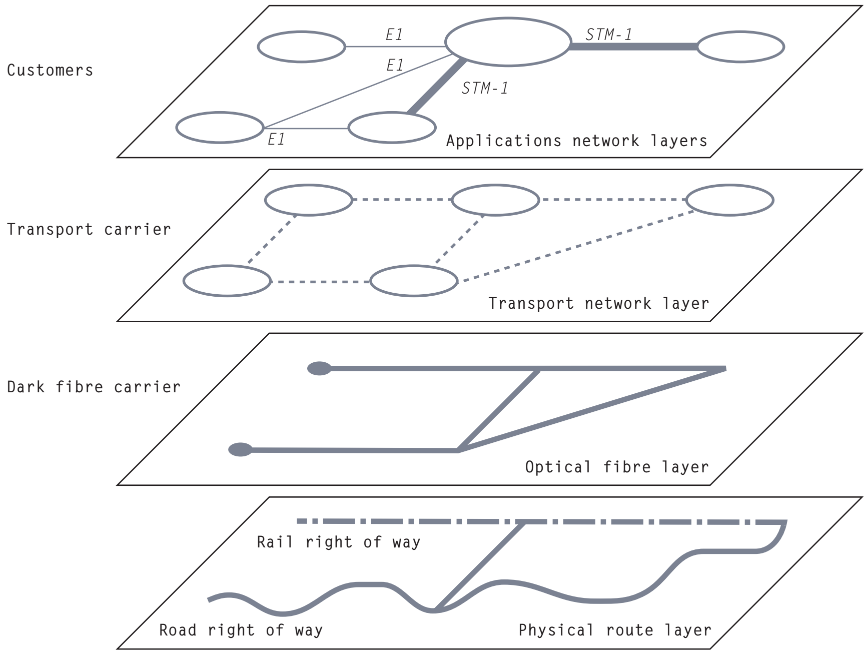
Figure 8.1 presents a layered network model which shows the major elements of optical fibre networks in terms of basic infrastructure and added higher layer service capabilities. This layered network model applies to national trunk networks as well as intra-city networks and global networks.

1 Consultel, 1999, *Cost estimates—network construction*.

Basically, each layer is separate and can be developed in isolation from the others. Carriers, large corporate customers or groups of similar users can alternatively build or lease capacity in each layer to develop the level of network appropriate to their business plan. In some cases, such as service resellers, they may lease all layers and provide a management component. Others may just provide higher layer service switching and lease wholesale network resources as available from the network, while still others (*carriers' carriers*) may concentrate on providing low layer infrastructure.

The bottom layer (sometimes called the real estate layer) covers the establishment of physical routes and sites for building a network and the next layer includes fibre installations. The fibre would need to include simple regeneration capability along the trunk links. This would in turn require sites and accommodation facilities. A limited end node capability would also be required to provide access to the fibres.

Figure 8.1
LAYERED NETWORK MODEL



These two layers establish a basic, dark fibre physical *network*. The third layer is where network intelligence and control are added which then enables the network to be made into a real managed and dynamic network. It involves the establishment of network nodes with multiplex equipment and management systems. This enables the delivery of basic managed leased point-to-point or *non switched* services including a managed dark fibre service and a range of fixed bit rate services. This is sometimes called a *carriers' carrier* network.

Both ATM and TCP/IP switches can be interconnected directly on a point-to-point basis using dark fibre without SDH transport or network bandwidth management functions. Such networks can perform the transport functions of SDH and, although lacking the operation and management functions of SDH, can provide services such as virtual private networks and point-to-point leases. Developments such as this blur some of the distinctions between carriers, service providers and users. This is currently a significant strategic issue in carrier network development.

Connections could be made to wholesale or retail customer networks in major cities by:

- broadband digital microwave radio relay systems; or
- dedicated local optical fibres.

The cost of extending access to a customer's network obviously depends on the relative locations. The study is only meaningful if the dark fibre or higher layer services derived from our networks are offered to multiple customers. Therefore, we have assumed that whatever the variable cost of providing reticulation of one or more fibres to each customer, it is separate from, and additional to, the cost of provision of the shared core network infrastructure required, and would give rise to a separate customer access charge.

There are no technical reasons why a network should stop at any particular layer. The major licensed carriers aim at full layer networking, while new players are largely limited to the higher layers, at least initially, primarily due to the lead time and high capital cost of physical infrastructure.

8.4 design and cost components

The major components of a fibre cable network project, both for national trunk networks and local intra-city networks are:

- regulatory and business aspects;
- network architecture;
- project management and design;
- route selection and approval aspects;
- fibre cable type, size and fibre count;
- cable installation procedures under various situations;
- node site location, size, selection, purchase and development for city nodes and inter-city repeaters;
- node equipment types and capacities, both optical and electrical;
- operation, administration and maintenance (OA&M) aspects;
- other service layers (ATM, TCP/IP); and
- customer access.

8.4.1 REGULATORY AND BUSINESS

Regulatory and business aspects have a critical influence on feasibility and cost for establishing and operating such networks. In particular, rules governing infrastructure installation, rights of way, use of existing facilities (e.g. Telstra conduits), are in general all covered by regulations. In particular, the reduced legal authority of licensed carriers in respect of access for rollout purposes and rights of way since deregulation, and the increased interest of state and local government in environmental matters, have in recent years significantly increased the time required for, and hence the cost of, establishing networks.

Many of the concepts used in this study reflect typical carrier business case analysis for new developments. The assumptions depend on many business factors, including market position, range of products or services, tariffs and strategic goals of the carrier developing the network. A new carrier with no existing services and tariffs to protect may take different design and construction decisions from an established player. Size and capital budget capabilities of the carrier building the new network are also key factors in determining any development strategy.

8.4.2 NETWORK ARCHITECTURE

Recent developments such as ATM and IP services, especially IP telephony, are impacting upon both carriers' current markets and network architectures as they are increasingly enabling customers to integrate many services in one physical bearer to a carrier. Service identification for charging and maintenance is becoming less easy and less important in this integrated customer interface.

Network architecture in terms of node types, network equipment, connectivity, diversity and redundancy will impact overall costs as well as service capabilities which will in turn influence route selection, link and node designs and site selection. The degree of redundancy and diversity and any decision to adopt a ring structure will significantly improve service performance while significantly increasing costs. Again, these are business decisions and assumptions are required in these areas.

The network architecture presented here is a simple non-diverse linear single path trunk network which provides no diversity and therefore offers no service restoration in the event of a major route failure. To offer reliability similar to existing carrier services on a competitive commercial basis, restoration paths would be required.

8.4.3 PROJECT MANAGEMENT AND DESIGN

Once a general business and network architecture strategy has been decided, detailed design and project management procedures are then initiated involving the establishment of systems engineering design and project management teams for planning and budgeting. These project resources are then used to design, specify, procure, develop and install the network. The detailed composition of this team would depend on the rollout strategy and overall business schedule, but would typically involve a number of highly skilled resources, including high level design engineers, project managers and construction managers.

The costs for project management and design would depend on the project rollout strategy, however it constitutes a fixed overhead cost which is generally proportional to the duration of the project. An estimate of 20 high level professional specialist resources averaging $100 000 per annum gives $2 million for a one year project. These costs are a relatively small component of overall

costs and, in the case where higher layer services are provided, are assumed to be shared equally between the physical fibre network installation and the transport and higher layer network installation.

8.4.4 ROUTE SELECTION

Route selection includes all aspects associated with selecting and obtaining approvals for the preferred cable routes. The selection of a particular route can significantly influence design, installation and length and hence overall costs of a cable project.

The effect of the numerous terrain considerations and authorities concerned makes it impossible to precisely quantify cost in a desk study such as this, but reasonable assumptions can be made on the basis of industry experience. The key parameter is the length of routes, which are variables in the cost tables. The main cost risk factors here are direct costs and delay-related costs associated with obtaining rights of way, including long leases for property access.

8.4.5 OPTICAL FIBRE CABLE SELECTION

Fibre cables are available in many sizes and types. The selection of cable size and type depends on business strategy, demand forecasts, network architecture, type of installation and many other factors. The cable selection decisions are a complex mix of business analysis and network design. In general, cable sizes being used for networks are increasing, driven by the rapidly increasing and uncertain demand for bandwidth, and reflecting the low marginal cost of additional fibres.

Cable types will depend on the installation method. For aerial installation, special self-supporting non-metallic cable is required, while for other situations standard outdoor cable would generally be sufficient but in some limited situations special protected cable types may be required. These all impact cost but to a lesser extent than other factors such as cable capacity.

Cable sizes are usually provided in modular quantities, typically in bundles of 12 fibres. Typical fibre counts are 12, 24, 36, 48, 60, 72, 90, 120, 240. Some of these are special sizes for select customers and may not be generally available. There are trends by suppliers to limit the range of sizes available to reduce

inventory, however, most large cable requirements are manufactured to order and this is not a restriction. There are also trends by large carriers to limit the range of cable sizes to reduce overhead costs and simplify installation practices.

The most significant aspect of fibre cable pricing is the size of the order or the size of the customer. For small orders from occasional customers, the costs are significantly higher than for large orders (say thousands of kms per month) from large buyers such as Telstra. The estimates for the sample network are based on the lower bulk order prices, as this network is likely to justify such prices.

While 24 and 36 core cables used to be the norm in intra-city links, the trend is now to larger cables and fibre counts of 60 and 120 fibres or more are being used for metropolitan and even suburban installations. Cable capacities in these situations may have an element of dark fibre capacity for use in customer service provision but are unlikely to have any allowance for wholesale provision of dark fibres to other service providers.

For national long distance routes, 12, 24 fibre cables are used and 36 fibre cable is used in some cases if an omnibus, that is a country town add and drop, network is being established.[2] Even higher fibre counts (48 fibre) may be used on some sections of long distance routes.

Existing inter-capital trunk networks and most intra-city networks are not sized to provide for any real volume of spare fibre for resale to others as *dark fibre* service capability. In the context of this study, the figure of 120 fibres for networks intended for dark fibre resale is reasonable and has been adopted.

8.4.6 CABLE INSTALLATION

There are many different types of cable installation techniques. The most appropriate for a given situation will depend on many factors, including terrain, regulatory and environmental considerations. The type of installation technique and the configuration of the corresponding installation team will have a major impact on construction costs.

2 In this context an *omnibus* network is one that has a connection to every town along the fibre cable route where traffic is *added in* or *dropped off*. The alternative is a cable which only connects the end points without stopping at the intermediate towns along the way.

Choice of installation method and run lengths of different methods cannot be determined in a desk study of a conceptual network.

The costs for shorter distance metropolitan and urban cable installation are typically much higher than for long distance rural cable installation.

In metropolitan and suburban installation, intensive trenching or directional boring and conduit installation are usually required. In addition, expensive reinstatement is often necessary and restrictions on installation practices also increase costs and working hours are also usually restricted to non-business hours. The initial construction work for conduit installation is then followed by a second fibre installation process and these two stages significantly increase costs. Particular variability is caused in urban situations by approval delays, construction co-ordination requirements with municipal teams, and the physical presence of infrastructure belonging to multiple utilities.

While city installation costs are estimated as high as $750 per metre, the average for the intra-city network has been estimated at $309, based on the likely proportion of each type of installation required for all runs. In rural installation, direct burial using heavy equipment and existing service corridor rights of way provides the lowest cost. This installation can also usually be carried out in continuous shifts to reduce equipment usage costs. If directional boring is required to bypass roads or other obstacles and if rock cutting and excavation is required, these factors significantly increase costs of rural installation. Estimates of each type of installation methodology are used in deriving an overall average installation costs figure which is used in the network costing model.

Cable installation costs typically range from a low of perhaps $5 to $10 per metre for open, flat and easily ploughed land to $500 per metre or more if complex, costly, slow and labour-intensive installation methods are involved. These costs are a variable in the model and the overall cost impact of changes in these cost components can be evaluated. In each case they are a major factor of the overall cost of network construction.

8.4.7 SITE SELECTION

Site aspects include definition of the various site types, ranging from major city nodes for termination of national network links, to other city nodes and repeater nodes on the long distance routes. Site selection, purchase or lease, building

type, support services and fit-out, need to be addressed. As CBD costs are high, city site selection will have a significant impact on overall costs. Site sharing with other network facilities will therefore be beneficial and dominant carriers or other facility companies have an advantage.

The decision to buy or lease would be a business decision. If sites are to be leased and site costs are lease costs, a capitalised cost could be based on, say, a ten-year lease. As locations impact on customer access and cable installation costs, site selection is also influenced by customer location and this is part of the business decision process. Where a trunk network city site in Sydney is used for a city network node, cost savings are identified. These costs are not a major component of the overall network capital cost but can be a significant recurrent cost.

8.4.8 TRANSMISSION NETWORK EQUIPMENT

For dark fibre management, optical fibre break-out trays are required as a means of physically securing and accessing individual fibres. Where terminating equipment is required, equipment may include opto-electronic modulation and multiplexing. Optical fibre cable regenerators are also required at regular distances.

The multiplexing technology commonly utilised for transport network equipment is SDH. This equipment has both electrical and optical interfaces for lower bit rates. Direct fibre connections are widely used to support bit rates from 155 Mbps (STM-1) up to 10 Gbps (STM-64). These facilities require a centralised management system to provide operation and administration functions.

Even with STM-16, very large capacities (relative to current demand) are available from modest fibre counts. While STM-64 equipment is available, the current trend for trunk networks and city networks is to start with lower order STM (for example STM-16 or even STM-4) systems per fibre and increase the number of fibres used to limit the impact of faults. The SDH facilities and fibres are typically established as survivable rings.

The network model used to calculate costs is based on the use of STM-16 multiplexing as the primary stage. This is proven equipment and the costs of using it are only marginally more than say STM-4. The use of higher level multiplexing (e.g. STM-64) would be a business and growth strategy decision taking account of the potential impact of a failure on the large capacity versus the limited network cost savings.

Assumptions used for equipment sizing allow for a fill factor in equipment configuration. However, in many cases, the costs of retro-fitting additional facilities, including the costs of potential service disruption due to errors, are comparable with fully equipped costs and the usual preference is therefore to forward equip to a large extent.

For the inter-capital network, optical amplifiers are considered as part of the long distance network infrastructure and included in the fibre network costs.

8.4.9 OPERATION, ADMINISTRATION AND MAINTENANCE

OA&M functions need to be provided for completeness of overall carrier service operations. Significant costs are incurred in setting up and maintaining operational support systems to provide these capabilities. A network/facilities management system is required as part of OA&M requirements to provide the following functions:

- configuration management;
- fault management;
- restoration management;
- security management; and
- accounting management.

It may also need to interface with management systems of customers, and other carriers.

While some capital costs are involved, these are substantially less than ongoing costs of staffing and site maintenance costs. If typical market levels of service quality based on availability and support (for example a mean time to repair of less than two hours) are to be offered, a substantial national resource of staff would be required, especially for the trunk network. For the purposes of the cost model a fixed estimate of OA&M costs has been included, taking into account typical values for the various cost components.

The cost impact of OA&M is demonstrated in table 8.3 at the end of the chapter.

8.4.10 OTHER SERVICE LAYERS

The most likely additional layers to be included in the model are a PSTN/ISDN layer and an ATM and/or TCP/IP layer. The PSTN/ISDN layer requires telephone exchanges which are large and expensive to purchase, install and maintain. Moving into this service layer requires a substantial operating organisation with OA&M, planning, marketing, sales, commercial, legal and human resources, and financial operational capabilities.

Establishing ATM/IP facilities at key sites, over an SDH transport layer, could provide a more flexible service platform enabling the provision of a greater range of retail services. While most ATM services offered today are fixed bit rate virtual point-to-point leases, including virtual networks, ATM capabilities for providing *soft* switched services such as video, data and voice are becoming available.

The *soft* services mean resource sharing and statistical gains, with contention and hence delay/loss aspects involved. The use of these newer ATM capabilities is now a major business decision, not a technical one, being addressed by all players within a framework of future demand estimates on various services and cost trends. Existing carriers are also looking closely at potential threats to existing service revenue streams.

It is technically possible to establish ATM using SDH framing only, thus eliminating the cost of SDH equipment. This is being considered by existing and especially new players. The ATM (and/or IP) nodes would be directly connected together using dark fibres. While this architecture limits provision of basic STM fixed bit rate services, the market may soon accept the replacement of these by *soft* or virtual leases. They should be able to provide the same end user service capability but be cheaper, especially allowing for an ATM bandwidth gain from reduced network overheads and cost reductions due to network simplicity. In this situation the higher network layers and the transport layer merge into one and the carrier's network becomes more of a combination wholesale/retail network with many service specific capabilities being migrated to customer premises equipment or private networks.

8.4.11 CUSTOMER ACCESS

The network models in this report do not include any customer access arrangements or costs.

8.4.12 NETWORK MODELS

This section describes the basic network cost models and the major cost items of fibre cable, cable installation, node sites and node equipment. The network models were prepared to determine how these cost components may be combined and to enable cost sensitivity studies to be carried out as required. Both models can be broken down into two sub-networks:

- a physical fibre network for *dark fibre* services; and
- a transport network for managed derived (bit rate) services.

8.4.12.1 inter-capital network

The first model is a national network linking Brisbane, Sydney, Melbourne and Adelaide. A diagram of this model is presented in figure 8.2.

Figure 8.2
INTER-CAPITAL NETWORK

The estimated costs for this network are shown in table 8.1. Suitable rights of way are assumed to be available between these sites and the distances are estimates of likely route lengths and can be varied to determine the impact of route selection.

TABLE 8.1

INTER-CAPITAL NETWORK COMPONENTS AND COSTS

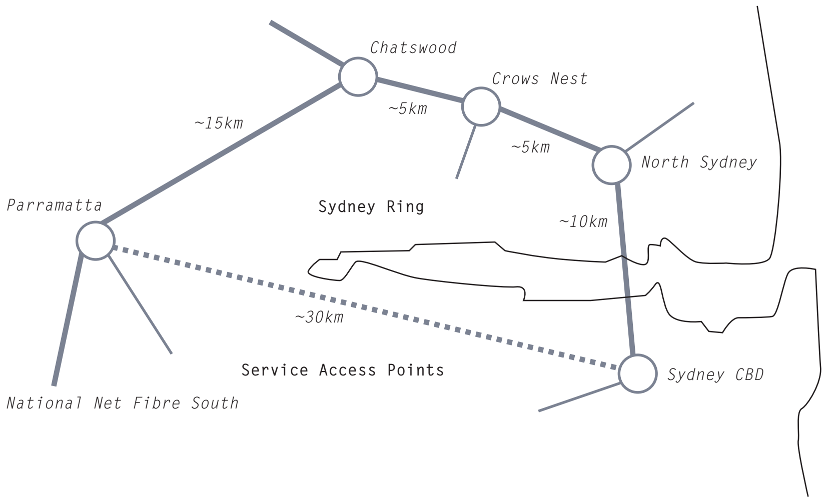
Cost components in network construction	*Per unit costs ($)*[a]	*Brisbane Sydney 1 000 kms ($000s)*	*Sydney Melbourne 900 kms ($000s)*	*Melbourne Adelaide 700 kms ($000s)*	*Total network 2 600 kms ($000s)*
Route selection	1 (per mtr)	1 000	900	700	2 600
Cable installation	30 (per mtr)	30 000	27 000	21 000	78 000
Fibre cable	30 (per mtr)	30 000	27 000	21 000	78 000
City sites	165 000 (each)	330	165	165	660
Simple regenerator sites	24 000 (each)	240	216	168	624
Splicing sites	12 (per mtr)	12 000	10 800	8 400	31 200
Optical node or end equipment	22 000 (each)	44	22	22	88
Optical regenerator sites	12 (per mtr)	12 000	10 800	8 400	31 200
City multiplexing nodes	3 650 000 (each)	7 300	3 650	3 650	14 600
Project management	1 400 000 (each)	538	485	377	1 400
Total — fibre only	-	86 152	77 388	60 232	223 772
Total — fibre plus network multiplex	-	93 722	81 280	64 070	239 072

Note: (a) Assumes a 120 fibre cable and a fill factor of 20 per cent. That is 20 per cent of the fibres in the network are equipped with regenerators and either sold as dark fibre or used for transport services in conjunction with multiplexing equipment, and the total system cost is amortised on the 20 per cent, with 80 per cent kept spare.

8.4.12.2 intra-city network

The second model is a Sydney metropolitan network linking the key Sydney sites identified. This is shown in figure 8.3.

Figure 8.3
INTRA-CITY NETWORK



The costs for this network model are shown in table 8.2. Suitable rights of way are assumed to be available between these sites. The distances are estimates of typical route lengths for short distance direct runs but can be varied to determine the impact of route selection.

Table 8.2

INTRA-CITY (SYDNEY) NETWORK COMPONENTS AND COSTS

Cost components in network construction	*Per unit costs ($)[(a)]*	*North Sydney Sydney CBD*	*Crows Nest North Sydney*	*Chatswood Crows Nest*	*Parramatta Chatswood*	*Sydney CBD Parramatta*	*Total network*
		5 kms $000s	*5 kms $000s*	*5 kms $000s*	*15 kms $000s*	*25 kms $000s*	*55 kms $000s*
Route selection	3 (per mtr)	15	15	15	45	75	165
Cable installation	300 (per mtr)	1 500	1 500	1 500	4 500	7 500	16 500
Fibre cable	30 (per mtr)	150	150	150	450	750	1 650
City sites	165 000 (each)	165	165	165	0	165	660
Splicing	84 (per mtr)	420	420	420	1 260	2 100	4 620
City fibre nodes	70 000 (each)	70	70	70	70	70	350
City multiplexing nodes	1 250 000 (each)	1 250	1 250	1 250	0	0	3 750
Project management	600 000 (each)	55	55	55	164	273	600
Total — fibre only	-	2 375	2 375	2 375	6 489	10 933	24 545
Total — fibre plus network multiplex	-	3 652	3 652	3 652	6 570	11 069	28 595

Note: (a) Assumes a 120 fibre cable and a fill factor of 20 per cent. That is 20 per cent of the fibres in the network are sold as dark fibre or used for transport services in conjunction with multiplexing equipment, and the total system cost is amortised on the 20 per cent with 80 per cent kept spare.

8.4.12.3 dark fibre

The cost of dark fibre, on a fibre pair basis, for the total distance covered by the inter-city and intra-city networks is presented in table 8.3. As there are no fixed (distance independent) costs in providing dark fibre, the costs for shorter route lengths would be proportional to the distance covered.

Table 8.3

NETWORKS AND FIBRE UNITS—CAPITAL AND OA&M COST SUMMARY

Network description or fibre units	*Total costs/tariffs ($ million)[(a)]*	
	Capital expenditure	*Capital expenditure plus OA&M[(b)]*
Inter-capital cable network	223.77	228.77
Intra-city cable network[(c)]	24.55	32.05
Inter-capital transport Network includes fibre and multiplexing	239.07	244.07
Sydney–Melbourne transport Network includes fibre and multiplexing	81.28	88.78
Intra-city transport Network includes fibre and multiplexing	28.60	36.10
Adelaide–Brisbane Inter-capital cable network cost per working fibre pair	18.65	19.06
Parramatta–Sydney Intra-city cable network cost per dark fibre pair	2.05	2.67

Notes: (a) The costs assume a 120 fibre cable for trunk and metropolitan networks and a fill factor of 20 per cent on both networks. The costs do not indicate whole-of-life costs for a complete business operation as they omit a number of recurrent costs for functions and processes important for full service provision.

(b) Includes five years of operation, administration and maintenance costs (OA&M) assumed at $1 million per annum for an inter-capital network and $1.5 million per annum for an intra-city network.

(c) Intra-city refers to Sydney.

8.4.13 SENSITIVITIES

The areas of most sensitivity in terms of cost are clearly the route selection, rights of way and the terrain, which all determine installation costs. The fibre count has an impact on cost but this is marginal for even significant fibre count increases. The incremental costs of establishing service facilities is also minor, once a significant fibre transport network and associated sites, is established. Service price outcomes are extremely dependent on take-up and the corresponding cost amortisation.

8.5 conclusions

Clearly, the network involves large capital expenditure. The national network is in the order of $240 million to build and the Sydney network in the order of $30 million. If city networks were built for the other cities (with similar but less than Sydney costs) the total network could be around $300 million. This is a large start up capital amount and would require a long term business strategy together with confident high demand estimates for the potential communications services to make this level of development a viable investment option. Notwithstanding these considerations however, such a network could well be within the strategic and budgetary reach of major Australian corporations (whether as carriers or major corporate communications users) particularly on a joint venture or consortium basis.

chapter 9

MARKET STRUCTURE

The historical telecommunications legacy has been a strong influence on the uneven development of competition.

The emergence of infrastructure competition has seen the development of a wholesale market for bandwidth in some areas.

Overall the Australian market can be seen as a series of markets with varying characteristics.

9.1 introduction

Term of reference 1 calls in part for the analysis of relevant market structure and commercial issues, including the current level and likely development of competition in relevant wholesale and retail carriage service markets within Australia. The level of competition determines how closely prices are aligned with costs. In the absence of competition there is no incentive for suppliers of bandwidth to pass on cost reductions in the form of lower prices to end users.

9.2 the traditional telephony supply model

The conventional economic model for competitive markets starts with supply and demand curves intersecting at prices that cover costs and clear markets. The model assumes numbers of sellers openly competing in the market. Where instances of market failure arise or social objectives other than those served by purely competitive outcomes are desired, policy and regulatory action comes into play. Such measures might involve, for example, investment incentives to induce additional supply, regulatory oversight to deter or redress anti-competitive behaviour or measures aimed at ensuring supply of services in circumstances where the market would not otherwise supply services except at unaffordable prices.

Historically, the conventional competitive model has not been followed in telecommunications. Around the world, telecommunications has developed as a monopoly service based on voice telephony, most often as a government owned monopoly. This has had major implications for both the price and availability of bandwidth. In Australia, the monopoly provision of telecommunications was characterised by a number of features that are summarised thus:

- Bundling of prices. The monopoly provider tended to offer full end-to-end services (including customer premises equipment) for a single price. For example, a leased line service would comprise network terminating equipment and dedicated access lines at either end, and a dedicated transmission path through the core network.
- Geographic price averaging. Customers paid the same price for the same service largely independent of the size and location of the area where they lived and with little reference to the cost of provision. For example, switched network calls were priced on the basis of distance bands or zones, regardless of the volume of traffic (and thus economies of scale) on the specific route involved. This was driven by a strong social equity commitment.

- Prices were not set on a marginal cost basis. A range of pricing practices were in evidence including:
  - *Prices set on a cost plus basis*. The effect of this practice was that in the early days of service introduction, prices were often very high due to high initial set-up costs and low initial utilisation. This had the effect of restricting potential demand and slowing market uptake.
  - *Setting prices to ration demand within capacity limits*. During the 1970s and 1980s state-owned telecommunications providers were generally required to fund all of their investment requirements for growth and new services out of retained earnings. This severely rationed the capital available, particularly for non-telephony services such as data services and leased lines, which in turn resulted in a restricted number of such services being offered to the market. Pricing was used as one mechanism to curb demand to within the capacity limits.
  - *Preservation of price relativities*. When new services were introduced, tariffs were set with reference to established services for administrative and marketing convenience and to limit the prospects for transfer of demand between established and new services. The preservation of tariff relativities was more important than the relationship between price and cost as detailed product costing information was rarely available.
  - *The customisation of tariffs was either not allowed or ignored*. Tariffs were developed for universal applicability with little regard for the possibility of different market segments with different demand elasticities and usage profiles. As a result, in many cases tariffing was arbitrary, and not responsive to changes in the costs of, demand for, or supply of telecommunications services.
  - *Substantial cross-subsidies between services*. The monopoly provider had to justify prices to the government in terms of their total costs and profitability, but individual service prices were not controlled except for politically sensitive charges such as telephone line rental and local calls. This lead to substantial cross-subsidies between services. For example, call charges often cross-subsidised below-cost line rentals and connection charges.
  - *Long distance call and leased line prices determined by distance*. Prices for long distance calls and leased line services were set in relation to distance which was measured in terms of radial distance between the originating and terminating point of the call or line. Alternatively, geographic zones were used as a proxy for distance.

- *Leased line prices a function of bandwidth*. The prices of leased lines varied in the same ratio as did the capacity of the lines. For example, a 2.4 Kbps service would typically be charged at twice the price of a 1.2 Kbps service on the basis that this was reflective of the value derived from the services by the subscriber.
- *Leased line prices reflected opportunity cost*. It was common for leased line prices to be set based on the revenue that could have been generated if the same bandwidth had been used to generate call revenues on the PSTN. This approach was so ingrained that it found its way into recommendations of the ITU. It was only in the 1990s that pricing prescriptions which included break even points between switched services and leased lines were removed by the ITU in a drive to remove anything that resembled cartel behaviour.[1]

- *Wholesale markets were often ignored*. Private network services such as leased lines were priced in such a way as to minimise the prospects of corporate customers building their own networks to bypass the PSTN. Bandwidth capacity on individual services was limited to a maximum of 2 Mbps and the prospects for service aggregation and arbitrage opportunities in volume discounts were limited.
- *A standardised service was provided by a single provider on a national basis*. A single provider tended to deliver the same services using the same technology to all customers no matter where they reside. There was an expectation that any upgrading of the service would be provided to all customers.

Australia's communications market structure starts from this end of the spectrum. In some critical respects it is a legacy based on a publicly owned telecommunications monopoly provider and legal and regulatory requirements regarding the provision of services. Underpinning these requirements was the policy objective of achieving universal service at affordable prices. Thus telephone services to rural and regional Australia were provided at equivalent prices to urban services and cross-subsidised from more profitable areas.

This led to the development of a carrier that was unresponsive to customer requirements and had no incentive to encourage demand growth or provide new and innovative services in a timely manner.

1 Ovum Pty Ltd 1999(a) *op. cit.*, p. 14.

9.3 the post-liberalisation market

9.3.1 THE DEVELOPMENT OF WHOLESALE AND RETAIL MARKETS

In opening up the telecommunications markets to competition all countries have resorted to some form of intervention. Ovum examined how competition may develop in both the wholesale and retail markets suggesting three outcomes are possible: infrastructure competition, unbundled incumbent (providing access to its infrastructure) and a continuation of status quo monopoly.[2]

Of the three, infrastructure competition is more likely to create an optimum environment for service innovation and price competition. However, infrastructure based competition can be slow to develop because of the high investment levels required and the associated business risks.

An alternative approach to infrastructure based competition is to require incumbent operators to unbundle the various elements of their network infrastructure and allow new entrants access to infrastructure on cost based terms. While this approach can foster competition more quickly in retail markets, it can discourage, if implemented inappropriately, investment in new infrastructure by both the incumbents and the new entrants thus constraining the development of a competitive wholesale market. In the longer term, service innovation can be limited, thereby reducing choice for end users.

Commenting on the third outcome—perpetuation of the status quo—Ovum noted that this is no longer a viable option at the national level but that this situation may persist in some regional and remote area markets where there are limited incentives for new entrants.

As the following discussion demonstrates, different parts of the Australian market exhibit features for each of these outcomes.

2 *Ibid*, pp. 38–9.

9.3.2 GEOGRAPHIC MARKETS

9.3.2.1 inter-capital routes

Some inter-capital trunk routes are also high volume routes. Infrastructure competition is strongest on the Sydney–Melbourne route, where there are up to four operators. Recognising these competitive developments, the ACCC did not declare this route along with the remainder of inter-capital routes to be subject to access obligations under the telecommunications access regime. By contrast, on routes such as Melbourne–Perth for example, there are only two infrastructure providers, and price reductions have been correspondingly less. However, on the Sydney–Brisbane route infrastructure providers are expanding their coverage and that route now has three carriers.

Strong infrastructure and service based competition have produced real benefits for corporate customers in the CBD and inter-capital markets, as already seen in the significant price reductions outlined in chapter 7.

The very thick route CBD and inter-capital markets are of the *consumer heaven* style of competition. The outlook for the next five years is for competition to strengthen in both market categories. As these markets mature, scope may exist for the entry of US style dark fibre carriers and for the emergence of spot markets.

9.3.2.2 regional routes

The business risks are such that there is less prospect of infrastructure based competition emerging at least in the short to medium term except on some of the thicker of these routes. Microwave technology may well provide competition on thicker routes particularly where a carrier has access to towers. Examples are the Soul Pattinson microwave network in NSW and Queensland, and the proposed Datafast project in Victoria.

As shown in table 7.1 infrastructure competition is likely to develop on the thicker routes leading to *consumer heaven* type markets. Medium thick routes are likely to be contestable and may see some limited infrastructure competition in the medium term, but are likely to remain in the exclusive club. The minor routes are unlikely to see any competition being a more traditional PTT or monopoly market.

9.3.2.3 customer access network

While the focus of this report is primarily upon backbone networks, the customer access network is critically important in terms of connecting and terminating calls. It is also an area repeatedly identified in industry consultations as a major cost component and a source of lengthy process delays where other providers have sought interconnection arrangements.

The CBDs in the larger capital cities are characterised by high levels of demand for data and voice services and low infrastructure costs relative to the potential demand. Cities like Sydney and Melbourne are served by multiple high capacity optical fibre rings and the services offered are tailored to the larger corporate client.

Some instances of infrastructure competition in other metropolitan areas are likely to develop, along the lines of the *TransACT* trial in the Australian Capital Territory, which will, if full deployment proceeds, effectively introduce an alternative customer access network across the ACT. Retail market competition in the metropolitan areas should also increase because of recent regulatory intervention by the ACCC to require local loop unbundling.

Some infrastructure competition is developing in the customer access network as a result of Optus' HFC network which passes 2.2 million homes. Optus now has over 300 000 customers connected to its HFC local network.

Alternative wireless delivery technologies such as LMDS, CDMA and satellite may also provide some level of infrastructure competition. Notwithstanding these prospects for limited infrastructure competition, Telstra's pre-eminent position is likely to continue in terms of land line connections for the foreseeable future.

9.3.2.4 remote areas

Remote areas are currently an effective Telstra monopoly and are only sustainable because of the cross-subsidies provided by the USO. Remote area customers are widely dispersed and relatively few in number. Given these features, satellite services are well suited to serving remote areas. As such it may be possible that infrastructure competition will develop in this market. The Government is currently examining ways of making the USO contestable to further encourage infrastructure competition.

However, while service quality can be expected to improve, the high cost of provision and very restricted competition, would make it unlikely that such areas will be profitable in the foreseeable future.

9.3.2.5 international connections

On international routes out of Australia, traditionally there have been a number of consortia supplying bandwidth to their members and third parties. Available bandwidth is in the order of 18.5 Gbps. However, there is now increasing competition due to the entry of new consortia such as Southern Cross Cable and to a lesser extent the availability of various satellite systems with footprints over Australia.[3] Given known commitments by market entrants, potentially available international bandwidth could jump by a factor of 15 to 278 Gbps in the next twelve months exerting further downward pressure on prices.

Nonetheless, Australia still remains a distant thin route in terms of the global market. For example, the Global Crossing fibre optic routes announced in August 1999 are not planned to extend south of Malaysia to Australia.[4] Project Oxygen's proposed global fibre optic network is planned to include Australia, but this route is the last on the current construction schedule (2003).

9.3.3 SERVICE MARKETS

9.3.3.1 cellular mobile

While there are several mobile service providers, the cellular phone market is characterised by marketing rather than price competition. Price competition is a relatively recent phenomenon. This probably reflects the high demand growth for mobile phones, together with lower price sensitivity in this market. In any event, the carriers have not until recently chosen to compete on price to obtain customers.

Remote areas have limited or no terrestrial mobile services, because sparse population in such areas make service provision a marginal proposition. New technologies like the CDMA networks and LEO satellite services have the potential to expand the coverage provided by such mobile services and in the case of LEOs provide ubiquitous mobile services. However, LEO services are expected to be a premium service in terms of price if not quality.

3 See chapter 5 for details.

4 See *http://www.globalcrossing.com*, October 1999.

Third generation and new mobile broadband services are also likely to drive this market in the future.

9.3.3.2 Internet

The Australian market for Internet services is very competitive. There are approximately 25 first-tier Internet Access Providers (IAPs) the largest of which are Telstra Big Pond and Optus Spinnaker. IAPs either provide or purchase Internet capacity in bulk and on-sell this capacity to ISPs. At 25 August 1999 there were an estimated 910 ISPs operating in Australia, ranging from large national operators like Telstra Big Pond, Connect.com.au and OzEmail through to regional, rural and niche market operators.[5]

9.3.4 SPOT MARKETS

As discussed in chapter 2, the US and Europe have already developed sophisticated bandwidth exchanges for PSTN and Internet minutes, for leased capacity, and dark fibre, though in most cases, these are comparatively recent developments. The exchanges operate either by facilitating or brokering the contact between buyers and sellers or by networking potential buyers and sellers and directly offering wholesale bandwidth at spot market prices.[6]

In Australia, wholesale spot markets of this range and diversity have yet to develop, although the emergence of an Asian spot market has been recently reported. However a fledgling retail spot market for bandwidth amongst ISPs on a State or regional basis has begun to develop. In South Australia, for example, members of the South Australia Internet Exchange actively trade spare bandwidth capacity.[7]

9.3.5 VERTICAL INTEGRATION

There is a strong element of vertical integration in the Australian market. One major, vertically integrated, wholesale and retail supplier (Telstra) has a predominant share of the current Australian market. As at September 1999 there were 31 carriers in the Australian market. Of these, only three own significant infrastructure while few have any reasonable market share.

5 Telecommunications Industry Ombudsman, Home Page, *www.tio.com.au*, September 1999.

6 OECD, 1999(a), *op. cit.*, p. 17.

7 ISP consultations, South Australia, June 1999.

In contrast with Australia, the US market has a much more diverse and competitive structure. Other features of the American market include:

- high levels of competition in the wholesale backbone or inter exchange market between long distance carriers such as Sprint, MCI and AT&T;
- dark fibre carriers and Internet based carriers, such as Qwest[8] at the inter exchange level, setting the scene for the development of dark fibre and spot markets; and
- at the local level, competition is emerging *between* the local telephone companies and cable companies, and driving the take up of innovative services such as ADSL.

However, the spate of mergers occurring across the US cable, telephony and Internet sectors are modifying the structure of the US market to some extent. For example, long distance carrier AT&T has recently purchased the local cable company TCI, and IAP America On Line has merged with a local cable carrier. Industry players seem to be using these alliances to gain competitive advantage in an increasingly global and customer centred market. By securing transport and access opportunities that enable bundling, industry players can interface more directly with customers.

9.3.6 AUSTRALIAN MARKETS — CONCLUSIONS

It is useful to think of the Australian market as a series of markets with varying characteristics, ranging from thin and, in some cases, commercially non—viable routes where Telstra remains the sole service provider, to thick, CBD, inter-capital and international routes in which both service and infrastructure based competition is occurring. While the fixed customer access network is overwhelmingly owned and controlled by Telstra, some competition has developed there also and regulatory decisions already taken by the ACCC should see more competition develop in the retail market.

While competition is developing, other providers are unlikely to provide a ubiquitous network. Also technologies are developing that suit particular market conditions. Therefore, in the future, services may be provided by different technologies and even different providers. However, carriers and service providers

8 See *www.qwest.com*, September 1999.

will continue to require interconnection arrangements with Telstra in order to serve most regional areas or terminate services in the customer access network. Ovum has described the outlook for competition in the following terms:

> The outlook is for substantial and sustained competition in intra-capital city and inter-capital city markets during the next five years. The outlook is less certain for competition in provincial and rural markets over the same period, and the diffusion of the benefits of competition elsewhere will be affected in consequence.[9]

Given this situation, regulatory oversight continues to be important.

9.4 regulatory framework

9.4.1 THE AUSTRALIAN REGULATORY FRAMEWORK

Around the world, governments have generally intervened in moving from a monopoly to a competitive model. The approaches to regulation have varied throughout the world but the objectives have generally been to promote infrastructure competition, ensure access by new operators to the incumbents' infrastructure or a combination of these.[10]

The Australian market was opened up to some very limited competition in advanced services in 1988. A transitional duopoly introduced in 1991 saw an alternative source of infrastructure and the development of competition in retail services.

The *Telecommunications Act 1997*, which came into force from 1 July of the same year, created an open telecommunications market in Australia. There are minimal restrictions on the type of technology used; no restrictions on entry to any telecommunications service market; and an increased reliance on industry self-regulation.

9 *ibid*, p. 7.
10 *Ibid*, p. 38.

The regime encourages infrastructure competition but where this is not likely to develop, regulatory oversight continues to be important in the telecommunications market. To this end, the regulatory framework provides for:

- pro-competitive measures such as the access regime and anti-competitive conduct regulation; and
- safety net obligations such as the universal service obligation and price control regulation.

The ACCC and the ACA are the two principal bodies that have regulatory oversight over Australia's communications markets.

The ACCC administers the telecommunications-specific regime of the *Trade Practices Act 1974* (TPA). Part XIB of the TPA relates to anti-competitive conduct. The telecommunications access regime (contained in Part XI C of the TPA), provides a framework for regulated access rights to be established for specific carriage services and related services, and establishes mechanisms within which the terms and conditions of access can be determined. The access regime will reduce the power of those owning or controlling important infrastructure or services which are necessary for competitive services to be supplied to users.

The access regime establishes access rights through the declaration of services by the ACCC. The ACCC may declare services to be the subject of regulated access—either on the recommendation of the industry self-regulatory body (the Telecommunications Access Forum, TAF) or where, following a public inquiry, it is satisfied that such declaration would be in the long-term interests of end-users of telecommunications services. Once a service is declared, carriers and carriage service providers supplying that service are (unless otherwise exempt) under an obligation to supply the declared service and specified ancillary services to requesting service providers. Access providers must comply with their access obligations:

- on terms and conditions commercially agreed by the access provider and access seeker;
- as detailed in an access undertaking; or
- as determined by the ACCC through arbitration.

The telecommunications industry is a complex, network-based industry. It is likely that in many areas, efficiency gains can be achieved by the industry itself negotiating, on a multilateral basis, standard terms and conditions for access to declared services. The access regime establishes a mechanism for industry to

develop an access code containing model terms and conditions for access to particular declared services. Once approved by the ACCC those model terms and conditions may be adopted in an undertaking by individual carriers or carriage service providers who are, or will be, under an access obligation.

The ACCC also administers some legislative provisions in the *Telecommunications Act 1997*, including price control arrangements relating to Telstra's retail services.

The ACA is responsible for regulating telecommunications and radiocommunications, including significant consumer protection responsibilities, such as the universal service obligation and customer service guarantees, which ensures reasonable and equitable access across Australia to standard telecommunications services.

9.5 emerging regional market models

Where competition may be slow to develop, some alternative strategies may be required to assist the process.

There are two broad cooperative models that can maximise economies of scale to enhance the provision of telecommunications services in regional areas—demand aggregation strategies and rural telecommunications cooperatives based on a North American model.

9.5.1 DEMAND AGGREGATION

The core objective of demand aggregation strategies is to seek to pool demand for voice and data traffic among participant organisations and users in order to attract cheaper per unit pricing (through *buying in bulk*), and/or attract new services or service providers into particular markets.

Essentially demand aggregation is about building buying power among users in markets where suppliers currently have significant market power.

There are several potential points of demand aggregation at the government, community/regional and service sector level.

The Western Australian Government, for example, has recently announced a Statewide Telecommunications Enhancement Program. The Government went to the market place with its aggregated current and forecast demand, and established a panel of two carriers to compete for that business, thereby establishing a basis for the development of infrastructure competition.

9.5.2 RURAL TELECOMMUNICATIONS COOPERATIVE PROJECTS

An option that is similar to the demand aggregation model outlined above is an industry-led and initiated cooperative model that is supported by joint funding from all levels of government.

Rural cooperatives have been formed between electricity and telephone companies in the US, based on the standard cooperative business model. Cooperatives are typically community-based and industry-led that pool resources on a non-profit basis, with revenues earned above operating expenses returning to cooperative members on a pro-rata basis. Financing can be from a range of avenues such as member equity fees; low interest government loans; and capital raisings on the bond market.

An example of this model is the National Rural Telephone Cooperative.[11] This cooperative positions each utility in its market as the premier provider of telecommunications services. The technologies are made affordable through the aggregated purchasing power of the cooperative's members. That is, the cooperative capitalises on economies of scale by purchasing in volumes and receives substantial discounts on products and services.

Some key features in this model are that rural communities get *local* access through the telephone cooperative; and a pooling of information resources on product updates and technical and marketing support.

The expertise gained in this model overseas is available to Australian regional bodies to emulate here. Pilot programs could establish the viability of this model for the Australian situation.

Social bonus funding from the latest sale of Telstra shares is being used for expanding access to telecommunications infrastructure and to the internet;

11 See *http://www.nrtc.org*, October 1999.

restoring services to regional towns; modernising local government service delivery; and providing new high-tech job opportunities in regional areas. In seeking to meet these objectives, these new models for providing services in rural areas need to be developed. Alternative models tried in other countries should also be considered.

9.6 liberalisation in other countries

9.6.1 UNITED STATES

The US is one of the leaders in terms of transforming its market structure and fostering competition, beginning with a limited extension of competition in 1971. This was followed by the Federal Communications Commission (FCC) ruling of 1984, which required AT&T to divest of its Bell Operating Companies (which were then restructured into the regional Bell operating companies—RBOCs).

Progressively since that time and accelerating through the 1990s, the US market has had strong competition develop in most areas of the market and a wide array of service offerings exists in both the wholesale and retail communications markets.

The 1996 Telecommunications Act fostered extra competition in local exchange carriage by introducing local loop (customer access network) competition. The Act, and subsequent decisions of the FCC, require the RBOCs to provide interconnection to the local loop, to make leased lines available for resale of services and to unbundle their networks so competitors can choose which network elements they wish to use. The FCC has moved universal service requirements from being funded by implicit subsidies (similar to the traditional Australian USO funding mechanism) to a more explicit subsidy regime to which carriers are required to contribute.[12] In the case of AT&T the costs of its Universal Service Fund contributions are in turn recovered by a separately identified monthly charge on its residential customers.[13]

Despite quite a degree of consolidation in the market through acquisition and merger activities, the level of competition remains strong. There are some 1 300 local telephone companies, while long-distance carriers increased threefold

12 Espicom Business Intelligence, *Communications Market Analysis: United States*, pp. 6–7.

13 See *http://www.att.com/connectivity_charge/* November 1999.

between 1986 and 1996 to over 600.[14] Competition, together with changing cost structures for communications infrastructure, has generally had a substantial impact on prices.

9.6.2 CANADA

The Canadian telecommunications industry is dominated by the Stentor alliance, which includes the nine major regional operators. Limited competition was introduced in 1979 for long distance carriage and extended to most other areas in 1994 following enactment of the *Telecommunications Act 1993*. In 1998, monopoly provision of international services was also terminated.[15]

The Canadian Radio-television and Telecommunications Commission is the industry regulator, responsible for implementing policy objectives established by Parliament and developed by Industry Canada. Industry Canada is responsible, under the Radiocommunications Act, for managing and allocating the radio spectrum.

Mobile telephone services are provided by a duopoly of Rogers Cantel and the Mobility Canada consortium. Personal communications services licences were awarded in 1996 to four companies to provide competitive services across Canada. These networks began operating in early 1998.

In May 1997, the CRTC announced a series of decisions that would enable the market to be fully liberalised by January 1998. Liberalisation was afforded immediately in the long distance and private line markets.

The decisions included new measures on:

- local competition (including issues of equal access for new services providers, and of common safeguards);
- price controls; and
- ensuring favourable conditions for convergence, to enable cable companies to enter the local telephone market (and conversely, telephone companies were able to offer broadcasting services from January 1998).

14 Espicom Business Intelligence, *op. cit.*, pp. 27 and 35.

15 Espicom Business Intelligence, *Communications Market Analysis: Canada*, p. 3.

9.6.3 UNITED KINGDOM

The United Kingdom has a very competitive market, having started the process towards liberalisation in the early 1980s. As a transitional measure, a regulated duopoly was created, with the market opened to full competition in 1991. Further regulatory change occurred in 1995, aimed at fostering competition and safeguarding against anti-competitive or unfair practices by incumbent carriers. Current regulation is based on the *Telecommunications Act 1984*, amended to align it with the European framework for telecoms regulation.[16] As in the US, there is competition in the supply of voice and data services from both mobile and cable television operators.

Regulatory responsibility lies with the Office of Telecommunications (OFTEL), created by the 1984 Act. Radio frequency spectrum planning and management is undertaken by the Radiocommunications Agency. The definition of telecommunications services is very wide and includes any electronic transmission however generated and however conveyed.[17]

Given its genesis as a public monopoly, British Telecommunications (or BT, as it is now known) has traditionally had a predominating share of the telecommunications market. However, that share has been reducing, initially under the impact of competition from Mercury (now Cable and Wireless) and subsequently from new entrants and now stands at around 64 per cent of total revenues (1997/98 figures).[18] According to the United Kingdom Department of Trade and Industry, BT's share in all markets is expected to continue to decline.[19]

Universal service has, for practical purposes, been the sole responsibility of BT. Given the changing competitive environment, OFTEL has examined whether BT's obligations in relation to the delivery of universal service impose a net cost on BT. "It has concluded that the current net cost to BT is not proven and does not justify setting up a universal service funding mechanism in the short term."[20]

16 Department of Trade and Industry, *http://www.dti.gov.uk/converg/annexb.pdf* November 1999.

17 *Ibid*.

18 Espicom Business Intelligence, *Communications Market Analysis: United Kingdom*, p. 11.

19 Department of Trade and Industry, *op. cit*.

20 *Ibid*.

9.7 structural separation and related proposals

In the course of this Inquiry a number of people have raised the issue of structurally separating aspects of Telstra's operations. This arises from frustration with Telstra's perceived performance in a number of areas:

- lack of responsiveness and lack of higher bandwidth availability in areas where Telstra has either a de facto monopoly or natural monopoly (e.g. in regional and rural Australia);
- extensive fibre optic network, including passing residential areas—but with residential access largely constrained to cable TV;
- bandwidth prices that are considered high in both absolute and relative terms both domestically and internationally, leading to the postponement of some bandwidth intensive applications and making Australia less competitive;
- Telstra's market power in CAN provisioning or upgrading for high bandwidth technologies and in providing access to competitors to the local loop network continues to limit availability and is hindering development of competition.

Separation proposals have generally not been developed in detail and can take a variety of forms:

- vertical separation, which can involve separation of 'monopoly' from competitive elements; 'core' from 'non-core'; infrastructure from service delivery. These proposals usually are based on the view that the customer access network is a 'natural' monopoly from which monopoly rents can be extracted or downstream advantage leveraged.
- horizontal separation, involves splitting the company's various lines of business e.g. mobiles, Internet, long-distance, etc (the purpose being to prevent unfair exploitation of economies of scale and scope and self-preferential treatment; and/or to increase the number of competitors).
- geographic separation—either into discrete geographic operators or by splitting off the rural and regional operations of the company. In this respect the profitable and loss-making market components would be separately addressed with a regional operator or operators delivering services more attuned to the needs of regional consumers.

9.7.1 INTERNATIONAL EXPERIENCE

Internationally, many countries comparable to Australia have not adopted structural separation arrangements for incumbent dominant carriers and are making significant progress in competition without it (e.g. United Kingdom, New Zealand, France, Germany and Sweden).

Standing behind many of the separation proposals is the perception that the split-up of AT&T in the US has been effective in promoting local call competition. It is worth noting that while AT&T operated as a virtual monopoly (there were some independent regional operators) it already had a business model in which it had structured its operations along regional lines, through some 22 Bell Operating Companies. Thus, with the requirement for AT&T to divest itself of these companies, these operational entities were variously merged into the resulting seven Regional Bell Operating Companies (RBOCs).

Nor is it clear that there is any straight-line equation between divestiture and competition. On the contrary, the RBOCs had effective monopolies over the CAN in their respective operational areas and were not at that time permitted to compete in each other's regions. While the development of competition predates the US *Telecommunications Act 1996*, it was a significant objective of that Act, which effectively reversed structural separation as a means of regulating access. Incumbent US local exchange carriers can now re-enter the long distance market if they meet regulatory requirements about providing access.

In the UK, the Office of Telecommunications rejected structural separation of BT's network and enhanced services because of:

- the practical difficulties of separating the assets used in both activities—and any such separation could involve a high degree of cross-selling;
- the benefits to be derived by consumers from BT's ability to exploit economies of scale and scope; and
- the feasibility of developing more effective regulatory controls over BT's market power.

9.7.2 IMPLICATIONS AND PRACTICALITY

While the structural separation proposals range in character, many of the associated problems tend to be generic.

9.7.2.1 competition in the CAN

Proposals for structural separation of Telstra generally relate to claims of its misuse of market power derived from its monopoly control of the CAN. While the CAN has, at least historically, some natural monopoly characteristics and control of CAN facilities is a source of market power, there is mounting evidence to suggest that the CAN is no longer a natural monopoly. An increasing number of operators

around the world are providing CAN facilities, both wireline and wireless, in competition with incumbents. This is also occurring in Australia. Technological developments are rapidly changing the economics of local loop competition and will continue to have the effect of reducing any natural monopoly characteristics of the CAN.

A natural monopoly is said to occur in a market in circumstances where, at any given level of output, it is cheaper for a single firm to produce that level of output than for any other combination of firms to do so. Natural monopolies may arise from economies of scale or scope such that expanding the capacity of the monopolist's infrastructure is less costly than establishing a duplicate infrastructure.

Whether the telecommunications industry is a natural monopoly has been increasingly questioned internationally. It is now widely accepted that there is no conclusive case for the existence of a natural monopoly in most sectors of the industry (such as long distance transmission and mobile telephony) and even with local telephone services technological change is increasing the competitive opportunities.

As discussed in chapter 5 and elsewhere in this report, technological developments in switching and network facilities, together with the continuing emergence of new technologies, such as broadband networks, wireless CAN and new generation satellite services, are changing the cost structure of the telecommunications industry. Combined with new revenue streams from new services, this is making it increasingly economic to reproduce infrastructure in most areas, including the CAN.

The definition of a natural monopoly assumes the existence of a commonly known single-best technology which delivers maximum operating efficiency. On this basis, not even the CAN represents a natural monopoly because:

- continuing technological change means that the best potential technology or mix of technologies is not known;
- the interconnection of networks can eliminate monopoly control and use; and
- competing facilities have already supplied competing local communications services.

These factors are, of course, more pronounced in the communications industry as technological innovation enlarges the capabilities of networks.

9.7.2.2 effectiveness of structural separation

While structural separation should be an effective mechanism for preventing a vertically integrated carrier from leveraging a downstream advantage from any monopoly it derives from its control of the CAN, it does not necessarily address the problem that whoever retains control of the structurally separate CAN, will still retain market power and need external regulation, for example, in relation to access processes.

9.7.2.3 practicality of structural separation

By contrast with the US situation where separate operating units already existed under the corporate AT&T umbrella, the break-up of a modern, vertically integrated telecommunications carrier would be practically difficult and expensive. Unlike mature and fairly simple network technologies such as electricity and water, communications involves dynamic and highly complex technologies. In practice, it could be difficult to separate the assets used in various operations. This consideration was a factor in the UK's decision not to split BT's operations.

9.7.2.4 economies of scale and scope

There are economies of scale and scope available to integrated communications companies. These may not necessarily result in an absolute cost advantage over competitors, but their removal would deny these economies to Telstra and can be expected to have an adverse effect on costs.

The Australian regulatory regime recognises that all industry parties should be free to pursue such economies (and associated efficiencies) within legal competitive parameters and that these economies are more likely to benefit end-users in terms of lower prices, new services and innovation.

9.7.2.5 other regulatory approaches

It appears to this Inquiry that the underlying issue that gives rise to separation proposals is about competitive efficiency, responsiveness, prices, diversity and innovation. In this sense, structural separation is a circuitous route that cannot guarantee these outcomes and has its own attendant disadvantages.

A more direct route is to ensure that the regulatory environment fosters competition, flexibility and diversity of service provision while also ensuring social objectives in terms of equitable access to services are simultaneously met.

Notwithstanding the difficulties involved in separating out parts of Telstra's operations, this Inquiry believes that Telstra should be encouraged to consider internal structural reforms which increase its organisational focus on the needs of regional, rural and remote consumers in particular and is recommending accordingly (see chapter 13).

chapter 10

CONCLUSIONS — BANDWIDTH AVAILABILITY AND PRICING

Currently installed backbone bearers will supply adequate bandwidth capacity to meet current and likely future demand for the next five years, through deployment of spare capacity and the application of new technology

- there are however some capacity constraints in some of the smaller towns.

Estimates of average annual growth in wholesale demand for bandwidth range from 30 to 60 per cent. Similar estimates for retail demand for bandwidth range from around 19 to 35 per cent.

Constraints exist in the delivery of services in the customer access network and in the organisational arrangements of carriers to deliver services without undue delay.

Backbone bandwidth capacity ownership is highly concentrated. Outside the large markets of the eastern seaboard there are only two significant providers of bandwidth, and one of them has true national coverage.

Competition is uneven and will lead to differences in price and price reductions across markets.

Unit prices of bandwidth in the wholesale market will continue to decline by 30 to 50 per cent per annum over the study period. This will be reflected in retail prices in capital city and thick route markets, but to a lesser extent in regional and rural markets.

Wholesale prices on international routes reflect commodity effects in a fully competitive market. They will increasingly do so on national routes.

10.1 introduction

The purpose of this chapter is to bring together the results of the previous five chapters, and to present some conclusions in relation to them. This synthesis draws largely on a supplementary consultancy undertaken for the Inquiry by Ovum.[1]

10.2 issues relating to the supply of bandwidth

The following is a summary of the main findings in relation to the supply of bandwidth.

- There is oversupply of existing and potential bandwidth on most national routes. The extent of this oversupply is by between two and five orders of magnitude, depending on the route. Oversupply on national routes will continue throughout the period until 2004. This will occur with any of the growth paths for demand anticipated by the demand studies. It should be noted that this is bandwidth available to the carrier which may not translate to bandwidth being available to the customer in a timely fashion or at reasonable service quality.
- There are also some routes in rural and remote Australia where bandwidth appears not to be adequate for current demand. However, this capacity can be increased substantially at relatively short notice, although this would be subject to commercial considerations. Usage of capacity is further examined later in this chapter.
- The situation in relation to international capacity to and from Australia is more constrained, due to the *lumpiness* of supply. Existing capacity appears to be matched to existing demand. There will be no significant spare capacity until the Southern Cross cable is operational within the next 18 months, and the Australia-Japan cable is operational some time after 2001.
- All carriers, and especially Telstra, have a high potential for upgrading the capacity of their existing terrestrial fibre base through technologies such as DWDM and packet based systems. With voice over IP, a 20:1 advantage in traffic carrying capacity may be achieved.
- Major carriers can upgrade the capacity of their transmission routes within three months, and fully design new routes to be operational within two years. Again this would be subject to commercial considerations.

1 Ovum Pty Ltd, September 1999(b).

- Most carriers do not have long term plans for bringing capacity on line as they are not able to accurately predict demand. Instead, they plan to have ample potential capacity available for short-term activation as required.
- For the whole network, the bottleneck is in the customer access components and this is likely to remain for some time.
- Feedback from customers in regional areas suggests that actual delivery of service can involve delays that appear to be inconsistent with the existence of substantial spare existing and potential backbone capacity. The consultants consider that delayed provision is a function of:
  - carrier organisation and availability of skilled human resources at particular locations,
  - upgrade planning and installation delays in the access network, and
  - limited regional competitive pressures for improved performance.

10.2.1 CARRIER PLANNING PROCESSES

Carriers are investing in transmission infrastructure in a climate of uncertainty, due in part to the level of over provisioning. They are installing optical fibre that can be readily brought into operation or have its capacity upgraded through the addition of new terminal electronics. They are also not aware of each other's plans, and public statements are treated with caution.

The laying of capacity greatly in excess of foreseeable demand can be justified because of the very low marginal cost of installing additional fibres at the time of network construction.

10.2.2 CONCENTRATION OF OWNERSHIP

At present there are 31 licensed carriers and of these only six have backbone network infrastructure. A further two organisations have material infrastructure but are not licensed. Of the carriers with their own infrastructure, most have limited their operations to the high demand routes linking major metropolitan centres along the East Coast.

Supply on a national basis is heavily concentrated—Telstra and Optus are the only providers. In many regional areas, the choice is between Telstra and Optus' satellite services. There are technical and commercial limitations to the provision of high bandwidth services on a point to multi-point basis.

10.3 demand

10.3.1 DEMAND DRIVERS

The demand for bandwidth is a derived demand based on the take-up of services and their level of bandwidth utilisation.

Other than CERP, the demand studies did not assume any major new bandwidth-intensive applications in the next five years. CERP modelled a *once off* 28 per cent increase in host demand in relation to the release of some popular new Internet application. In particular, the Network Strategies study explicitly noted that its findings assumed no new content-based application that would cause a marked increase in the demand for bandwidth. A so-called *killer application* may develop within the timeframe of this Inquiry, however it is not possible to predict when it might happen, the take-up rate or how bandwidth intensive it might be.

10.3.2 DEMAND GROWTH

Three demand models were developed to provide a variety of different approaches which have produced a range of results due to differences in the model designs and the assumptions employed. These results can be further expanded by developing more scenarios from the models. However, for the purpose of this report, the scenarios developed by the consultants and the CRU have been retained. The results from these are summarised as follows:

- the growth in *wholesale* bandwidth demand is expected to be in the range of 30 to 60 per cent per annum. This range incorporated views of the demand growth in regional areas and on thin routes, and on major high-growth inter-capital routes;
- the demand growth assumptions used are at wholesale level and do not allow for the following which are not necessarily taken into consideration when modelling demand at the retail level:
  - redundancy and operational uses and spares at wholesale level,
  - redundancy and operational uses and spares at retail level,
  - other supply chain effects, and
  - the purchase quantities available to end customers;
- Network Strategies' forecast under their likely scenario is for annual growth rates in aggregate bandwidth demand of around 13 per cent in 1999 rising to around 21 per cent in 2005, compared with current growth rates

estimated at between 11 and 15 per cent. These figures refer to the aggregate peak bandwidth usage levels implied by the applications used at retail customer level;

- CERP's likely forecast is for an increase from 167 Gbps in 1999 to 440 Gbps in 2004. This is around 21 per cent per annum;
- CRU's mid-range or likely forecast is for an increase from about 300 Gbps in 1999 to 1370 Gbps in 2004. This represents an average annual growth rate of more than 35 per cent;
- growth in demand is expected to increase across all segments—residential, and small, medium and large business, as well as in all States, regions and communities; and
- the growth rates in the Network Strategy's and CERP's models are not particularly optimistic.

10.3.3 VARIATION IN INITIAL DATA AND ASSUMPTIONS

Some of the factors accounting for the differences in the results of the models are:

- the studies did not consider the way in which service packaging might affect the purchase levels of customers. Products will continue to be defined by carriers in terms of purchasable bandwidth, leading to systematic over-demand by customers;
- the starting points for the studies are estimates only and differences in assumptions are to be expected; and
- the base data for the models came from different sources. The CRU and Network Strategies used Australian Bureau of Statistics input data throughout. CERP has used assumptions derived from United States data on users per host. The treatment of this data has produced a variation in results by a factor of at least two.

10.4 usage of capacity

In relating demands to supply, it should be noted that the demand modelling was based on bandwidth demands for services, and therefore did not include allowances for network management, redundancy or the practice of making bandwidth available in large chunks (e.g. a business may buy or lease a two Mbps link but may only use on average say, 1.6 Mbps).

Using the CRU bandwidth model to estimate current usage and Consultel's estimates of capacity, we have arrived at estimates of the proportion of current bandwidth capacity that is used for international and selected inter-city routes. These estimates are depicted in table 10.1 and figure 10.1.

Table 10.1
USAGE OF CAPACITY[2]

	Melbourne %	*Brisbane* %	*Hobart* %	*Adelaide* %	*Perth* %
Sydney	0.72	1.09	0.26	0.82	0.26
Melbourne		0.37	0.42	0.41	0.23
Brisbane			0.32	0.33	0.35
Hobart				0.17	0.15
Adelaide					1.61
International			21.00		

International routes show the highest usage at an estimated 21 per cent of capacity. Sydney–Melbourne estimated usage is at about 1.09 per cent of capacity (capacity about 91 times usage), Adelaide-Perth is about 1.61 per cent of capacity (capacity about 62 times usage) and estimated usage for all other capital city routes are all less than one per cent of capacity (capacity ranges from 100 to as much as 600 times usage).

The methodology used to arrive at these estimates is necessarily subject to some caveats. Apart from those caveats relating to the demand and supply models themselves that are discussed in the sections dealing with these models, it must also be recognised that the capacity on any particular inter-city route may be shared among the towns and cities along that route, and also shared with traffic that is being carried beyond the city pair being analysed to other cities and international gateways. While these considerations were taken into account in the modelling exercise, it necessarily involved assumptions concerning how traffic was routed that need not apply in every particular instance. For instance, routing of Internet traffic is notoriously changeable depending upon the level of congestion in particular segments of the network.

2 Consultel *op. cit.* and CRU model.

Figure 10.1

BANDWIDTH UTILISATION

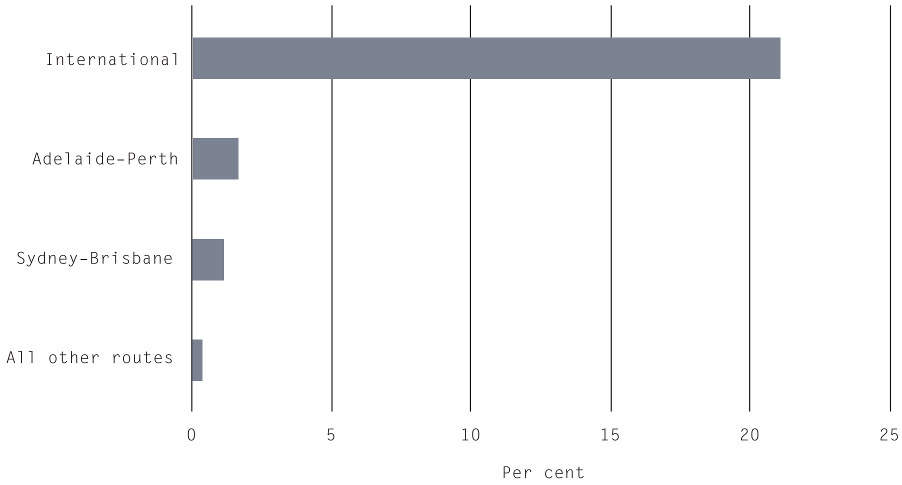


Table 10.2

USAGE OF CAPACITY, TOWNS OF VARIOUS SIZES, 1999[3]

Type of town	*Capacity (Mbps)*	*Usage (Mbps)*	*Proportion of capacity used (%)*	*Factor by which capacity exceeds usage*
Small town (av. population 490)	208	8	3.8	26
Medium town (av. population 2 853)	1 200	52	4.3	25
Large town (av. population 17 128)	3 740	273	7.3	>13
Small city (av. population 47 704)	8 818	690	7.8	>12

Using the Network Strategies' model to estimate 1999 usage for towns of various sizes, and the AAS survey results for capacity, we have arrived at estimates of the average proportion of capacity used for these towns as shown in table 10.2.

Note that the table is based on averages. The AAS survey revealed that there are some towns in the bandwidth capacity survey that may be severely bandwidth constrained in that they had only an average of six or seven Kbps per person of

3 Amos Aked Swift *op. cit.*, Network Strategies *op. cit.*

installed capacity (refer table 5.2). According to the demand modelling work by Network Strategies, typical average peak demands for towns of similar size are of the order of 16 to 18 Kbps per person, or more than twice the apparent capacity.

10.5 pricing issues

10.5.1 SERVICES AND APPLICATIONS

- The cost of bandwidth as a proportion of total costs of retail services should decrease substantially over the next five years. However, the cost of bandwidth in the backbone network will remain a core determinant of the price of retail carriage services, but other cost components will increasingly dominate. The emphasis will increasingly be on the price of applications, with bandwidth packaged as an element of the overall product.
- The choice for corporate customers between retail and wholesale services will depend on the bandwidth volumes and the service features they require. It will also depend on the internal capabilities of the customers for managing network elements and their business needs for control of the communications services they use.
- Raw bandwidth service at both the wholesale and retail level will increasingly take on the characteristics of a commodity and it will be difficult to extract a value premium.

10.5.2 PRICE LEVELS AND STRUCTURE

The market for bandwidth services involves participants with quite different leveraging power and market knowledge. The market is complex and becoming more so, resulting in a range of prices being able to coexist at any given time or place for services offering similar bandwidth. Most market participants have an imperfect view of the whole market, and pricing is through trial and error, particularly in wholesale markets for high bandwidth services.

Only when bandwidth becomes a global market based on international networks, where distance no longer determines the cost of communicating, will it be possible to speak of a single or standardised price for bandwidth. This will happen first on the high capacity cables now being deployed on major intra-continental and inter-continental routes linking the world's top 100 cities.

The structure of prices is expected to change significantly over the next five years. The main changes are likely to be:

- distance elements will become less important in the price of bandwidth;
- price levels in the retail market will reflect packaging and value. Alternative funding of services and applications, including *all you can eat* pricing, will proliferate at retail levels;
- usage related pricing will continue to be appropriate for many session-based services, such as EFTPOS usage, but increasingly, contracts will be written on a bandwidth and contractual commitment basis both nationally and internationally;
- price levels in the wholesale level will reflect commodity cost factors, together with commodity level margins. The extent to which a value related premium might be achieved depends on how far down the supply chain the wholesaler operates. There will be increasing opportunities for contracting in of network functions by service providers. There will be no value margin in bandwidth as such;
- the wholesale price of bandwidth in intra-capital city and inter-capital city and other thick route markets is expected to decline by 30 to 50 per cent per year for each of the next five years. The decreases in unit prices (per Kbit/s) will be most noticeable in high bandwidth services of two Mbps and more, and particularly noticeable in very high bandwidth services at 155 Mbps and above; and
- negotiated prices based on applications and specific customer network configurations will be common practice—particularly in the corporate and government sector. This may penalise smaller business and consumers that do not have the economies of scale or market savvy to negotiate.

10.5.3 GEOGRAPHIC AND OTHER PRICE DISPARITIES

- The benefit of lower price levels will be available initially to larger users in larger markets because of their greater importance in revenue terms. Without competition, users will not receive the full or timely benefit of reduced costs. Competition is generally less robust in regional and remote areas, and this will continue over the next five years.
- Wholesale and retail prices for bandwidth can be expected to reflect underlying costs in the longer term. However, wholesale prices for bandwidth will reflect underlying cost differences in bandwidth more acutely than retail prices because of the higher proportion of total service costs that bandwidth represents in wholesale markets.

10.5.4 COMPETITION AND MARKET STRUCTURE

- Without significant competition there will be no pressure on carriers to pass on cost savings through technological development and improved processes in the form of lower prices to users.
- The outlook is for substantial and sustained competition in intra-capital city and inter-capital city markets during the next five years. The outlook is less certain for competition in rural and remote markets over the same period, and the diffusion of the benefits of competition elsewhere will be affected in consequence.
- There are likely to be only three or four major infrastructure network carriers in Australia over the next five years, providing fixed network bandwidth transmission services over a substantial part of Australia. In addition there will be four to five mobile carriers with cellular network infrastructure. These carriers will not be equally ubiquitous. However, most are expected to cover major population centres and thick route corridors.
- There may be a number of smaller carriers with regionally limited transmission infrastructure and carriage service providers. These should ensure that competition in retail markets remains high in major city markets, and that some diffusion of prices occurs in related regional markets.
- Mobile operators will increasingly compete to attract applications from fixed service networks, and to displace fixed network operators. This trend will be spearheaded by mobile-only operators.
- The need for new entrants to control factors determining product definition and cost competitiveness means that they will have a bias towards building in the build/buy decision. This will be offset by the oversupply of existing or potential backbone capacity.

10.6 overall findings and conclusions

A range of issues have been highlighted that need to be borne in mind in the analysis of supply, demand and price of bandwidth. Major themes are covered below.

10.6.1 CAPACITY AND INVESTMENT INCENTIVES

- The excess of existing utilised and potential capacity over demand is, in aggregate, between two and five orders of magnitude. In this environment there is some disincentive for further investment in transmission infrastructure.

New investment will be considered where:

- there is a committed demand;
- there is a high likelihood that average prices will stay ahead of incremental costs by a good margin; and
- there are special requirements for dedicated infrastructure (for example utility security considerations).

- Constraints exist in access networks and the resources that carriers with market power might care to devote to meeting customer needs within a reasonable time.
- It is understood that carriers favour the build option in a build/buy decision in order to have control over their own product development and commercial destiny. Increasingly, however, this preference is being applied to intra-city capacity, and to thick routes connecting centres of high and growing demand in eastern Australia, rather than across the board.
- Investment in Australia also depends on our ability to attract funds into Australia from the rest of the world. Within Australia investment is likely to continue in the thick inter-capital and main regional centres and slowly spread to other thinner routes in regional areas.

10.6.1.1 market concentration

- Capacity is heavily concentrated in the hands of six of the 31 licensed carriers. Of those, only two have significant bandwidth capacity outside the eastern capitals and inter capital routes. Only Telstra has a ubiquitous trunk network to provide for high bandwidth demand nationally.
- Competition is critical to converting cost reductions achievable through new technology to price reductions enjoyed by customers, and to stimulate innovation in bandwidth-intensive service and applications development.
- Competition is uneven in its spread, and the benefits of competition are likely to be similarly uneven.
- The policy issue is how best to create competitive effects. The creation of tradeable usage rights and the development of a spot market as a result, is one way, but the effect of such an approach on underlying investment in infrastructure needs to be considered further.

10.6.1.2 applications content development

The critical factor for the demand for services employing backbone bandwidth is the development of applications and content that are valued by end users. The development of a wholesale market for bandwidth and unit price reduction through technology and competitive effects will stimulate the development of bandwidth intensive applications that would have been prohibitively expensive to deliver in previous times. Applications development would appear to be the single greatest opportunity for targeted intervention by Governments as policy makers and major users.

10.7 implications

The implications of these findings on future policy directions are further outlined in chapter 11.

chapter 11

IMPLICATIONS FOR THE INFORMATION ECONOMY AND THE WIDER ECONOMY

There are no physical constraints on backbone bandwidth capacity that are likely to have a material effect on the evolution of the information economy, with the possible exceptions of some of the smaller towns, particularly in regional and remote areas. There are, however, constraints in the customer access network.

There is also some evidence that the risks of economic constraints to bandwidth availability are generally not significant for the adoption of e-commerce, but may impact on the further development of e-commerce.

There is some evidence that advances in telecommunications and information technology involving the use of bandwidth hungry applications have been, and will continue to be, strong contributors to Australia's economic growth. These advances will be accompanied by significant structural adjustments in the economy as traditional ways of doing business are converted to an Information Economy framework.

11.1 introduction

Term of reference 3(a) requires an analysis of the degree to which there is a risk of constraint on the availability of bandwidth in any significant part of the Australian telecommunications network, especially the trunk network, over the next five years which is likely to have a material effect on the evolution of the information economy in Australia; and consideration as far as practicable of the costs of such constraints to the wider economy.

11.2 the risks of constraint in the availability of bandwidth

In chapter 5 of this report, it was found that bandwidth capacity currently installed is adequate to meet current and likely future demand for the next five years, although there are some isolated capacity constraints in some of the smaller towns (and surrounding regional and remote areas). Stakeholders also expressed the view that there is a problem with bandwidth availability in the customer access network, especially in regional and remote areas. In most of these cases where there may be some capacity constraint, it was found that this capacity could be increased substantially at relatively short notice, subject to commercial considerations. In general therefore, there is no apparent infrastructure problem in backbone bandwidth capacity that might give rise to risks of constraints to growth in the Information Economy. Problems with access may need to be addressed however.

There is also some evidence that the cost of bandwidth is not generally perceived by business as a constraining factor—at least not as it relates to their present levels of e-commerce activity.

Firstly, bandwidth is one of a number of inputs to the costs associated with e-commerce. The Telstra case studies commissioned for this inquiry show that the price of bandwidth is often a relatively minor cost of doing electronic business—marketing and web-site development costs are often much more significant.[1] The costs of bandwidth may also be outweighed by the efficiency gains to be made from going online.

1 Refer to the Case Study Report: Doing Business in the information economy, on the CD attached to this report.

Other factors may well present a bigger hindrance to development of the information economy, for example the costs of developing new content and better web sites, e-commerce security and protection of intellectual property rights.

Secondly, prices of bandwidth have fallen and forecasts indicate that they will continue to fall (although not perhaps as fast as the underlying cost of supply is falling). In chapter 9 it was found that wholesale prices of bandwidth in intra-capital and inter-capital city and other thick route markets are expected to decline by 30 to 50 per cent per year for each of the next five years.

Modelling work has indicated that the economy responds positively and strongly to more efficient pricing of telecommunications bandwidth. For instance, a Productivity Commission report on National Competition Policy reforms found that a 25 per cent reduction in subscriber trunk dialling call prices and a 30 per cent reduction in international call prices between 1991 and 1997 had increased real gross domestic product by 0.8 per cent per annum, with beneficial flow-on effects for incomes and real consumption.[2] These benefits were found to be shared across most regions in the economy (with remote regions generally benefiting more than relatively densely settled areas).

Given the above conclusions and the 30 to 50 per cent per annum reductions in wholesale bandwidth predicted in chapter 9 of this report, a significant boost to overall Australian economic growth can be expected from this source over the study period. The extent to which the wholesale level savings will be passed on to retail markets will of course depend upon the level of price competition in those markets.

While the cost of bandwidth may not be a significant constraint on firms to engage in online commerce, businesses did express concern about the impact of bandwidth costs on their customers. From an e-commerce perspective, the interests of suppliers are best served by having their customers and potential customers permanently connected to the Internet. In this respect, US and Canadian flat-rate residential pricing models facilitate consumers remaining connected either permanently or for long periods of time. Some Australian ISPs have moved towards flat-rate, *all you can eat* pricing packages (though a variety of constraints can apply to these packages). However, the underlying cost model, which is based

2 Productivity Commission 1999, *The Impact of Competition Policy Reforms on Rural and Regional Australia*, Report, plus supplementary paper on *Modelling the Regional Impacts of Competition Policy Reforms*, Productivity Commission, Melbourne, available from Internet site: *www.indcom.gov.au/pcpubs/reports.html* or Ausinfo.

upon volume charging, means that such packages are only sustainable where average volume flows remain relatively low. As such it would dampen demand for bandwidth hungry services such as entertainment. These potential constraints were not analysed in the context of the case studies and thus no firm conclusions can be drawn on their over-all impact.

11.3 macroeconomic impacts

11.3.1 BANDWIDTH AND E-COMMERCE — HOW DOES AUSTRALIA COMPARE?

How does Australia compare in developing its online environment? One issue is whether there is a 'first mover advantage' from investing in e-commerce. Firms, and perhaps even countries, are capable of pre-empting the market for e-commerce by taking advantage of the large fixed costs and indivisibilities of investment (see Tirole 1988 for a theoretical discussion).[3] Another consideration is whether there is 'learning by doing'. Firms (and again even countries) may establish absolute cost advantages through superior production techniques learned through experience with e-commerce. There are attendant risks in being a first mover, in terms of the potential to mis-read the market opportunities. Nonetheless, the Inquiry believes that Australian business needs to be actively seeking opportunities both to lead the way in online developments and to react quickly to developments elsewhere (i.e. to be a *fast follower*).

There is a general understanding that we are approximately two years behind the US in our Internet and e-commerce development. The CERP demand study for this report for example, reflects the assumption that we are mirroring US developments with a significant time lag.

According to a major study by the Department of Foreign Affairs and Trade, Australia can be seen as a 'second-wave' country in terms of its Internet development, behind the 'first-wave' of the US, Canada and some Nordic countries.[4]

A major UK government study puts Australia ahead of Britain in relation to e-commerce: 'The UK lags behind the major economies of USA, Canada and Australia on measures of both business and consumer e-commerce use. In Europe,

3 Tirole, J., 1988, *The theory of industrial organisation*, MIT Press, Cambridge, USA at p. 346.

4 Australia, Department of Foreign Affairs and Trade, Trade and Economic Analysis Branch 1999, *Creating a clearway on the new silk road—international business and policy trends in Internet commerce, www.dfat.gov.au/nsr/clearway.pdf*

the UK is also substantially behind the smaller economies of Finland, Sweden and Norway. Germany may well overtake the UK this year and France, after a slow start … is catching up fast.'[5]

Elsewhere in this report we have found that:

- there has been a high level of growth in economic activities that are intensive users of communications bandwidth, leading to burgeoning growth in the demand for bandwidth itself;
- significant growth in the ability to supply bandwidth; and
- this growth is, on the balance of available evidence, likely to continue in the near future at an even higher pace than that experienced to date.

The remainder of this chapter explores the macroeconomic implications of this level of growth in bandwidth demand and supply. The impacts on aggregate economic growth, employment, savings, investment, the balance of trade, inflation and demography are considered.

Bandwidth growth is likely to have had, and to continue to have, significant effects on the wider economy, though we are not able to quantify the aggregate impacts precisely, because we are unable to determine:

- how much of the observed growth in bandwidth represents a substitution for existing consumption and production activities, and is thereby simply displacing existing activities; and
- how much represents new demands and new production possibilities.

11.3.2 FACTORS AFFECTING AUSTRALIA'S ECONOMIC GROWTH

Australia has experienced strong macro-economic growth[6] and strong growth in overall productivity[7] in recent years. The causes of this growth are likely to include both the increased demand for new information technology goods and services, and improvements in productivity brought about by their use. While we can be confident about these effects in principle, it is difficult to determine how much of this growth is due to developments in bandwidth-using activities.

5 Performance and Innovation Unit, UK Cabinet Office 1999, *E-commerce@its.best.uk*, downloaded from the Internet @ *www.cabinet-office.gov.uk/innovation/1999/ecommerce/index.htm/ec_body.pdf*, UK Cabinet Office, London.

6 Treasury 1999, *Statement 2 of the Commonwealth Budget: Economic and Fiscal Outlook* and *Economic Roundup*, Winter, downloaded from Internet site: *www.treasury.gov.au*

7 Parham, Dean 1999 '*The new economy? A new look at Australia's productivity performance*', Productivity Commission Staff Research Paper, June, downloaded from Internet site: *www.indcom.gov.au*

It is highly likely that observed productivity growth has been due to a combination of factors, including:

- recovery from recession;
- dividend from micro-economic reform; and
- underlying 'disembodied' technological advances (as opposed to those captured in capital input measures).[8]

Advances in telecommunications and information technology are the most likely contributors to the last of these causes of productivity growth, because these advances are those most likely to have contributed to disembodied change, through organisational and management improvements, as opposed to technological changes that are embodied in capital inputs.

Moreover, the recent upsurge in macroeconomic and productivity growth coincides in timing with the widespread adoption by business and government in Australia of recent advances in information technology and telecommunications, such as personal computers, computer networks, fibre optic communications, mobile telephony and the Internet (including email and the World Wide Web). The United States has experienced a similar boost to its economic growth.

11.3.3 RELATIONSHIP BETWEEN USE OF BANDWIDTH AND ECONOMIC GROWTH

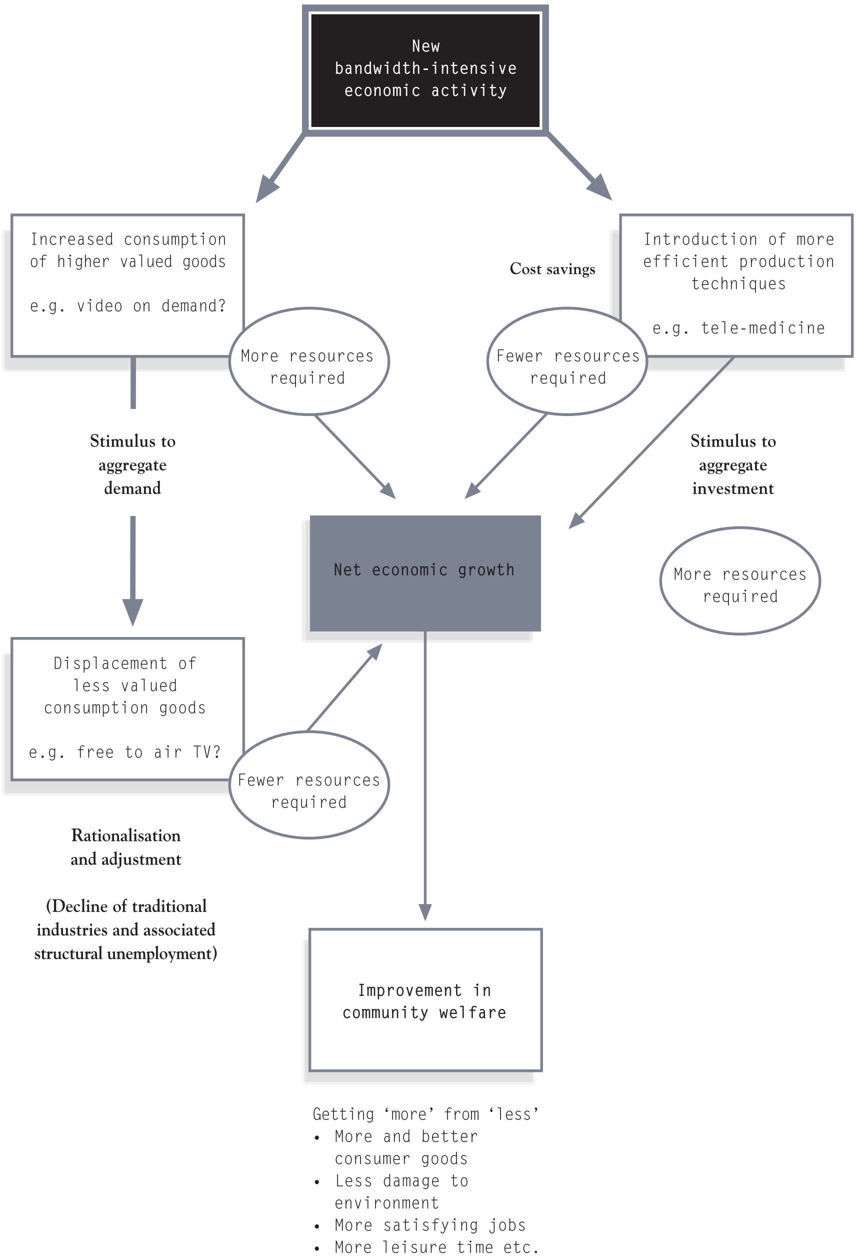
A simple model of how new bandwidth-intensive economic activities may contribute to economic growth and improvements in community welfare is sketched out in figure 11.1. It is composed of two primary effects.

The first effect is on the consumption side of the economy, where new higher-valued consumption goods such as the Internet may provide a stimulus to aggregate demand, through purchases of computers, peripheral equipment and telecommunications services. At the same time, however, there is likely to be some demand substitution and some displacement of established consumption patterns: for example, the time that people spend surfing the Internet may well be a substitute for time spent watching television.

8 Parham *op. cit*. p. 14.

Figure 11.1

MACROECONOMIC EFFECTS OF NEW BANDWIDTH-INTENSIVE ECONOMIC ACTIVITIES—EFFECTS ON CONSUMPTION, RESOURCE USE AND ECONOMIC GROWTH



A recent report attributes only six per cent of online commerce in 1999 to incremental sales, that is, those that would not have occurred otherwise through traditional retail channels.[9] Even so, it appears that there will be some net increase in aggregate demand, although it is not likely to be as great as the gross increase in demands for the new products.

The second effect is on the production side of the economy. Intensive use of bandwidth may be included in the introduction of new more efficient production techniques, such as more cost-effective management and organisation. This may introduce some overall cost savings through shedding of resources no longer required. In turn, this could involve associated structural unemployment and 'rust belts' of disused capital. However, on balance, the effects are likely to be positive, through the associated stimulus to aggregate investment required by retooling for the information economy, and through the demand stimulus made possible by the scope for increased production and consumption from a given supply of resources.

While the expected effect is a net increase in aggregate economic growth, it can be seen from figure 11.1 that there are both negative and positive effects arising from the more intensive use of bandwidth, so that the answer derived from theoretical analysis alone is ambiguous. Similar ambiguity applies to the likely impacts on inflation, employment and trade balances.

11.3.3.1 inflationary impacts

A crude analysis of the impact of bandwidth might be that it will increase the velocity of circulation of money in the economy, through increased use of digital cash transactions, and therefore have an inflationary impact. However, this would ignore the advances that have been made in recent years in bringing inflation under control through more prudent management of government spending and taxing policies and independent monetary policies of central banks such as the Reserve.

11.3.3.2 effects on aggregate employment

As far as aggregate employment is concerned, it is likely that there could be significant structural adjustments as traditional ways of doing business are converted to an information economy framework. For example there may be less

9 Jupiter Communications 1999, *Digital commerce growth will be at expense of off-line dollars*, downloaded from the Internet on 10 August, 1999 from *www.jup.com/jupiter/press/releases/1999/0804.html*

demand for 'behind the counter' staff and more demand for 'behind the scenes' staff to the extent that business is done electronically instead of in person. It is apparent that this is already happening in many areas, for example, in banking. The skills required for these new labour demands are likely to be quite different, leading to a need for significant retraining and reorganisation of the workforce. In the meantime, there may well be skill shortages in some areas such as information technology and a surplus in other areas, particularly the unskilled. This could lead, at least in the short term, to increases in wage rates for scarce skills and a redistribution of income and wealth towards those with such skills.

In these circumstances, it is important that governments ensure that their education policies monitor and respond quickly and positively to structural changes in the skills mix and shifts in labour demand.

11.3.3.3 impacts on trade balances

The effects on trade balances are similarly ambiguous. Australia has become a major net importer of both computer and telecommunications equipment and of Internet data (mostly from the United States) to support the move to the Information Economy.

Apparent trade imbalances are little more than a symptom of the economic principle of comparative advantage plus differing underlying propensities to save and invest across countries, with matching imbalances on capital accounts going in the other direction.

The Internet can be a major force in improving Australia's competitive position. The Internet drives down the cost of transacting business by lowering the cost and improving the efficiency of communications with trading partners. It also improves the distribution and transport of goods and there are greater efficiencies in the processing of payments and improvements in cash flows.

One of the underlying keys to success is affordable and abundant bandwidth to enable such systems to develop and usage become widespread. Improving Australia's trade balance also has flow on effects to employment and taxation. However, if applications and/or content move offshore to environments seen to offer better bandwidth, there are potentially negative effects for both employment and the tax base.

11.3.3.4 effect on overall community welfare

The next step, converting economic growth as conventionally measured, into an improvement in overall community welfare, requires even further analysis. It may be the case that improvements in productivity engendered by the online environment are likely to provide greater flexibility in the economy to cater to individual and community needs. However, many other issues would need to be analysed in detail before such a proposition could be said to be supported by the evidence. These would include:

- the relationship between improvements in efficiency engendered by the Information Economy and potential external costs such as increased isolation or a breakdown in the social fabric;
- whether the distributive effects of change would be regarded as beneficial to everyone; and
- the extent to which people actually take advantage of improved consumption and production possibilities to give themselves more satisfying lives.

These issues cannot be resolved by abstract theorising alone. A more robust investigation would require detailed empirical analysis, although it is still likely to be incomplete due to the limited data available and inadequacies in current economic modelling tools.

11.3.3.5 computable general equilibrium modelling

The strongest contenders for analysing these issues are computable general equilibrium (CGE) models such as the MONASH model developed by the Centre of Policy Studies at Monash University,[10] the ORANI model (a forerunner of MONASH) developed by the now defunct Impact Project,[11] the Access Economics CGE Model[12] and the suite of Murphy models developed by Econtech Pty Ltd.[13] The most thoroughly documented of these models is the ORANI model, but it has now been superseded by the MONASH model.

These kinds of models provide for detailed inter-industry analysis built around the Input-Output and National Income accounting frameworks produced by the

10 See for example, Dixon, P. and Rimmer, M., 1998, *Forecasting and policy analysis with a dynamic CGE model of Australia*, Preliminary Working Paper No. OP-90, Centre of Policy Studies, Monash University, June.

11 Dixon, P.B., Parmenter, B.R., Sutton, J., and Vincent, D.P. 1982, *ORANI: a multisectoral model of the Australian economy*, North Holland.

12 See for example, Access Economics 1997, *Modelling policy options for assistance to the Australian automotive industry*, submission to the Industry Commission inquiry into the Automotive Industry, April.

13 See for example, Econtech 1997, *National, regional and adjustment implications of reducing car tariffs*, submission to the Industry Commission inquiry into the Automotive Industry by the South Australian Government.

Australian Bureau of Statistics. The wider economic effects of bandwidth will require such detailed analysis because of the complex and far reaching flow-on effects of substituting bandwidth intensive activities for traditional consumer goods and ways of doing business as discussed above. Ultimately, this requires analysis of items in the economy such as the balance of trade and balances between income and expenditure accounts at the macro level. In this regard, it is necessary that the model be 'closed' in all respects; that is, the model needs to determine internally (or endogenously) all the things that are ultimately internal to the policy problem being analysed. For example, aggregate expenditures in the economy should generally be directly related to aggregate incomes.

While they have limitations that are well-known to modelling practitioners and which have lead to strenuous efforts to achieve improvements in modelling techniques over many years,[14] computable general equilibrium models do provide a structured framework for analysis. To structure this analysis satisfactorily, the database and all the assumptions underlying these models need to be open to scrutiny. This contributes to an understanding of why the model produces the results that it does; and if there is surprise or disagreement with the results, the focus of debate can be narrowed to the source of differences.[15] Debate over such assumptions can in itself be a useful process in generating further insights into how the economy actually works and how this can be realistically modelled.

The National Office for the Information Economy (NOIE) commissioned a joint study with selected industry partners to measure the wider economic effects of e-commerce on the Australian economy.[16] In particular, the study sought to examine the impact of e-commerce on gross domestic product, aggregate employment, productivity, and competitiveness, as well as on industry sectors and geographic regions. The study used the MONASH model. It provided some indications of how to go about modelling the wider economic effects of moving to an economy with extensive access to broadband technologies.

The study found that a growth dividend could be expected if the productivity gains from more efficient modes of operation are realised. It estimated that these gains could result in a 2.7 per cent increase in the level of national output and

14 Current CGE models generally assume all markets are perfectly competitive with constant returns to scale and scope. They are not therefore well suited to analysis of monopolistic competition and oligopoly such as is typical in telecommunications markets, nor of the consequences of economies of scale or of external costs and benefits. Other problems are discussed in Pagan, A.R. and Shannon, J.H., 1987, 'How reliable are ORANI conclusions?', *The Economic Record*, 63(180), March, pp. 33–45.

15 Industries Assistance Commission 1986, *A guide to the IAC's use of the ORANI model*, Industries Assistance Commission, October.

16 National Office for the Information Economy 1999, *E-commerce beyond 2000*.

enhance wellbeing by more than $10 billion within the next decade. The sectors that are most amenable to e-commerce such as media and entertainment, and banking and finance, will be the biggest beneficiaries. There is also likely to be flow on effects to other industries such as housing. In other industry sectors, such as retail and wholesale trade, there are likely to be some negative impacts due to structural effects of e-commerce on these services.

The study also found that a flow on impact of the productivity gains and growth could temporarily lead to deterioration in the balance of trade. However, looking into the medium term the export enhancing benefits are likely to outweigh other factors and the trade situation is expected to improve.

Further work is being undertaken to complement work already undertaken to further examine the impact on rural Australia.

11.3.4 DIFFICULTIES IN PREDICTING MACROECONOMIC EFFECTS

At this stage there are problems with even specifying the inputs that would have to be entered into a CGE model in order to analyse the macroeconomic effects of increased bandwidth. In particular, the size of the *impacts* that wider bandwidths are imposing and are likely to continue to impose on the economy are largely unknown. This, in turn raises issues like:

- how much productivity gain is achieved from wider bandwidth (versus other sources of gain); and
- the appropriate benchmark against which to measure these *impacts*.

11.4 possible further work

Outputs from this report provide a basis for better defining the *impacts* which would need to be fed into a general equilibrium model for the purpose of analysing the macroeconomic effects of wider bandwidths. There is considerable scope for a more detailed examination of these wider economic effects which could be undertaken in the light of this report and the outcome of the NOIE project to examine the wider economic effects of e-commerce.

chapter 12 — part 1

REGULATION OF SUBMARINE CABLES AND INTERNATIONAL CHARGING ARRANGEMENTS IN RELATION TO THE INTERNET

Submarine cables form an important part of trunk networks in Australia and carry the overwhelming majority of data and voice to international destinations;

The regulatory framework for the installation and protection of submarine cables needs clarification:

- carriers argue they have neither explicit authorisation to install nor adequate protection and compensation for damage to existing cables; while
- the fishing and shipping industries are concerned about damage resulting from contact with cables; and
- the relationship between Commonwealth and State and Territory legislation is not clear to stakeholders.

The authorisation and protection framework currently in place in New Zealand could provide the model for an Australian solution.

12.1 introduction

Term of reference 2 calls, in part, for the analysis of the implications of regulatory arrangements relating to the installation of backbone network infrastructure, in particular submarine cables, at all levels of government. This chapter explores the current role of submarine cables in the provision of bandwidth and recommends possible improvements to the regulatory context in which they operate.

12.1.1 IMPORTANCE OF SUBMARINE CABLES

Submarine cables are the underwater trunk network connections linking the Australian telecommunications network with other continents or, in some cases, linking places within Australia separated by water. Estimates provided by Telstra indicate that over 95 per cent of international telecommunications traffic to and from Australia is routed via submarine cables. In the case of major destination traffic (USA, UK, Germany and Japan), the proportion of traffic routed via submarine cables is closer to 98 per cent.

There are currently twelve submarine cables landing in Australia: six in or around Sydney (including one which also lands at Norfolk Island); two in Cairns; two near Perth; one at Port Hedland; and one which crosses between Sandy Point (Victoria) and Boat Harbour (Tasmania). These cables include both coaxial systems and newer generation fibre optic systems, of which there are two basic types:

- lightweight (armourless) cable, generally laid in water depths of greater than 1 000 metres and protected by a sheath of polyethylene; and
- armoured cable, generally laid in water depths of less than 1 000 metres and protected by one or more layers of steel wires.

Reliance on submarine cables for international communications is likely to increase over the next five years. Data traffic currently exceeds voice traffic on Telstra's telecommunications network,[1] and most of this travels internationally via submarine cable. Telstra's investment in this network is substantial; the corporation's key asset has been described as the fact that it is one of the largest

1 Telstra Corporation, *Telstra Annual Report*, 1999, p. 16.

owners of submarine cables in the world.[2] With the installation of major new submarine cable networks, such as the Southern Cross Cable, international bandwidth capacity to and from Australia is set to increase even more.

The Inquiry welcomes recent changes to the tax system which will make it more attractive for Australian companies to invest in international submarine cable systems. In response to the recent Review of Business Taxation, the Government has announced it will allow telecommunications companies to write off their investment in submarine cables by treating them as depreciable assets. Companies who have indefeasible rights of use (IRUs), currently cannot write off expenditure until the right expires, which is usually at the end of the cable's life. IRUs are arrangements under which owners of cable systems grant rights over cable capacity to other carriers. IRU holders pay for maintenance and installation costs in proportion to the capacity of the cable they have the right to use.

All these factors form a context of bandwidth provision and demand in which submarine cables play a vitally important role. As their importance increases, so does the cost of cable failure or damage and the need for clarity of the regulatory climate in which submarine cable owners operate.

12.2 current regulation of submarine cables

There are three main identified areas of legislative importance for submarine cables:

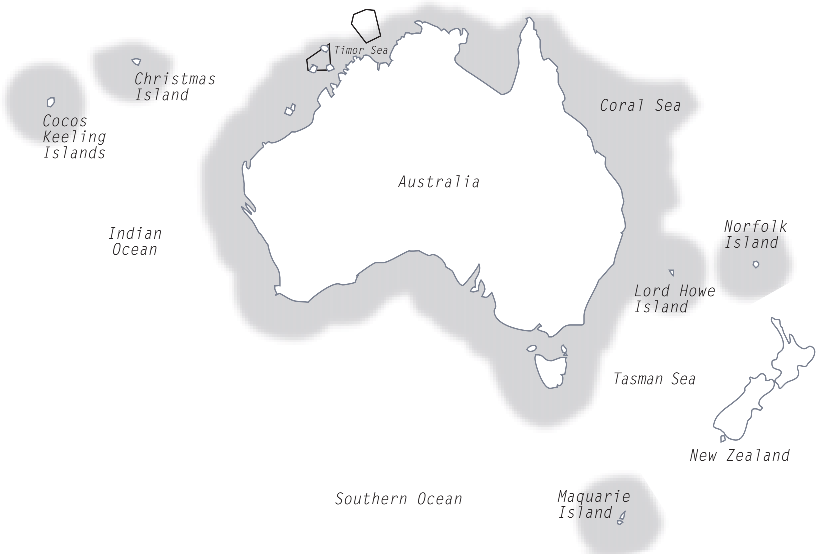
- authorisation to install;
- installation; and
- protection.

The existing legislative framework is complex, both for reasons of jurisdictional control over different parts of the seabed and because of the number of pieces of relevant legislation.

The Commonwealth has both sovereignty and title at international law (though no current assertion of proprietary ownership at domestic law) over the seabed lying between 3 and 12 nautical miles (nm) from the territorial sea baseline. The Commonwealth has sovereign rights over the continental shelf extending from the outer limit of the territorial sea to at least 200 nm from the territorial sea baseline. This area is known as the Exclusive Economic Zone (EEZ) and is almost twice as large as Australia's land mass.

2 Elliott, G., 'Seducing Ziggy', *Weekend Australian*, 16/10/99, p. 35.

Figure 12.1
AUSTRALIA'S EXCLUSIVE ECONOMIC ZONE (EEZ)



The States and Territories have jurisdiction over and proprietary ownership of the seabed out to 3 nm from the territorial sea baseline, as well as land where cables emerge from the sea.

Telecommunications providers wishing to install submarine cables are, therefore, required to comply with State and Territory laws for installation of undersea cables within areas covered by their jurisdiction. Commonwealth legislation may provide for exemptions from requirements to comply with some or all State or Territory laws in the installation of submarine cables, but no explicit exemption currently exists.

In addition to State and Territory laws, the installation of submarine cables must also comply with Commonwealth legislation in both the 3 to 12 nm territorial waters and the 12 to 200 nm EEZ. This legislation includes the:

- *Submarine Cables and Pipeline Act 1963;*
- *Limitation of Liability for Maritime Claims Act 1989;*
- *Crimes Act 1914;*
- *Coastal Waters (State Powers) Act 1980;*
- *Coastal Waters (State Title) Act 1980;*
- *Seas and Submerged Lands Act 1973;*

- *Sea Installations Act 1987;*
- *Foreign Acquisitions and Takeovers Act 1975;*
- *Telecommunications Act 1997;*
- *Environment Protection (Impact of Proposals) Act 1974;*
- *Endangered Species Protection Act 1992;*
- *National Parks and Wildlife Conservation Act 1975;*
- *Sea Installation Act 1987*;
- *Native Title Act 1993;*
- *Great Barrier Reef Marine Park Act 1975;* and
- *Environmental Protection and Biodiversity Conservation Act 1999*.

No Commonwealth legislation explicitly provides authority for the installation of submarine cables. However, the *Environmental Protection and Biodiversity Conservation Act 1999* and the *Sea Installations Act 1987* both require persons to seek the authority of the Commonwealth to use the seabed for international cables.

12.3 options for change

Several possible changes to the current regulation of submarine cables have been identified and these include:

- strengthen existing penalties for cable damage;
- bring cable installation regulation more clearly under the broader telecommunications framework (by, for example, determining submarine cables to be low-impact facilities);
- include submarine cables under regulatory provisions which currently regulate other marine installations; or
- create new legislation specific to submarine cables along the lines of New Zealand's *Submarine Cables and Pipelines Protection Act 1996* (which establishes exclusion zones around cables and provides strong powers to enforce those zones).

During the consultation process a variety of comments were received on these options for change.

12.3.1 PLANNING REGIME

It was commonly acknowledged that the current legislative framework is complex and falls across the administrative remit of several agencies.

Most of the submissions stressed the necessity for a regime which more explicitly authorised the installation submarine cables and offered better protection to cables in situ. A different approach was advanced by MCI WorldCom which proposed that submarine cables should be declared as low-impact facilities under the *Telecommunications (Low Impact Facilities) Determination 1997* (the LIF Determination), thereby providing authorisation to install and exempting installation from State and Territory laws. Environment Australia (EA), however, objected to this approach on the grounds that submarine cables are not necessarily of low impact to the environment. EA further argued that States and Territories should appropriately be responsible for regulating such facilities in their waters. The Inquiry is of the view that the LIF Determination would be a less than optimal mechanism for the regulation of submarine cables and that other approaches outlined below would be preferable. The Inquiry also notes that there is no evidence at this stage that either environment protection or State and Territory laws are impeding the rollout of submarine cables landing in Australia.

Implicit in the discussion of regulatory change was the recognition that there are many stakeholders in the seabed, and that it is crucial to find a way to meet the needs of all these stakeholders and to resolve any conflicts fairly. EA highlighted the importance of establishing a planning regime which recognised the priorities of all parties with an interest in the seabed. This theme was also touched upon in the submission from C&W Optus, which suggested the need for a mechanism to co-ordinate the process of access, the settlement of conflicting use and the assessment of environmental impact. Southern Cross Cables also stressed the need for increased certainty regarding the rights and responsibilities of seabed stakeholders.

The availability of accurate information on cable location was also raised. Queensland Transport pointed out the importance to navigational authorities of accurate positioning information about submarine cables both for the purpose of navigational aids and warnings to mariners. The need for improved information on cable location was also stressed by the Australian Fisheries Management Authority.

12.3.2 ENVIRONMENTAL CONSIDERATIONS

Despite the suggestion that a more explicit planning regime was necessary, environmental and State and Territory agencies argued against any moves to exempt submarine cables from their planning and environmental protection regimes. Environment Australia was also opposed to any changes which might limit or exclude cables from the application of the *Environment Protection and Biodiversity Conservation Act 1999*, or from any other environmental legislation. The Great Barrier Reef Marine Park Authority had similar concerns and explained that under the provisions of the Great Barrier Reef Regulations, an environmental impact assessment process was required in order to ensure that environmental, cultural, and other factors are taken under consideration by potential cable installers and operators.

While the Inquiry believes that better protection for cables is necessary, it agrees that submarine cables should be installed in accord with existing environment protection laws. This recognises that parts of the seabed are of significant environmental importance, and that seabed installations should be required to meet applicable environmental requirements. The Inquiry notes, however, that there is no evidence to suggest a conflict between existing environment protection laws and current industry practices in relation to the installation and operation of submarine cables.

12.3.3 LIABILITY AND COMPENSATION

More than 80 per cent of repairs to submarine cables occur at depths of less than 1 000 metres, and are due to external factors rather than factors relating to faults intrinsic to the cable itself.[3] Fishing activities, and in particular certain procedures involving trawling or dredging equipment, are most likely to damage submarine cables in place, although anchoring, mining and other seabed activities could also cause damage.

The question of liability and compensation for damage to both submarine cables and fishing or other equipment is an issue. MCI WorldCom argued that the existing provisions to prevent cable damage were inadequate and did not give a real incentive for other seabed users to avoid submarine cables. If damage did occur, it argued that only limited relief for carriers was provided, and that penalties for damage should be substantially increased.

3 Williams, D.O., 'An Oversimplified Overview of Undersea Cable Systems'. European Laboratory for particle Physics (CERN). Geneva, 1999. *http://nicewww.cern.ch/~davidw/public/subcables.html*, October 1999.

NSW Fisheries, on the other hand, suggested that compensation for damage or loss of fishing gear, or of fishing fields in the vicinity of submarine cables, may be an issue for the fishing industry. NSW Fisheries indicated that a model incorporating exclusion zones might have benefits for the fishing industry provided the zones were carefully chosen in consultation with interested parties. It also stressed the importance of ongoing consultation with the fishing industry on the issues associated with submarine cable regulation.

The Commonwealth is currently proposing to increase the limits contained in the *Limitations of Liability for Marine Claims Act 1989* to reflect proposed changes to the United Nations Convention on Limitations for Marine Claims which would significantly increase liability limits based on the size of the ship involved. In the event, however, that the necessary legislative amendments were passed by the Commonwealth Parliament, Australia would remain bound by the existing Convention and could not give effect to increased limits until the Protocol amending the Convention entered into force internationally (90 days after at least ten countries have expressed their consent to be bound by the Protocol). It is understood that a number of countries are in the process of consenting to this agreement, and that it could be in effect internationally within the next year.

A related issue is the level of penalties which apply to parties found to have damaged submarine cables. This is currently set by the *Submarine Cables and Pipelines Protection Act 1963*. The Inquiry recommends an increase in fines under this Act, with the view that this would more effectively deter avoidable damage.

It follows that in order to be an effective deterrent, increased liability limits and fines for damage must be enforceable. The Inquiry is of the view that an improved enforcement framework is required which more effectively identifies culpable parties and imposes applicable fines. New Zealand's *Submarine Cables and Pipelines Protection Act 1996*, discussed below, could provide an appropriate model.

12.3.4 NEW ZEALAND MODEL

In the period preceding the discussion paper, carriers proposed that the Government consider adopting a legislative framework similar to that enacted in the New Zealand *Submarine Cables and Pipelines Protection Act 1996*. That legislation provides for:

- the Governor-General to declare any area within the internal territories, territorial sea or exclusive economic zone of New Zealand to be a protected area, usually being areas around submarine cables (section 12);

- prohibition of certain activities (fishing operations and the anchoring of ships) in protected areas (section 13);
- the evidence of specified enforcement or protection officers and approved maritime surveillance equipment about the location of ships and certain conduct by ships to be prima facie evidence of those matters in proceedings brought before a court (section 13(4) and (5));
- protection officers to order ships from protected areas or seize equipment in certain circumstances (section 17 and 18); and
- the Minister to appoint persons to be protection officers (section 16).

However, this model does not include any provisions explicitly authorising the installation of cables or any regulations regarding installation itself.

In consultations three organisations suggested using the New Zealand Model.[4] The carriers suggested there is a strong case for introducing legislation which could impose protected areas into which submarine cables could be laid. Southern Cross Cable Network found this model attractive because of the long term certainty and security it could offer to all seabed stakeholders. NSW Fisheries was also of the opinion that consolidating cables into one location, which is the expected effect of defining protected areas, would limit impact on the aquatic ecosystem and prevent damage to fishing gear. The other submissions did not express an opinion on this specific issue, although there was widespread agreement that there are problems with the current regulatory system regarding submarine cables.

Under the New Zealand Act, the evidence of protection officers regarding the location and conduct of ships in the protected zones is prima facie evidence before a court. It is the Inquiry's view that this certainty regarding responsibility for damage, combined with increased fine and liability limits, would serve as a strong deterrent from cable damage.

In summary, the problems with the current regulatory framework were thought to be:

- lack of explicit authorisation to install submarine cables, and insufficient protection of cables once they are in place;
- multiple legislative obligations imposed on carriers installing cables; and
- ineffective enforcement regime and inadequate penalties in relation to cable damage.

4 These three submissions were from NSW Fisheries, Southern Cross Cable Network, and Cable and Wireless Optus, which contained input on the issue from Telstra.

12.4 recommendations

Australian regulatory arrangements for the authorisation, installation and protection of submarine cables need to be clarified and, in some instances, strengthened.

The Inquiry recommends that:

1. The planning and protection regime for submarine cables to and from Australia be strengthened. New Zealand's *Submarine Cables and Pipelines Protection Act 1996* appears to provide an appropriate model.

Flowing from the need for greater protection and planning certainty is the necessity for a clearer and more explicit authorisation framework for the installation of submarine cables. The Inquiry therefore recommends:

2. More explicit authorisation to install submarine cables be included in legislative provisions regarding cable protection and planning.

Existing liability limits and penalties for damage are ineffective as deterrents to avoidable damage to submarine cables. The Inquiry recommends:

3. The penalties for damage (and limits on liability) to cables should be increased at the earliest opportunity in order to create a more effective deterrent to unnecessary disruption of these key elements of the national information infrastructure.

The Inquiry recognises that these recommendations have significant implications for other seabed users. Planning considerations need to be carefully examined to fairly balance the needs of various seabed stakeholders. The Inquiry therefore recommends:

4. That any new provisions for the regulation of submarine cables be developed in consultation with other stakeholders, including the fishing, shipping, and other maritime industries, environmental agencies and relevant State and Territory agencies.

chapter 12 — part 2

INTERNATIONAL CHARGING ARRANGEMENTS IN RELATION TO THE INTERNET

The current international charging arrangements for Internet services are inequitable as:

- Australian ISPs do not get reimbursed for carrying US-generated traffic on the trans-Pacific link; and
- Australian ISPs are not reimbursed (or revenue offset against the cost of accessing US networks) for carrying US-generated traffic on their Australian domestic Internet networks.

The effect of this is that Australian ISPs' costs to provide Internet services is higher than it should be and all Australian Internet users are paying more for Internet access than would be the case under a more equitable arrangement. Australian ISPs and Internet users are also subsidising US ISPs and their customers, which has implications for Australia's international competitiveness.

The Government has been working on getting this issue addressed via multi-lateral fora, such as the WTO, the ITU and APEC.

12.5 introduction

This part provides a brief overview of current international charging arrangements for Internet services, in particular between Australia and the US, and examines the key issues relating to such arrangements.

The terms of reference include a requirement that the Inquiry is to report on the constraints, if any, which exist on the ability of the Australian telecommunications network to meet the likely demand of an Australian information economy, including:

- determining relevant international market structure and commercial issues, including an assessment of international settlement arrangements for Internet Protocol networking.

12.6 issues

Unlike international telephony, international cost-sharing arrangements in relation to Internet traffic have not been based upon international regulations. Internet traffic has not been considered to be subject to the special treaty-based settlement systems that are applied to international telephony.

Traditionally, international voice calls are circuit switched. This means a call is carried via a dedicated end-to-end circuit (or virtual circuit) that the switching system sets up for the purpose of each call. This dedicated circuit enables the calling party to send (speak) and receive (hear) for the duration of the call. The terminating carrier provides a service to the originating carrier and bills the originating carrier, usually on a per minute of traffic basis, for completing the call (usually at half the ‘accounting rate’). The accounting rate is bilaterally negotiated between the originating and terminating carriers, usually based on the carriers’ end-to-end facilities costs.

In telephony, large capacity international links are often shared equally between carriers at either end. These are described as ‘half circuits’ joining at the mid-point of the link.

These arrangements have not applied to international Internet Protocol traffic, which is packet-switched rather than circuit-switched. This means that an Internet message is broken down into many packets that may be individually routed over many different networks to arrive at the endpoint where they are reassembled

into their original, coherent form. Individual messages therefore do not occupy a defined circuit for a defined time. Sending and receiving, whether it be email or data, are also separate activities, ie. they are not part of the same 'call' setup.

Traditionally, domestic ISPs agreed to interconnect without regard to traffic flows or financial settlement. Such arrangements for the exchange of traffic and access to another ISPs network are known as 'peering' arrangements. This reflects the assumption that these are exchanges of equal value between peers, involving no cash settlement. As such no method has been developed to measure traffic flows and settlement pricing mechanisms have not been developed.

With the burgeoning growth of the commercial Internet, the formerly insignificant data volumes have increased dramatically and ISPs of all different sizes are operating in the marketplace. As a result, the larger ISPs have not been willing to enter into domestic peering arrangements with smaller ISPs. Larger ISPs are 'peering' domestically only with other ISPs that have similar size networks and hence traffic levels. Smaller ISP are required to pay to interconnect to their networks. The large ISPs may have significant market power making it difficult for the smaller ISPs to negotiate fair prices.

Interconnection arrangements in the Internet are significantly different at the national and international levels. At the national level there are regulatory mechanisms through the *Trade Practices Act 1974* to deal with anti-competitive practices. However, at the international level Australia does not have jurisdiction over foreign carriers operating in foreign countries and the distortions may impact on Australia's ability to take advantage of the information economy.

In the US the so called *Tier 1* ISPs will only peer amongst themselves. Other ISPs both domestic and international are required to pay for the full cost of reaching their network and pay to access the major US ISPs (referred to as 'port charges').

This creates a disadvantage for ISPs in countries such as Australia as there is no reciprocal payment or offset for US-generated traffic, ie. US customers accessing Australian websites or sending emails to Australians, etc.

The current arrangements in relation to the Internet are due to the historical development of the Internet in the US, with the US subsequently developing as a global hub where the largest amount of content and largest numbers of hosts are located.

The consequences of these arrangements are that Australian consumers accessing the Internet pay more than their US counterparts because the US ISPs don't pay the Australian ISPs anything to use their international capacity to the US or their domestic Australian Internet networks to carry traffic generated by US customers. In effect Australian consumers are subsidising US consumers.

Australia is at the end of a long, thin traffic route. As such we do not appear to have any locational advantages for hubbing or site hosting and if we are to be internationally competitive we must ensure that communication costs are minimised. Therefore there is a need for more equitable cost sharing arrangements in the Internet.

12.7 current objectives and processes

The Government's general principle is that competitive market-based solutions are preferred and governments should avoid imposing unnecessary regulations. Consistent with this, Australian representatives in the relevant international fora support market-based solutions and minimum intervention by governments.

Australia's engagement in the formal international processes is directed toward supporting a consistent approach to a converged market in bandwidth-based services. If markets are operating effectively, appropriate economic results will emerge on a commercial basis, making the best of technical and commercial opportunity. The principal Government strategy for change is to exert influence in the multilateral processes that set the global regulatory environment, by building on regional and bilateral alliances with governments that share common objectives with Australia.

The principal objectives are:

- The next round of World Trade Organisation (WTO) General Agreement on Trade in Services (GATS) negotiations should result in recognition of telecommunications termination services as traded services that are subject to the standard GATS disciplines of transparency and non-discrimination, including National Treatment and most favoured nation (MFN).
- The International Telecommunication Union (ITU) should modify its basic instruments so that the International Telecommunication Regulations appropriately reflect the reduced role of governments in managing

telecommunications businesses in open and competitive markets for international telecommunication services, recognising the new technical and economic environment.

- Equivalent market-based principles as are applied to conventional telecommunications should be applied to the telecommunication elements of Internet services, with emphasis on light-touch, industry self-regulation and a minimum of new or specific regulation.

Further details on the work in International fora are at Appendix 7.

12.7.1 IMPACT OF THE CURRENT ARRANGEMENTS

Of current Australian Internet traffic, one estimate is that 70 per cent is international in origin or destination, of which at least 60 per cent has the US as its origin or destination.[5] This is compared to less than 4 per cent of telephony traffic being international in origin or destination. The 70 per cent figure largely reflects the origins and development of the Internet in the US and the US's position as the source of much popular content. Over the long term, the proportion of Internet and IP traffic that is foreign can be expected to reduce, as Internet becomes more integral to domestic communications services and patterns of use evolve more to resemble current telephony patterns.

However it is important to note that the Internet is global in nature and the charges to end users are quite unlike international telephony charges that currently reflects distance (though in many countries the distance component is diminishing rapidly). To the end user there is no perceived cost penalty involved in downloading from the US instead of Australia (though local downloads of the same material may often be faster).

Of the 70 per cent of Internet traffic that is international, 70 per cent is inbound traffic from the US and 30 per cent is outbound traffic to the US.[6] However it is not the direction of the traffic that is important but who generates the traffic. For example a small request to download from a website may generate a large traffic flow in the opposite direction. It is understood that traffic generated by US ISPs accounts for around 30-40 per cent of all Internet traffic between Australia and the US.

5 Telstra submission to the Productivity Commission Inquiry into International Telecommunications Market Regulation, p. 18, *http://www.pc.gov.au/inquiry/intelmkt/subs/sub004.pdf*

6 Inbound traffic could be substantially higher if it was not for extensive caching arrangements by Australian ISPs.

The proportion of inbound traffic from the US is likely to remain of the same order of magnitude so long as the main Internet bandwidth usage consists of consumers downloading information products. The 70 per cent inbound traffic figure is closely comparable to the proportion of foreign information products such as books, recorded music, and television programs that are consumed in the Australian market. Major growth in demand for Internet services is most likely to continue being driven by downloads of packaged content.

One way to change this traffic imbalance is to encourage the production of content in Australia. However, a necessary requirement for this is cheap and abundant bandwidth which the current arrangements do not assist.

The impact of the current arrangements is that the cost incurred by Australian ISPs is higher because Australian ISPs have to bear the cost of carrying US generated traffic on their network without reimbursement. This increases the cost of hosting content/applications in Australia and the cost to end users that access this or international content or send emails etc. It should be noted that the end-users normally pay the same price irrespective of whether they use the Internet to communicate domestically or internationally.

As outlined in Telstra's submission[7] there are several ways in which Australian participants are affected by the current arrangements:

- without adequate reimbursement for the traffic generated by the US, Australian ISPs have less funds to invest in their network;
- the higher costs for Australian ISPs are passed on to Australian content/ applications providers putting them at a competitive disadvantage compared to their US counterparts;
- the higher costs are also passed onto Australian end-users limiting the take-up and growth of the Internet in Australia; and
- the higher prices paid by Australian Internet users also increase the cost of doing business in Australia where they are a business input.

It had been estimated that the total annual cost of international Internet connection to the US for the Australian market in the 1999 year would be around $300 million.[8] In its submission to the Inquiry, Telstra has updated this estimate with an estimate that this cost to Australian ISPs in the 1999/2000 year will be

7 Telstra Submission, p. 9.

8 International Telecommunications Market Regulation Inquiry, Productivity Commission, ch. 7, p.7, *http://www.pc.gov.au/inquiry/intelmkt/finalreport.pdf*

around $406 million. Using the above estimate that 30–40 per cent of the trans-Pacific bandwidth of Australian ISPs is used to carry traffic generated by US ISPs, the cost to Australian ISPs in 1999/2000 of carrying this traffic will be in the range $133 to $177 million. As the Internet traffic grows this will become even more significant, although it may be offset by the reduction in bandwidth cost due mainly to technology improvements and more competition in international carriage.

In its submission to the Inquiry, Telstra estimated that when the flow-on effects of this increased cost on Australian businesses and the Australian economy were taken into account, the current arrangements will cost Australia around $585 million in 1999/2000.

12.8 sharing costs of Internet transmission

The Internet does not have a consistent, agreed set of international charging arrangements. The Internet has developed on a cooperative, barter exchange model, with no centralised or authoritative management structure. Its engineering structure is based upon the application, by consensus, of common standards to communication between independent networks. Currently, ISPs interconnect and exchange traffic under a wide variety of commercial or non-commercial arrangements, using bandwidth most commonly supplied by telecommunications carriers. There is no transparent commercial basis for such arrangements, and as such there is significant scope for anti-competitive behaviour.

The Internet has grown in an organic, voluntary fashion. Some leading Internet stakeholders still maintain that the Internet is a “private” rather than a public facility. From its original core of US Government and educational sites, the Internet has grown to include successive new US and foreign networks. Historically, each network joining the Internet backbone has responsibility for its own costs of connection. With the privatisation of key backbone facilities in the US, this has meant that all non-US operators have been required to pay for the whole infrastructure that carries traffic in both directions to and from the US Internet backbone access points. In the past, foreign ISPs have accepted this because of the historical origin of the Internet in the US, because the traffic volumes were low and because the US has been recognised as the global hub where the largest amount of content and largest numbers of hosts and routing facilities are located. Non-US carriers are now forced to continue to accept these

arrangements even though the Internet has now become global in nature and the networks of non-US ISPs are carrying ever-increasing volumes of traffic generated by US ISPs.

As the scale of the Internet grows rapidly, these differential settlements are becoming significant in value. Non-US ISPs, particularly in the Asia-Pacific region, are complaining that they are being forced to carry an unfair proportion of the costs of interconnection. In Australia's case, the above estimates are that approximately 30–40 per cent of the Internet traffic being carried on Australian ISPs' network capacity to/from the US is generated by US ISPs—but Australian ISPs pay 100 per cent of the trans-Pacific link costs, regardless of who generated the traffic.

In meeting the rapid increase in demand for bandwidth linking Australia with the US, full costs fall on the Australian carriers and must be recovered from Australian users. Telstra predicts 100 per cent compound annual growth in demand for Internet-related bandwidth until 2003, which would take its connectivity capacity with the US from 507 Mbps (1999) to in excess of eight Gbps (2003). As the scale of global multimedia networking increases, they can become more significant in determining the efficiency and even viability of communications infrastructure investment in particular markets.

The equity of these arrangements is a matter of current debate in several international fora including the OECD, APEC, WTO and the ITU. There is general acceptance that it is not appropriate to try to apply regulatory models that were developed for telephony to the different circumstances of Internet. The various elements that make up "Internet" services will need to be identified and costed so as to develop norms for fair trading and market behaviour, including international trade rules. So far, there is no international consensus, and no industry consensus, on how this should be done.

US ISPs point out that the traffic imbalance reflects eager demand for US-based information services, and that high telecommunications and Internet connection costs within and between other countries generally manifest a lack of competition in the supply of services. The first point may be right, but it is irrelevant to the issue of putting in place fair and equitable international Internet settlement arrangements. The second point is not valid in the case of Australia, where we have had network competition since 1991 and an open regime since mid 1997.

Other factors contributing to cost differences include the overall wealth of each economy (affecting returns on investment), geography, population characteristics, and the maturity and structure of the telecommunications market. In the US, the largest ISPs have close links both with content providers and with major telecommunications carriers. Australia has over 900 ISPs, but many other countries have been reluctant to open up their ISP markets. In most of Asia, there are few ISPs and most of these are carrier subsidiaries.

The unyielding exploitation of a position of dominance by US ISPs works to undermine the willingness of Asian governments to accelerate the liberalisation of telecommunications and Internet markets in the region, so contributing to the maintenance of high cost levels and straining the development of content providers outside the US.

Equitable and commercially sustainable arrangements for cost sharing of the international Internet traffic carriage component need to be developed by international consensus.

Australia's imbalance in traffic with the US is not unusual. Similar ratios are common in all countries outside the US. Even in China, where there is no common language factor, China Telecom has recently established additional international links for its ISP service comprising eight Mbps outbound and 45 Mbps inbound—a ratio of about 82 per cent inbound traffic.[9]

Current settlement arrangements at the wholesale level in ISP services are relatively chaotic, with outcomes reflecting market power and passed on to final consumers through bundled access charges. Australian users, especially content developers and content host sites, have reason to be concerned that the current arrangements favour US-based competitors, because the global delivery of their products and services is effectively subsidised by the ISPs outside the US who pay for transport both to and from US ISPs and sites.

9 Intelsat press release 9 June 1999.

12.9 recommendations

There are two commercial practices, which add to the costs born by Australian ISPs:

- Australian ISPs are not reimbursed for the cost of carrying US generated traffic between the US and Australia; and
- Australian ISPs are not reimbursed (or offset against the cost of accessing US networks) for carrying US generated traffic on their domestic networks.

While the Australian Government and industry are seeking to develop and obtain international acceptance of fairer charging arrangements for Internet traffic, this is likely to be a slow process.

The Inquiry recommends that:

1. The Government should convene a high level industry advisory group, preferably with ministerial participation and involving the AIEAC, to co-ordinate Australian involvement in international communications trade and related issues.

This may assist the Government's processes and the speed with which results are delivered.

2. If no substantial progress is made on the charging arrangements issue with the US soon, then the Government should consider using regulatory tools to explore and/or address the issues or consequences of the inequity in charging arrangements between Australia and the US.

Under Part 20 of the *Telecommunications Act 1997*, the Minister may make Rules of Conduct about dealings with international telecommunications operators which seek to prevent, mitigate or remedy unacceptable conduct engaged in by international telecommunications operators. Unacceptable conduct is considered to be that which is contrary to the national interest. The ACCC is responsible for administering any Rules and Conduct and it may carry out an investigation of a contravention of a Rule of Conduct. Under subsection 372(3) of the Telecommunications Act 1997, the Minister may also direct the ACCC to review and report on specified matters relating to this Part of the Act.

chapter 13

GENERAL BANDWIDTH ISSUES/RECOMMENDATIONS

This chapter identifies and discusses issues (other than those relating to international issues and submarine cables) which have emerged from:

- discussions with stakeholders;
- the analysis in chapters 4 to 9;
- issues raised in submissions to the Inquiry, other than factual matters that have been taken up in other parts of this report; and
- the Inquiry's views about the need for consideration of bandwidth issues to be rooted in a view of aims and broad market directions, as discussed in chapter 3.

The discussion leads to a number of findings and recommendations.

13.1 introduction

As will be clear from previous chapters, bandwidth markets are neither simple nor homogenous. They are also undergoing significant change in structure. At the same time, communications has a substantial *legacy* from the historic world of telephony and broadcasting services which for the present retain considerable public policy interest.

In this type of environment, it is important to work through issues systematically. It is important that gaps, and potential gaps, are identified between desired outcomes and the likely market reality. It is also important that any solutions are carefully considered. Otherwise, there is a potential risk that intervention may cause more problems than it solves, or may cause unintended consequences.

13.2 issues identification

13.2.1 STAKEHOLDER CONSULTATION

Inquiry staff, and the AIEAC subcommittee, have undertaken extensive consultations with industry. This has involved:

- one-on-one interviews and meetings;
- focus groups organised by peak bodies such as the Australian Telecommunications Users Group, the Australian Information Industry Association, the Australian Multimedia Industry Association, the Internet Industry Association, Education Network Australia and the Screen Producers Association of Australia, in Sydney, Melbourne Adelaide, Brisbane and Perth;
- consultant-based consultations;
- discussions with State and Territory Governments on both a one-on-one basis and jointly through the Ministerial Online Council and related processes; and
- consideration of the views expressed in submissions to the Inquiry.

Generally, most stakeholder views were understandably focussed primarily on problems which they are currently experiencing with the supply of telecommunications services, rather than necessarily looking out too far into the future. (In this, they resemble telecommunications suppliers who, as pointed out in chapter 5, tend to do most of their bandwidth provisioning up to only two years ahead.)

The discussions with stakeholders have been wide ranging, covering wholesale, retail, consumer and regional issues associated with the supply of bandwidth. However, stakeholder concerns (other than Telstra's) about bandwidth can probably be usefully summarised under three main headings:

- a view that retail bandwidth prices are high in both absolute and relative terms both domestically (particularly in regional areas) and internationally, leading to the postponement of some bandwidth intensive applications and making Australia less competitive;
- a view that Telstra's current high market power in CAN provisioning or upgrading for high bandwidth technologies (particularly in regional areas) and in providing access to competitors to the local loop network for such services continues to limit availability and is hindering the development of competition; and
- a view that there is a problem with bandwidth availability in the customer access network, especially in regional and remote areas. These concerns relate to the provision of basic telephony, as well as to newer data services. They also relate to the *comparative* position of non-metropolitan Australia *vis a vis* the situation in the larger cities.

In addition, most participants in discussions identified a lack of competition in key markets as being an underlying cause of these issues.

Some particular competition issues raised by ISPs and some carriers included:

- Internet peering arrangements (or lack of them for smaller operators);
- frustration with current interconnect disputes and delays;
- the perceived importance of access to copper wire customer access network infrastructure in helping the bandwidth innovation process; and
- problems with the speed and service performance by Telstra in providing *tails* to customers who took trunk bandwidth from suppliers other than Telstra.

On the other hand, some suppliers, including Telstra and some new entrants, consider that the competitive market is generally working well in many areas given that it has only been two years since the introduction of full competition in 1997. They support this by pointing to falling retail prices in international, long distance, inter-capital leased line, mobile telephony and Internet markets and the investments already made or committed in:

- CBD fibre rings;
- the Southern Cross Cable consortium;
- new trunk links; and
- LMDS, 1.8 GHz and 800 MHz spectrum auctions.

Some particular issues raised in relation to servicing regional Australia included:

- existing geographic service differentials in relation to standard telephone services;
- concerns that Telstra is not adequately focussed on servicing regional Australia;
- concerns that Telstra appears to be telling some regional customers that retail bandwidth products (such as ISDN) are not available from particular exchanges. Sometimes, these services were subsequently made available following high level approaches to Telstra, implying that this was based on a decision not to supply, rather than an inherent problem with the exchange. (By contrast, Telstra claims that its provisioning policies allow for bandwidth products in regional areas to be made available as early as practicable following the first order in an area, and that Telstra does not wait for demand to reach a point where the product supply will be commercially viable.);
- pricing of bandwidth products in regional areas where Telstra has a *de facto* monopoly are unreasonably high. This situation even applies to large customers such as banks and State Governments;
- the difficulties involved in getting new entrants to focus on the needs of regional Australia during the early phases of competition. New entrants are understandably focussed on servicing the larger metropolitan markets first, however, this at the least creates a perception that the service differential for regional Australia is growing; and
- Telstra's concerns about the funding arrangements for the USO and the implications of this for future investment in telephony bandwidth.

The results of the market analysis in chapter 9 appear to support many of these perceptions, at least in so far as they relate to the current bandwidth environment in Australia. However, it is less clear whether these issues are transitional, and will be solved in whole or part by the operation of the market. Certainly, some of the specific concerns are likely to be worked through within existing regulatory processes currently underway with the ACCC.

13.2.2 OTHER ISSUES

In addition to these issues raised by stakeholders, the Inquiry also identified a number of potential issues which it considers merit further exploration. These are:

- the extent to which bandwidth is likely to be a source of comparative national advantage for Australia over the next five years—this is considered in conjunction with the pricing issues already identified by stakeholders;

- the likely *depth* of the bandwidth market in terms of:
  - whether Australia is well placed to attract appropriate levels of investment in bandwidth, and
  - whether the market supports and fosters a culture of innovation in bandwidth markets.

This is considered below in conjunction with the issues raised by stakeholders about Telstra's current dominant market position;

- linkages between content and bandwidth markets;
- non-geographic *consumer* equity considerations in the data world; and
- a general need for all relevant stakeholders in Australia consciously to rethink communications policy issues:
  - away from a legacy systems mindset based around a voice telephony past, and
  - towards frameworks based on the emerging 'data world' future.

The rest of this chapter explores these issues in more detail.

13.3 moving from a legacy systems mindset

As will be clear from the following discussion, the Inquiry sees the bandwidth future representing a significant shift from the past.

The radical data world described in figure 3.4 in chapter 3 may not come to pass during the next five years—but then, given the pace of change in the communications industry evident over the past five years, it just might. In any event, the Inquiry considers it generally important that Australia set its sights on that data world, and how we can most effectively make the transition from our legacy past.

The Government has and is likely to continue to place primary reliance on competitive and market pressures to encourage industry outcomes which meet the needs of consumers and the nation generally. Governments, however, have a range of tools which can be used to achieve policy objectives. These include:

- pro-competitive measures, such as the access regime and anti-competitive conduct regulation;
- direct regulatory obligations, such as the USO and price control regulation;

- funding measures, such as Networking the Nation and the social bonus programs to be funded from the privatisation of Telstra; and
- leverage gained from the Government's role as a leading user of bandwidth.

The regulatory framework which currently applies to telecommunications carriers (the suppliers of the bulk of existing bandwidth in Australia) is in many ways dominated by the regulation of voice telephony. This is demonstrated by the framework's focus on issues such as preselection, numbering, customer service guarantee and itemised billing. Existing price control regulation applying to Telstra and even the untimed local call obligation have their roots in a voice telephony paradigm.

Most of these obligations will continue to play an important role in ensuring voice telephony services meet the needs of Australian consumers. However, as discussed later in this chapter they limit the ability of new and existing players to exploit the opportunities of the new data world. For the reasons described in chapter 3, the structural changes in the market, business models and nature of the industries involved in the move to the data world, mean that, many of these existing tools may not be appropriate or effective in addressing the consumer safeguard and community interest requirements of the information economy.

13.3.1 BANDWIDTH ISSUES

There are essentially two broad bandwidth challenges that have arisen from this study:

1. To create vigorous and innovative markets that will provide centres of excellence that are internationally competitive.
2. To find ways of providing affordable and high quality bandwidth to Australians living in regional, rural and remote areas of Australia.

The issues arising from these challenges and recommendations are discussed in the remainder of this chapter.

13.4 bandwidth availability issues

The analysis in chapter 5 of this report essentially concludes that the existing telecommunications physical infrastructure in place in Australia should be capable of meeting Australia's trunk communications infrastructure needs on almost any demand scenario, given the advent of:

- DWDM technologies for optic fibre cables;
- new satellite systems currently in place, or likely to proceed; and
- datacasting.

The survey also found that, in the first two years of open competition, a number of new entrants had installed new infrastructure, and planned to install more, albeit in limited areas.

In a general sense, the Inquiry considers this underlying state of affairs in relation to physical backbone infrastructure to be satisfactory.

The main weakness revealed by the infrastructure survey was that ownership of trunk infrastructure is highly concentrated. The issues which this appears to raise are:

- a lack of responsiveness to customer needs by way of providing access to this backbone infrastructure;
- a continuing risk that the incumbent owner(s) of trunk infrastructure (especially fibre) may, actively or passively, use their monopoly position to ration supply of bandwidth in a way which leads to under-supply of bandwidth, potentially at higher prices than would be justified by underlying demand or the costs of supply;
- the increased ease of incumbent response using DWDM technology may be having the, perhaps perverse, effect of reinforcing a natural monopoly tendency in the supply of trunk bandwidth by creating for new entrants the spectre of incumbent owners having a very large *overhang* of potential capacity which can be brought to bear at low incremental cost should a new entrant invest in new infrastructure itself; and
- international and satellite capacity have longer provisioning lead times, and thus if there is going to be a problem with the supply of backbone capacity, it is likely to be in this area. While the demand analysis suggests that there is not likely to be a problem, a comparative analysis of investment in international capacity in the trans-Atlantic and trans-Pacific routes suggests that investment on those routes is *proportionately* considerably higher than between Australia and the rest of the world.

The problems with supply rationing behaviour, and supply overhang, are strongly linked to investment and competition issues, which are canvassed below.

The other significant factor emerging from the analysis is that:

- the customer access network is in general likely to be a significantly more important potential choke-point in servicing bandwidth needs than the trunk network, and should be the main focus of attention in relation to addressing the supply of bandwidth to the point of sale.

RECOMMENDATIONS

Against this background, the Inquiry recommends that:

- The Government's principal focus of policy attention in relation to bandwidth issues needs to be on transforming bandwidth capability into bandwidth availability by developing competitive and responsive market conditions, particularly in the customer access network and provisioning of trunk capacity.
- The Australian Communications Authority's reporting on carrier performance should be expanded at least to develop measures for the following:
  - carrier response times to customer requests for higher bandwidth data services, particularly in regional areas,
  - payments of CSG penalties, and
  - measures of carrier responsiveness in the provision of broadband services.
- Access and interconnection regulation should have as its primary objective the facilitation of timely commercial solutions. The key role of the regulator in this regard is both to help create an informed market within which access negotiations can take place and to intervene where commercial outcomes are unlikely. While the Inquiry acknowledges recent strengthening to the competition regime, the review of the telecommunications competition regime in 2000 should focus on ensuring the Australian Competition and Consumer Commission has adequate tools to facilitate timely access negotiations—to resolve both bilateral and multilateral issues.

13.5 prices and international competitiveness

The analysis in chapter 7 in essence reveals that:

- in some areas of retail bandwidth pricing (for example Internet dial-up access, mobiles, some leased line charges) Australia is generally internationally competitive;

- retail and wholesale pricing of other important bandwidth products in Australia appears to be comparatively expensive at present, especially when compared with emerging e-commerce hubs in North America (San Francisco Bay area, Boston, larger cities) and Europe (Scandinavia, United Kingdom, Netherlands);
- pricing differentials between Australia and key overseas markets are likely to narrow over the next five years, especially in the *consumer heaven* markets where competition prevails. Prices will reduce in other areas, but in relative terms by lesser amounts;
- the relative importance of bandwidth prices as an input cost for e-commerce is likely to fall over the next five years; and
- while the cost of wholesale bandwidth in the backbone network will remain a core component of retail prices, its significance will diminish as other cost components (for example marketing and billing functions) increasingly dominate.

It is important to note that these conclusions were against the background of little direct information on costs, and an acknowledgement that the *structure* of prices (which were in some cases significantly averaged) made comparisons for particular users difficult. As discussed in chapter 4, the lack of agreed international measures for making comparative assessments of price against performance also adds to the difficulties of comparison.

13.5.1 AUSTRALIA'S COMPARATIVE POSITION

In the longer run, a sustained difference in the price of an important factor of production for e-commerce, such as bandwidth, is likely to have a structural effect on Australia's competitiveness in the emerging information economy. It is therefore important that Australia does its best to ensure communications markets are capable of supplying their services at prices and levels of service which are competitive in the longer term.

In this regard, the pricing work commissioned by the Inquiry is fairly sanguine about the longer term position, at least in *consumer heaven* markets.

However, the Inquiry is concerned about the speed at which the market is likely to work in reducing the differences in prices with emerging e-commerce hubs. This is principally because if bandwidth prices are a significant factor in

e-commerce supply, then there is a risk that this may be enough to confer first mover advantages on overseas competitors, or to encourage Australian innovators to move offshore.

The case studies undertaken on behalf of Telstra and DOCITA did not indicate that existing bandwidth prices were a significant factor (though in two instances the web-sites were located off-shore). It is important to note however, that those studies were not in any sense a representative, structured sample. In addition, several of the case study firms indicated plans for the future with substantial additional bandwidth requirements both for themselves and their customers (e.g. video-based content) which raises the issue of affordable, high bandwidth within customer access networks for such e-commerce strategies to be feasible. In this connection, ATUG observed that, 'If the past experience continues of monopoly rents or dominant player tariffs, development of the on line commerce world [in Australia] will be severely constrained.[1] 'The same submission goes on to note:

> While the transition of some services to the packet switched environment will no doubt occur, further increasing the effective carrying capacity of existing and proposed transmission services, the choke in transmission capacity to the premises will tend to inhibit the development of bandwidth hungry applications.[2]

13.5.2 WHAT IS CAUSING THE PRICE DIFFERENTIALS?

The Ovum and OECD analyses canvassed in chapter 7 suggest that bandwidth price differentials vary the most in those areas where:

- competition has been operating the longest and/or working the best;
- there is less averaging of prices, either between geographic regions, or between service offerings; and
- there are the greatest concentrations of users—presumably with consequent economies of scale in supply.

There is likely to be little Australia can do about underlying economies of scale and scope. There may inevitably be a structural cost differential which will ultimately mean that long run prices in Australia—other than for thick traffic corridors like Melbourne–Sydney—are somewhat above those in overseas markets with higher densities.

1 Australia Telecommunications Users Group Ltd, *National Bandwidth Inquiry*, October 1999, p. 2.

2 *Op. cit.*, p. 3.

However, this does suggest that the likely key strategies in narrowing the gap between Australian e-commerce suppliers and overseas competitors are:

- encouraging competition; and
- avoiding interventions which are overly prescriptive in forcing averaging of bandwidth prices.

This is not to say that averaged prices are necessarily undesirable, or indeed would not be provided commercially. Pricing in the relatively competitive market for mobile telephony at present suggests that geographically averaged prices, and internal cross-subsidies between lowering connection costs and increasing usage charges is acceptable to customers in that market. Similarly, price bundling is a strategy which is likely to be pursued in a number of retail markets, in part because that may be what consumers want.

13.5.3 IS INTERVENTION IN BANDWIDTH PRICING DESIRABLE?

Interventions to attempt to lower bandwidth prices might take the form of direct regulation of prices (e.g. price caps), or indirect forms, such as encouraging competition and removing impediments, or even moral suasion. Traditionally, interventions in telecommunications have been a mix of these methods. There has been considerable direct regulation of telephone prices in the form of price caps which have dictated to a considerable extent not only the level, but also the structure of retail prices. This has been premised in large part on the idea that regulation needed to operate in part as a surrogate for competition while the market was developing. Indirectly, the Government has sought to encourage price reductions by introducing competition.

It is also important to note that interventions intended to address pricing problems, carry risks, even in the short term. This is because price plays an important role in terms of sending investment signals. Attempts to artificially adjust prices downwards in some areas, and/or to introduce or entrench cross-subsidies may have effects on investment decisions by new entrants (and reinvestment by incumbents) in those areas where prices are below cost. In turn, this may have the effect of limiting the scope for price falls in potential *consumer heaven* markets which must cross-subsidise the regulated markets, thus risking loss of international competitiveness.

Balancing short-term and long-term benefits can be very difficult to achieve. In commenting on the existing access regulatory arrangements, Telstra noted:

> The propensity of the ACCC to declare services that are the building blocks of the information economy dramatically undermines the incentives for investment in bandwidth. What business will invest in new communications infrastructure if it faces the very real possibility of supplying that service to competitors at regulated prices?[3]

By contrast, C&W Optus considers that more emphasis should be given to the competitive significance of local loop unbundling. It notes that:

> The evidence from the US is that implementation of local loop unbundling will be substantially more complex than any other interconnection task undertaken to date in Australia. The complexity of local loop unbundling provides opportunities for the incumbent to delay and divert the process of implementation. These risks are potentially greater in Australia as the ACCC's declaration is much less specific in its technical and operational requirements than the FCC's Local Competition Order.[4]

RECOMMENDATIONS

The Inquiry recommends:

- The Government should maximise the potential for the development of a fully and vibrantly competitive infrastructure market in those parts of Australia where there is the greatest prospect of true international competitiveness in a global e-commerce market by removing as far as practicable regulatory distortions to the operation of such a market. At the same time, the Government also needs to ensure appropriate mechanisms are in place to meet social equity and public interest goals.
- In particular, existing telecommunications-specific regulations should be progressively reviewed to ensure that such regulatory instruments do not unintentionally hinder the development of an internationally competitive information economy. The Inquiry notes that the current price control arrangements are scheduled to cease in 2001. Examination of other policy mechanisms for their impact on the development of a vibrant information economy should take place at such times as they come forward for review.

3 Telstra Corp Ltd, *Submission to the national bandwidth inquiry,* October 1999, p. 11.

4 C&W Optus, *National bandwidth inquiry: response to discussion paper*, p. 3.

- Retail pricing objectives should principally be addressed by addressing the drivers of price (as proposed in other recommendations in this report) rather than through direct price regulation of particular products.

Other recommendations that affect international competitiveness of the bandwidth markets are those set out in chapter 12 relating to international undersea cables and the international charging arrangements for the Internet. These are as follows.

submarine cables

- The planning and protection regime for submarine cables to and from Australia should be strengthened. New Zealand's *Submarine Cables and Pipelines Protection Act 1996* appears to provide an appropriate model.
- More explicit authorisation to install submarine cables should be included in legislative provisions regarding undersea cable protection and planning.
- The penalties for damage (and limits on liability) to cables should be increased at the earliest opportunity in order to create a more effective deterrent to unnecessary disruption of these key elements of the national information infrastructure.
- Any new provisions for the regulation of submarine cables should be developed in consultation with other stakeholders, including the fishing, shipping, and other maritime industries, environmental agencies and relevant State and Territory agencies.

international charging arrangements

- The Government should convene a high level industry advisory group, preferably with ministerial participation and involving the AIEAC, to co-ordinate Australian involvement in international communications trade and related issues.
- If no substantial progress is made on the charging arrangements issue with the US soon, then the Government should consider using regulatory tools to explore and/or address the issues or consequences of the inequity in charging arrangements between Australia and the US.

13.6 infrastructure investment, innovation and market diversity

As noted in chapter 9, it is difficult to talk about a *single* bandwidth market. Already in Australia there are at the least wholesale, retail and geographic markets together with product differences which are characterised by very different market structures. For example, the retail Internet service provider market is regarded widely as being highly competitive. The rural market for high bandwidth data products is essentially a monopoly. Even there, however, there are substitutes in the form of satellite services. Mobile telephony would be seen as somewhere in between.

Full competition in Australian bandwidth markets is still fairly new. In the two years since 1997 there have been considerable improvements in the dynamism of some areas of the market and entry at a number of levels.

In this context, C&W Optus cautions in its submission to the Inquiry against mistaking the progressive deployment of broadband network and services, characteristic of the early stages of market development, for market failure. The submission goes on to observe that:

> It would be counterproductive, and ironic, if government-directed planning and regulation was reintroduced at a time of greatest opportunity for expanded competition.[5]

The Inquiry has increasingly come to the view that, for the present at least, there remains an apparent and important difference in the *qualitative nature and depth* of the trunk bandwidth market between the parts of North America and Europe which have had competition for longer periods than Australia.

In some parts of the North American market, not only are there many more trunk suppliers, many of whom own their own infrastructure, there is also a wider range of *types* of supplier of bandwidth, which appears to be a substantial contributor towards the depth and dynamism of the most competitive parts of that market.

5 C&W Optus, *op. cit.*, p. 1.

As noted in chapters 2 and 9, the different types of bandwidth suppliers include:

- *dark fibre* carriers;
- Internet based carriers, such as Qwest[6] which are operating on the basis of different cost structures and business models; and
- consortium based investment in bandwidth, such as undersea cable consortia.

In turn, this appears to have led to market innovations such as:

- the emergence of bandwidth *spot markets*, particularly in international markets[7] in part because of long term bandwidth supply commitments made to undersea cable consortia;
- deeper wholesale markets;
- a more entrepreneurial *can do* culture in relation to matters such as infrastructure barters between suppliers, and between suppliers and users; and
- a generally faster time to introduction for higher bandwidth products, even by incumbent telecommunications carriers. For example, ADSL is currently being rolled out in a number of major US cities, whereas Telstra is reported as indicating that it is not proposing to introduce its service commercially until later in 2000.

As already noted, infrastructure competition is still relatively recent in the Australian market, which was only fully opened in mid 1997. There is a question about whether this kind of innovation will now develop by itself, and/or whether further encouragement is necessary or desirable.

By establishing an open market for telecommunications, the Government has enabled new operators to enter the Australian market with few limitations on technology choice or market strategy. Also, a conclusion of chapter 9 was that the overwhelming need for new entrants to control factors relating to product definition and cost competitiveness means that they should have a bias towards building in the build or buy decision.

In its submission to the Inquiry, AAPT referred to its commitment to rolling out fibre loops in CBDs and deploying LMDS in a wide number of locations. It goes on to note that 'these strategies will only result in relatively small competitive local distribution networks by comparison with Telstra's ubiquitous CAN.'[8]

6 See *www.qwest.com*, September 1999.

7 See *www.techreview.com/articles/nov98/cavanaugh.htm*, September 1999.

8 AAPT Telecommunications, *National Bandwidth Inquiry*, October 1999, p. 2.

As detailed in chapter 5, infrastructure ownership for the present remains highly concentrated, and this is a key factor influencing bandwidth markets. New carriers have installed some capacity on the major trunk routes and CBDs but very little capacity has been built in other areas. There is little competition in infrastructure outside the key capital city markets on the Australian east coast. While the consultants found that six licensed carriers own significant backbone network infrastructure, only two own material infrastructure outside the key east coast markets, and Telstra's network remains the sole ubiquitous backbone network.

Looking ahead over the five year timeframe of this Inquiry, the conclusions of the consultants suggest that bandwidth supply capabilities in the backbone network will continue to be capable of meeting or exceeding market demand. The analysis also suggests that significant improvements in the competitive nature of the industry will occur over the next five years in most areas of Australia. Nevertheless, the consultants conclude that many areas will remain subject to an *exclusive club* style of competition or even see little or no competitive infrastructure activity.

This suggests that attempts to deepen the supply side of the market need to be carefully informed by the underlying factors and market realities that might be affecting investment decisions—with intervention decisions being complex.

For example, as noted earlier, one of the factors which could be working to inhibit investment includes, perhaps ironically, the fact that DWDM now allows existing incumbents to increase bandwidth supply at low incremental cost. Thus, a new trunk optic fibre entrant faces the prospect of a significant potential supply *overhang* from incumbents who can quickly lower prices, after the entrant has sunk potentially significant investment in fixed infrastructure (such as installing a backbone optical fibre link or network).

One possible solution to this potential oversupply problem might be regulatory—to mandate access to services provided over the incumbent's backbone infrastructure.

However, a market which relies exclusively or extensively on regulation in the longer term to deliver access to managed trunk bandwidth services may have difficulty delivering the kind of market *depth* described above. Nor is it likely to guarantee that economically efficient outcomes, let alone innovative diversity in the use of the underlying infrastructure, will result. This is in part because the

terms and conditions for access by all competitors will almost inevitably tend to be usage based, rather than developed from a true *infrastructure* mindset. This, in turn, will tend to be influenced heavily by the views of regulators and their economic and technical advisers who will necessarily be working within the world of the *second best*. So while regulated access rights will often serve to improve competition in downstream service markets, it is not likely to increase competitive pressures in upstream markets.

Thus access regulation to increase rights of access to an incumbent's network may not serve to increase the commercial pressures on the network owner to improve its responsiveness in network provisioning and upgrades. Therefore, the decision to adopt a *build* or *buy* strategy by new competitors is likely to significantly influence the nature and structure of the future Australian bandwidth market.

The telecommunications access regime under Part XIC of the *Trade Practice Act 1974* already seeks to balance the incentives for both access providers and access seekers with a view to promoting competition and the efficient use of and investment in infrastructure. By seeking to eliminate the potential for incumbents to exercise market power over bottleneck facilities, access regimes aim to ensure that the incentives to build or buy reflect those which might apply in a mature competitive market. In making key decisions under the access regime (such as about whether to apply access regulation in relation to particular services and in making determinations about the terms and conditions of access) the ACCC is required to have regard to the need to ensure those decisions will promote the efficient use of an investment in infrastructure.

The ACCC's recent declaration of local telecommunications services represents a potentially significant extension of access regulation and will enable competing carriers and service providers to rollout new access technologies making use of the existing access network. The development of such arrangements has ramifications for the rollout of broadband services and the growth of demand. Concerns have been raised by a number of stakeholders, however, about when access would be made available.

RECOMMENDATIONS

The Inquiry recommends:

- Governments at all levels should consciously develop ways of fostering and supporting new types of telecommunications operators who will add to the depth and range of the Australian market. In particular the Commonwealth should:
  - review existing carrier licensing arrangements to ensure carrier licensing is not presenting any unintended barriers to entry by new and innovative operators, in particular, for the provision of services in rural Australia,
  - ensure arrangements for access to spectrum suitable for high-bandwidth services operate as speedily as possible, and
  - extend the recently announced adjustments to the tax treatment of international Indefeasible Rights of Use (IRUs) to any IRU arrangements established for domestic cable systems to encourage other models for acquiring domestic cable capacity. In addition, there is a need to ensure that tax treatment of IRUs is such as to encourage local availability of international bandwidth capacity at competitive rates.

An early focus for the development of new models should be on international links and regional areas.

13.7 content and bandwidth

The Inquiry also considered that there were significant, if in part hidden, issues linking content markets to bandwidth markets which were important to explore.

At an obvious level, bandwidth is a cost input into the delivery of content products. If bandwidth costs are high, then this is likely to affect, possibly significantly, Australia's ambitions to become a provider of content to the world. This is, essentially, the same price differential as noted above for e-commerce providers.

A related, but more subtle point, flows from the fact that the structure of the Internet provides many content creators (and e-commerce providers) with considerable flexibility in choosing locations for hosting material. A server in the US need look no different from a server based in Australia, as far as an end

user is concerned.[9] If bandwidth prices are lower there, then it is in fact likely that hosting will move. In turn, such a scenario:

- represents a loss of both direct and indirect business to Australia; and
- represents a risk that the supplier might move all of their business.

A third related set of issues comes from the fact that the quality and quantity of content hosted to a large extent determines the quantity and direction of communications traffic flows. For example, the United State's ability to 'dictate terms' to the rest of the world regarding the charging arrangements for Internet traffic results largely because the overwhelming bulk of the content which is demanded by Internet users around the world is hosted there: in one sense, control over content does provide control over at least some terms of supply for bandwidth.

Fourthly, it may well be that content suppliers do control some of the newer means of supplying bandwidth to the home in the form of digital television, radio and datacasting systems. Many of these content industries (e.g. television, radio, newspapers) have historically been vertically integrated industries with business models which closely link the content provided with its means of delivery. In this environment, it is inevitable that content owners or brokers will attempt to influence heavily the way in which bandwidth is provided and marketed.

This has been historically evident in pay television markets where content suppliers around the world have sought, where possible, exclusive supply arrangements with bandwidth providers, or have used related systems, such as conditional access systems to work to this end. In these circumstances, arrangements for the supply of these services is likely to have some potentially significant interactions with the development of bandwidth markets more generally. The issue is raised as to whether these networks should be regulated (by such mechanisms as access arrangements) in the same manner as telecommunications carriers.

Fifth, the nature of payment for bandwidth products may ultimately be determined through product bundling arrangements with content suppliers or e-commerce vendors. Early evidence of this kind of trend has come from offers such as the one recently announced by the National Australia Bank to provide free Internet access to some of its customers. Free Internet in return for push-based advertising is

9 In other words, the domain name (and hence URL) for the webpages could still be of the form *xxxxxxxx.com.au*

already a reasonably common form of supply. This sort of trend, incorporating smart card and other technologies can be expected to exert a continued influence on bandwidth market developments.

Sixth, in discussions, some stakeholders considered that there was a potential *chicken and egg* situation in relation to content and bandwidth. For example, carriers took the view that if the demand for content was there (which people were willing to pay for), carriers would provide bandwidth services to support that demand—the trouble, they claimed, was that there was no *killer application* (or content) justifying that upgrade.

Some users and content developers suggested that by initiating the supply of low price, high bandwidth services, carriers will establish an environment in which the encouraged demand will in turn support further investment in supply. In essence the *build it and they will come* model for investment. This suggests that stimulating applications development may be a component of a bandwidth investment strategy.

The Government may also play a key role as a significant user of bandwidth to provide a viable base of demand to encourage greater carrier investment and service provision. Such *anchor tenant* arrangements are also at the core of demand aggregation activities generally which are designed to transform otherwise marginal or unviable disaggregated sources of demand into one which provides a sound base for commercial investments.

RECOMMENDATIONS

The Inquiry recommends:

- The development of content and applications should also be encouraged, such as through the provision of testbeds and incubators across Australia through Commonwealth funding such as under the Building on Information Technology Strengths (BITS) program.
- Collaboration in the multimedia industries particularly on global projects should be encouraged by industry and Government working together to develop network solutions which allow them to move large amounts of digital material encouraging greater competition and efficiency in the use of resources.

13.8 bandwidth and regional Australia

Meeting the needs of regional equity in communications has always been a challenge, and it is becoming harder.

During the telephony era, the model adopted by most of the world to deliver affordable access was essentially to rely on cross-subsidies among the users of a fairly uniform product, charged at fairly uniform prices to pay for the rolling out of a fairly uniform, but capital intensive, supporting infrastructure.

The emerging communications environment is changing most of the presumptions underpinning such an approach:

- the *product* is no longer uniform—telephony, Internet access, mobile telephony and television are all products in demand;
- the infrastructure on which they are supplied is no longer uniform (these points are perhaps most clearly seen from the direction of change summarised in figures 3.1, 3.2 and 3.3 in chapter 3);
- technologies and associated costs are changing quickly, meaning that the underlying economics of service provision are also changing;
- the *cross subsidy* strategy carries significant risks for new bandwidth products of raising costs, lessening innovation, and lowering Australia's competitiveness in our important emerging e-commerce markets in the cities; and
- using a cross subsidy strategy as the sole basis for intervention is unlikely to be effective in meeting the needs of regional Australia. At best, a system which relies solely on cross-subsidies will lead to an increasing lack of focus by suppliers on servicing the higher cost component of its markets. At worst, it could lead to suppliers withdrawing or choosing not to supply the market at all.

The analysis of supply summarised in chapter 5 suggests that competitive pressures are likely to become significant in metropolitan and some related regional markets over the next five years. In this period, the market is most likely to evolve to one dominated by three to four major infrastructure network carriers providing fixed network bandwidth transmission as outlined above. These operators will be accompanied by four to five cellular mobile network providers and some smaller, specialist regional operators such as Soul Pattinson. However, carriers other than Telstra are unlikely to provide ubiquitous networks and as such some rural and remote areas may continue to see little or no competition.

These broad conclusions reflect the reality that investment in infrastructure occurs first in the high demand, high growth areas. This situation is also relevant to Australia's position internationally. Comparatively, Australia is a very small market at the end of a long thin route and, as such, is likely to face a national problem in attracting timely investment in communications infrastructure within timeframes similar to those in the densest routes in the US and Europe.

However, the Inquiry considers that it is very important that ways are found to address these problems creatively and in a manner that recognises these realities.

One of the features of the current market is that the underlying structure favours the incumbent supplier in regional areas over much of the range. In contestable and monopoly segments of the market, any incumbent owner of existing infrastructure is likely to be generally in a strong position. The incumbent's economies of scale and scope and incumbency put them at an advantage *vis a vis* new entrants, and indeed in relation to customers as well—since there is likely to be little natural competitive pressure to perform. Other benefits in supplying these markets include the network externality effects for any supplier of having more customers on its own network, and brand advantages.

It is mainly at the higher loss making end of the market that a supplier to all areas is likely to suffer significant detriment. If that end of the market is in fact very expensive, then the costs may outweigh benefits in other areas—this has been an aspect of Telstra's claim in relation to servicing the telephony USO in recent years. It also claims that, under current arrangements, the USO is underfunded and this is turn has implications for future investment:

All universal service providers, including Telstra, require a commercial return before committing the investment necessary to provide the required services. Without certainty of commercial returns, universal service providers operating in a competitive market will either not make the investments required, or ultimately demand a higher risk premium than those investments would otherwise require. In the longer term this could exacerbate the digital divide between urban and rural Australia.[10]

In considering this, it is unlikely that a simplistic *pure* USO approach will, by itself, meet the bandwidth needs of regional Australia. Rather, it suggests that a

10 Telstra, *op. cit.*, pp. 18–19.

better approach may be to find ways of providing incentives, or ensuring that there are suppliers who are practically focused on serving the needs of the relevant regional community. These suppliers should be able and prepared to do this in a way which, as far as practicable, provides all Australians with broad equality in the available communications choices.

In recent years, the Government has established several mechanisms to address deficiencies in telecommunications services in regional Australia. $250 million from the first partial privatisation of Telstra was used to establish the regional telecommunications infrastructure fund (Networking the Nation). The Government has also announced a significant additional allocation of funds from the further privatisation of Telstra to a range of programs designed to address regional communications needs.

The Government is also actively reassessing the basis for telephony USO funding, and alternatives for making such funding contestable.

Governments at all levels are also looking at ways of aggregating demand and encouraging the supply of appropriate infrastructure capable of providing appropriate and affordable bandwidth. Some private sector organisations, such as the National Farmers Federation, have also been involved in trials which are testing new market models for delivery of services to regional Australia.

The foregoing suggests that the most likely strategy for meeting regional bandwidth needs is one which brings these developments together, as far as possible, in a way which promotes the best practical outcomes for regional Australia.

RECOMMENDATIONS

The Inquiry recommends:

- Telstra consider the possibility of outsourcing commercially some of its regional networks or operations to local operators or local communities. One option might be to develop a franchising model drawing on the experience of Australia Post in relation to its establishment of licensed post offices and postal agency operations which are owned and operated by local businesses.

- In using social bonus funds derived from the sale of Telstra, a key focus of attention should be on encouraging new market models for entry by infrastructure competitors. This should be undertaken in consultation with the states/territories and could include models involving:
  - community owned and operated carriers,
  - 'infrastructure only' carriers,
  - models such as the Palo Alto and TransACT initiatives with a view to developing arrangements to encourage local communities, authorities and utilities to pursue similar opportunities. In this regard the Local Government Fund component of Networking the Nation is one source which could provide some catalytic funding for initiatives in this area.

Consultation with state and territory governments may be necessary to ensure flexibility for cross-border regional initiatives.

- The Government review the possibility of supplementing funding for telecommunications bandwidth infrastructure, services and content through consideration of further financial support for infrastructure, service and content investment.
- Demand stimulation and aggregation are important to assist the market work better, particularly in regional areas. The Government should, in consultation with the other tiers of government and private sector stakeholders, continue to develop online strategies across key areas of service delivery (such as health, education and social security) taking account of opportunities to use such strategies to encourage infrastructure competition. The Commonwealth Government's objective is to have all appropriate Government services delivered online by 2001. The state, territory and local government initiatives are acknowledged and greater co-ordination should be encouraged through Online Council.
- Demand stimulation projects should also be used to encourage the development of content and applications to support these online services. This will also assist in the development and retention of online skills in regional Australia which are also part of the problem.
- Where possible, regulatory obligations imposing minimum levels of service assurance should be expressed to reflect the desired level of utility to the consumer rather than particular technical network capabilities.

appendix 1

PRESS RELEASE AND TABLING STATEMENT FOR THE DIGITAL DATA REVIEW

national bandwidth inquiry

The Minister for Communications, Information Technology and the Arts, Senator Richard Alston, today announced that he willl ask the newly formed Australian Information Economy Advisory Council (AIEAC) to examine the issue of bandwidth availability and pricing within, and to and from, Australia.

This is in keeping with the Government's election commitment to set up a National Bandwidth Taskforce to consider these issues.

'The inquiry is intended to provide an authoritative analysis of issues relating to the capabilities of the Australian telecommunications network to deliver adequate infrastructure support for a full information economy,' Senator Alston said.

'It will focus on the "backbone" telecommunications data networks and links within Australia, and between Australia and other countries.'

Senator Alston announced the inquiry when tabling in Parliament the report of the Digital Data Review conducted by the Australian Communications Authority. This review examined the question of whether the Universal Service Obligation should be upgraded to include a digital data capability of 64 kilobits per second.

The Minister's tabling statement, which provides further details in relation to the inquiry, is attached. The AIEAC will report on:

- the drivers of demand for bandwidth;
- bandwidth availability and pricing within Australia, and to and from Australia and key overseas markets; and
- relevant commercial and regulatory issues.

The AIEAC will also report on any constraints on the availability of bandwidth to meet current and projected demand, and make recommendations about Government and industry actions regarding those constraints.

The detailed terms of reference for the inquiry will be finalised after consultation with the AIEAC at its inaugural meeting in Sydney on December 17. Supported by a secretariat in the Department of Communications, Information Technology and the Arts, the AIEAC will consult widely with industry and community groups and provide its report in October 1999.

Media contact:
Terry O'Connor, Minister's office 02 6277 7480
217/98 9 December 1998

digital data review — tabling statement

The Coalition Government has shown a longstanding commitment to ensuring that all Australians have access to advanced telecommunications services, including digital data services.

In 1996, upon taking office, the Government commissioned a Review of the Standard Telephone Service. This Review highlighted the increasing importance of digital data services to all Australians, and some of the problems being experienced, particularly by rural and remote Australia, in accessing these services. The review recommended that the Universal Service Obligation (USO) be upgraded to include a data communications requirement. What the report did not do, however, was clearly identify what the costs or benefits of this upgrade would be.

To bridge some of the gaps in telecommunications services, access and costs between urban and non-urban Australia, in 1997 the Government launched Networking the Nation—the Regional Telecommunications Infrastructure Fund. This program, worth $250 million over five years, derived from the first one third sale of Telstra, aims to assist the economic and social development of rural and remote Australia by funding projects which enhance telecommunications infrastructure, promote use of telecommunications services and reduce disparities in access to such services.

In drafting the new telecommunications legislation that came into effect last year, the Government incorporated a requirement that a further review of digital data capability be conducted before 30 September 1998.

On 30 April 1998 I directed the Australian Communications Authority (ACA) to conduct this review via a public inquiry. The key issue to be examined was whether a digital data service, comparable to a 64 kilobit per second (kbps) Integrated Services Digital Network or ISDN service, should be incorporated into the universal service obligation (USO). The ACA was also asked to examine the costs and benefits of putting the service in the USO, paying particular attention to the needs of rural and remote customers.

The ACA provided the Report of its Digital Data Review to me on 15 August 1998. In accordance with the legislation, the report has been tabled in this chamber and in the House of Representatives today.

The report is comprehensive and makes a positive contribution to our understanding of this issue.

It provides, for the first time, a summary of the quality and level of data services available in the Customer Access Network throughout Australia, and the costs and benefits associated with upgrading that network.

There are two key messages in the report.

Firstly, the ACA found that the costs of upgrading Telstra's network to provide a 64 kilobit per second (kbps) digital data service would significantly exceed the benefits. Also, the costs of upgrading the network to 28.8 or 14.4 kbps would exceed the benefits, although to a lesser degree.

Second, the ACA concluded that those currently experiencing problems in terms of access to affordable and quality data services are mainly located in rural and remote areas. These consumers are disadvantaged comparative to services available in urban areas in a number of ways.

Rural and remote areas are limited in the data rates that they can achieve over the network. In the main this is due to attenuation problems in the long runs of copper wire used to provide telephony services to these areas and the limitations of the Digital Radio Concentrator Systems, used in the most remote areas. By comparison, the majority of customers in urban areas can achieve 'reasonable' data rates over the customer access network-somewhere between 14.4 and 28.8 kbps.

The technical problems that prevent rural and remote customers from accessing higher data rates over the twork, also prevent them accessing high data rate

ISDN services. By the end of 1998 Telstra, as a condition of its licence, must provide 96 per cent of the population with access to an ISDN service on demand. It follows, therefore, that the majority of the four per cent who cannot access ISDN are probably located in rural and remote areas.

The ACA also found that this disparity of access over the network is increased by the higher prices paid by rural customers for data services, particularly for using the Internet. In the main this is because of a lack of Internet points of presence in rural areas, which require rural customers to pay STD call rates to connect to their Internet Service Provider (ISP). This is compounded by the fact that rural customers, who often cannot achieve over 2.4 kbps, must stay connected to the Internet for longer periods of time to access the same information as their city counterparts.

Against this background, the Coalition has developed a responsible and balanced response to the report. During the election campaign the Government announced a number of regulatory and budgetary initiatives.

In summary, the key initiatives are:

- an upgrade of the USO;
- targeted expenditure on upgrading infrastructure; and
- a national bandwidth taskforce to examine bandwidth availability and pricing.

The USO upgrade has three parts:

- Telstra's current licence condition to provide ISDN on demand to 96 per cent of the population will be incorporated in the USO;
- for the four per cent not able to access ISDN on demand, the provision of an on demand Internet-based asymmetric satellite service that delivers a satellite downlink service comparable to 64 kbps service will be mandated in the USO; and
- to help address the issue of affordability of the satellite service, those not able to access ISDN on demand, will be eligible for a reimbursement of up to 50 per cent of the price of purchasing the necessary satellite receiving equipment.

There are three key components to the infrastructure upgrades, funded from the next 16 per cent sale of Telstra:

- the allocation of an additional $36 million to the Regional Telecommunications Infrastructure Fund to increase points of presence in rural and remote areas;

- as part of the social bonus from the sale of the next 16 per cent of Telstra the allocation of $150 million over the next three years to upgrade the CAN to enable untimed local calls in extended zones in remote Australia; and
- the allocation of up to $70 million over five years to install Rural Transaction Centres into smaller rural towns.

In addition, the pastoral call rate of 25 cents for 4.5 minutes, which applies to calls to the community service town, will be replaced with a preferential rate of 25 cents for 12 minutes.

The Government is looking at creative ways to implement these initiatives. For example, the Department of Communications, Information Technology and the Arts is currently working on a paper canvassing the issues involved in tendering out the provision of some or all USO services.

The Government recognises that ensuring Australia's telecommunications infrastructure continues to meet the needs of business and community generally is fundamental to the developing information economy. The ACA's Report has contributed significantly to our knowledge base in this area, with a particular focus on customer access network issues. The Government responses I have noted today will go a long way to addressing identified concerns.

The Government, however, acknowledges that further work is necessary to ensure we have a commercial and regulatory environment, both domestically and internationally, which will meet increasing bandwidth demand in an information economy.

I am happy, therefore, to announce that the Government will ask the Australian Information Economy Advisory Council to undertake a major study of issues associated with bandwidth availability and pricing within Australia and to and from Australia. This gives effect to the Government's election commitment that it would establish a National Bandwidth Taskforce to conside these issues.

The Taskforce's work is intended primarily to provide an authoritative analysis of issues relating to the current and future capabilities of the Australian telecommunications network to deliver adequate infrastructure support for a full information economy. The focus of the Taskforce will be on the 'backbone' telecommunications data networks and links within Australia, and between Australia and other countries.

Importantly, the Taskforce will contribute to Government and industry understanding of the development of Australian telecommunications infrastructure. It will report on

- the drivers of demand for bandwidth;
- potential constraints on bandwidth availability, including pricing within Australia and to and from Australia and key overseas markets; and
- relevant commercial and regulatory issues.

The Taskforce will also report on any constraints on the availability of bandwidth to meet current and projected demand and make recommendations about Government and industry actions which might address those constraints.

The Taskforce will consult widely with the industry and community and report to me by early October 1999.

appendix 2

PRESS RELEASE — NATIONAL BANDWIDTH INQUIRY TERMS OF REFERENCE

The Minister for Communications, Information Technology and the Arts, Senator Richard Alston, today released the detailed terms of reference for an inquiry into the issues associated with bandwidth availability and pricing within Australia and to and from Australia.

The inquiry will be conducted by a team within the Department of Communications, Information Technology and the Arts. This work will be overseen by the Australian Information Economy Advisory Council (AIEAC) which considered the terms of reference at the Council's inaugural meeting in Sydney yesterday.

The AIEAC study gives effect to the Government's recent commitment that it would establish a National Bandwidth Inquiry to consider these issues.

The Inquiry's work is intended primarily to provide an authoritative analysis of issues relating to the current and future capabilities of the Australian telecommunications network to deliver adequate infrastructure support for a full information economy. The major area of focus should be the 'backbone' telecommunications data networks and links within Australia, and between Australia and other countries ('the trunk network').

It is intended to ensure that this study complements as far as practicable, and without unnecessary duplication, recent reports presented to Government, including the Australian Communications Authority's digital data inquiry, which focussed on data capabilities and related issues in the customer access network. The primary timeframe for the report is the next five years, 1999–2004, although the Inquiry would also be expected to give its views on any matters going beyond that period where this is appropriate.

The focus on the current and future capabilities of the Australian telecommunications network, especially the trunk network, recognises that the availability of adequate, high quality and appropriately priced bandwidth is an important strategic issue for the development of the infomation economy in Australia.

The terms of reference are attached. Individuals or organisations wishing to make submissions to the inquiry should write to:

National Bandwidth Inquiry
Department of Communications, Information Technology and the Arts
38 Sydney Ave
FORREST, ACT 2603

Media Contact: Terry O'Connor, Minister's office 02 6277 7480
Website *www.richardalston.dcita.gov.au*
227/98 18 December 1998

TERMS OF REFERENCE

The Inquiry is to:

1. Report on the drivers of demand for bandwidth in a present and future Australian information economy, including:

   (a) the applications, in particular Internet-based services, which are most likely to drive demand for data communications on the network, especially the trunk network, from residential, business, community, academic and research and public sector users, including governments at all levels;

   (b) the likely takeup of these applications within the timeframe outlined above, including an indication of the likely price sensitivity of the potential markets for these applications; and

   (c) the likely levels of demand for telecommunications bandwidth within Australia and between Australia and key overseas markets.

2. Report on the constraints, if any, which exist on the ability of the Australian telecommunications network to meet the likely demand of an Australian information economy, including:

   (a) providing a 'stocktake' of Australia's existing trunk network, and planned changes to that network by commercial operators and state governments, with information disaggregated regionally, as far as practicable;

   (b) determining the current and reasonably anticipated data carrying capabilities of the trunk network;

   (c) outlining the technological changes, which are likely to affect the data capabilities of Australia's trunk transmission network;

   (d) analysing pricing for key high bandwidth services, including existing pricing structures, trends, and the benchmarking of current prices in Australia against those in comparable markets overseas;

   (e) outlining relevant market structure and commercial issues, including the current level and likely development of competition in relevant wholesale and retail carriage service markets within Australia;

   (f) determining relevant international market structure and commercial issues, including an assessment of the international settlement arrangements for Internet Protocol networking; and

   (g) analysing the implications of regulatory arrangements relating to the installation of trunk network infrastructure, in particular submarine cables, at all levels of government.

The above analysis should consider both present constraints and any future constraints that may emerge in the move to a full information economy in the primary timeframe for the report.

3. On the basis of the foregoing, and any other matters the inquiry considers relevant, provide:

   (a) its assessment of the degree to which there is a risk of constraint on the availability of bandwidth in any significant part of the Australian telecommunications network, especially the trunk network, over the next five years which is likely to have a material effect on the evolution of the information economy in Australia; and consideration as far as practicable of the costs of such constraints to the wider economy; and

(b) its views on the options open to the Government to address those constraints, including its preferred option (if any).

The inquiry is to report to the Government by 1 October 1999, and sooner if practicable.

It is expected that the inquiry will prepare and publish interim reports or discussion papers on matters referred to above in order to facilitate industry and community discussion and encourage input to the inquiry's work. In particular, the Group should prepare an additional and separate report on the matters relevant to term of reference 2(f).

appendix 3

ORGANISATIONS CONSULTED AND/OR SUBMISSIONS PROVIDED TO THE NATIONAL BANDWIDTH INQUIRY

AAPT Telecommunications

Australian Broadcasting Corporation

Alphawest

American Express International Inc.

Asia Pacific Networx

Australia ATM Interest Group

Australian Competition and Consumer Commission

Australian Information Industry Association

Australian Local Government Association

Australian National University - ACYS, Cooperative Research Centre for Advanced Computational Systems

Australian Photonics Pty Limited

Australian Private Hospitals Association

Australian Telecommunications Users Group

Australian Vice-Chancellor's Committee

Beale Telecommunications

Brisbane Internet Technology

BT Asia Pacific

Cable & Wireless Optus

Camtech

Catholic Telecommunications

Council of Australian University Directors of Information Technology (CAUDIT)

Chariot Internet

Chromium

CIRCIT

Commonwealth Bank

Commonwealth Government Department of Education, Training and Youth Affairs

Compaq Computer Australia Pty Ltd

COMPUGAMES, Albany Internet Services

Connect.com

CSIRO

Denton, Timothy

Dinsdale and Associates

Education.au Limited

Ericsson Australia Pty Ltd

Fantastic Corporation, The

Federation of Australian Commercial Television Stations

Gardener, J A

GIO Australia Ltd

Handshake Media Pty Ltd

IBM Australia Pty Ltd

iiNet Technologies Pty Ltd

Internet Society of Australia

Internode

JMC Academy

Kwan C

LCH Pty Limited

Macquarie Corporate Telecommunications

MIT Laboratory for Computer Science (USA)

Newbridge Networks (Australia) Pty Limited

Network Exchange Pty Ltd

NTL

ONet Networking

OIC

Omen Internet, CBI Enterprises Pty Ltd

ONet Networking (Toronto, Canada)

Ozemail Pty Limited

PARNet

Peter Farr Consultants Australasia Pty Ltd

PowerTel Limited

Productivity Commission

Project Oxygen Ltd, Bermuda

Propagate Institute Pty Ltd

Redfern Fibres Pty Ltd

Redwood, Neil

SE Network Access Pty Ltd

Sun Microsystems Australia Pty Ltd

State and Territory Governments of:

- New South Wales
- Western Australia
- Tasmania
- South Australia
- Queensland
- Victoria
- Northern Territory
- Australian Capital Territory

TECHQUAD

TELCAM Asia Pacific (Telecommunications Content and Applications Management Group), Graduate School of Business, University of Technology, Sydney

Teledesic

Telstra Corporation Ltd

3V and Merlin Integrated Media

UIH Asia/Pacific Communications Inc.

US Consumer Project on Technology

Vanguard Productions Pty Limited

Wantree Internet

WestNet Pty Ltd

Westpac Banking Corporation

Woodside Energy Ltd

Worldcom Australia Pty Ltd

World Geoscience Corporation Limited

Xamax Consultancy Pty Ltd

appendix 4

SAMPLING METHODOLOGY FOR TOWNS INCLUDED IN THE CAPACITY SURVEY

To make the study of bandwidth supply as representative as possible, the consultant sought information on network capacity according to town size and geographic location. As it is not possible for carriers to detail the capacity into all towns in Australia, a segmented sample of towns was provided.

The approach was to divide the towns into five discrete population bands and request that the carriers provide information on capacity into a specified number of towns in each population band and each state or territory. Each carrier was requested to respond as comprehensively as possible to the extent to which their networks matched this format.

All carriers indicated that specific information on the capacity of a network into a particular town or city was an area of significant commercial sensitivity. The larger operators indicated that their competitive advantage relied on the confidentiality of information on network capacity relating to specific geographic areas such as towns and cities. They argued that the release of information that identified exact areas where a network was broken out and the corresponding terminating capacity of the network at the break out points would erode that advantage.

Noting the sensitivity of this issue, information on the capacity of networks terminating at particular towns and cities was collected using population centres, rather than named locations. Details of the number of towns sampled in the discrete population bands by location is provided in table A4.1. The final number of towns in each state or territory for which the carriers provided information fell short of the number sought. However, the sample was sufficiently large to make the study of capacity representative.

The actual towns selected was a matter left to each network operator. Given that Telstra is the only operator with significant backbone capacity outside the inter-capital routes, they chose the samples of towns below a population of 100 000. To

demonstrate that the towns were selected at random, Telstra provided a certificate to the consultant from a registered auditor to certify that where a choice was required within a particular population range, that choice of towns was in fact random.

Table A4.1
NUMBER OF TOWNS SAMPLED

Population range	*State or Territory*								*Totals*	*No. towns sought by state/ territory*	*No. towns in sample*
	ACT	*NSW*	*NT*	*QLD*	*SA*	*TAS*	*VIC*	*WA*			
100 000 and above	1	4	0	3	1	1	2	1	13	All	13
30 000 to 99 999	0	8	1	7	0	1	4	2	23	5(max)	18
10 000 to 29 999	0	24	2	16	8	3	16	9	28	10(max)	52
1 000 to 9 999	0	210	13	129	53	34	127	61	627	10(max)	70
Less than 1 000	0	278	37	193	90	60	165	95	918	10(max)	70
Totals	1	524	43	348	152	99	314	168	1 659		223

appendix 5

TELECOMMUNICATIONS TECHNOLOGY AND ITS INFLUENCE ON CAPACITY

introduction

This appendix considers the means by which network capacity might be expanded with particular emphasis on the known and probable future technological developments. The discussion provides:

- a basic introduction to digital communications technology and network architecture;
- consideration of the technological factors affecting capacity of the terrestrial backbone network and customer access network; and
- a summary of the main broadband satellite capacity over Australia and possible future developments.

digital communications technology — the basics

NETWORK EVOLUTION

Long established communications networks based on telephony, such as that owned by Telstra, have been designed to be, a far as possible, backward compatible with ageing equipment originally designed and installed on an electro-mechanical network.[1] Telephone networks evolve by upgrades in relatively small increments over time, with the result that at any one time the age and technical sophistication of a network varies considerably in different locations.

One of the legacies of this 'historical' approach to network design, is the *circuit switched* architecture. Circuit switching was first developed in the late nineteenth century and depended on the establishment of a dedicated circuit between the

1 For example, a large black bakelite analogue telephone handset manufactured in the mid 1950s will still operate on the telephone network today.

caller and the called party at the time the call was connected. At its simplest, this circuit was a number of individual copper pairs connected in series through a set of electro-mechanical switches (or sometimes by a human operator). This meant that the path and capacity of a call were reserved and fixed for the duration of the call. With more sophisticated switching and call traffic aggregation, the circuit was dedicated in terms of a capacity and path reservation on a multi-circuit switch or bearer. This notion of circuit switching has remained in modern digital networks. In this context, it refers to a dedicated path for transmission of the packets, although in some cases the capacity of the path may vary dynamically depending on the requirements of the connection.

ANALOGUE AND DIGITAL

The human voice is analogue and the modern telephone network is digital. Therefore to carry a voice transmission, the voice signal (the caller's words) must be converted into a digital form, transmitted across the network and re-converted back to voice so it may be heard at the receiving telephone. This process involves converting the continuously varying voice frequency into binary numbers which provide a representation of the original signal. Binary numbers, or numbers to the base 2, are used because electronic processing equipment most easily operates in two states, off or on, representing the numbers zero and one in a binary system.

After conversion, the voice signal appears like a string of binary numbers represented by zeros and ones. This is exactly the same structure as a data signal from a computer. Thus digitisation potentially allows data and voice to be carried in the same way over the same network. The digitised information stream is not continuous, as it is broken up into a large number of small, discrete packets of data which are directed separately through the network. Each packet contains a destination address, part of the message to be carried and a means of identifying how the final message is to be reassembled. Each packet might represent one character in a written document or a tiny sample of a voice transmission.

NETWORK ARCHITECTURE

The design and operation of modern telephone networks may vary considerably from place to place within one network or between networks depending on their age and the purpose they are, or were, intended to serve. The transmission medium,

sometimes referred to as a bearer, may be copper, optical fibre or radio and most call circuits would use a combination of these depending on the origin and destination of the call.

For the fixed network the most common connection to the customer's premises is one or more dedicated pairs of copper wire. These copper wires go to the local telephone exchange or to some point between the exchange and the customer's premises where a number of copper pairs are all *connected* to a single bearer, which is often an optic fibre cable. The different signals from the copper pairs are bundled together or multiplexed onto the one cable. Multiplexing is the process of aggregating a number of individual call circuits or data streams onto the one transmission bearer. Any connection between population centres, such as the backbone network, contains one or a number of bearers carrying multiplexed information.

In a digital switched network, switching equipment is located at the intersection of two or more bearers or between copper pairs and bearers at what has been traditionally referred to a a telephone exchange. The switching and other equipment in a telephone exchange within a digital backbone network perform a number of functions the most important of which are:

- establishing and maintaining sufficient capacity on a bearer to provide a dedicated path for a line connection from one point to another;
- sending and receiving packets of data along their respective dedicated paths, depending on the addresses contained in each packet;
- verifying the safe and accurate receipt of data sent, and if necessary re-sending any *lost* packets; and
- performing other intelligent network functions such as call redirection or collecting billing information.

All these functions are performed in accordance with a set of international telephone network standards collectively referred to as signalling system 7 (SS7). A digital switched network carries end user data and SS7 instructions at the same time, the latter defining how the end user data is to be treated, how the network operates and how the *intelligence* contained in the network is to be applied. To the network user or customer these features appear as the different types and levels of communications services, for example, leased line call waiting and itemised billing. SS7 and the communications services it defines are under the centralised control of the network operator.

ALTERNATIVES TO THE CIRCUIT SWITCHED NETWORK

The circuit switched network has developed from voice telephony where the path between the caller and the called party is fixed at the time the call is established and dedicated for the duration of the call, whereas a different network design and operating structure has developed for the purposes of carrying pure data. In the 1960s the first large scale universal data networks were established and these developed into what we now refer to as the Internet. On the Internet, packets of data are dynamically directed on their way by the shortest available path by equipment referred to as routers. As such, the packets associated with any given point to point connection may, and do, travel by a variety of paths to reach the same destination. If no path is available between two routers, because of congestion for example, no packets are sent and the user experiences a delay in data transmission until such paths become available.

The Internet network operates according to a set of standards known as the transmission control protocol-Internet protocol (TCP/IP) or IP for short. The IP routes data on a *best endeavours* basis compared with the dedicated path and capacity of a switched circuit. A switched circuit remains open, using network resources even when no data is being transmitted, for example during a pause in conversation, while IP only uses network resources if there is data available to send. IP is therefore inherently more efficient than circuit switching in terms of the network resources required for the network to function.

As voice and data look like the same stream of packets to a network, both Internet and voice traffic can, and are, carried over either switched or IP networks. The difference between the networks is in the rules or standards relating to the carriage of traffic, not in the physical characteristics of networks. Internet traffic is usually carried on the same physical network as circuit switched traffic, with the differences in the network being in their logical configuration. For most existing telephone networks, dedicated switched circuits have priority and Internet traffic is fitted onto bearers as and when capacity permits.

For the Internet there is currently no overall network management system, as packets travel by any path governed by their delivery address and the availability of network resources. Compared with a digital switched network, an IP network has little network intelligence and is often referred to as a *dumb* network as the necessary intelligence is in the devices connected to the network, such as personal computers and web servers.[2] Thus, unlike switched networks, the services available on an IP network are largely under the control of the network users.

2 A *web server* is a computer that provides World Wide Web services on the Internet, including TCP/IP protocol recognition, web pages and accepting requests from web browsers to download HTML pages and images.

technological factors affecting capacity

TERRESTRIAL BACKBONE NETWORKS

Significant increases[3] in bandwidth on terrestrial land based backbone networks will be brought about by improved or expanded point to point microwave systems or optical fibre infrastructure.[4]

Additional microwave networks have been installed by Macrocom between Sydney and Melbourne and microwave is likely to form a significant component of the Soul Pattinson network. The advantage of microwave systems is that the technology is very well established and they are relatively cheap to install compared with trenching for cables. This is particularly the case for a company like Soul Pattinson which already has a transmission tower network in north east NSW, based on the NBN television transmission network. However, the capacity of such systems is limited by the availability of radio spectrum and the limitations of multiplexing for radio frequency bearers.

To significantly increase bandwidth on terrestrial land based optical fibre networks to meet increasing demand, network providers are faced with three possible responses:

- install more optical fibres;
- increase the bit rate and therefore the capacity of existing fibre using time division multiplexing (TDM); and/or
- increase the capacity of existing fibre using wave division multiplexing (WDM).

installing more optical fibres

Providing an increased number of physical links from point to point has traditionally been one of the main means of expanding network capacity over the last 100 years. The first terrestrial optical fibres cables deployed in the 1970s contained perhaps six fibres while today the number of fibres per cable is often 60 and can be up to 480.[5]

3 *Significant* here refers to capacity improvements which potentially provide for or expand the delivery of broadband services. As such, Telstra's high capacity radio concentrator service (HCRC), while providing improved communications access for some rural customers, as compared to the existing digital radio concentrator system (DRCS), is not examined.

4 The report does not consider the possibility of upgrading the capacity of the backbone network by installing more copper wire (such as co-axial cable) although this may occur in rare circumstances.

5 Consultel *op. cit.*, Section 2.4.2 *Recent Planning Practice*, p. 9.

Increasing the number of fibres in a communications cable may be a cost effective approach to increasing network capacity as the marginal cost of adding additional fibres at the time of constructing the network is small compared with the cost of installing a whole cable. However, the commissioning cost is roughly the same for each fibre. This has resulted in the existing carriers often installing a large number of fibres and leaving some or many of them unlit until increases in the demand for bandwidth justifies the cost of commissioning[6].

Oversupply of capacity is now a characteristic of the domestic backbone network. There is a significant surplus of spare, or potential, capacity terminating in all the centres surveyed in the stocktake. The potential capacity exceeds the installed capacity by two to five orders of magnitude.[7]

time division multiplexing

At their simplest, optical fibres transmit information by carrying flashing laser light beams and the faster the laser flashes the more information that is carried. TDM increases the capacity of a fibre by slicing time into smaller intervals at the electronic layer, thereby increasing the frequency of laser flashes and this enables more bits (data) to be transmitted per second. Traditionally, this has been the industry method of choice to increase the transmission capacity of existing and new optical fibre networks.

There are two closely related modern standards for TDM and the associated network management, developed around 1990. These are referred to as synchronous optical network (SONET), largely used in North America, and synchronous digital hierarchy (SDH), mostly used in Europe, Australia and international networks. A synchronous mode of transmission means that the laser signals flowing through an optical fibre system have been synchronised to an external clock. The resulting benefit is that data streams transmitting voice, data, and images through the fibre system flow in a steady, regulated manner so that each stream of light can readily be identified and easily extracted for delivery or routing.

SDH and SONET operate well in legacy networks where the network infrastructure varies significantly in design, age and capacity. The architecture is

6 Amos Aked Swift, *op. cit.*, p. 4.

7 *Ibid.*

known for its capacity to operate in self healing rings that offer network redundancy and protection against faults.[8] It also provides the ability to add and subtract capacity on a fibre, to create network meshing or serve a population centre via a spur or ring off a main route.

The transmission rates associated with SDH and SONET are set out in ever increasing incremental steps defined by an n x 4 sequence, where n = 51.84 Mbps for SONET and 155.52 Mbps for SDH. The fastest bit rates readily available are the SONET optical carrier 192 (OC-192) and the SDH synchronous transport module 64 (STM-64), each with a transmission rate of ten Gbps. Most existing Australian SDH networks are operating at speeds of 2.5 Gbps (STM-16) or less. Over the next five years capacity upgrades to ten Gbps would be possible for much of the existing optical fibre networks, should this be required to meet increased demand. A comparison of SDH and SONET multiplexing levels and other common transmission rates is provided in table AP5.1.

Table AP5.1

SDH AND SONET MULTIPLEXING LEVELS AND COMMON MEASURES OF CAPACITY

Trans-mission scheme	*Multiplex level (Mbps)*			*Capacity*	*Comment*
	Digital signal	*SDH*[(a)]	*SONET*[(b)]		
T1	DS-1	-	-	1.544	Mainly in United States
E1	-	-	-	2.108	Mainly in Europe — commonly 2 MHz
T2	DS-2	-	-	6.312	Mainly in United States
E3	-	-	-	34.368	Mainly in Europe
T3	DS-3	-	-	44.736	Mainly in United States
-	-	STM - 1	OC - 3	155.52	Commonly 155 Mbps
-	-	STM - 4	OC - 12	622.08	Commonly 622 Mbps
-	-	STM - 16	OC - 48	2 455.32	Commonly 2.5 GHz
-	-	STM - 64	OC - 192	9 953.28	Commonly 10 GHz

Notes: (a) Synchronous digital hierarchy used in Europe, Australia and for under sea international cables.

(b) Synchronous optical network used in the United States.

8 Walley, W., *Putting the Squeeze on SDH*, Global Telephony, May 1999, p. 28.

wave division multiplexing

WDM is another more recent multiplexing technology which can significantly increase the capacity of existing optical fibre. This is achieved by assigning different colours (representing different frequencies or wavelengths) of light to each data stream and combining the colours into one laser beam. This process is carried out in the optical layer and is therefore independent of the bit rate (or bit rate standard, SONET or SDH) employed and the network protocol used (IP, asynchronous transfer mode or frame relay). A single colour or wavelength can therefore carry the same amount of data as the original fibre, before WDM was installed, producing a capacity multiplier effect.

Early WDM systems provided two or four wavelengths and this was later expanded using dense wave division multiplexing (DWDM) so that 16 wavelength DWDM networks are now common place. Telstra is currently deploying 16 DWDM (40 Gbps using an STM-16 traffic stream) in much of its inter-capital transmission network. DWDM has advantages over other multiplexing technologies in that it can be installed in any optical link of a network, carry a different protocol on each channel and not affect the architecture or operation of the rest of the network, thus permitting capacity scaling in selected sections of a network to meet potential increases in demand for bandwidth.

Over the next five years the capacity of DWDM systems is set to dramatically increase. For example, Nortel announced on 4 May 1999 the development of a 160 channel DWDM product called *OPTera 1600G* which will provide 160 channels each of ten Gbps or 1.6 Tbps. The technology will be commercially available in 2000. While this report was being produced Nortel announced on 12 October 1999 a successful demonstration, outside of laboratory conditions, of a 480 kms long test system carrying up to 6.4 Tbps on one fibre. The system uses an 80 Gbps transmission platform on up to 80 channel DWDM. The product should be commercially available in 2001 and existing *OPTera 1600G* installations will be capable of being scaled up to the new capacity.[9]

asynchronous transfer mode

Asynchronous transfer mode (ATM) is an evolution of packet switching technology which integrates multiplexing and switching functions at the electronic layer and is designed for high performance multimedia networking.

9 For details see *www.nortelnetworks.com*, October 1999.

An asynchronous mode of transmission means that the signals flowing through a fibre-optic system are not synchronised to an external clock and labelled cells of information can be sent at any time. The basic unit of ATM is the virtual circuit (VC) which carries a single stream of fixed length cells (containing a number of packets) in order from the calling to the called party. A collection of virtual circuits can be bundled together into a virtual path forming the basis of a backbone connection between two ATM switches.

ATM is well suited to *bursty*[10] traffic and allows communications between devices that operate at different speeds. This is possible because ATM is connection orientated and allows the dynamic allocation of network resources on a per-connection basis which may be represented as a form of *traffic contract* within a network. ATM has five classes of resource allocation ranging from a constant bit rate using a high level of network resources, to emulate a circuit switched connection for voice, to an unspecified bit rate, using low resources for the passage of TCP/IP data. These classes provide the basis of many different traffic contracts which enable ATM networks to be efficient, versatile and responsive to varying traffic demands.

undersea cables

Theoretically the same capacity enhancement technologies can be applied to undersea optical fibre cables as those on land. However, installing the necessary hardware upgrades in undersea optical amplifiers to provide for higher factors of WDM, for example, is often not technically possible and very rarely cost effective. As a consequence undersea cables usually remain for their working life at the capacity available when they were installed. For this reason undersea cables are usually installed with the latest technology, and are at their full capacity immediately after commissioning. This contrasts with terrestrial cables which are designed to operate with the latest available, or foreseeable future technology and their capacity is scaled up over time in response to demand.[11] The proposed Project Oxygen network is an example of an undersea cable being installed with capacity of 2.56 Tbps on trans-oceanic segments, based on eight fibre pairs of 32 wavelength DWDM each carrying an STM-64 traffic stream (10 Gbps). Oxygen is a planned global undersea optical fibre cable network with a first phase

10 The term *bursty* refers to a highly variant traffic rate over time, or traffic which comes in 'bursts'.

11 The Southern Cross cable will not follow this traditional pattern, as it is proposed that the capacity on some segments such as between Australia and New Zealand will be capable of being scaled up in response to demand. This will be achieved by installing high resolution, high bandwidth undersea optical amplifiers at the time of construction, thereby enabling an upgrade of the DWDM equipment attached to the terrestrial ends of the Tasman Sea section of the cable. See Merrill Lynch Report *Southern Cross Cable*, April 1999.

comprising approximately 168 000 kilometres of optical fibre cable, 97 landing points in 76 countries and locations. Cable installation is scheduled to begin in 1999, with the major trans-Atlantic and trans-Pacific links operational in 2001. The full first phase will be complete in mid-2003.[12]

IP TELEPHONY

IP defines the basic unit of data transfer used throughout a TCP/IP network, performs the addressing and routing of packets and includes a set of rules that embody the idea of packet delivery on a *best endeavours* basis. Telephony refers to the carriage of voice messages or their equivalent[13] over circuit switched networks such as the PSTN. IP traffic and telephony traffic currently use the same physical network but different virtual networks. IP telephony is concerned with the integration of data and voice on the one virtual network.

IP telephony switches enable voice calls to be made within IP networks, such as the Internet or the private IP network of a large organisation, and between IP networks and the PSTN. The latter connections are referred to as media gateways. Gateways digitise and compress voice calls from the PSTN connected calling party and convert them into IP packets for routing across the IP backbone network. At a point close to the destination of the call another gateway decompresses the voice and re-converts it to analogue for carriage to the called party.

An uncompressed voice circuit typically requires 64 Kbps bandwidth, however when compressed it requires only eight Kbps or less. The digitisation process provides a further bandwidth saving of about 270 per cent and this combined with compression means that voice over IP can deliver a bandwidth efficiency gain of about 20 times.

With data communications now requiring the majority of communications bandwidth in a growing number of organisations, the concept of integrating voice and data on IP networks can make a significant saving on bandwidth costs for long distance calls.

12 See *www.projectoxygen.com*, August 1999.

13 This would include such things as facsimile and other transmissions that begin and end in an analogue form.

telstra's data mode of operation

In July 1999, Telstra announced the first phase of a network upgrade referred to as the *Data Mode of Operation* (DMO). The DMO is a program of installing media gateways and other IP telephony equipment to carry voice over the Internet protocol (VoIP). Telstra expects that most of its voice traffic will be sent over IP within five years. As the majority of Telstra's backbone network is already operating in digital mode, VoIP can be expected to provide a bandwidth efficiency gain of about eight times for voice traffic, thereby making much more efficient use of network resources. VoIP could also be expected to reduce network switching costs as packet routing is inherently simpler than circuit switching. In addition, IP based networks potentially provide the ability to integrate a range of services into packages that more effectively meet a customer's requirements.

IP OVER ATM, SDH AND ALL OPTICAL NETWORKS

In most existing communications networks, IP backbone traffic, including VoIP, is carried by a virtual IP network over the ATM layer. The ATM layer is, in turn, carried over SDH (or SONET) which then operates over the optic fibre network. Alternatives to this model include, in the USA, the university based *Internet2* research network which is being developed using IP directly over a high speed SONET network and IP-over-SONET routers.[14] In Canada, Canarie are building a national backbone research network known as *CA*net 3* which will carry IP directly on the light signal transmitted on the optical fibre,[15] generating an optical Internet. These developments are discussed in more detail below.

IP over ATM and SDH

The foundation of bandwidth management in ATM technology is the *traffic contract* that is used to assign the bandwidth to a specific customer requesting an IP based service. The contract ensures that only the required bandwidth is reserved on each node, based on one of the five classes of resource allocation, thus making the most efficient use of physical resources within the network.

14 See *www.internet2.edu*, August 1999.

15 See *www.canarie.ca*, August 1999.

Within an IP over SDH network all bandwidth is available to all customers and all applications at all times. There are no end-to-end traffic guarantees or contracts that allow the user to be sure that their data will arrive in a timely fashion. Network providers can manage variable demands for bandwidth by over provisioning the networks and ensuring there are no bottlenecks at critical points. Given that the marginal cost of installing extra capacity can be very small, this over provisioning may not be a significant issue in network design.

Systems such as ATM and SDH use part of the available bandwidth to operate, for example the packet address and the cell header take up some data space which would otherwise be used by the message itself, and this is referred to as overhead. The bandwidth overhead required to operate IP over ATM or SDH is significantly different. IP achieves about 85 per cent of the available line rate over ATM and this rises to about 95 per cent over SDH. This is because ATM, which runs over SDH, has its own overhead plus the SDH overhead.

standardisation

The ITU set of recommendations referred to as H.323 defines how delay sensitive voice and video traffic is transported over IP networks. However, PSTN based (VoIP) can reduce the quality of service experienced by the user because IP does not dedicate bandwidth to a particular end-to-end connection. To support real time quality of service, a new IP based protocol has been proposed called Resource Reservation Protocol (RSVP). However, until an RSVP standard is widely accepted and implemented in network routers, it is not possible to reserve end-to-end connections, thereby guaranteeing a PSTN like quality of service in an IP network using IP telephony switches outside the ATM layer or an unspecified bit rate within an ATM traffic contract.

Call control and network intelligence is another area where further standardisation is occurring. Despite the widespread use of H.323 by equipment vendors, protocols for call control within IP networks are still largely based on independent proprietary systems. Various standards organisations are currently working on developing a cohesive and widely accepted suite of protocols which will enable the transport of SS7 signals over IP networks.[16]

16 See *www.microlegend.com/what-it.htm*, August 1999.

an all optical network

In an all optical network, the fibres in the network are directly connected to a high performance network router that performs the functions that ATM and SDH (or SONET) switching or multiplexing equipment do in more traditional networks. The router becomes the key node device that controls DWDM wavelength access, switching, routing and protection, as well as the usual packet routing. This potentially removes the layers and complexity of the more traditional telecommunications networks and produces higher data speeds.

The transition to IP directly on optic fibre as part of existing legacy networks is a big step probably characterised by a number of development stages, starting with IP over SDH (or SONET) followed by the development of an effective integration between DWDM and existing network layers and finally the elimination of the SDH layer. Many new products are expected on the market soon which will be designed to simplify telecommunications networks by providing some degree of intelligent optical transport and switching. Ultimately, these products must combine optical networking software with the intelligence and restoration capabilities of SDH and the bandwidth capacity of DWDM.[17]

The *CA*net3* is the first large scale all optical network to be constructed with data transmission speeds up to 40 Gbps using 32 DWDM technology. At this stage it is an experimental network and the characteristics of commercially based end user services it might provide are uncertain. Current research includes investigation into:

- using both working and protection fibres, potentially doubling capacity;
- asymmetric transmit and receive wavelengths/capacity;
- building an optical Internet exchange; and
- hybrid optical/ATM or SONET networks.

The results of this and other research is likely to change the direction of communications network architecture development within the next few years.

TERRESTRIAL CUSTOMER ACCESS NETWORKS

Customer access networks represent the *last mile* of a telecommunications network which terminates at the customer's premises. Traditionally these networks have

17 Walley, W., *op. cit*.

consisted of large numbers of discrete twisted copper wire pairs carrying an analogue signal, with one (or more) pairs going to each customer. The bandwidth available over plain copper is limited to not more than 56 Kbps and is often considerably less than this, because of the frequency limitations of analogue transmissions over bundled unshielded copper wire.

In recent years a number of alternative technologies have been, or are being developed, to augment or expand the bandwidth capacity of the copper customer access network. These technologies include the various forms of the digital subscriber line (xDSL) transmission technique over the existing copper,[18] new fibre networks deployed in a hybrid design with coaxial cable or xDSL, microwave point to multipoint distribution systems such as local multipoint distribution systems (LMDS), cellular mobile networks and datacasting systems. These systems all have the potential to provide a varying level of broadband services to the end user.

hybrid fibre copper networks

Equipment in the home or business for accessing broadband services operates by electronic means (for example the personal computer), however most of the backbone communications networks are based on optical fibre technology. Therefore, in order to deliver broadband services to the customer, the signal must at some point be converted from optical to electronic format and this conversion usually occurs in the customer access network. At the conversion point the cable changes from fibre to copper. The location of the conversion equipment and the resultant network architecture has significant impacts for the performance and commercial viability of a network.

The best performance would be obtained by running the optical fibre all the way to the customer and installing the optical-electronic converter on the customer's premises. However, with the average cost of converters at around $1 000 each, this option is very expensive. In addition, it can be difficult to tap into an existing fibre cable in a street to add new customers. Alternately, if the optical electronic converters are placed at or near the end of the backbone network, the customer access network is predominantly copper and the bandwidth provided to each customer could decline as more customers connect to the network and/or the distance from the converter increases. The compromise commonly used by network designers is to strategically place optical-electronic converters somewhere in between the backbone network and the customers, so that a number of customers can be served from one converter.

18 Other copper based multiplexing systems are also in use such as *pair gain*, however they do not provide broadband capacity.

The Optus and Telstra broadband networks employ this system with a number of customers being connected to a single copper coaxial cable loop which terminates at the optical electronic converter. While this is a relatively cheap system to install, the potential bandwidth delivered to each customer may decline to unacceptable levels as more customers are connected to a shared coaxial cable of limited capacity. In contrast, xDSL overcomes this problem by using individual copper pairs from the optical electronic converter to the customer.

xDSL

Digital subscriber line (DSL) technology uses specialised modems to carry high bandwidth over existing copper twisted pairs in the customer access network. Like all modems, xDSL uses data compression and error correction. Compression algorithms enable data transmission rates to be enhanced two to eight times over normal or clear transmission rates and error correction examines incoming data for integrity and requests retransmission of selected information when it detects a problem.

Coupled with compression DSL technology employs a frequency range between 4KHz and approximately 1.1 MHz, compared to voice grade transmissions which have a frequency range of from 0 to 4 KHz. Unlike voice, DSL usually also uses asynchronous transmission, that is, considerably more capacity in one direction than the other. The combination of these features under the right conditions allows very high transmission rates using xDSL technology.

Signal attenuation[19] determines the actual data rate over twisted pair copper wire and this in turn is a function of the diameter of the wire, the line length and frequency of the transmission. Table AP5.2 indicates the practical limits on data rates for a number of variants of xDSL as a function of distance (length of copper wire) from the end of the communications network high capacity bearer (for example optical fibre cable).

ADSL and VDSL Australian applications

Telstra have been involved in ADSL research and development for a number of years and consider the technology suitable to augment the bandwidth available on their very extensive copper wire customer access network. A large number of

19 *Attenuation* refers to the process of decline in the power of a signal over distance. For example an audible noise gets quieter (attenuates) as one moves further away from the source of the noise.

Telstra customers are connected to their local exchange by copper lines which exceed 1 500 metres, and the ADSL technology provides a balance between reasonable bandwidth and distance. DOCITA understands that from a technical perspective Telstra is in a position to market ADSL services at short notice and any decision to deploy the technology and the timing of such deployment will be determined by economic and market factors.[20]

Table AP5.2

XDSL DATA RATES AS A FUNCTION OF DISTANCE[21]

Maximum data rate to the user (Mbps)	*Maximum data rate from the user (Mbps)*	*Distance[(a)] (Metres)*	*Type of xDSL*	*Typical applications*
1.5	0.384	6 000	ADSL Lite[(b)]	Domestic Internet connection not requiring a technician to install it on the customer's premises
6.3	0.64	4 000	ADSL[(c)]	MPEG Video and Internet connection[(d)]
1.5	1.5	3 500	HDSL([e)]	Symmetric communications like email
8.4	0.64	3 000	ADSL	MPEG video, and Internet connection
12.9	2.3	1 500	VDSL[(f)]	MPEG video, telephony and high speed Internet connection
25.9	2.3	1 000	VDSL	Multiple MPEG video, telephony and high speed Internet connection
51.8	2.3	330	VDSL	Multiple MPEG video, telephony and high speed Internet connection

Notes: (a) Assumes 24 gauge twisted pair copper cable.

(b) Also known as G Lite or Universal ADSL, based on ITU-T recommendation G992.2.

(c) ADSL — asynchronous digital subscriber line.

(d) MPEG — motion picture expert group video compression standard.

(e) HDSL — high data rate digital subscriber line which is symmetrical in transmission speed.

(f) VDSL — very high speed digital subscriber line

21 From a Telstra briefing to the National Bandwidth Inquiry sub-committee of the AIEAC.

20 Adapted from Pielle Consulting, *Copper Access Technologies*, What's New in Communications, May 1999; Evans, S., *G.Lite (G.992.2)*, Australian Communications, October 1999, p. 34; Evans, S., personal communication; and Federal Communications Commission (United States), *Broadband Today*, A staff report to FCC Chairman W E Kennard, October 1999, p. 21.

The Australian Capital Territory Electricity and Water Corporation (ACTEW) conducted a successful trial of a VDSL network (called *TransACT*) in the Canberra suburb of Aranda. Based on the results of that trial the ACTEW board will shortly decide if VDSL should be deployed throughout Canberra.

Following the pattern of the Aranda trial the proposed network would be deployed in co-location with ACTEW's existing electricity network, which is approximately 70 per cent overhead and 30 per cent underground. It would consist of an optical fibre network running to suburban nodes supplying 36 houses over copper feeders not exceeding 300 metres in length. The network will be ATM switched, providing up to approximately 36 Mbps of useable bandwidth to each customer and this capacity is largely independent of the number of customers connected.[22]

It is proposed that ACTEW will only offer network capacity and local telephony, and will not provide any content or other specialised services over the network. Instead, a variety of service providers will offer a competing range of services to customers including Internet access, near video on demand, pay television, and community and free to air television stations.

third generation mobile

The first generation of mobile telephony covers analogue cellular systems providing voice communications, such as the Telstra AMPS network. Second generation mobile systems are narrowband digital systems providing voice and data messaging up to 32 Kbps, such as GSM. The third generation mobile systems will offer services such as voice, Internet and real time video, providing the potential for a multimedia pocket sized personal communicator with transmission speeds up to two Mbps, operating on terrestrial and satellite based networks.

A number of differing standards for the air interface[23] component of third generation mobile systems are in various stages of development or testing. The most significant of these standards are wideband code division multiple access (WCDMA) proposed by interests in the United States and Japan, CDMA2000 (code division multiple access 2000) proposed by interests in the United States and a time division multiple access system (TDMA) developed in Europe and based on the GSM TDMA kernel specifications.

22 The available bandwidth is limited by the design specifications of VDSL and the total capacity of the connecting optical fibre, although the latter is not likely to be significant given the potential capacity of optical fibres.

23 An *air interface* is the radio component of a mobile telephone system which interconnects the user's handset to the base station.

If the various air interface standards were implemented in different parts of the world, this would effectively prevent widespread international roaming by users of third generation mobiles. For this reason the International Telecommunications Union (ITU), through its various study groups, has almost completed development of a suite of recommendations to harmonise third generation mobile standards. These recommendations are collectively referred to as IMT-2000 (International Mobile Telephone 2000). IMT-2000 is not a single standard, but a range of technical requirements that, if implemented by manufacturers of third generation mobile equipment, would ensure the maximum level of international roaming through, for example, low-cost dual mode handsets.

datacasting

The radio frequency spectrum is, and will continue to be, widely used to transmit data on a point to multipoint basis, for example, teletext, satellite broadcasting and LMDS. Datacasting is a particular subset of wireless data transmissions involving services which are delivered on frequencies which can be accessed by consumers through the television sets and receiving antennae they already have. Consumers are familiar with this equipment and only require the addition of set top decoders to access the new service. Thus, datacasting is broadly defined in the *Television Broadcasting Services (Digital Conversion) Act 1998* as a non-broadcasting service using spectrum set aside for broadcasting services.

The Digital Conversion Act specifies that digital terrestrial television broadcasting (DTTB) commence by 1 January 2001 in metropolitan areas and in regional areas no later than 1 January 2004. DTTB is more spectrum efficient than existing analogue free to air television, thereby enabling the provision of additional services such as datacasting.

Australia has adopted the European based digital video broadcasting terrestrial standard (DVB-T). Broadcasters must simulcast the same service in analog and digital formats, using the DVB-T standard, for at least eight years from the commencement date of digital transmissions. Each existing free to air broadcaster will receive seven MHz of spectrum for broadcasting and other services, including datacasting. Additional spectrum will be set aside specifically for datacasting. The datacasting channel/s will be auctioned with a proviso that existing broadcasters cannot purchase them.

These regulatory arrangements provide essentially two sources of spectrum for datacasting:

- that part of the spectrum allocation provided within a broadcaster's transmissions not required for the broadcasting service; and
- that which is provided pursuant to a datacasting spectrum.

Embedded spectrum

MPEG based digital video transmissions use dynamically varying bandwidth, broadly proportional to the amount of movement occurring in a given frame of video. This means that there is potentially unused bandwidth in the low movement frames of a video transmission amounting to between 10 and 17 per cent of the total spectrum otherwise used for the transmission. The standard bit rate for a seven MHz channel using DVB-T will be 19.3 Mbps, thereby potentially releasing between 1.93 and 3.28 Mbps for datacasting. This process is referred to as statistical multiplexing or joint bit rate encoding of television program streams.[24]

unused spectrum

A digital standard definition television (SDTV) signal can require from four to 19 Mbps of data to broadcast. Broadcasters will be required under the *Television Broadcasting Services (Digital Conversion) Act 1998* to provide an as yet unspecified proportion of their services in high definition television (HDTV) which uses up to 19 Mbps at its highest format. Broadcasters will also have the option of using additional spectrum to provide incidental and directly linked services, such as alternate angles of a sporting event, team and player profiles or information, or possibly a wireless return channel. The amount of unused spectrum available for datacasting will therefore largely depend on the number of hours broadcast, and the formats chosen for HDTV.

dedicated datacasting

The information carrying capacity available to the new datacasting organisations who purchase seven MHz of spectrum specifically for that purpose will vary depending on a number of factors. Unlike the digital television broadcaster, specific rules have not yet been defined with respect to transmission schemes, so the eventual standard may allow the datacaster to opt for different coding schemes to

24 Communications Strategies & Management Pty Ltd, *The Development of Datacasting Technologies and Services*, a report to DOCITA, 1999, p. 129.

suit the application. For example seven MHz of spectrum using the DVB-T standard can offer data rates between five and 30 Mbps. The lower bit rate would enable fewer transmission towers, greater transmission distances and better error correction, while the higher bit rate would experience a sharp drop off in reception in the presence of interference resulting in a lower coverage per transmission site. In weighing up these trade-offs, the datacaster may opt for different levels of service in different areas given that it may be feasible to operate with smaller coverage areas and therefore greater bit rates in built up areas, whereas a basic service will be all that can be commercially justified in more remote areas.[25]

audience interaction

Regardless of the availability of broadcasting spectrum for datacasting, the basic service is only one directional, from the service provider to the user. Where the service requires an interactive response from the user, this is provided by a separate return path, either a dial up modem connected to the PSTN or a separate wireless based network. Datacasting set top box decoders used overseas often have the capacity to connect a telephone line directly to an internal modem and automated communications software which together provide a seamless return path for the user.

A European Union sponsored consortium of thirteen companies have been developing a wireless terrestrial broadcast interactive television system since March 1998. The project, known as interactive terrestrial television integration (iTTi), is designed to operate with one Mhz of ultra high frequency (UHF) spectrum to provide a return connection from a datacast user receiving a DVB-T/MPEG2 digital television signal, like that being introduced in Australia in 2001.

The system was successfully demonstrated in September 1999 at the *IBC '99* exhibition in Amsterdam using eight MHz of UHF spectrum to receive a digital standard definition television signal and provide a low power narrow band return path transmitted from the existing television reception aerial. It is intended that

25 Amos Aked Swift, *op. cit.*, p. 17.

the system be refined and eventually become part of the DVB set of standards operating from one transceiver set-top-box with the return channel having the following characteristics:

- a cellular architecture based around the DVB transmitting tower and additional receiving towers where the traffic density requires;
- a combined time and frequency synchronised multiplexed signal referred to as synchronised frequency division multiple access;
- four modes with varying code rates and modulation schemes providing 24 possible transmission rates ranging from
  - 0.38 Kbps, with 500 ms transmission bursts over a range of up to 70 Kms for up to 2 000 individual channels, to
  - 27.328 Kbps with 15.625 ms transmission bursts over a range of up to two kms for up to 62 individual channels,

  to suit a number of different network configurations; and
- potential to embed the extra bandwidth into the existing seven MHz DVB-T standard spectrum allocation.[26]

The iTTi system is still under development and a number of technical, economic and marketing issues have yet to be addressed before the interactivity it provides can be made available to the public.

satellite services

SATELLITE CAPACITY

The actual capacity of a satellite footprint will depend on the application and the receiver equipment in use. Applications vary from one-to-many broadcasting and data transmission to large point-to point links. In addition, the footprint is a shared resource between all receivers and if links are dedicated to one transmitter and receiver, the number of such links is strictly limited. Given the rapid expansion of the capacity available on optic fibres, the capacity available on satellites relative to fibre is substantially declining.

26 See various articles describing the iTTi system: Gill, G., Callonnec, D., Carral, J., Charles, A., Faria, G., Kopp, R., Lauer, L., Masera, G., Point, J., Moschini, N., Senn, P., Souloumaic, O., Wayne, B., *Wireless Interactive TV Outcomes from ACTS iTTi Project*, Proceedings of the Fourth European Conference on Multimedia, Applications, Services and Techniques, Madrid, 25–27 May 1999; Scalise, F., Charles, A., Gill, G., Callonnec, D., Faria, G., Carral, J., Lauer, L., Masera, G., Souloumaic, O., Senn, P., Point, J., Kopp, R., Wayne, B., *A New Solution for Wireless Interactive TV Based on DVB-T Standard and SFDMA Technique*, proceedings of Society of Motion Picture Engineers '99 conference, Sydney 13–17 July 1999; iTTi Partners, *ITTi Partners demonstrate interactive digital terrestrial TV*, Press Release, *www.st.com/stonline/press/news/t611a.htm* November 1999; Advanced Communications Technology and Services, *Interactive Terrestrial TV Integration*, *www.uk.infowin.org/ACTS/RUS/PROJECTS/ac321.htm* November 1999.

satellite backbone

The satellite bandwidth provided by the geostationary (GEO) satellite is expressed in megahertz. The satellites could be considered as *analogue* devices as they are receiving and re-transmitting radio frequency signals (which often carry digital services such as digital television). The digital equivalent of a satellite's 'analogue' capacity, that is the efficiency of the satellite spectrum utilisation, would, as described above, depend on the services provided. For example two-way 140 Mbps service would require 2x72 MHz of satellite bandwidth, two-way 45 or 34 Mbps would use 2x36 MHz of satellite capacity, while two-way 64 Kbps would need 2x100 KHz.

With the advent of the high-capacity optical fibre cable the importance of GEO satellites as primary means of providing domestic or intercontinental backbone networks has decreased. However, the GEO's are increasingly used by TV broadcasters to provide global coverage.

satellite customer access networks

geostationary orbit satellites

Direct to user communications based on geostationary satellites have been in use for many years, with Inmarsat being the first and now one of the largest global providers. These services have, for the most part, been narrowband voice and data. Within Australia, land based Inmarsat services[27] and services based on the Optus satellites traditionally followed this trend.

More recently, satellite based services in the low end of the broadband range have begun to appear. For example, the Telstra *MiniSat MultiMedia* service based on the Inmarsat M4 project with ISDN (integrated services digital network) capability. Telstra are also about to offer *Big Pond Advance* with 400 Kbps individual download speed and up to three Mbps for multicast file delivery using the PanAmSat 2 satellite.

27 The capacity provided by Inmarsat GEO satellites is assigned on demand and shared among many users and the maximum data bandwidth per service is 64Kbps.

Optus satellites

Optus currently operates three satellites of two types, the A series and the B series. A third type, the C series, is in the process of being procured. A3 is located at 152 degrees east in an inclined orbit, B1 is at 160 degrees east and B3 is at 156 degrees east. The C1 will be located at 153 degrees east and B3 will be moved to 152 degrees east.

The three existing satellites provide beams covering National, North Eastern, South Eastern Australia, Central Australia, Western Australia, South West Pacific, Papua New Guinea and New Zealand. There is also a high performance beam. These are used primarily by commercial, free to air television broadcasters and pay television operators with B3 being the preferred satellite for digital direct to home services. The B series spacecraft includes an L-band transponder which provides the *MobileSat* voice and data service. The main characteristics of these satellites are summarised in Table AP5.3.

Access to the available bandwidth is subject to a number of restraints to ensure most cost effective use of the payload and to ensure that access by any one customer does not adversely affect any other. Optus customers may use their own earth stations, use Optus earth stations which require a terrestrial link or use mobile/ portable earth stations anywhere up to 200 kms offshore from either Australia or New Zealand.

The A3 satellite is in a two degree inclined orbit and may not be accessed by anyone without a tracking antenna. It now provides backup to the B series satellites and some services to New Guinea.

The B1 satellite provides analogue services and may be used for networking, point to multipoint or point to point communications, and may be accessed using fixed antennae. Currently used by free to air television operators, carriers and large corporate organisations, this satellite provides an effective maximum one-way bandwidth of 45 MHz modulated at 80 Mbps per transponder. Some users use bandwidth in six MHz subsets or subdivisions thereof.

Table AP5.3

OPTUS SATELLITE CONFIGURATION[28]

Attribute	*A Series (A3)*	*B Series (B1 and B3)*	*C series (C1 commercial payload)*
Nominal life remaining	A3—Inclined orbit operation only and requires tracking antenna to access	B1—to 2006 B3—to 2009	15 years—2002 to 2017
Number of transponders	15 x Ku band	15 x linearised Ku band 1 x L band	24 x Ku band
Transponder power	11 at 12 watts 4 at 30 watts	Ku band 50 watts L band 150 watts	110 watts
Transponder bandwidth	45 MHz	54 MHz	16 at 36 MHz and 4 at 72 MHz
Ku frequency band	Up 14GHz, down 12GHz	Up 14 GHz, down 12GHz	Up 14 to 15.5 GHz, down 12.25 to 12.75 GHz
L frequency band		Up 1 545 MHz, down 1 263 MHz	
Aggregate bandwidth	-	600 Mbps (both way) each	-

The B3 satellite is dedicated to direct to home broadcast and its performance has been optimised to serve small, fixed antenna dishes ranging in size from 0.6 m to 1.5 m. The standard service used mainly by free to air and pay television operators is a digital video broadcast providing an MPEG-2 video and data service. B3 provides a single carrier per transponder with multiplex capacity to deliver video and Internet services typically at 4 Mbps. In the context of this study, this bandwidth should be regarded as access, not trunk capacity.

The C1 satellite currently being procured by Optus is planned to be launched in early 2002 and will replace the B3 satellite as the new digital satellite optimised for direct to home services. The satellite will carry a commercial and military communications payload of about equal capacity. Its commercial footprint will cover Australia including Indian Ocean Territories and Norfolk Island, New Zealand, most of South East Asia (including Hong Kong), Korea, Japan and Hawaii.

28 Table developed from Consultel, *op. cit.*, p. 12 and Optus Media Release, *Cable and wireless Optus to launch $500M satellite*, 24 October 1999, and associated background material, 26 October 1999.

The commercial payload will provide an enhanced capacity to deliver direct-to-home television, Internet, telephony and high bandwidth data communications throughout Australia and into Asia. The 24 X 110 watt Ku band digital transponders have more than twice the power of existing B series transponders potentially enabling the use of smaller receiving dishes.

PanAmSat satellites

PanAmSat (PAS) has a 19 satellite global system which provides coverage of the Americas, Europe, Africa, the Middle East and Asia. The PAS 2 and the PAS 8 satellites have footprints in the Ku band which are specifically targeted at Australia. The transponders on these satellites are to a certain extent switchable between footprints meaning that any estimate of capacity is a function of Australia's share of the total demand for capacity on the bird. The main characteristics of these satellites are summarised in table AP5.4.

Based on the general assumption that one 64 Kbps channel requires 100KHz of spectrum and assuming the maximum number of transponders are switched to the Australian footprints, from the data in table AP5.4 the maximum Australian capacity for:

- PAS 2 is in the order of 240 Mbps; and
- PAS 8 is in the order of 280 Mbps.

In addition, PanAmSat has tended to wholesale their satellite capacity in blocks that appear to be already heavily committed to television transmission.[29] It is therefore probable that the PAS 2 and PAS 8 capacity still available for sale would be minimal

Low altitude satellites

Two companies, SkyBridge and Teledesic, plan to offer low earth orbit (LEO) satellite broadband services in the future. Both systems would effectively cover all the inhabited areas of the world with broadband services provided to fixed satellite dishes. In Australia Telstra and SkyBridge have signed an in-principle agreement which gives Telstra first option to become an equity partner in SkyBridge and the regional service provider in Australasia and the South East Asia region.

29 See the *program lineup* on the PanAmSat web pages *www.panamsat.com/sat/p2info.htm* and *www.panamsat.com/sat/p8info.htm*, October 1999.

Table AP5.4
PANAMSAT SATELLITES WITH SIGNIFICANT FOOTPRINTS OVER AUSTRALIA[30]

Attribute	*Satellite*	
Satellite name	PAS-2	PAS-8
Spacecraft design	Hughes HS 601	Space Systems/ Loral FS 1300
Orbital location	191° west longitude 169° east longitude	166° east longitude
Launch date	July 1994	November 4, 1998
Launch vehicle	Ariane	Proton
End of life	2010	2013
Polarisation	Linear	Linear
C-band payload	12 x 54 MHz, 4 x 64 MHz 34 Watts Pacific Rim Beam (13-16)[(a)] Oceania Beam (0-3)	24 x 36 MHz—50 Watts Pacific Rim Beam (24)
Ku-band payload	12 x 54 MHz, 4 x 64 MHz 63 Watts China Beam (5-8) Northeast Asia Beam (4) Australia/NZ Beam (4-7)	24 x 36 MHz—100 Watts Northeast Asia Beam (6-12) Southeast Asia Beam (6-12) Australia Beam (0-12)
C-band frequencies uplink downlink	 5.925–6.425 GHz 3.700–4.200 GHz	 5.925–6.425 GHz 3.700–4.200 GHz
Ku-band frequencies uplink downlink	 14.000–14.500 GHz 12.250–12.750 GHz	 14.000–14.500 GHz 12.250–12.750 GHz
Coverage	Asia-Pacific	Asia-Pacific

Note: (a) The number ranges in brackets designate the number of transponders that may be switched to that beam, for example, in the case of the Australia/New Zealand beam on PAS 2, four transponders are fixed and a further three may be switched to that beam from the total number of transponders.

The VIRGO satellite system is intended to also provide broadband services and is based on a small constellation of satellites in non-geostationary inclined elliptical medium earth orbits with good continental coverage. The satellites are in use during the low or perigee part of their orbits which are close to geosynchronous at that point. They therefore appear almost stationary from earth at very high elevation angles from the horizon, enabling low signal propagation delays and

30 Table compiled from data on the PanAmSat web site *www.panamsat.com/sat/*, October 1999.

limited satellite handoffs. The system is still in the planning stages with the Federal Communications Commission (FCC) of the United States yet to grant the company a licence to launch and operate the satellites.

Table AP5.5 provides a comparison of the three proposed LEO broadband systems.

Table AP5.5

COMPARISON OF LOW ALTITUDE BROADBAND SATELLITE SYSTEMS[31]

Attribute	*SkyBridge*	*Teledesic*	*VIRGO*
Cost of space segment	$4.8 billion US	$9 billion US	$2.64 billion US
Commence services	2002	2003	2004[(a)]
Number of satellites	80	288	15
Uplink capacity	2 Mbps residential 10 Mbps commercial	2 Mbps residential 64 Mbps commercial	Yet to be announced
Downlink capacity	20 Mbps residential 100 Mbps commercial	64 Kbps residential 64 Mbps commercial	Yet to be announced
Uplink frequency	12.75GHz–14.5 GHz	28.6 GHz–29.1 GHz	14.0 GHz–14.5GHz
Downlink frequency	10.7 GHz–12.75 GHz	18.8Ghz–19.3 GHz	11.2 GHz–12.7GHz
Waveform propagation	TDMA[(b)]	CDMA/TDMA/FTMA[(c)]	Yet to be announced
Orbit	Circular at an altitude of 1 469 kms	Circular at an altitude of 1 375km	Elliptical with an apogee of 27 388 kms and a perigee of 517 kms
Satellite type	Bent pipe	Switching	Bent pipe

Notes: (a) Assumes FCC approval in 2000.

(b) TDMA—time division multiple access.

(c) CDMA—code division multiple access.

TDMA—frequency division multiple access.

31 Table based on DOCITA research from *www.skybridgesatellite.com*, *www.teledesic.com*, *www.virtualgeo.com* and presentations by SkyBridge and Teledesic to DOCITA staff.

appendix 6

ABBREVIATIONS

AARNet2	Second generation Australian Academic and Research Network
AAS	Amos Aked Swift Pty Ltd
ABS	Australian Bureau of Statistics
ACA	Australian Communications Authority
ACCC	Australian Competition and Consumer Commission
ACTEW	Australian Capital Territory Electricity and Water Corporation
ADSL	asynchronous digital subscriber line
AIEAC	Australian Information Economy Advisory Council
AMPS	Analog mobile phone stystem
ANZCAN	Australia–New Zealand–Canada
ANZSIC	Australia and New Zealand standard industry classifications
APEC	Asia Pacific Economic Community
APEC TEL	Asia Pacific Economic Community Telecommunications Working Group
ATM	asynchronous transfer mode
AV-CC	Australian Vice-Chancellor's Committee
BDT	broadcast data transmissions
bps	bits per second
CANARIE	Canadian Network for the Advancement of Research, Industry and Education
CAUDIT	Council of Australian University Directors of Information Technology
CBD	central business district
CDMA	code division multiple access
CERP	Communications Economics Research Programme at Curtin University, Western Australia
CRTC	Canadian Radio-television and Telecommunications Commission
CRU	Communications Research Unit
CSIRO	Commonwealth Scientific and Industrial Research Organisation

DOCITA	Department of Communications, Information Technology and the Arts
DOCSIS	data over cable service interface specifications
DMO	Telstra's data mode of operation
DRCS	digital radio concentrater system
DS–n	digital signal (level)
DSL	digital subscriber line
DTTB	digital terrestrial television broadcasting
DVB-T	standard for terrestrial digital video broadcasting
DWDM	dense wave division multiplexing
EDI	electronic data interchange
EEZ	exclusive economic zone
EFTPOS	electronic funds transfer point of sale
FCC	Federal Communications Commission of the United States
Gbps	gigabits per second
GEO	geostationary satellites
GATS	General Agreement on Tarrifs and Trade
GHz	Gigahertz
GSM	global system for mobiles
HCRC	high capacity radio concentrator
HDTV	high definition television
HTML	hypertext mark-up language
HTTP	hypertext transport protocol
HFC	hybrid optical fibre and coaxial cable networks
IAP	Internet access provider
IMT–2000	international mobile telephone 2000
IP	internet protocol
IRU	indefeasible rights of use
ISDN	integrated services digital network
ISP	internet service provider
iTTi	interactive terrestrial television integration
ITU	International Telecommunications Union
ITU-T	International Telecommunications Union, Telecommunications Sector
Kbps	kilobits per second
KHz	kilohertz
km	kilometre
LEO	low earth orbit satellites

LMDS	local multipoint distribution system
m	million
Mbit	megabit
Mbps	megabits per second
MDS	microwave distribution systems
MHz	megahertz
MPEG	motion picture expert group video compression standards (e.g. mp3)
ms	milliseconds
mtr	metre
nm	nautical mile
NZ	New Zealand
OA&M	operation, administration and maintenance
OC	optical carrier
OECD	Organisation for Economic Cooperation and Development
OFTEL	Office of Telecommunications in the United Kingdom
PAS	PanAmSat
PC	personal computer
POTS	plain old telephone service
PSTN	public switched telephone network
PTT	post, telegraph and telecommunications—usually referring to a monopoly state owned organisation
RBOC	regional Bell operating companies
RSVP	resource reservation protocol
SBS	Special Broadcasting Service
SDH	synchronous digital hierarchy
SDTV	standard definition television
SEA–ME–WE 3	South East Asia–Middle East–Western Europe 3
SME	small to medium enterprise
SONET	synchronous optical network
STM	synchronous transport module
SS7	signalling system 7
Tbps	terra bits per second
TCP/IP	transmisssion control protocol/internet protocol
TDM	time division multiplexing
TDMA	time division multiple access
TPA	*Trade Practices Act 1974*
UHF	ultra high frequency

USO	universal service obligation
VC	virtual circuit
VCR	video cassette recorder
VDSL	very high speed digital subscriber line
VoIP	voice over internet protocol
VPN	virtual private network
WCDMA	wideband code division multiple access
WDM	wave division multiplexing
WTO	World Trade Organisation
WWW	World Wide Web
xDSL	generic acronym for digital subscriber line systems

appendix 7

ITU REFORM

The ITU is the traditional forum for international agreement on telecommunications regulatory issues, and still has a significant role to play. At the highest level, the ITU must recognise the fundamental changes that are occurring in the role of government regulators *vis a vis* the structure of international telecommunications. The necessary constitutional changes are not great, but the processes for achieving change are treaty-based, cumbersome, and take several years to accomplish even where there is a strong consensus for change.

So far, the ITU's considerations continue to focus on the reform of PSTN arrangements in response to pressure of market liberalisation. On this issue, the WTO GATS commitments provide an acceptable alternative for liberalised and liberalising economies such as Australia that are WTO members. There is some risk that ITU processes, with greater representation from conservative and less-developed economies, will become the haven of resistance to liberalisation, and hence be marginalised. The campaign for ITU reform depends to some extent on convincing conservative ITU members that they have more to lose from the sidelining of the ITU than from accepting changes in the ITU.

ITU work on Internet-related bandwidth issues has yet to get off the ground, although a general mandate for such work was established at the Plenipotentiary Meeting in late 1998.

Asia Pacific economic cooperation telecommunications working group

APEC TEL has been tasked by the Fourth APEC Ministerial Meeting on Information and Telecommunication Industries to study issues concerning the provision of Internet bandwidth and access in the Asia-Pacific. The study was motivated by those APEC economies on the western side of the Pacific who are concerned that current arrangements favour increased US centrality and dominance in the regional Internet service provision business.

NOIE, with Australian industry support, is using this process to promote the development of pricing and access principles that encourage rational development of Internet infrastructure and services. Since March 1999, NOIE provides the chair of the Task Force established by the APEC TEL, and is in a position to steer debate to some extent. The Task Force is to report back to APEC TEL Ministers in May 2000. The expected outcome will be a joint statement of common principles. Australia's objective is that this statement will not favour direct interventionist regulation, but will encourage application of appropriate market disciplines to balance the substantial market power of the most developed economies.

appendix 8

CD ROM CONTENTS

consultants reports

- Bandwidth In the Future—Consultel
- Report on the Capacity and Current Utilisation Of Communications Bandwidth—Amos, Aked and Swift
- An Investigation of Future Demand for Bandwidth—Network Strategies
- The Investigation of Future Demand for Bandwidth—Communications Economics Research Program (CERP), School of Economics and Finance, Curtin University of Technology
- Future Pricing Trends for Bandwidth—Ovum
- A Report On Selected Issues Associated With The Cost Of Constructing Telecommunications Networks in Australia—Consultel
- Consultancies Co-ordination Report—Ovum
- Case Study Report 'Doing business in the information economy'—Hitech Marketing Services

demand models

The Inquiry team commissioned three demand models that can be used to model the future demand for bandwidth:

- Network Strategies developed a judgemental model which builds total demand from the summation of a large number of user profiles;

– ABS Business Register September 1998 extract
– Demand
– Population & Household Projections
– User profiles

- Communications Economics Research Program (CERP) at Curtin University in Western Australia developed an econometric model. The model assumes Australia will follow a similar pattern of demand for communications as the United States, after a time lag; and

- The Communications Research Unit of DOCITA developed a judgemental model which uses Australian Bureau of Statistics data on expenditure on communications to derive demand in a range of industry sectors.
  - mid-range estimate of demand for bandwidth
  - optimistic demand for bandwidth
  - pessimistic demand for bandwidth

All the models are written in Microsoft Excel 97 and may be downloaded and run for different demand scenarios on a PC. The models come with limited explanation and would require a good knowledge of Excel modelling techniques to enable them to be used. The Department of Communications, Information Technology and the Arts accepts no responsibility for the content or operation of the existing models or for any scenarios generated from them (see copyright and disclaimer notice).

submissions to the inquiry

(unless non disclosure was requested)

MAIN REPORT

AAPT Telecommunications

Australian Business

Australian Photonics Pty Limited

Australian Private Hospitals Association

Australian Telecommunications Users Group

Australian Vice-Chancellor's Committee

Cable & Wireless Optus

Council of Australian University Directors of Information Technology (CAUDIT)

CSIRO

Dinsdale and Associates

Federation of Australian Commercial Television Stations

Gardener, J A

Internet Society of Australia

Kwan, C

Redwood, Neil

Tasmanian Department of Education

Telstra Corporation Ltd

3V and Merlin Integrated Media

SUBMARINE CABLE REGULATION

Commonwealth Department of Transport and Regional Services

Environment Australia

Great Barrier Reef Marine Park Authority

MCI Worldcom

NSW Department of Fisheries

Queensland Environment Protection Agency

Queensland Transport

Southern Cross Cable Limited

INTERNATIONAL CHARGING ARRANGEMENTS

Telstra Corporation Limited

the report

Executive Summary

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2. The bandwidth environment
3. Towards a vision for bandwidth
4. The bandwidth market outlook: a framework for analysis
5. Supply of bandwidth
6. Demand for bandwidth
7. Pricing issues
8. Costs
9. Market structure
10. Conclusions: bandwidth availability and pricing
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Press release and tabling statement for the digital data review

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Appendix 3
Organisations consulted and/or submissions provided to the national bandwidth inquiry

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Appendix 6
Abbreviations

Appendix 7
ITU reform

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CD ROM contents

Bibliography

This information is also available on the Internet at *www.noie.gov.au/bandtask*

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national bandwidth inquiry

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The modelling is provided as a tool to estimate demand using different scenarios. The reliability of such tools depends on the underlying assumptions inherent in their design and the level of accuracy of the input data. As such the Commonwealth takes no responsibility for any estimates generated by the models.

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Senator, The Hon Richard Alston
Minister for Communications, Information Technology
and the Arts
Parliament House
CANBERRA ACT 2000

Dear Minister

On behalf of the Australian Information Economy Advisory Council, we have pleasure in submitting to you the report of the National Bandwidth Inquiry.

The Inquiry recognises the importance of the backbone infrastructure in supporting the information economy. The report has provided a factual base on the available infrastructure and some of the technological developments available to increase the capacity. It has also sought to forecast likely demand. The difficulties of accurate forecasts in this fast moving technological age are acknowledged. However, the modelling tools provided will assist others in developing their own demand scenarios.

The report has also sought to develop a vision of the future bandwidth world and draw out the issues that confront us during a transitional period. The two key challenges identified by the Inquiry are:

- maximising the international competitiveness of the Australian bandwidth market, and
- achieving a similar level of service in rural Australia as in metropolitan areas.

In finding solutions to each of these challenges, it has been important to ensure that the approaches adopted in addressing one do not unintentionally constrain opportunities to meet the other challenge.

Don Mercer
Chairman
Australian Information Economy
Advisory Council

Dr Terry Cutler
Deputy Chairman
Australian Information Economy
Advisory Council and
Chairman
National Bandwidth Inquiry
Sub-committee

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EXECUTIVE SUMMARY

The Government asked the Australian Information Economy Advisory Council (AIEAC) to conduct a National Bandwidth Inquiry (NBI). The request arises in light of a widespread recognition that the market conditions for 'bandwidth' (broadly speaking, communications capacity for data services) is likely to be a key factor of production for the emerging information economy. Indeed, the AIEAC considers that the creation of a market environment which fosters the provision of abundant and affordable bandwidth should be a major national objective.

Clearly, Australia's ultimate performance in a global information economy and its success in the world of e-commerce goes wider than simply addressing questions relating to bandwidth. Other factors, such as community attitudes to the uptake of technology, the skills and knowledge of consumers, content creators and service providers, for example, are part of the overall performance equation and these issues are being addressed by other processes within governments. While mindful of the bigger picture, however, the Inquiry's particular focus is on bandwidth related issues.

While the Inquiry had wide ranging terms of reference, it was asked in particular to examine the bandwidth outlook in relation to Australia's international and domestic trunk telecommunications network, and identify any potential issues in that network. However, issues relating to the timely provision of services to the customer were also considered as backbone capacity is only material when it is available to the customer.

The Inquiry's conclusions are that the market outlook for the trunk network, particularly in the inter-capital markets, is reasonable, with competition likely to develop further over the next few years. However, while the trunk infrastructure

to provide services is largely already in place, substantial anecdotal evidence suggests that there are problems with making data services available in a timely and affordable manner in practice, particularly outside the central business districts of Sydney, Melbourne and Brisbane. If this shortfall in customer available bandwidth is not addressed, there is a risk that Australia's ultimate performance in the global information economy will be adversely affected.

Against this background, and the fact that ownership of this infrastructure is highly concentrated, the Inquiry took the view that its discussion and analysis of bandwidth issues needed to go more broadly, and accordingly in a number of areas its recommendations go wider.

Australia's bandwidth challenge

The Inquiry considers there are two broad 'bandwidth' challenges for Australia which must be addressed with equal priority by 2005:

1. to enable, through the operation of a vigorous and innovative market, the creation, in any location, of centres of Australian 'bandwidth excellence' which are capable of matching the bandwidth supply conditions in terms of innovation, quality and price for bandwidth prevailing in the emerging centres of e-commerce excellence in North America and Europe; and
2. at the same time to find appropriate and empowering ways of meeting the challenges of providing affordable, quality and timely access to bandwidth, to enable Australians living in regional, rural and remote areas to participate fully in the information economy.

There are potential challenges in doing both of these things using existing 'telephony' regulatory and policy tools at least in areas that reach beyond basic voice telephony. The 'one size fits all' approach—which made some sense in a telephony world where there was only one size—is no longer tenable in an environment of diverse and multiple communications needs.

The Inquiry considers that the way those objectives are met needs to be re-thought creatively, in a way which consciously recognises, and indeed facilitates, the underlying shift in our communications markets away from telephony and the telephony-paradigm for the underlying business model for infrastructure investment, towards a quite different globalised supply environment increasingly dominated by an Internet paradigm. It is recognised that new technologies are

providing different commercial incentives for providing services in smaller markets with different cost structures. We consider that this requires a change in the regulatory and market culture in Australia and a rethinking of many of the traditional elements of the regulatory environment for communications which have been inherited from the telephony world—in particular the underlying presumptions of uniformity.

For example, if we require the delivery of new services on a highly cross-subsidised, uniform priced, basis (the telephony legacy model), then we reduce or eliminate the prospect of competitive entry and discourage the incumbent from further investment and service improvement in non-profitable or less profitable areas of the market. At the same time, the maintenance of a cross-subsidy based regime results in prices in more profitable areas of the market being higher than would otherwise be necessary. Such an approach runs the real risk of failing to address either of the challenges set out above: we may not achieve a fully competitive global position in the information economy and the supply of new services to meet the real needs of regional Australia is either further delayed or simply does not materialise. This would clearly be a 'lose-lose' outcome for Australian society.

That said there may continue to be a need for regulatory intervention to meet the needs of people in areas where there is no reasonable prospect of a competitive outcome.

The second broad issue addressed by the Inquiry in formulating its recommendations relates to transitional versus structural issues. As the Ovum pricing study conducted for this Inquiry suggests, competition will develop significantly in many areas of the market. Issues such as improving competitive outcomes in major metropolitan markets appear to be matters that will be resolved primarily by the market as the impact of the competitive regime deepens and matures. In this respect it is more a matter of how the process might be assisted in terms of competitive outcomes.

By contrast, the problems of the supply of diverse services to regional and rural Australia, appear to involve structural issues at two levels. First, the real costs of supply of these services are greater and this is inevitably reflected in pricing. While technological developments may reduce the differential and encourage competition in many areas, the greater attraction of 'low hanging fruit' represented by dense metropolitan markets will mean regional areas will probably always lag behind their urban counterparts in achieving equivalent levels of services and prices.

Second, where these prices are contained by regulatory measures, this can result in undesirable supply and service outcomes. Again, the solution set must be one that takes account of both the transitional and structural issues, while minimising any negative impact of responses to one category of issues on the other category.

These considerations thus provide a framework to the findings and recommendations which follow.

the trunk bandwidth outlook

The Inquiry was required to investigate in some depth the likely supply, demand and pricing conditions in Australian bandwidth markets over the next five years, with a focus on trunk carriage markets, and to identify potential constraints. The request for a focus on the trunk network in part recognised the need to build on, and not duplicate, work already done in previous inquiries, most recently the Digital Data Inquiry conducted by the Australian Communications Authority (ACA) in 1998. That Inquiry looked in some detail at the current state of, and market outlook for, the customer access network (CAN) in the context of an examination of whether the universal service obligation should be required to include a digital data service. The ACA's report found that the CAN's capability to provide data services was indeed limited, and reported on possible ways of upgrading it, along with a costs and benefits analysis. Timely and affordable access is still a concern.

The Inquiry's examination of the trunk network complements that earlier work by essentially asking a further question about whether Australia's trunk network(s)—a different part of the network to the CAN—is likely to be a significant bottleneck to the provision of bandwidth services over the next five years. Researching these issues constituted a substantial part of the Inquiry's work.

FINDINGS

While inevitably speculative, particularly in relation to demand issues, the Inquiry's principal findings about the market for trunk bandwidth services in Australia are as follows (further detail is provided in relevant chapters of the report):

F1. The Inquiry identified the following as the main applications which will drive growth in demand for bandwidth over the period 1999–2004: voice communications, Internet access, corporate networking, business-to-

business communications, e-commerce, collaborative working, and residential video services. The Inquiry was not able to identify any single 'killer application'.

F2. The Inquiry identified the following as key industry segments which are likely to have a particularly high demand for bandwidth: retail trade, property and business services, health and community services and education.

F3. Currently, peak bandwidth demand usage in Australia, including international incoming and outgoing traffic, is in the order of 300 Gbps. Of this demand, about 15 per cent can be considered to be trunk or *backbone* bandwidth, that is international, inter-city and inter-regional demands.

F4. Usage, except in international routes, is estimated to be generally less than one per cent of current bandwidth capacity.

F5. Demand is growing rapidly and most of the growth is in data traffic. Forecasts of growth in bandwidth usage by the year 2004 range from an increase in bandwidth requirements (which represents peak demand, and which will be less than actual data traffic) by a factor of 2–5 over current usage.

F6. Currently installed domestic backbone bearers (e.g. installed trunk optic fibres) are likely to be capable of supplying adequate bandwidth capacity to meet current and likely future demand in most parts of Australia over the next five years. However, some rural and remote routes do not currently have sufficient capacity or it is often not provided in a timely manner. Moreover, the installed capacity is immaterial if it is not in fact available to the customer. Capacity can be substantially increased through new technologies, principally dense wave division multiplexing (DWDM), which makes it possible to upgrade the capacity of existing optic fibres by huge multiples easily, although commercial viability will be a consideration.

F7. There is insufficient objective information about the actual state of supply of data services (including provisioning times and quality of service) in Australia on which to assess carrier performance in relation to the provision of retail bandwidth products supplied to end-users.

F8. Nonetheless, there is strong anecdotal evidence to suggest that there are problems in practice with the translation of the potential trunk capacity on the optic fibre network into actual capacity available for data services,

particularly in regional Australia. This lack of customer access to bandwidth on a timely basis would seem to flow from problems in the customer access network and from the provisioning priorities within carriers' systems.

F9. Backbone bandwidth capacity ownership is highly concentrated. Outside the large markets of the eastern seaboard there are only two significant providers of bandwidth, and only one of them has true national coverage. This market concentration may limit the amount of capacity that is actually supplied to the market through active or passive 'rationing' of that capacity by its owners.

F10. The Inquiry notes that in addition to 'traditional' trunk capacity, there is also now for the first time the genuine prospect of a number of new operators looking to provide data and related services using a range of new technologies, including datacasting, third generation mobile, LMDS and satellite services. We note that the Government is also looking at more contestable mechanisms for meeting community obligations, while the social bonus funds from the partial sale of Telstra are likely to have a beneficial effect on the provision of services to regional Australia.

F11. On international routes, supply is expected to broadly meet demand projections although the lumpiness of supply changes may constrain the ability of suppliers to respond rapidly to demand changes.

IMPLICATIONS

While the Inquiry's focus has been on the backbone network, it is clear that limitations in the customer access network can present a bandwidth barrier (or choke point) both for 'bandwidth hungry' firms and also the introduction of new, bandwidth intensive, applications aimed at the wider consumer market (such as entertainment services). Limitations in the customer access network can, therefore, effectively inhibit demand growth—which in turn may slow improvements in bandwidth supply.

Limitations in carrier responsiveness to provisioning of backbone networks may further compound timely CAN service availability.

Competition is essential in placing real pressure on suppliers of bandwidth to reduce prices and improve service.

Backbone bandwidth capacity is currently subject to highly concentrated ownership with Telstra dominating almost all markets and the sole provider of a ubiquitous network. While infrastructure competition will broaden to include a number of fixed and mobile operators, many rural and remote areas will not experience significant competition over the period being considered by the Inquiry.

The Inquiry's analysis suggests that technological and competitive developments will force wholesale bandwidth prices down substantially over the next five years. This, in turn, will mean bandwidth costs will be a declining factor in determining the price of retail services.

While prices are likely to decline everywhere, the more limited development of competition in some regional and remote areas may mean the relative price disparities between those areas and the more competitive capital city and major regional routes may increase. This may also mean that there will be less pressure on incumbent suppliers in rural and remote areas to respond to consumer demand. It is important that the Government put particular focus on encouraging the development of competition as far as is possible in regional Australia.

Policy initiatives should be directed at facilitating the development of both infrastructure and services competition by addressing potential barriers to market entry and by encouraging demand growth. Innovation in products and the commercial provision of services will also encourage demand.

RECOMMENDATIONS

Against this background, the Inquiry recommends that:

R1. The Government's principal focus of policy attention in relation to bandwidth issues needs to be on transforming bandwidth capability into bandwidth availability by developing competitive and responsive market conditions, particularly in the customer access network and provisioning of trunk capacity.

R2. The Australian Communications Authority's reporting on carrier performance should be expanded at least to develop measures for the following:

- carrier response times to customer requests for higher bandwidth data services, particularly in regional areas;

- payments of Customer Service Guarantee (CSG) penalties; and
- measures of carrier responsiveness in the provision of broadband services.

R3. Access and interconnection regulation should have as its primary objective the facilitation of timely commercial solutions. The key role of the regulator in this regard is both to help create an informed market within which access negotiations can take place and to intervene where commercial outcomes are unlikely. While the Inquiry acknowledges recent strengthening to the competition regime, the review of the telecommunications competition regime in 2000 should focus on ensuring the Australian Competition and Consumer Commission has adequate tools to facilitate timely access negotiations—to resolve both bilateral and multilateral issues.

making bandwidth internationally competitive

Making judgements about the extent to which the Australian bandwidth market is internationally competitive is difficult. The most obvious way of addressing this issue is by comparing price, and indeed the Inquiry was asked to, and did, explore this issue and our findings are set out below.

The Inquiry was also asked by its terms of reference to address a number of other specific issues, including the regulatory environment for international undersea cables and issues related to international charging arrangements for international communications links. These are also presented below as they are both factors which affect the international competitiveness of our bandwidth markets.

FINDINGS

F12. Australian prices for leased lines and switched data services appear to be generally higher than prices for comparable services in comparable markets in the United States and Europe, although direct comparisons are difficult because of variance in the basis of capacity and distance charges, and the confidential nature of individual commercial contracts.

F13. Unit prices of bandwidth in the wholesale market are likely to continue to decline by 30 to 50 per cent per annum over the study period in capital city and thick route markets, but by less in regional and rural markets.

F14. Major influences on price trends are underlying cost structures and the levels of competitive pressure in the market.

F15. The pricing of bandwidth will increasingly move to pricing models which are less distance and time dependent, however this will depend to some extent on competitive pressures.

F16. Wholesale prices on international routes already reflect commodity effects in a highly competitive market. They will increasingly do so on major national routes.

F17. The Australian telecommunications market is more concentrated than in some other communications markets, although competition is improving.

F18. The Australian bandwidth market has not to date seen the same levels of innovation in the type and range of infrastructure and service provision as is seen in the most competitive North American and European markets. In particular, Australia has not to date developed dark fibre or bandwidth spot markets to any significant extent.

F19. The Inquiry's consultations suggest that some potential infrastructure providers, or organisations which may be seeking to solve their own community needs, could be dissuaded from initiating business projects if they perceive that the regulatory obligations on telecommunications carriers are complex and broad.

F20. Submarine cables form an important part of trunk networks in Australia and carry the overwhelming majority of data and voice to international destinations and thus are strategic and sensitive national assets which justify appropriate levels of protection from interference.

F21. The regulatory framework for the installation and protection of submarine cables needs clarification.

F22. The current charging arrangements for Internet traffic between Australia (and most other world markets) and the US are inequitable because:

- Australian ISPs do not get reimbursed for carrying US-generated traffic on the trans-Pacific link; and
- Australian ISPs are not reimbursed (or revenue offset against the cost of accessing US networks) for carrying US-generated traffic on their Australian domestic Internet networks.

F23. The effect of the inequitable charging arrangement with the US is that Australian Internet service providers' costs are currently between $133 to $177 million per annum higher than they should be. Consequently, all Australian Internet users are paying more for Internet access than would be the case under a more equitable arrangement. Australian ISPs and

Internet users are also subsidising US ISPs and their customers, which has implications for Australia's international competitiveness. These effects are likely to be exacerbated as data traffic grows and voice traffic moves to data streams.

IMPLICATIONS

The global information economy and the burgeoning growth of e-commerce mean that the trade-exposed sector of the economy continues to expand. This presents both opportunities and risks for Australia. On the positive side, Australian exporters of goods and services (including content provision among the latter) have new tools for accessing globalised markets. Equally, overseas business can access the Australian market.

Maximising the competitiveness of Australia's bandwidth markets is a vitally important goal for positioning this country into the next century. The strategies for doing this will involve a number of strands, not least among which is rethinking the current cross-subsidy based approach to telecommunications policy.

Critical in this endeavour is the depth and strength of competition both in terms of ensuring an abundance of bandwidth and a diversity of services to meet a growing diversity of needs and strong pressure on both prices and costs. In this regard we need to ensure that the Australian communications regulatory environment does not impose unnecessary burdens on potential entrants and that the investment regime does not deter inwards investment in infrastructure and services. Nevertheless, in seeking to remove distortions the Government must ensure the social equity and public interests are not diluted.

Also critical is creating an environment which encourages content development both through positive measures, and by avoiding regulatory controls which lessen Australia's attractiveness as a content development and hosting centre.

RECOMMENDATIONS

general

R4. The Government should maximise the potential for the development of a fully and vibrantly competitive infrastructure market in those parts of Australia where there is the greatest prospect of true international

competitiveness in a global e-commerce market by removing as far as practicable regulatory distortions to the operation of such a market. At the same time, the Government also needs to ensure appropriate mechanisms are in place to meet social equity and public interest goals.

R5. In particular, existing telecommunications-specific regulations should be progressively reviewed to ensure that such regulatory instruments do not unintentionally hinder the development of an internationally competitive information economy. The Inquiry notes that the current price control arrangements are scheduled to cease in 2001. Examination of other policy mechanisms for their impact on the development of a vibrant information economy should take place at such times as they come forward for review.

R6. Governments at all levels should consciously develop ways of fostering and supporting new types of telecommunications operators who will add to the depth and range of the Australian market. In particular the Commonwealth should:

- review existing carrier licensing arrangements to ensure carrier licensing is not presenting any unintended barriers to entry by new and innovative operators, in particular, for the provision of services in rural Australia;
- ensure arrangements for access to spectrum suitable for high-bandwidth services operate as speedily as possible; and
- extend the recently announced adjustments to the tax treatment of international Indefeasible Rights of Use (IRUs) to any IRU arrangements established for domestic cable systems to encourage other models for acquiring domestic cable capacity. Also to ensure that tax treatment of IRUs is such as to encourage local availability of international bandwidth capacity at competitive rates.

An early focus for the development of new models should be on international links and regional areas (see R17).

pricing

R7. Retail pricing objectives should principally be addressed through the drivers of price (as proposed in other recommendations in this report) rather than through direct price regulation of particular products.

submarine cables

R8. The planning and protection regime for submarine cables to and from Australia should be strengthened. New Zealand's *Submarine Cables and Pipelines Protection Act 1996* appears to provide an appropriate model.

R9. More explicit authorisation to install submarine cables should be included in legislative provisions regarding undersea cable protection and planning.

R10. The penalties for damage (and limits on liability) to cables should be increased at the earliest opportunity in order to create a more effective deterrent to unnecessary disruption of these key elements of the national information infrastructure.

R11. Any new provisions for the regulation of submarine cables be developed in consultation with other stakeholders, including the fishing, shipping, and other maritime industries, environmental agencies and relevant State and Territory agencies.

international charging arrangements

R12. The Government should convene a high level industry advisory group, preferably with ministerial participation and involving the AIEAC, to co-ordinate Australian involvement in international communications trade and related issues.

R13. If no substantial progress is made on the charging arrangements issue with the US soon, then the Government should consider using regulatory tools to explore and/or address the issues or consequences of the inequity in charging arrangements between Australia and the US.

content development

R14. The development of content and applications should also be encouraged, including through the provision of testbeds and incubators across Australia through Commonwealth funding using, for example, the Building on Information Technology Strengths (BITS) program.

R15. Collaboration in the multimedia industries, particularly on global projects, should be pursued by industry and Government working together to develop network solutions which allow them to move large amounts of digital material in the interests of greater competition and efficiency in the use of resources.

bandwidth in regional Australia

As noted earlier, many of the issues surrounding bandwidth availability in regional, rural and remote areas are structural in character. Part of this stems from the higher cost of provision to less densely populated areas of the country, though this may diminish over time as new technologies (e.g. satellite-based) pave the way for more cost-effective delivery. While the unit cost of bandwidth is decreasing, the impact on prices in areas of low population density and hence low aggregate bandwidth demand is limited.

The Inquiry notes that, for the first time, there now appears to be a genuine prospect of a number of new operators looking to provide data services using such technologies. As discussed in that context, there is a greater diversity of demand for communications products which do not fit well within the traditional cross-subsidy, uniform pricing model for telephony services. The negative implications for both metropolitan and rural consumers of locking new products and services into the old model have already been canvassed.

It is important that action by Government or regulatory authorities ensures that the opportunities provided by changing technologies, potential entry and new models of provision are not frozen out by measures that look solely to the short-term. Rather, it suggests that a better approach may be to find ways of providing incentives, or ensuring that there are suppliers practically focussed upon supplying the needs of local communities. The Inquiry notes that the effects of regulation to address short term goals can affect investment incentives which then have long term consequences.

In this context, there are a number of funding mechanisms available to assist communities in addressing their communication needs and useful models of supply operating at a local level. In determining which projects to fund, the Inquiry believes that, while the principle of competitive neutrality has some weight, it should not be stressed to the point where innovative and even potentially commercial proposals are ruled out of account for funding purposes. The Inquiry considers that it is very important to make interventions (including funding interventions) in ways which empower communities.

FINDINGS

F24. Competition is uneven and will lead to differences in price and price reductions across markets. While prices in all regions are likely to fall, regional pricing disparities are likely to widen due to different levels of competition.

F25. The regulatory tools which were used to provide telephony accessibility to regional Australia will become increasingly inappropriate.

F26. With the increasing diversity of communications supply and needs between different consumers and communities, the telephony 'one-size-fits-all' model is increasingly out of tune with the emerging market realities and needs. Given this, policy makers at all levels of government need to find new ways of empowering communities through the use of communications infrastructure and services.

F27. Internationally, local authorities and/or public utilities have directly developed new, high bandwidth, infrastructure (e.g. Palo Alto in the San Francisco Bay area). Similar developments are occurring in Australia (e.g. the TransACT trial conducted by ACT Electricity and Water). Such initiatives provide powerful models with potential for emulation more widely within regional communities.

RECOMMENDATIONS

R16. Telstra consider the possibility of outsourcing commercially some of its regional networks or operations to local operators or local communities. One option might be to develop a franchising model drawing on the experience of Australia Post in relation to its establishment of licensed post offices and postal agency operations which are owned and operated by local businesses.

R17. In using social bonus funds derived from the sale of Telstra, a key focus of attention should be on encouraging new market models for entry by infrastructure competitors. This should be undertaken in consultation with the states/territories and could include models involving:

- community owned and operated carriers;
- 'infrastructure only' carriers; and
- models such as the Palo Alto and TransACT initiatives with a view to developing arrangements to encourage local communities, authorities and utilities to pursue similar opportunities. In this regard the Local Government Fund component of Networking the Nation is one source which could provide some catalytic funding for initiatives in this area.

Consultation with state and territory governments may be necessary to ensure flexibility for cross-border regional initiatives.

R18 The Government should review the possibility of supplementing funding for telecommunications bandwidth infrastructure, services and content through consideration of further financial support for infrastructure, service and content investment.

R19. Demand stimulation and aggregation is important to assist the market work better, particularly in regional areas. The Government should, in consultation with the other tiers of government and private sector stakeholders, continue to develop online strategies across key areas of service delivery (such as health, education and social security) taking account of opportunities to use such strategies to encourage infrastructure competition. The Commonwealth Government's objective is to have all appropriate Government services delivered online by 2001. The state, territory and local government initiatives are acknowledged and greater co-ordination should be encouraged through Online Council.

R20. Demand stimulation projects should also be used to encourage the development of content and applications to support these online services. This will also assist in the development and retention of online skills in regional Australia which are also part of the problem.

R21. Where possible, regulatory obligations imposing minimum levels of service assurance should be expressed to reflect the desired level of utility to the consumer rather than particular technical network capabilities.

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