Media Streaming and Broadband in Australia

Report to the Australian Broadcasting Authority

Prepared by the Centre for Telecommunications Information Networking

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About CTIN

The Centre for Telecommunications Information Networking (CTIN) at the University of Adelaide was formed in 1993. Since that time, the Centre has established a reputation of independence and excellence in the communications industry, drawing on the multidisciplinary talents and the broad experience of its staff.

CTIN relies on its staff to deliver solutions which transcend the narrow, engineering only approach which has traditionally hindered research in the communications sector. We operate as consultants, as researchers and as industry trainers across a broad range of disciplines and a wide range of technologies and related issues.

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Executive summary

Streaming is a technique for making video and audio information available in digital form. It allows the large amounts of data required for broadcast-like images to be stored and transmitted in an efficient manner. It is primarily a means of economising on transmission and storage resources.

As is explained in section 2 dealing with technology, in the current era of narrowband connections and relatively low storage capacity in receiving devices, streaming is a powerful and important technique. It provides access to low quality digital video or to FM quality audio data, allowing images to be sent from some remote content store via the most common transmission methods (across the telephone lines using the Internet Protocol) to the current generation of PC (or even to TVs with digital processing ability).

In the coming era of broadband and more powerful PCs, streaming will work better than today and for a while will be relatively common. However, the greater transmission and storage capacities that will be available in future will make the economising which streaming allows less needed. The spread of broadband will also make new techniques available, techniques that support digital cable TV and interactive PC/TVs. Advances in the storage capacities of receiving devices will also allow personal selection and storage of a number of media files. Such alternatives will provide quality better than even improved streaming.

More importantly, as we explain in section 4, these new technologies look likely to attract most of that portion of compelling media content which will be transferred from existing media channels to the new formats where it is better suited. The related point is that, like some other nascent convergent technologies, streaming lacks a viable business model at present.

This all means that, in our view, over the long term it is broadband in general not streaming in particular that will make broadcast-type content available on a one-to-one basis at broadcast-like quality.

The new competition and streaming's relative lack of content will mean that it is unlikely to remain a mass medium. Over the medium term scope of this report, broadband and other advances will usher in alternatives. However, streaming will have some uses which are likely to survive into the long term, including the provision of some live content, applications for closed user groups and in areas where broadband is not available.

The technique will remain important where broadband connections are uncommon or expensive. Streaming will also have a long term role in making live content available over the Internet, in special interest applications and in what we call supplementary services such as promotion or advertising inserted into other media.

In section 3 we have compiled a set of demand estimates which show that streaming is currently growing fast, at some 30–35% per annum. Despite the impressive growth, we estimate the total number of Australians who have streamed is only 650,000-920,000 so that it is relatively uncommon at present.

We also predict that streaming will grow quickly over the next 2 years and more moderately through to 2008 when it will peak at some 5.5 million Australians who will stream on average for some 5 hours per month. Our estimation is that thereafter streaming will decline to 2010 with the maturing of broadband delivery and the introduction of better reception devices.

While considerable uncertainty attaches to our estimates, particularly to the timing of the peak and the rate of subsequent decline, our expectations do not suggest that streaming is unimportant simply because it is transitory.

Firstly, as we have already noted, there are instances and applications where we expect it will survive. One reason for this is that while the primary function of streaming is to economise on digital transmission and processing capacity, it also deals with the problem of so called jitter (variation in the data transmission rates) which can disrupt the smooth flow needed for life-like video. Jitter will always be a problem on the Internet no matter how broad the bandwidth and so streaming will remain useful for accessing live media content over the Internet because that content must be sent as it is being created if it is to attract a premium price. However, the Internet will not be the major means to deliver premium live content.

Streaming will also continue to have a role in instances where the transmission infrastructure is limited, such as at remote locations or on some private networks. Finally, we expect streaming will continue to be used by commercial interests not for commercial applications but for promotion (such as streaming advertisements into other media) or for delivering pre-recorded training videos or messages from management. In short, streaming will not disappear despite that it will not be the mass medium of choice in the mature digital age.

The second reason that streaming is important is because of its regulatory implications and we deal with that matter in the final section 5 of this report. Streaming is best thought of as one of the first in a series of transition technologies that take us from the era of analog TV and radio, when broadcasting has been pre-eminent (augmented by cinemas and video stores), to the coming era when that same content is transmitted digitally and by a variety of means. Because it is one of the first transitional technologies, streaming indicates the emerging regulatory pressure points.

Section 5 uses a number of case studies to illustrate the relation of streaming services to the *Broadcasting Services Act 1992* (BSA). The investigation shows that some streaming services are currently provided in ways already covered by the BSA. This should be unsurprising given that the BSA includes provision for content transmitted by means other than the Broadcasting Services Bands and for digital content.

However, streaming also raises three possibilities of regulatory interest: two where the BSA seems not to apply, the other where its application is uncertain.

Firstly, there is the prospect, enhanced over the next few years, of streaming being used as a means of giving access to live content. This is a regulatory pressure point because the BSA's Internet content provisions cover only stored content. Live streaming using an Internet carriage service is therefore not covered by the relevant provisions.

However, it appears to us that the solution is not simply a matter of including live streaming as Internet content for the purposes of the BSA. This is because, as noted above, one of the enduring uses of streaming will be to provide personal messages between pairs or among small groups. The difficulties in clearly distinguishing live content that should be regulated for the same reasons we regulate broadcasting from live content that is in fact personal communication will be great.

The second regulatory issue associated with streaming concerns the use of what we have called Online media content which is not also Internet content because it is transmitted across private networks unconnected to the telecommunications system. Such content does not require an Internet carriage service and therefore is not subject to the Internet content provisions of the BSA. However, this does not necessarily imply that such content ought to be brought under the BSA: if the stream is not publicly accessible like broadcasting, regulatory notions developed for broadcast might be inappropriate.

The final regulatory issue we are least sure about. It concerns provisions in Schedule 5 of the BSA which defines Internet content as being transmitted in a way which is not "in the form of a broadcasting service". This would appear to exclude streaming content delivered via the Internet from the provisions of the BSA. However, that proposition turns on the precise meaning of "in the form of a broadcasting service" and we leave that matter to others.

This project has underlined that little is known about the spread of broadband in general and streaming in particular. In response, we have suggested that further research be conducted into the policy issues surrounding the roll out and uptake of broadband. Further, we have concluded this report by offering some suggestions for improved monitoring. We suggest that the ABA requests of the ABS or some other relevant body:

- Additional surveys regarding new broadband connections: how many, what kind?
- A clearer, more consistent differentiation of broadband from narrowband
- Additional information concerning the use of broadband connections, at home and at work
- New surveys related specifically to streaming: frequency, length of sessions, etc
- Monitoring of the age (and therefore storage capacity) of the stock of personal computers

This research and new information will help alert the ABA to any acceleration in developments and will aid policy makers, industry and researchers in refining their understanding and expectations of streaming media and broadband in Australia.

1. Introduction

1.1 Scope and Structure

CTIN has been engaged by the ABA to offer advice on “the potential impact that … technological and market developments may have on (the Authority’s) role and functions”. In particular, the project focuses on so called streamed media and its relation to broadband technologies which can offer broadcast-like services. The tasks are to make an assessment of the likely Australian demand and the technical and infrastructure factors related to the provision of such services.

This work has its genesis in the recent broadening of the ABA’s responsibilities which now include digital broadcasting, Datacasting and Online services. We deal with the relation of streaming and broadband to those responsibilities in the final section, using the five case studies raised in the research proposal as illustrations.

That is the final objective. The first task is to provide a definition and description of streaming and this is done in section 1.2. Our research for this study has emphasised that streaming is not well understood and that its promoters tend to overstate its current relevance and future prospects. Our first response is to better define what streaming is and what it is not.

We then explain how we will approach these research tasks and the last section of this introduction sets out our method.

In the following section 2 we look at the technology which makes streaming work and its relation to broadband transmission. In section 3, we estimate demand for streaming and broadband to 2010. Section 4 looks at the commercial issues surrounding streaming and broadband and also at some of the strategic considerations that will influence their futures. We consolidate the analysis around the emerging regulatory issues in section 5 which also offers some conclusions.

This report focuses on the medium term. Streaming is a relatively minor activity today and there are a number of constraints on its expansion in the short term. Nonetheless, the potential for growth in the medium term is significant before streaming declines as broadband delivery and other digital technologies mature.

We focus also on the Australian situation, despite that much of the technology, the content and some of the service providers are from overseas. We look to highlight the peculiarities of the Australian market and regulation and their implications for streaming and broadband.

As to technology, the scope of our inquiry is limited to the spread of proven but not necessarily deployed technologies. Over-the-horizon delivery systems such as a fourth generation of mobile networks or ultra-broadband (greater than 10 Mbps) are unlikely to be widely available in the medium term and are therefore outside the scope of this research.

1.2 Definition and Description of Streaming

One of the primary tasks of this research report is to offer a clear definition and explanation of streaming so that it can be well understood by people who are not technically trained or inclined. It is important to understand what streaming is and what it is not.

In section 2 below we give more of the technical details and deal with some of the exceptions and complications missing from the explanation which follows here. Even there we have attempted to steer clear of jargon and presumptions of prior knowledge on the part of the reader. Here, we just stick to the basics.

The concept of streaming is best understood by appreciating its purpose. The primary purpose of streaming is to allow a large set of data to be delivered from one point to another at a variable rate and then to be displayed in real time. The importance of streaming becomes clear when it is understood why that is useful.

The point is that when a live TV or radio event or a stored piece of media content such as a film, a book or a music CD are converted into digital form, they create very large sets of data. In addition, for many applications these data sets need to be displayed at a high but even rate which makes images and speech appear to be happening at normal speed, so called real time.

To put it in perspective, we are talking of files 10-100 times larger than the text files most of us commonly attach to an e-mail message. Such large data sets, arriving at variable rates, present problems for transmission, processing and storage, especially in the present era dominated by narrowband connections. Streaming is a technique to deal, albeit imperfectly, with those problems, thus enabling media-type content to be accessed by the same Internet technologies that provide for e-mail and access to web sites.

Essentially, streaming is a technique which allows the large files created when media content is transformed into digital data to be presented to the user at a steady, streamed rate so that they appear to be real. Streaming also deals with the problem that the rate at which data are transmitted can vary during transmission, so called jitter. By enabling access to media content, streaming therefore allows for broadcast-type services to be delivered on a one-to-one basis.

What sets streaming apart from other kinds of data transfer and what gives it the name is that it is a technique which provides a relatively small but continuous flow of data to the user, like the way in which a weir provides a controlled stream of water down a river. In addition, the user can begin watching or listening to the stream before the whole data set has been processed.

The way this is achieved is by a process called buffering. A buffer is like a reservoir of data. When the streaming transfer begins, the receiving device (usually a personal computer), initially takes in data without displaying it so as to build up the buffer. Once a given quantity has been buffered, the data are made available to the user at the steady rate, which can be greater than or less than the initial rate at which it is being transferred to the buffer. If data are being used faster than they are being received (as is often the case), the reservoir will begin to empty. If it empties before the user has finished viewing or listening, the stream stops until the buffer is replenished.

Note that, while the user equipment creates a buffer so that it can produce the smooth stream, the data are not otherwise stored on the user's equipment and the buffer itself disappears in the process of viewing or listening. The user cannot store streamed data.[1]

It is also important to emphasise that the data to be streamed might have been created in the past and stored somewhere in digital form or, equally, it could be created as it is being sent, as is the case with streaming live media. So called live streaming occurs when a camera or microphone is making a digital recording of some event and the resulting data are being transmitted almost immediately and displayed to a user. Although it is called live streaming, note that there is a short delay in establishing and maintaining the transmission link and in creating the buffer so that it is not live as we understand the term in broadcasting.

[1] However, as we shall see in section 3, there is a different type of data flow akin to streaming that can be viewed as it is downloaded *and* remains on the users PC on completion.

This description leads to a definition of streaming. We have used the following from an authoritative source:

> "(Streaming is a) technique for transferring data such that it can be processed as a steady and continuous stream. Streaming technologies are becoming increasingly important with the growth of the Internet because most users do not have fast enough access to download large multimedia files quickly. With streaming, the client browser or plug-in can start displaying the data before the entire file has been transmitted" (Tech PC Webopedia).

In other words, streaming gives access to files of media-type content and does so as quickly as is currently possible. Let us re-emphasise the key points.

Media-type content requires very large sets of data and they need to be displayed at fast rates so that they can be viewed in real time. This creates a series of difficulties, especially for current transmission technology and the current vintage of processing equipment. For example, storing such large files on a personal computer is often unrealistic: only a few movies would exhaust the memory capacity of most currently available PCs; similarly, a record collection would fit only on the most advanced computers.

Given this, the notion is to store content elsewhere (or create it live elsewhere) and transmit it to the computer when it is requested. However, the Online technologies used to send simple files such as e-mails are generally inadequate for large media-type content: data links are too slow and variable. In short, streaming is a response to the difficulties associated with dealing with digital, media content. It is useful at present when transmission speeds are relatively slow and data storage by the user is limited

It is an imperfect response, as noted above. For example, it doesn't solve completely the problem of displaying events on a PC as they happen. Streaming involves a delay for buffering and other reasons. In its current form it also involves some data losses in transmission and provides less than broadcast quality. But it does give access to media-like content across the telecommunications networks which are used for the Internet and across other Online transmission technologies (that technical distinction between the Internet and Online is discussed further below). And it will improve with the spread of broadband delivery systems, although so too will other, competing technologies.

As with many new applications of information and communication technologies, there are exaggerated claims associated with streaming and it is common to find elements included under the rubric of streaming which do not properly fit. Hence, we can further clarify the definition of streaming by describing some of the misuses of the term.

Firstly, we need to recognise that streaming is not the same as downloading data. Downloading requires that a complete file is recorded onto a hard drive and is then accessed. With streaming only part of the file is available on the PC at any time (again, there are extensions to streaming that are more akin to downloading, as we discuss in section 2 below).

Streaming is not an interactive medium such as so called iTV or many other Internet applications. The Internet provides a two way connection between the user and the data source. There is a downlink to supply data to the user and an uplink to receive instructions or data from the user. While streaming is often delivered via the Internet, the fact that it is buffered means that the user does not have the full breadth of interactivity with the data stream that we are familiar with in most Internet applications. For example, streamed video cannot be rewound or fast forwarded. However, it is possible to stop the flow or to skip further along or go backward into the file. The latter possibilities would require that a new buffer is created, so called re-buffering, at the new starting point and hence there will be a delay in the stream.

The last way to define streaming by describing what it is not is to make some basic points about how it is unlike broadcasting. More detail on this issue is found within the report and we add further to the comparison in the concluding section 5.3.

By way of introduction, streaming and broadcasting are similar in some respects: neither is interactive and, like broadcasting, streamed data can be sent from one point to many (even though it is fundamentally a one-to-one service). However, some key differences in quality remain. Streamed video and, to a lesser extent, audio would be instantly recognisable as something other than broadcasting by all users. This is because the rate at which streamed data can be made available is much lower than that required to give clear, wide screen pictures. It is at less of a disadvantage in audio because the amount of data needed for digitalised sound is much lower than for pictures and sound.

The last point to make in this section is to highlight that not all streaming is done over the Internet ie using the public access network. Streaming can also be delivered over a dedicated medium, as is the case with TransACT's streaming offering discussed briefly below. In our view, the latter should not be thought of as the Internet but as an Online service and we will briefly explain the distinction and its relevance to streaming.

The Internet is not merely a connection of computers. That could be called simply a network. The Internet is a connection of networks or, if you like, a network of networks but of a special kind, as signified by its use of the upper case "I'. A lower case internet could be any network of networks. The upper case Internet is a global network of networks, fundamentally different because it has ubiquity of access via a public Internet carriage service and over a medium such as the public switched telephone network (known often simply as the PSTN). By comparison, a lower case internet is not global and access is limited to fewer points and fewer people.

Internet services are a subset of Online services. Whereas the Internet requires ubiquitous, public access, other Online services use a dedicated access medium which allows for restricted user access. Hence, while anyone can access the Internet through any Internet Service Provider or other Internet carriage service, Online services which are not the Internet are generally available only to closed user groups.

We can further understand the concept of streaming by describing some of the ways it has been used and to do that we will use the five case studies found in the research brief. The first of these is the so-called "webcasting of 'reality' shows" such as the webcast of the "Big Brother" in June 2001. "Big Brother" followed the interactions among a group of young people in a specially prepared house by means of multiple video cameras. Highlights were broadcast on free to air TV but more content could be accessed using video streaming, 24 hours per day, from a dedicated website. That is an application of streaming across the Internet that is an alternative to broadcasting.

The second case study is so called Internet radio such as Thebasement.com.au.[2] That is a digital stream of audio data and it too fits as a substitute for broadcasting. Thebasement.com.au is a prime example of how streaming can be used at present. Because radio is audio only, the data flow it requires is limited compared to video and can be carried across the current narrowband connections. This makes it a viable current application. By contrast, the loss in quality compared with broadcasting is much greater for TV.

A third use of streaming involves using a dedicated fibre optic broadband platform and the brief directs attention to the service the company TransACT offers in Canberra. The network is dedicated for media content delivery, rather than also being a telecommunications medium like the

[2] Note that Thebasement.com.au also provides a video feed of the presenter or performers.

Internet, and TransACT has laid out its infrastructure in such a way as to allow streaming to multiple users, even though it is fundamentally a one-to-one technique.

The fourth case is a virtual walled garden which is a site on the Internet which has access restricted as one would find on a dedicated, private platform. With a walled garden, such as AOL offered in the US, the wall is substantial and manifest. With a virtual walled garden the Internet leads to the gateway but only members can pass through. It is something like a means for personal communication and something like a method of public narrowcast.

The final category is that of "exhibitionists and voyeurs with web-cams streaming live". This is even more like personal communication and suggests the limits of the distinction between digital communication and digital broadcasting. It also alludes to the likely long term use of streaming: because jitter will always be with us, so streaming will always be useful in transmitting live content across the Internet or some other Online medium.

In summary, streaming is currently the only way to watch live TV or to hear radio as Online services. It is also the most practical way to provide Online access to movies or music or other stored media which must be displayed in real time. At the moment it is much less than broadcast quality and will remain so over the medium term but it is the closest to broadcasting that is currently available, outside the broadcasting regime.

Section 2: The Technologies of Streaming and Broadband

2.1 Introduction

In this section, we will develop the notion of streaming by deepening the description of how it works and we will show how streaming fits within the suite of technologies associated with broadband delivery. This addresses the requirement laid out in the brief to focus on "technical and related infrastructure factors in the provision of (streaming) services".

An understanding of the technologies is important because, firstly, it describes the limits of streaming. Knowing how it works tells us what it can do while allowing us to avoid the exaggerated claims which too often typify the new convergent technologies. In describing how it works we can also indicate some of the other uses of broadband and the likely development of technologies which can substitute for streaming. This tells us how streaming fits into the process of digital convergence, now and in the future.

In section 1.2 above we have provided a broad overview of streaming. In this section we add to that definition by analysing each part of the streaming process. We look at how streaming content is packaged, delivered and consumed in parts 2.2 to 2.4 respectively. This covers also the difference between broadband and narrowband technologies.

Section 2.5 puts the analysis together to show how the quality of the streaming service is an outcome of the combination of the three preceding processes. Section 2.6 then looks ahead at new technologies which might have an impact on streaming in the medium term. This includes the prospects for delivery over broadband wireless and over existing electricity cables. We complete section 2.6 with some conclusions about the future for streaming and some of its competing technologies.

2.2 How streaming content is packaged

When digital audio and video clips become more than a few minutes long, the size of the file needed to store the data becomes large, of the order of 3-4 Mbytes for a single song on the widely used MP3 format and something like 5 Gbytes for the video capacity of a DVD.

We have already seen in section 1.2 that such large file sizes create problems in transmission and storage and the techniques which prepare content for streaming are primarily intended to address those problems. If content were not packaged for streaming, it would not be possible to process or access it with current delivery and consumption techniques. The files would be too large to store and the time taken to process them would be beyond the patience of much of the media consuming public.

The first response to this problem is for content to be coded and compressed before it is streamed. To give a sense of the degree of compression needed, consider that a Standard Definition Television (SDTV) picture is transmitted in compressed digital form at a rate of between 4Mbits/s and 6Mbits/s[3]. By comparison a dial-up narrowband connection gives a maximum available bandwidth in the order of 50kbits/s. Hence, the content needs to be compressed a further 100 times for it to be available across the narrowband connection. Even with broadband connections, which are discussed in more detail below, there is still a need for coding and compression.

Coding is the basic packaging required to maintain the data stream. It refers to the processes that attach addresses to each data packet, provide a so called overhead capacity for error correction and encrypt the data for security and other purposes. Coding is required before content can be sent across the Internet or Online via a dedicated medium.

Compression is the packaging required to deal with the problem arising from the large size of streaming files. There are a number of compression techniques or formats associated with the various software platforms used for accessing the stream. The purpose of compression is to reduce the file size so that delivery and processing times are shortened.

There are two types of compression known as *lossless* and *lossy* techniques but only the latter is applicable to streaming. As the name implies, a lossless technique compresses all the data so that the complete set is recreated at decompression. Lossless compression is achieved by assigning the simpler digital codes to the more common parts of the transmission.[4]

Lossy compression, on the other hand, is a technique which removes information in the process of compression and decompression. In the first instance, detail which is imperceptible to the human senses is discarded but, if higher levels of compression are required, perceptible detail is necessarily

[3] Using the MPEG-2 standard which introduces about 10:1 compression. The actual required bandwidth depends on the events happening in the scene on the television.
[4] It is the same as with Morse code, which uses short codes to represent the most common letters ("." for E, "-" for T) and assigns longer codes to rarer letters. Lossless coding is critical for computer software and text where any corruption of the data can make the transmission useless.

lost and, when the data are decompressed, the resulting presentation is of poorer quality. Lossy techniques are an essential part of all video formats and are also the basis for MP3 audio coding.

Lossy compression has enabled audio and video streaming at currently achievable data rates but it comes at a cost to quality. Not only is quality necessarily compromised but lossy compression is only suitable for the final presentation of the data stream. If lossy compression were used during an editing process, each time the data stream was altered, there would be a loss of quality which would accumulate in the final presentation.

2.3 How streaming is delivered

Streaming is unlike many other Internet applications in requiring two servers, one to forward the request for streaming and to manage the flow of streamed data and another to transport the data from the streaming server to the user. One resides at the webserver where the user visits to link to the streaming content which is cached or created somewhere else. The streaming server controls access to that content. The figure below describes the process.

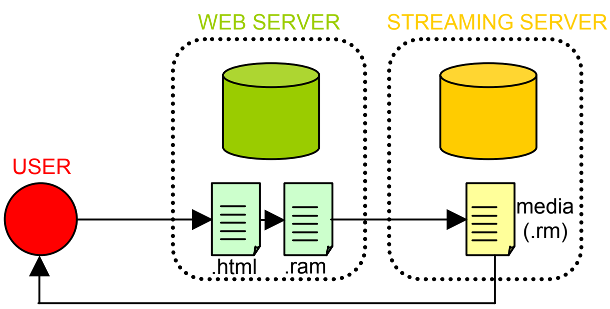

Figure 2.3.1: schematic of streaming content

Firstly, when a user requests a streaming file from the web server he or she links to an intermediate file (.ram in the case of Real media; other possibilities are described in section 2.4 below). The .ram file is just a plain text file containing nothing more than the address of the streaming media file. The job of the .ram file is to direct the request to the streaming server.

The streaming server houses the media file itself (such as a .rm file for Real media). The streaming server's job is to package the data to be streamed and to maintain a balance between the tasks of delivering streaming files to many users.

Streaming over the Internet or other Online media use a packet-based connection method (usually the Internet Protocol (IP)) so that each packet is addressed to reach the destination individually. (The difference between packet based and the older so called circuit switched technologies is discussed in Appendix 1) Theoretically each packet can be routed through the Internet from the source to the destination over a unique path.[5] Since the time of arrival over one path compared to another will vary, a queue within the buffer is employed to re-order the packets when they arrive and also to provide a smooth delivery into the decoder.

This gives further reason for the buffer as a critical component in streaming. As described in section 1.2 above, a streamed service requires a steady flow of digital information for continuous presentation and, as just described, packet-based delivery usually cannot guarantee a steady flow of bits, but can be quite variable. This is a problem known as jitter and buffering is a technique which is used to take the jitter out of the data flow when it is displayed.

As also described in section 1.2, if the average bit rate inflow is slower than that required for continuous presentation, the buffer can assist by temporarily storing enough of the presentation to provide continuity. In the extreme case, it may be necessary to download all (or most) of the presentation before presentation but we distinguish this situation from downloading *per se* by noting that the buffer storage is temporary and is discarded on presentation.

On the other hand, if the data can be transmitted much faster than is required for presentation, the buffer again assists us by filling quickly, then instructing the streaming server to slow down or temporarily stop the stream. As the buffer empties, the stream can be restarted at the server. The buffer also assists in dealing with the delay in sending instructions through the network by allowing the presentation to continue while those instructions are sent and acted upon.

We now turn to the distinction between narrow and broadband which has already been introduced in section 1.2. Here we give a more detailed explanation of the two and point up the differences between them.

Narrowband delivery has nevertheless played a very important role in the development of streaming and a great deal of research and development effort has gone into narrowband streaming technologies. This is primarily due to the high penetration of narrowband delivery, which most often uses the relatively common telephony modems and deliver data rates in a typical range of

[5] However, in practice, in the order of 90% of packets follow the same path from source to destination.

9.6kbit/s to 56kbit/s. ISDN is also a narrowband technology and it delivers a digital channel of 64kbit/s.

Most streaming standards are able to operate at the reduced quality that is necessarily part of a narrowband service and we note that the MPEG-4 standard was developed expressly for this purpose. That the MPEG-4 standard is still at a very immature stage is testament to the difficulties of delivering narrowband multimedia content at a reasonable level of quality.

Streaming over Broadband

Turning now to broadband, the most important delivery methods in Australia are the so called DSL and cable technologies.

In Australia, DSL is primarily supported in the form of Asymmetric Digital Subscriber Line although other variations are available.[6] As the name suggests, DSL is a method of sending digitalised data across the traditional circuit-switched, copper phone lines network without the need for alteration (again, the difference between circuit-switched and packet-based networks is described in Appendix 1). ADSL adds the notion of asymmetry ie while it allows for two way flows, the download capacity is greater than the upload (1.5 Mbps cf. 0.5 Mbps at standardised rates).[7] ADSL requires a modem at the user's premises and an associated modem at their local telecommunications exchange (known as a DSLAM or DSL Access Multiplexer) which then connects to the backbone network. The modem provides the user with an always-on Internet connection.

ADSL is an exclusive connection between the user and the exchange, thus providing the user with a physically secure link and more consistent data speeds than with the major alternative of cable technology, as we describe below. Hence, we note that any bottleneck in ADSL is not the last mile (the connection from the exchange to the customer premises) but in the backbone network operating under the Internet Protocol (in which a constant end-to-end pipeline is not guaranteed).

Many experts consider that ADSL will become the dominant broadband technology over the medium term not because it is inherently superior to cable, as we describe below, but because it

[6] Symmetric HDSL is also available but is of primary interest to business users who need a nearer balance between the download and upload rates for applications like hosting web sites. ADSL, HDSL and B-ISDN are high speed data services which operate over twisted-pair telephone lines and are known to mutually interfere with each other. For this reason and taking into account the suitability of ADSL for domestic broadband use, the Australian Communications Authority has determined that should such interference occur, ADSL will be supported and that subscribers to other DSL and B-ISDN services will need to find alternative broadband solutions.
[7] It is referred to as a standardised downlink because, while ADSL can produce higher speeds it has been standardised at lower rates (into the so called G.lite standard) for greater reliability and to allow for more of the existing copper wires to be used, thus broadening the potential penetration.

uses the near-ubiquitous legacy network of phone lines and provides a consistent and broad bandwidth.

Cable, the second major broadband technology, is known technically as hybrid fibre coax or HFC. It uses an optical fibre backbone which is then split into a coaxial cable as it nears the users' premises, usually along the users' street, for distribution to individual homes. This means that the coaxial cable is then servicing multiple users who share the available bandwidth. The cable links into a pay TV converter box or into a cable modem for data access such as with streaming to a PC. It is also possible to support voice telephony over the HFC network.

It is important to realise that the coaxial cable which distributes the signal to individual users has a limited capacity and is shared by the neighbourhood which uses it. In other words, all users must share this fixed capacity and, hence, the performance of cable broadband can vary greatly depending on the number of users accessing information at once. Typically a single coaxial distribution cable may service 100 homes and is dimensioned to handle an average of ten simultaneous broadband data users. The fibre-optic backbone network is also capacity limited but this has much less impact than the coaxial distribution cable.

Another important issue for broadband cable is that coverage is not complete. While a number of companies are planning to roll out more cable, of Australia's 7.2 million households, only some 2.5 million are passed by cable and only 1.4 million subscribe, although some uncertainty attaches to those data (ACA, 2002, Table 14.3).

Some see cable broadband access as having an advantage over DSL technologies in that it uses cable which is already accessed in large numbers of households for subscription television. In that sense, cable broadband is a convergent technology and links to the notion of accessing interactive TV across existing cable TV lines. This is especially true in North America but is also true in Australia where, in 2000, there were 4 times as many cable connections as there were ADSL.

A major issue for streaming delivery is the quality of service which the various methods provide. In this regard, Online transmission over a private and dedicated medium holds a significant advantage over other methods.

Delivery over the Internet suffers from a significant and inherent problem. As described in Appendix 1, delivery using the Internet Protocol (IP) is a so called best efforts process. The IP is unlike older delivery methods in that it does not establish a single connection dedicated to the sender and receiver for the course of their interaction. Instead, the path of transmission is determined periodically during the connection, depending on other traffic on the network. This means that the time to delivery and indeed the delivery itself is problematic over IP. Although operators make their best efforts, guarantees of the quality of service can only come by reserving network capacity and that is very expensive. This means that so called Service Level Agreements will be rare and surrounded by caveats so that the quality of content streamed over the Internet will be problematic.

A similar problem exists with cable networks, albeit not quite so severe. The problem for cable is, as we described above, that the total amount of data which can be transmitted is fixed and shared. The network is sized in such a way as to economise on establishment costs but this means that the capacity is less than that which would be needed to provide a streaming service to all users at once.

It means that, as with Internet streaming, quality guarantees can be problematic but with dedicated cable delivery the uncertainty is handled in a different way. With streaming using the IP, additional demands lead to so called graceful degradation whereby the loss of quality tends to be shared across users. This is also known as a soft limit on the network. With streaming over dedicated cable, any additional demand beyond the limits of the network are simply refused and the situation is described as one of hard limits.

In addition, cable networks such as TransACT's are owned and operated singularly. This means that TransACT's Video-on-Demand service can be entirely controlled (using soft and hard limits as desired) within their own network. With a public access network such as has carriage of the Internet, it is not possible to know how many could be using at any one time. This is partly because other network operators might have agreements for access and calling parties might come from outside the carrier's clientele and might, of course, come from overseas. Again, it means that the quality of streaming services is problematic but less so for dedicated and private cable systems.

2.4 How streaming is consumed

The process of consuming streaming content usually begins with the user requesting a standard Web page that contains links to streaming media (refer to Figure 2.3.1 above). This Web page can reside on any Web server.

A PC with relatively high processing capabilities and relatively advanced software is required to view or listen to streaming content and we examine that matter in more detail below.

The following are the most common streaming formats:

- RealNetworks' RealMedia format (.rm file extension)
- Microsoft's Windows Media format (.wmf file extension)
- Apple Computer's QuickTime format (.mov file extension)
- MPEG 4 format (.mpg file extension)

The streaming software for each format is freely downloadable. All are available for both Macintosh and Windows, and Real is also available for UNIX.

The user's decision as to which format is best will be based on the legacy of the type of computer they have and the type of server to which they connect as it is the combination of these two that controls the streamed content. In general, encoding Real streaming media works better with a PC than with a Mac but QuickTime streaming is easier to build right now and is proprietary Apple software. However, increasingly the choice of format is less critical because of developments which mean that the format in which the file is prepared no longer dictates the software which might be used to view it.

The receiving equipment must meet certain minimum requirements in order to access the streaming audio or video and we summarise the position for PC and Macs in the table below.

Recommended Windows Computer	Recommended Macintosh Computer
▪ 200MHz Intel Pentium processor or better ▪ 32MB or more of RAM ▪ 56.6Kbps or better modem ▪ Full Duplex Sound card and speakers ▪ 65,000-color or better video display card ▪ Windows 95, Windows 98, Windows 2000, Windows 2000 ME (final release version only) or Windows NT 4.0 with Service Pack 4	▪ G3 233 (or faster) PowerPC ▪ 64MB RAM or more ▪ 56.6Kbps or better Internet connection (both audio and video) ▪ Virtual Memory turned on, set to 128MB ▪ Mac* OS 8.5 or later

Table 2.4.1: Recommended receiving equipment

This means that streaming requires an up to date receiving computer. The 200MHz Pentium processor needed for access using the Windows operating system has been commonly available only since 1997. For the Mac, OS 8.5 or later is compatible with machines less than 7 years old (the 1995 Mac had 8.1 OS) but OS 8.5 became the standard only as of mid to late 1998.

In addition to the computer operating system, an appropriate browser software is also required. The more current the browser, the greater its access to streamed content. This means that, in order to have reasonable access to streaming audio or video, the computer will need to be compatible with Netscape version 4.0 or later or with Microsoft Internet Explorer version 4.0.1 or later.

To reiterate, these are minimum requirements and the most recent versions of the major streaming software will only run on the most recent computers. Taking the requirements together, we suggest that satisfactory streaming requires computer equipment of a vintage no greater than 2 years.

A key point in considering the user interface is that introduced in section 1.2 above concerning downloading and storing streamed content. Remember the points made there were that while streaming necessarily includes the notion of buffering and that streamed data is not the same as downloaded data, there are ways to extend beyond streaming so that a permanent record is stored on the receiving device. There are two ways in which that can be done; one proprietary, the other nefarious.

The first is Apple Quicktime's so called FastStart. This is a facility which looks like streaming and is promoted as a kind of streaming but is, in fact, a sophisticated method of downloading. In this case, the intention is to allow the user to download media for later playback. However, the format is designed so that once a download has been started, the downloaded file can be interpreted as a buffer and the QuickTime software simply starts to view the file from the beginning, before the download is completed.

The second possibility is for the user to create their own software which performs the same function as FastStart and allows for downloading of the data stream even though that is not necessarily the intention of the party who provided the content. Essentially, to record a streaming video involves further processes which bypass the safeguards put in place to prevent the buffered data being recorded. Indeed, one of the advantages of streaming for the content owner is that it does not make a permanent copy available to the user.

To reiterate, these are additional techniques that extend beyond streaming *per se*. In thinking about them it might be useful to have in mind the parallels that currently exist with products such as hired movies on VHS or DVD formats. In both cases it is not the intention of the provider that the content be copied and in some cases it might be illegal. However, the technology to make copies is available even if it is not as commonplace as are VCRs or DVD players.

Another important matter for streaming concerns format standards and software. In the personal computer environment, any standard which can deliver streamed media, whether open or proprietary, can be deployed by making a compatible viewer available for download. The more adept PC users are familiar with this process from other software applications but many PC users find it difficult.

By contrast, broadcasting requires a single transmission and content representation standard to ensure compatibility with the ubiquitous television set (or its advanced digital equivalent). The standard cannot be changed because the processing done by the TV cannot be upgraded. The difference is sometimes described as that between lean back and lean forward technologies. TV is lean back: the user turns on the set and consumes what is presented. Applications on PCs are generally lean forward: the user literally leans forward on their chair and must play a more active role in downloading software, requesting content, etc before consuming.

The difference between streaming and TV delivery is a matter of pros and cons. On the one hand, the lean forward nature of streaming means it is currently advantaged over broadcasting in that it can make the most of the latest developments in coding, compression, etc by downloading the most recent versions of the software. On the other, it is at a disadvantage in that many late coming users will not be computer-adept to the point where they can keep up to date.

We can take that point further in comparing various user platforms for the consumption of audio and video content. Table 2.4.2 overleaf establishes three methods of consuming content across three different consumer interfaces.

	TV/Radio	3G	PC/Mac
"Play" *lean back*	Broadcasting ▪ Free to Air ▪ Pay TV ▪ Cable TV	Broadcast Radio ▪ Nokia 8310 has in-built FM radio Broadcast TV ▪ Not yet ▪ Korean demonstration	Broadcast ▪ Need TV card ▪ Lower cost substitute for digital TV equipment
"Buffer & Play" *lean forward*	Video on Demand ▪ One-to-one service	Possible but ▪ Bandwidth limited ▪ Limited memory ▪ Small screen ▪ High cost	Major focus of streaming and broadband in medium term
"Store & Play" *lean forward then lean back*	VCR, Set-top Box	Memory Sticks ▪ Very restricted memory ▪ May not use radio interface (e.g. download through PC connection)	Hard Drive ▪ Music sharing ▪ Napster

Table 2.4.2: Media Platforms and Consumer Interfaces

If we consider the first column which lists the media platforms, it reiterates the distinction between 'lean back' and 'lean forward' platforms and adds a third alternative which we have called 'lean forward then lean back'. TV and radio broadcasting are lean back platforms which simply play content to the user. Streaming, called 'buffer and play' in the Table, is a 'lean forward' technology which allows for choice over content but requires actions on the part of the user.

The last possibility of store and play is a 'lean forward then play' platform in which the user must still play a part. Currently, the most popular such medium would be the VCR technology for TV with which we are all familiar. In the future this platform will include other possibilities using broadband connections to receiving equipment with large memory and we discuss these further in section 2.6 below because they will compete very effectively with streaming.

The table is best understood by considering the possibilities described by matching the three media platforms with each of the three user interfaces. The column headed TV and radio are generally play only platforms. However, Online video on demand such as is offered by TransACT, is a one-to-one streaming service to the TV and fits in the second cell of that column. In addition, TV and radio can be store and play as is the case with the VCR where the user obtains a complete copy of the content (from the video store or by recording from free to air) and then plays it to the TV. We will discuss the future digital examples in 2.6 below.

The second column shows the same three platforms on the next generation of wireless interface, so called 3G. The first cell refers to the application, currently available on some Wireless Access

Protocol (WAP)[8] and 3G phones, of receiving broadcast radio. TV broadcasting onto 3G handsets is currently being demonstrated in South Korea. The second cell in the 3G column refers to the possibility of streaming video and audio onto 3G phones but note that the bandwidth, screen size and memory are limited and the cost is high so that this is unlikely to be a major application of streaming. The last cell refers to a future possibility of using so called memory sticks which are loaded through a PC and provide temporary storage for relatively small files such as songs which the user might want to hear repeatedly on their mobile hand sets.

The last column shows the three platforms as applied to the PC. Firstly, it is possible to use the PC to receive broadcast media via an attached aerial plus converter card or via a cable from the PC to the TV antenna. This set up will be used by some as an alternative to buying a digital TV when that is wanted or when it becomes necessary after 2007. The primary focus of this report is on the second cell in that last column ie that of streaming onto a PC, which we have described above. The last possibility, the third cell, is the process of downloading audio and video content onto a PC, such as with Napster's music downloads. However, as discussed when describing streaming in section 1.2 above, *at present* this is a limited application because it doesn't deal with the issues addressed by streaming ie download times are long and file sizes tax the PC memory.

To reiterate, the possibilities set out in Table 2.4.2 are important because they locate streaming onto a PC against the alternative means of access and because, as discussed in section 2.6, it indicates the future technologies which will compete most effectively with streaming.

2.5 Connection Speeds and Quality

The quality of streaming media content is the outcome of all that precedes the consumption activity. In other words, it is dependent on the rate of the data link and this is determined by the interplay of each of the elements described in the preceding parts of this section 3. Data rates will be particularly influenced by the weakest link in the chain of operations and that link will vary depending on where the user is located and the particularities of the connection they use.

We are aware that there is a tendency to exaggerate the quality of streamed content currently available. In general it is not of a quality comparable to analog TV. We believe that the minimum data speed for satisfactory streaming is 56kbit/s. However, as the following Table 2.5.1 shows, that is a long way short of broadcast quality.

[8] WAP allows for text and simple pictures to be transmitted from a server to a WAP-capable mobile phone.

The table makes analog broadcast quality the measure and then rates the various broad and narrowband streaming technologies and standard definition TV by comparison.

Technology	Bit rate	Audio quality	Video + Audio quality
Narrowband	56kbit/s	Better than FM radio	Thumbnail + poor AM
Broadband	>200kbit/s	CD quality	Quarter-screen + AM
Cable or ADSL	1.5Mbit/s	Surround sound	Low grade videotape or VideoCD + FM stereo
Dedicated Cable or digital broadcast	4 Mbit/s		Broadcast SDTV + Stereo sound
DVD	10 Mbit/s		Hi quality SDTV + Surround Sound
HDTV (digital broadcast)	15 Mbit/s		Hi quality High Definition TV + Surround sound

Table 2.5.1: The Relative Quality of streaming and related services

2.6 Developments in Streaming Technology and its Competiton

Future improvements in the quality of streaming content will come in two areas. Firstly, improvements in the compression techniques will provide better quality from the same amount of data. Secondly, we expect that delivery techniques will improve so that users will be able to receive more data.

As to compression techniques, keep in mind that the extraordinary gains in multimedia compression in the last decade have been achieved through lossy compression, that is through discarding information which has little, if any, discernible impact. Contemporary techniques are already pushing the limits of lossy compression and it is doubtful that data rates could be better than halved for equivalent quality using such approaches.

On the other hand, the MPEG-4 standard is intended to approach the problem of reducing bandwidth from a radically different perspective. Conventional video may be thought of as a sequence of picture frames in rapid succession. Transmitting video therefore comprises sending a sequence of pictures, exploiting whatever lossy techniques are available to achieve compression. MPEG-4, on the other hand, treats a multimedia presentation as a collection of objects which are then animated according to a sequence of instructions. This assists with the quality of the final presentation because it can allocate bandwidth to the most important objects (such as facial movements) while losing or reducing the quality of background and other unimportant objects.

The MPEG-4 standard was first released in 1998 and is still in development. It should be noted that, in reducing the data rates required for multimedia content, MPEG-4 introduces extraordinary complexity in both computation (only some parts of the MPEG-4 standard have been implemented in commercial software) and content development (requiring a process similar to animation). Importantly, this means that current frame-by-frame content (i.e. films and video) are not easily re-versioned to the MPEG-4 format.[9]

At the same time as compression and representation techniques are improving, so too delivery techniques are likely to be developed further. This will occur in three areas: broadband availability and take-up will widen, data rates will increase and the quality of service will improve.

[9] It is worth mentioning here that MPEG is now developing two further standards – MPEG-7 and MPEG-21. MPEG-7 defines a content description technique for multimedia content and is intended for database reference.
MPEG-21, currently in the earliest stages of development, is intended to provide a systematic framework for the seamless delivery of content over a wide range of delivery mechanisms. At this stage the standard is little more than a wish-list.

We have considered broadband delivery above, including reference to 3G wireless technologies. Broadband delivery over power lines is also being considered although this is at an early stage of development.[10]

The prospect for higher data rates is also being addressed through additional capacity in current backbone infrastructure. For example, the optical fibre infrastructure across the nation is largely unlit and can be upgraded by adding equipment at end points of the cables rather than laying more cable at considerable expense. There are also additional capacity improvement techniques in each optical fibre including Dense Wave Division Multiplexing (DWDM) – in effect transmitting multiple digital channels down a single fibre using different colours of light.

With regard to quality of service issues, it is important to reiterate that the Internet Protocol is a best efforts service. It is not possible to prioritise packets of data and so the high data rates necessary for good quality streaming cannot be guaranteed. New versions of the Internet Protocol and new ways of using the existing version also promise improved quality of service and the prospect for attractive Service Level Agreements but without fundamentally changing the nature of streaming content over the Internet.[11]

It is also worth making the point that at some hypothetical point in the future when the bandwidth of network technologies far exceeds the requirements for real time, HDTV quality transmission, streaming of some kind will still be used. This is because at no point will bandwidth become free: it will always be expensive to provide and in limited supply. This, combined with the problematic nature of carriage over the IP means that transmission will be jittery. Hence, there will always be a need for a streaming technique.

This is particularly significant for the future provision of live content over the Internet. To produce life-like moving images as is necessary for content such as sport and to do so in near-real time, which is essential to attract a price premium for that content, a buffer will be needed to deal with jitter. This will be a primary function of streaming in the longer term.

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[10] Power lines clearly have an advantage, similar to the telephone network, of near ubiquitous distribution with the sunk cost of roll-out already managed. Unlike ADSL, however, power lines impose electrical safety issues and associated implications for wiring standards, in addition to equipment and "last metre" infrastructure requirements at both customer premises and power sub-station.

[11] The new version of the Internet Protocol, version 6 (IPv6) incorporates two key features: prioritisation of packets (thereby addressing quality of service) and an extended address space (thereby allowing for a much larger number of devices to be connected to the Internet).

Unfortunately, the upgrade to IPv6 is of little use unless the changeover is ubiquitous. If it is not, there will still be bottlenecks in the transmission system. For this reason there has been little incentive for the upgrade to occur. However a number of other techniques are being developed which piggyback onto IPv4 (the current version of the Internet Protocol) including:

- RSVP (Resource Reservation Protocol) which reserves resources for individual traffic flows through a network.
- DiffServ (Differentiated Services) which provides relative QoS differentiation for different classes of data, and
- MPLS (Multiprotocol Label Switching) which improves QoS by reserving a path through the Internet.

However, having said that, we expect that streaming will be most relevant and most common in the near future. This expectation arises from our view on the new technologies which are becoming available. To discuss their importance, we refer back to Table 2.4.2 on page 26, which considers media platforms and consumer interfaces from section 2.4.

The key technical developments to consider are those associated with the spread of digital TV (especially digital cable TV) and the expansion of bandwidth to and memory on PCs. These involve developments in both what we have called play on the one hand and store and play platforms on the other.

Developments in the first instance will come with the digitalisation of cable TV that will make an unprecedented number of channels available to the lean back and play users and we expect this to be a very attractive method of accessing video-on-demand type services. The second is the development of store and play technologies, in particular the extension of memory in set top boxes which, when combined with digital transmission, means that it will be possible to send and store large quantities of commonly required content at the TV set which can then be accessed on demand. For example, all that day's news and current affairs broadcasts could be downloaded and cached along with a selection of one's favourite first release or free-to-air offerings. With large connection pipes and memory capacity this will provide users with access to much new media content on demand.

A third development involves advances in memory capacity and transmission rates onto PCs. This will overcome some of the problems to which streaming responds, especially that download times are long and media-content files are large. Without buffering, it will still be necessary to wait until the whole download is complete but that period will be very much shorter in future.

In our view, these are critical competitive developments for the future of streaming. We do not expect streaming to be a mainstream activity when these alternatives are available. As we have said, streaming is a response to particular conditions and while it has a future, it will peak as these superior responses become available.

Section 3: Estimates of Streaming Demand in Australia

3.1 Introduction

We do not know much about streaming in Australia and making estimates of current demand and predictions for future demand are important parts of this project. This work will indicate the scale of streaming activity and the importance of streaming technology and of broadband delivery. Our estimates might also be useful to the ABA in signalling when and if a regulatory response is required and we recommend in section 5 that a watching brief be kept over some critical matters.

The biggest problem in this work is that there is a general paucity of data. To provide estimates we must cast the net of inquiry broadly. We begin by considering the international experience because the breadth of information is greater and the comparisons we make set the context for our Australian estimates. We will use a variety of data sources, especially from the US, and we will also make use of OECD data which are separately estimated from official sources.

This section does not give a comprehensive overview of factors which might drive streaming demand. In section 4 below we discuss some of the applications of streaming that might be viable in the medium to long terms and some of the related questions concerning the viability of streaming as a business. Here, we deduce our estimates indirectly by focussing on the following key matters: the spread and growth of the Internet and of broadband and predictions for the future growth of each. Essentially, the technique is to obtain estimates for each of these for the US and to use them in conjunction with whatever information is available for Australia so as to generate estimates of Australian streaming demand and its future growth.

3.2 The International Experience

3.2.1 The US Experience

The US has the largest population of Internet users and is said to be the nation in which streaming is most developed. For this reason we will use the US experience as an indication of where Australia might be headed.

Focussing firstly on the Internet, the following estimates of Internet penetration and numbers of users in the US come from the two most often quoted sources. They are given in Table 3.2.1 below.

Source	Penetration of Internet, % pop (number of users)
Nielsen Net Ratings (Sept 2001)	39% (185.6 m)
Arbitron/Edison Media (Aug 1998)	31%
Arbitron/Edison Media (Jan 2001)	58%
Arbitron/Edison Media (June 2001)	66%

Table 3.2.1: Internet market in the US 2000-2001
nb these data are estimates of Americans with access to the Internet.

We will use the Nielsen data for Internet penetration, largely because their method is more explicit and comprehensively explained.

We have seen that broadband is important to streaming and the following table shows the uptake of broadband in the US and the more limited data which are available on streaming.

Source	Broadband users	Streamers
Nielsen Netratings Nov 2000	11.2m	34.4m
Nov 2001	21.3m	40.8m
Arbitron/Edison Media Jan 2000		22.5m
Jan 2001	18.1m	29.5m

Table 3.2.2: Broadband and Streaming demand in the US 2000-2001

nb (1) the estimates for broadband users are the number who have access
(2) streamers are defined as those who have accessed streaming at home (Nielsen) and those who have ever streamed (Arbitron)
(3) Broadband in the US uses the FCC definition of 200 Kbps download.

The table shows that both broadband and streaming growth have been impressive with streaming growing in the order of 20-30% pa depending on the data source. We opt for a mid range growth rate of 25% pa in the US.

Survey results show that as many as 45 million Americans have listened to streamed audio, mainly in the 12-24 age cohort. It is further estimated that 21% of online Americans have streamed. However, despite this impressive growth, it is said that streaming in the US remains an infrequent not habitual activity (Arbitron/Edison Media).

Table 3.1.2 also shows that the number of streamers greatly exceeds the number with broadband connection, meaning that, in the US, a lot of streaming is currently done over narrowband. However, it is broadband users who make up the majority of streaming growth. Broadband streaming is growing at 90% pa; narrowband streaming is growing at only 1% pa.

There are no systematic predictions of future streaming growth in the US but the many estimates of the future of broadband, as shown in the following Table 3.2.3, give an indication based on the proposition that most new broadbanders will stream. That proposition suggests that the rate of growth of streaming will increase over the next few years with the continuing rapid spread of broadband.

Source	Annual growth in Broadband (2001-2004, average annual change, %)
Emarketeer	54
Garnet Dataquest	53
Jupiter Research	46
Ovum	58
Strategis Group	48

Table 3.2.3: Projections of Broadband Demand Growth, US 2001-2004, (% of all households)
Source: eMarketeer

3.2.2 Other nations

The best data source for international comparisons of streaming related technologies is the OECD. These data have been carefully compiled to allow for comparisons but are for broadband only, broken into DSL and cable to give a total for broadband penetration per 100 inhabitants.

Table 3.2.4 show the data for selected nations:

Nation	Broadband penetration (per 100 inhabitants)	Cable as % total	Annual growth (1999-2000, %)
Australia	0.39	86	428
Canada	4.54	66	200
Denmark	1.27	55	459
Japan	0.5	98	312
Korea	9.2	36	1492
United Kingdom	0.09	33	U/a
United States	2.25	60	238

Table 3.2.4 Broadband Penetration in Selected OECD Nations, 2000
Source: OECD (2001)
nb the OECD defines broadband as downstream access of at least 256 Kbps

The table shows that broadband growth rates are very high, even though the pace of change varies among nations. The differences are not just in the penetration rates but in the relative importance of cable compared with DSL.

Korea is clearly a leader in broadband penetration. A range of reasons have been put forward for this including that competition is strong (OECD, 2001, p 32); that telephony over IP is widespread (ITU), that the concentration of Koreans in apartment buildings aids the roll out and that government has played a leading role, both through its own demands and in stimulating private sector uptake (eg Kaye, 2001).

The point from this is that there is no agreement among commentators as to what causes growth in broadband access. We can clinch the point by considering the case of Canada which ranks second among OECD nations. In that case the opinion covers issues such as the early launch of cable and the now near ubiquity of cable TV and the major role of government.

The research team believes there is value in extending the understanding of broadband uptake because it is likely to have important policy implications. It is, as we have seen, a central issue not just for streaming but for a range of technologies that lie at the heart of digital convergence.

Such research should consider the likely impact of a range of factors with special relevance to Australia such as demographics, population densities and disbursements, the existing spread of cable, free to air services, etc. This work should be extended by making it an element of the watching brief we recommend to the ABA in the final section of this report.

3.3 Streaming in Australia

Not a lot is known about streaming in Australia. However, we can begin by locating Australia's broadband experience within the OECD. As can be seen from Table 3.2.4 above, Australia is relatively lowly ranked and is in fact 16th out of the 28 nations surveyed in 2000, down from 13th in 1999.

There is no shortage of critical comment to account for the relatively poor uptake of broadband in Australia. According to a recent survey of Telstra's BigPond Internet services, only one in 25 users believe it is value for money (Lebihon, 2002). BizFocus, adds that "39% of Australian consumers had no idea whether broadband access was worth the extra money" and that the ADSL network "has been plagued with problems" (BizFocus, 2001). Some believe that the broadband roll out in Australia is not sufficiently profitable (Kaye, 2002) and others have sheeted the problem home to government policy, particularly that broadcasters have been protected from broadband competition (Spender, 2002).[12]

One of the most common reasons proposed for the slow uptake of broadband in Australia has been its price. It is said that broadband in Australia is "three times more expensive than a narrowband 56k modem alternative" (Scevak, 2001). Microsoft Australia has recently cited pricing as the major reason why Australia's broadband take up is slow (AFR, 6.02.02).

To put Australian prices in perspective we should compare them with those of other advanced nations. However, as noted by the OECD, such comparisons are complicated and fraught, especially for DSL as indicated by the first note to the following table. We must take into account a range of factors including the initial service charges, the cost of modems and the monthly service charge and any limits and penalties and we must do so for all service providers and for cable and DSL.

When the calculations and simplifications are made and the results expressed in US dollars and in terms of so-called purchasing power parity (the most reasonable comparison) the following data emerge:

[12] It should be noted that in February 2002 the Federal Government has responded by establishing two committees to look at broadband availability and related issues. They are the Broadband Advisory Group and a study group called ICT Framework for the Future. The Minister for Communications, Information Technology and the Arts will chair both.

Nation	DSL Kbps of data /$US*	Cable** $US, (Mbyte limit)
Australia (BigPond)	9.7	145.12 (3000)
Canada	30.7	133.40 (unlimited)
Denmark	10.7	140.16 (unlimited)
Japan	58.9	49.64 (unlimited)
Korea	27.5	61.14 (unlimited)
United Kingdom	12.7	66.46 (unlimited)
United States	17.9	141.85 (unlimited)

Table 3.3.1 International Comparison of Broadband Prices

** total for downstream/upstream Kbps per USD per month*

*** DSL comparisons are made by adding upstream and downstream speeds and then dividing them by the monthly fee plus the connection fee spread over 4 years to give a total bandwidth per $ figure.*

These data provide support for the proposition that Australia's broadband prices are relatively high: data download per $ by DSL is the lowest of the selected nations; the cost of cable is the highest and download limits apply. Of course, that the Australian price is high is not to say that it is too high. As we have seen, some say that Korea's pre-eminent position is the result of having its population concentrated in apartment buildings. The counter point might well apply in Australia and account for both the high cost and the low penetration. To the extent that is so Australian broadband rates and prices might always differ from those of other, comparable nations.

We can get a feel for the growth of broadband in Australia by making use of the survey of ISPs conducted by the ABS on a quarterly basis. Unfortunately the surveys have been running only since September 2000 and do not make a broadband/narrowband distinction. Nonetheless, with some re-arrangement of categories, the following table 3.2.2 can be generated:

Date	Broadband	Narrowband
September 2000	60	3789
December 2000	78	3843
March 2001	98	3870
June 2001	116	4065
September 2001	130	4143
Growth rate (Sept 00- Sept 01)	**116%**	**9.3%**

Table 3.3.2: Broadband in Australia, '000 users

NB ABS data have been rearranged as follows to give the broadband-narrowband distinction: The data for narrowband technologies are the sum of all Dial-up access technologies plus the Analog and Digital Permanent access technologies. The broadband data are derived as the sum of DSL, cable, satellite, microwave and permanent access technologies not counted as narrowband.

These data give the same overview as for the US: broadband is growing fast but from a low base. We will use this information again in making estimates of current and future streaming growth rates in Australia.

We are also interested in predictions of future broadband growth in Australia as these will also be used in generating estimates of future streaming. The predictions from some selected sources are reproduced in Table 3.3.3. They all show an expected increase in broadband uptake in the medium term and we compare these predictions with the estimates of the current number of broadband connections from Table 3.3.2 (ie 130,000 in September 2001) to give expected annual rates of growth, which are shown in parentheses.

Source	Estimate of Broadband users	Year (and annual growth rate)
IDC Aust	2.6 m	2005 (111%)
Telstra	1.5 m	2005 (84%)
DFAT (2000)	0.6m	2003 (149%)
Tonic Media	2.0m	2004 (115%)

Table 3.3.3: Predictions of Broadband Growth in Australia

In applying these data when making our projections of Australian streaming demand we will use a simple average of these growth estimates ie 115% pa.

To give sensible estimates of the current use of streaming in Australia we need to develop a method which can make use of the US data detailed above.

We propose that streaming in Australia is different from that in the US because of two factors. Firstly, the penetration of the Internet is lower in Australia and, secondly, the intensity of Internet use is lower. We make our estimates for Australia by adjusting the streaming data for the US to take account of these differences.[13]

[13] The adjustment can be expressed algebraically as follows:
Rate of streaming in Australia = rate of streaming in the US x {Internet penetration x intensity of use in Australia} divided by {Internet penetration x intensity of use in US}
As to the different Internet penetration rates, from Table 3.1.1 we have that there are some 185.6 million Americans with Internet access, representing a penetration rate of 39%. By comparison, the ABS estimate that some 4.3 million Australians have access, 21.4% of the population.

The adjustment for intensity of use is simply the ratio of monthly use in the US cf. Australia. For the US, Nielsen provide the figure of 18 hours per month. There are few data for Australia. Nielsen Netratings suggest that the average will be around 9.5 hours per month (the data reported are 11 hours for males and 7:39 for females. As 54% of users are male, this gives a weighted average of 9.48 hours). A similar figure is offered by Scevak: that average Internet usage in Australia is 26 minutes per day or 13 hours per month. We employ an average of 11.25 hours per month.
These deductions suggest that the data for US streaming should be modified by the ratio 0.34 to give estimates for Australia (where 0.34 = {.39x18}/{.214x11.25}).

There are between 30 and 40 million streamers in the US (the range of Nielsen and Arbitron estimates) from a population 285 million and, once we make the modifications detailed in the footnote below, this suggests that the current number of Australian who have streamed is between 652,000 and 921,000.

The range of estimates are lower for Australia than for the US and this is consistent with the OECD data on broadband ranking and with the proposition that broadband take up is slower in Australia because of the relatively high price. There is also other evidence that this lower figure should be expected.

For example, it has been suggested by an industry leader that the lack of local content inhibits both advertisers and streamers in Australia (Mr Mark Hollands, Gartner, in Lidell, 2001). We consider that matter further in the following section. It has also been claimed that, in Australia, "the quality of streaming services remains low" (BizFocus, 2001) being mostly flat HTML files and low resolution videos. Hence, it can be confidently predicted that Australia's streaming uptake will be lower than in the US and our estimates confirm this.

The last task for this section is to estimate the current rate at which streaming is growing in Australia. Again, we have no specific data so we must generate estimates using a proxy. Our approach is to use the same ratio of streaming growth to broadband growth as is currently apparent in the US and apply that to broadband growth rates for Australia. From section 3.2.1 we know that streaming is growing between 7% and 30% of the rate of broadband growth. Table 3.3.4 below reproduces the second part, the estimates of broadband growth for Australia from the ABS and the OECD and for the US.

Item	**Current rate of growth (%pa)**
Australian broadband:	
ABS	116
OECD	428
US broadband:	
Nielsen	90
OECD	238
US streaming:	18-31

Table 3.3.4: Estimates of current broadband growth rates in Australia

Applying these to OECD data for Australia and to the ABS data respectively, we estimate that the rate of growth of streaming in Australia is between 35% (ie 0.3 x 115) and 30% (ie 0.07 x 428).

3.4 Estimates of Demand for Streaming in Australia, 2002-10

We now turn to the question of future growth rates for streaming in Australian and we approach the question firstly by establishing lower, then mid range and then upper bounds. Secondly, we run a check on those estimates.

3.4.1 Establishing the lower bounds

We establish lower bounds by applying the simple proposition that most streaming will grow as quickly as the Internet. The number who stream will be estimated as the proportion of Internet users who stream.[14]

The rate of growth of the Internet in Australia can be taken from a series of ABS surveys of IT use by householders, business and government which suggest that the rate of Internet growth in Australia is 11% pa, growing from 3.89m to 4.27m in the period September 2000 to 2001 (ABS cat no 8153.0).

Unfortunately there is no estimate for the proportion of Australian Internet users who stream and we use our own estimate of current numbers of Australians who stream (ie 786,000 being the average of 652,000 and 921,000 calculated in section 3.3) and the ABS' figure for the current number of Internet users (4.27 million) to give the figure of 19%. This is quite close to the figure of 21% estimated for the US by survey.

[14] Algebraically;

the growth of streaming = growth of the Internet x % Internet users who stream

In other words, the lower bound estimate is that the *rate* of streaming growth will track that of Internet growth and the *number* of new streamers will be given by the proportion of Internet users who stream.

Hence the lower bound for the rate of streaming growth is the product of the 11% pa growth in the Internet and changes in the number of Internet users who stream. As to the second, we have assumed that the proportion of Internet users who stream increases by 1% pa to 2007 when it is 25% and then declines to 17% by 2010. This means that there are estimated to be some 114,000 new streamers over 2002 bringing the total number to 900,000. Data for subsequent years are shown in the footnote below.[15]

3.4.2 Introduction of broadband

Those lower bounds are probably too low. The uptake of streaming will probably be faster than the rate of growth of the Internet because, as we have seen, broadband connections make streaming more attractive. In other words, if we change the focus from the Internet to broadband we will generate higher estimates of streaming demand for two reasons. Firstly, the rate of growth of broadband is greater than that of the Internet and, secondly, a greater proportion of broadbanders also stream than is true for Internet users overall.[16]

There is a widespread expectation that the rate of broadband take up will accelerate in the near future but that is probably only a temporary phenomenon. Based on the uptake of other technologies, the growth rate for broadband will describe an S-shaped curve when set against time. In other words, that growth accelerates at first (we assume by 2% pa to 2004) before decelerating through to 2010. This is a typical profile for the uptake of new technologies (Rappaport, 2002, p 3) and is shown in Table 3.4.1.

15

Year	Number of Internet Users (millions)	Number of streamers ('000)
2002	4.74	900
2003	5.26	999
2004	5.84	1109
2005	6.48	1231
2006	7.19	1367
2007	7.90	1517
2008	8.86	1684
2009	9.84	1870
2010	10.92	2075

16 Hence, this generates a second set of estimates based on the proposition that:

the rate of growth of streaming = {rate of growth of broadband x % of broadbanders who stream} + {growth of narrowband x % of narrowbanders who stream}

Year	Estimated Broadband Growth rate (%)	Number of year end broadband users
2001		130,000
2002	116	280,000
2003	118	612,000
2004	120	1,346,000
2005	100	2,692,000
2006	80	4,846,000
2007	60	7,753,000
2008	40	10,854,000
2009	30	14,110,000
2010	20	16,932,000

Table 3.4.1: Estimated Uptake of Broadband in Australia, 2002-2010

The figure for the proportion of broadbanders who stream is again for the US, taken from Nielsen data quoted above (Table 3.3.2). That shows there are 12.7 million broadband streamers from a total broadband population of 21.3 million. This gives the figure of 60% and we assume it will apply in Australia until 2007. After that the proportion of broadbanders who stream is assumed to decline to 20% by 2010 as the new alternative technologies become mainstream.

As to narrowband, we rely on ABS data showing the current rate of growth and we then modify that by assuming a deceleration of 2% pa in the rate of growth of narrowband. In other words, narrowband declines as the rate of growth of broadband increases. Hence, narrowband growth for 2002 is 9.3% falling to 1.3% by 2006 and declining strongly thereafter as users substitute broadband for narrowband.

[17]The proportion of narrowbanders who stream again relies on US data, calculated as for broadband and giving a figure of 17%.

17

Year	Estimated Narrowband Growth rate (%)	Number of year end narrowbanders ('000's)
2001		4143
2002	9.3	4528
2003	7.3	4858
2004	5.3	5116
2005	3.3	5284
2006	1.3	5352
2007	-10	4816
2008	-20	3853
2009	-30	2697
2010	-40	1618

Bringing these two elements together creates Table 3.4.2 below which gives mid range estimates for streaming growth.

Year	Broadband streamers	Narrowband streamers	Total streamers
2002	208	704	912
2003	367	770	1137
2004	807	825	1632
2005	1615	898	2513
2006	2907	909	3816
2007	4651	818	5467
2008	6512	655	7167
2009	8466	458	8924
2010	6559	275	6831

Table 3.4.2: Estimates of Australian Streaming Growth, 2002-2010, '000 users

3.4.3 Other Adjustments

It is possible the previous estimation techniques are too much influenced by the past and that higher streaming growth rates might be expected. We base that proposition on two factors: firstly, our estimates have not yet included the growth potential of Online streaming which is not over the Internet (ie uses a dedicated delivery platform such as with the TransACT case study) and, secondly, we should include non-commercial applications such as streaming by special interest groups.

As to the first, we have no way of knowing how significant non-Internet Online services might become. We believe that they will remain on the margins of the set of Online services, largely because content will be limited under such arrangements which are therefore less likely to attract advertisers (we look at that in more detail in section 4).[18]

The second adjustment is also speculative. Special interest use might not seem rational to outsiders in the sense that the services might need to be provided at a loss or paid for at very high prices. Equally, it might involve undesirable content and might be secret. Nonetheless, we believe some upward revision for such uses is reasonable.

18 However, the OECD reports that such dedicated streaming platforms are growing quickly in Sweden and Iceland. In the former, so called property networks (ie within apartment buildings) using fibre optic Ethernet LAN connections are growing at 150% pa to 200,000 subscribers in 2001 (cf total other broadband connections of 105,000). Like the OECD, we have not focussed on these technologies because they do not provide "leading options for broadband access" (OECD, 2001, p 7). Nonetheless, they play a part in setting our upper bound estimates.

Taking these two adjustments together, we add a further 10% to our mid range estimates. We have made one further adjustment to our mid range estimates. As stated above, we expect that the new technologies, especially those ushered in by the spread of broadband, will out-compete streaming over the course of this decade. However, considerable uncertainty attaches to the timing of that process. Our mid range bounds show streaming declining quickly after 2007. The adjusted, upper range bound estimates assume that the competition is less severe in the period 2007-10. Hence the estimates diverge after 2007.

Bringing these together gives us upper bound estimates of 1.25 million in 2002, rising to 5.5 million by 2010.

A last matter of importance to be raised here is that related to streaming access provided by Internet connections at work. Some have said that this is the largest and perhaps fastest growing segment of the market and it raises the prospect of needing adjust our estimates further to take the possibility into account.

We have looked at some of the relevant data and have decided not to develop this part of the estimates. Data from the US and Australia suggest that, while Internet users at work are more active than those at home[19], there are far fewer of them. In addition, their income and professional profiles suggest that many of those with access at work also have access at home and so are already counted. In Australia only 544,000 of the 4.3 million Internet connections (12.7%) are provided by business and government. In any case, the large numbers sometimes quoted for this category are likely the result in part of access at work being free to employees. That situation might not last.

3.5 The Estimates

We now consolidate our estimates of future streaming demand in Australia, according to our lower bound, mid range and upper bound calculations. This is summarised in Table 3.5.1 below and its accompanying figure:

19 Nielsen data for Australia and the US are as follows:

	Males (h:m:s)		Females (h:m:s)	
	At home	At work	At home	At work
US	11:34:51	21:44:50	9:52:53	16:40:14
Australia	8:26:39	11:02:14	6:38:44	7:39:22

Year	Lower	Mid	Upper
2001	786	786	786
2002	900	912	1003
2003	999	1137	1250
2004	1109	1632	1795
2005	1231	2513	2764
2006	1367	3816	4197
2007	1517	5467	6013
2008	1684	7167	7883
2009	1870	8924	9816
2010	2075	6831	7514

Table 3.5.1: Estimated Streaming Demand in Australia, 2002-2010, (thousands of streamers)

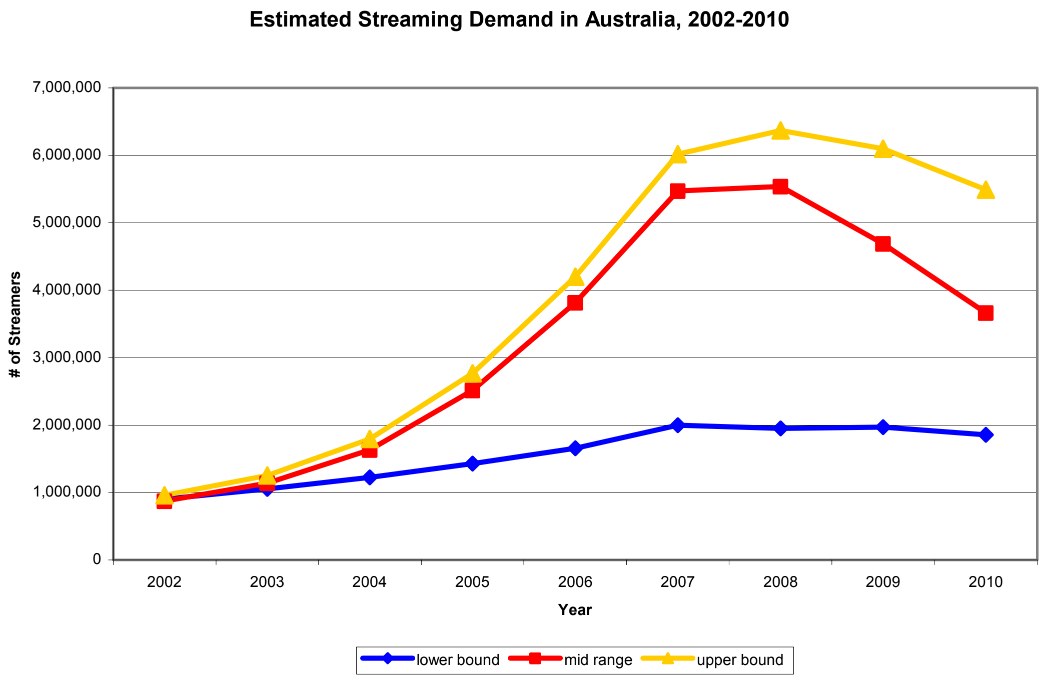

Figure 3.5.1: Estimated Streaming Demand in Australia, 2002-2010, (thousands of streamers)

It is important to emphasise what has been presented in the preceding table. We have estimated the number of Australians who will have streamed during each year listed. Unfortunately that tells us nothing of the amount of streaming they will do or how much they will spend or how it might affect existing media.

We have had little choice in this matter. The raw data we have used from the US are estimates of access or numbers who have streamed and our adjustments to that data do not alter their unit of measure.

We can offer little further advice from existing data sources but what little is available can help give some perspective to the numbers. The ABS has surveyed time use and shown that more than 9% of time is spent consuming “audio visual media, recreation and leisure” (PC, 2000, p 62). That amounts to nearly 65 hours per month. ABS data for Internet use show that 47% of those with Internet access use it daily and 40% use it 2 to 6 times per week (ABS cat no. 8147.0). In section 3.3 above we have also estimated Internet use in Australia at some 11.25 hours per week.

These data are all relevant but remain incomplete and difficult to combine. In addition, changes in one are likely to produce changes in others so that we cannot take estimates of future media, recreation and leisure consumption and assume that any growth is due to new forms of access such as streaming, rather than being due to change in existing forms.

However, from internal discussions among the research team, we predict that, by 2007, streaming will have peaked but will not be quite as common as all Internet use today, which is something like 10 hours per month. We guess that streaming will be half that. It will not be an habitual activity with many Australians and will not completely displace traditional media but, prior to the full introduction of digital TV, we expect it to be a relatively mainstream, relatively infrequent activity.

A Reliability Check of the Estimates

The paucity of appropriate data has meant that a high degree of uncertainty would attach to our estimates. In response, we have devised a method of checking which is very different from that we have used above. The method we have chosen is to focus not on the delivery technology but on the receiving apparatus; in other words, we will check the estimates based on Internet and broadband technologies by generating estimates from the spread of computer technologies compatible with streaming.

This approach makes use of the discussion in section 2 above which observed that streaming requires personal computers of a vintage less than two years to be able to run the required streaming software comfortably. Our method for checking is based on making estimates of the number of computers of the appropriate vintage and applying assumptions to that as to how many of these would be used for streaming and how many of future personal computers will be used for streaming. This is not our first preference as a method but it will let us know if our base line estimates for 2002 are reasonable.

One reason for our reluctance to give this method greater prominence is that, as with streaming itself, there are very few reliable data available. The calculations we make are detailed in the footnote below.[20] We estimate that 1,375,000 PCs are able to connect to the Internet and stream video and audio at broadband rates, if they were broadband connected. To reiterate, our estimate of streaming for 2002 was between 780,000 and 1,003,000, again suggesting the check is using slightly high estimates. Nonetheless, this additional calculation implies that there are sufficient PCs to do that much streaming and it offers some assurance that our early year estimates are within the ballpark.

The last points to be made in this section should be thought of as caveats to our previous estimates. The first of these is that they are based on the implicit assumption of *ceteris paribus* ie that everything remains equal other than the forces currently at play.

If, for example, a large multinational were to enter the Australian streaming or broadband services market, prices and the behaviour of existing players would change. We develop that notion in section 4 below.

Similarly, and perhaps more likely, if government were to change significantly the rules governing broadcasting, datacasting or online services, our estimates might be less accurate.

In short, our check suggests that the estimates are robust but they remain sensitive to changes brought on by major players in the field. In the light of these uncertainties, we recommend that the ABA request monitoring agencies such as the ABS consider extending its data collection to include a number of specific questions related to streaming and broadband uptake in Australia.

[20] Firstly, we have data that there were 3,800,000 PCs in Australia in May 2000. The ABS estimate that 40% (1,500,000) of these had been updated in the previous 12 months and that one-third would be upgraded in the next 12 months; we assume this is one-third on those not upgraded in the last 12 months ie 33% of 2,300,000 or 750,000. This gives a total of replacement PCs less than two years old of 2,250,000.

Secondly, to this we must add the estimate of PC sales in the period, net of retirements. The data for sales are not easily determined and there are a range of estimates: IDC (Nov 2001) gives 2.2 million; PC Data, 2.5 million; and, IDC (May 2000) 1.8 million. We opt for a figure around 2,000,000 for gross sales and then subtract retirements of 40% of the stock to give net new additions of 500,000 and a total of computers less than two years of 2,750,000. This figure might be a little on the high side. It has recently been reported that the boss of Dell Computers reckons that half of existing computers were of less than three years age.

Finally, we know from ABS data that some 50% of PCs have an Internet connection (ABS, cat no 8147.0, Table 1.3). This gives 1,375,000 streaming capable PCs in Australia.

Section 4: The Potential Impact of Corporate Strategies on Streaming in Australia

4.1 Introduction

The purpose of this section is to ask how streaming uptake in Australia will be affected by commercial and strategic factors. It's always important to know what and whose interests are at stake in any new development. In this case it is critical: we want to know how streaming fits into the business rationalisations that are emerging with digitalisation and convergence and also into the on-going search for a robust business model.

The analyses of technology and demand in the previous sections deal with issues underlying cost of delivery and willingness to pay respectively. Under competitive conditions these considerations will determine the price and viability of streaming services. But conditions in the real world are seldom competitive. This section firstly expands on that question of viability by considering the commercial factors which surround streaming. It then looks at the potential impact of corporate strategies under which companies might override commercial considerations in the short term to steal the march on their rivals or to protect existing profits.

The purpose of this work is to determine whether commercial or corporate considerations might suggest variations to our demand estimates and hence to the importance and impact of streaming.

In section 4.2 we discuss the current business models which underlie streaming and stress their shortcomings. In section 4.3 we develop an analysis of strategic issues which might affect streaming and find they lack force. Section 4.4 then briefly states our conclusions.

4.2 Commercial Considerations

One of the most vexed issues surrounding streaming and indeed the whole of online business is the lack of a simple but compelling business model. We report some of the observations about business models for broadband (James, 2001) and draw out the parallels with streaming.

There are said to be two possible business models, neither of which seems viable for streaming. The first is the so called value added service model by which a company which owns the required infrastructure takes over or merges with or develops exclusive long term contracts with companies which can supply the content. This says that if you have the transmission infrastructure, all you need is content. The second model is based on an adaptation of the advertising and subscription approach currently used for newspapers and broadcasting.

The value added model is also called a vertical integration strategy whereby the infrastructure owner integrates the activities or contract over the output of the upstream content owner. It is sometimes thought of as a "build and they will come" strategy whereby rolling out the infrastructure attracts the customers. Content is thought of as important but secondary because it will inevitably be attracted to the delivery platform. We will develop some strategic scenarios around that notion in the following section. Here, we point out that the model has one key weakness: how to pay for the costs of implementing it?

This is not so much a matter of paying for the cost of developing and employing the infrastructure. That is just more of the pricing model commonly used in telecommunications and, despite that it is problematic in some respects, the infrastructure owner will likely be familiar with it. Rather, the principle difficulty is paying for the content. In the telecommunications model the content is the communication itself, provided freely by the users but, with streaming services, the content must be paid for and this is associated with a number of difficulties.

Firstly, content is difficult to value and there has been a tendency to overvalue it, its importance notwithstanding. The point is that the price of content does not reflect the costs of production (which are relatively well known) so much as the willingness of consumers to pay and that is often difficult to gauge. Just how difficult is shown by the fact that some of the world's biggest and most experienced media companies have got the valuations very wrong indeed.[21] Secondly, if the content is compelling (new release movies and the like), the price will be high. High prices (plus the technological factors cited in section 2.4 and 2.6) count against streaming having mass appeal in the longer term.

Thirdly, the movie and music producers and TV broadcasters who create or own the content already have well developed methods of presenting it. Making that content available to streaming service providers or even to other, better broadband technologies can undermine these existing arrangements with uncertain results. In other words, the interests of cinemas, video stores and broadcasters would all be threatened if the content were made available for streaming before it was

21 For example, it has been widely reported that News Corporation has spent "too much" in securing rights to content, especially sport (Collins, 2002), which it currently uses on its satellite service and TV stations outside of Australia (see for example Chenoweth in AFR 16-17.02.02). This has contributed greatly to the losses it has made in the last year.

available to them. Of course, if the streaming services were the last to use the content it would no longer be compelling.

As observed recently by Mr Peter Coroneos of the Internet Industry Association, there is also a related chicken and egg problem: streaming might become a mature medium when popular content is widely available but significant amounts of compelling content will not be made available until streaming becomes popular.

This problem of content provision is well known amongst the key players. Telstra, for example, has responded with a $50 million broadband fund one purpose of which is to develop appropriate content. Similarly, as noted above, the Federal Government has initiated a Broadband Advisory Group which will also consider matters of content.

There is one important caveat to the proposition that content is the major inhibitor to streaming and that comes with peer-to-peer traffic where the people using the medium either produce the content themselves or place it on the Internet or some other digital network, often without having paid for it. Sometimes this will be content which would be restricted under classification regulations but it will also include more innocuous content produced by special interest groups like the local bike club or golf association or even within large corporations. In our view, these uses should not be thought of as commercial streaming activities. Rather, streaming used in this way makes it more like a communication medium used by those with a special interest in doing so.

A related example is that vehicle manufacturer BMW which provides streaming video to promote its new products. Again, this is not strictly a commercial proposition, although it is arguably a commercial application of streaming. A similar example would be the use of streaming within a large corporation to make training available online or to communicate messages from management. We will discuss other applications of streaming below which we think will be successful over the longer term.

The second commercial approach to streaming is to adapt the business model long used in broadcasting, that of attracting advertisers by virtue of attracting users (James, 2001). In this sense streaming is just another way to get people’s attention and, once that is done, it becomes a valuable medium for merchants who will use it for advertising purposes.

That model sounds simple enough and it might be possible to adapt it for streaming. However, it should be noted that, unlike much traditional media, the reach of streaming is nation-wide if not greater than that. At the same time, streaming online or over the Internet is fundamentally a one-to-one service and is particularly well suited to the provision of content to narrow interest groups. In other words, it is suited to narrowcast but is available on a global basis. That is a dilemma for advertisers: streaming is not a mass medium with national or local focus such as TV or radio and so does not attract sponsors prepared to help pay for content as has been the case in TV or radio.

One possible response to that dilemma is to use or develop the model employed in newspapers where the service is made profitable by a combination of subscription and advertising fees. In other words, people pay part of the costs of the content service by buying the paper but must also consume the advertising and the fees paid by advertisers makes the venture profitable overall.

That appears to be a viable commercial model for pay TV and might be extended to streaming services. It could be adapted into a 3-tier model where streaming services (transmission and content) are paid for partly by subscription, partly by advertising and partly on a pay-per-view basis.

However, we would note that, in Australia, people are conditioned to TV and radio which is mostly free-to-air and might not appreciate being required to pay part of the cost of access, even for content they can choose. It is also true that, in countries where TV and radio user licences are collected, there is still considerable resistance to this business model.

We make no prediction about the business model which will emerge for streaming in Australia. However, it should be noted further that this issue has been around since the beginning of the Internet and, as the losses made on even some of the most popular Australian web sites indicate, there appears to be no universal solution as yet. The lack of a compelling business model has probably slowed but not stopped the spread of the Internet and we expect that its lack alone will have the same result for streaming.

Having raised the issue of streaming content, the last task here is to indicate the kind of content which is likely to be streamed commercially. In the medium term, before the advent of better technologies, streaming seems best suited as a means of accessing premier news services that are not available at the user's location via broadcast. Australians might access the BBC from home via a streaming service or the ABC when they are overseas. Streaming also has value as a marketing tool so that some content, such as movie trailers or music video clips, could be made available at less than full cost. Some of that will be compelling content for some users, provided by the owner because of its promotional value and profitable for the streaming service provider because they do not need to pay the full price for it. None of this gives strong reason for revising the proposition that streaming lacks a viable business model.

In the longer term we believe that it is not the commercial issues discussed here but technological issues discussed in section 2.6 which will mean that streaming does not become a mass medium. The content that it would need will not be made available because newer, better means will be devised to deliver it.

We have noted also in section 2 that streaming will continue to be useful in providing live content across the Internet. We can expand on the commercial implications, in particular by noting that, in the longer term, streaming is unlikely to attract premium live content such as highly popular sport. The reason is that such content is more likely to be delivered via the radio frequency spectrum or via digital cable. In both cases the jitter problem is non-existent so streaming can be avoided. Further, the cost of these delivery methods will be lower per viewer and so profitability will be greater.

In other words, we expect streaming of live content will be used for niche markets. It might be part of a suite of live and stored content delivered over the Internet but will exist at the margins of commercial applications. In commercial applications it will likely carry live content that is in the special interest category (such as the less popular sports) and will find its niche outside the broadband coverage areas or at the margins of transmission networks.

4.3 Corporate Strategies

The last section proposed that there is not a compelling business case for streaming as a mass medium. Nonetheless, streaming might be advanced in Australia by loss-making strategies which are pursued in the medium term to protect existing assets or to steal the march on rivals. To investigate those possibilities we need firstly to develop an appropriate method.

The analysis of corporate strategies is a complicated task and the results are often contingent and uncertain. The aim must be something less than detailed predictions about the future: who will own what, for example, is not our concern. Instead, we will lay out the key strategic issues and develop a system to combine them in a way that allows us to indicate what are the possible directions that might be taken by whichever players are involved.

The orthodox economic theory of competitive markets offers little assistance in following corporate strategies. It says simply that rivalry will force price down to cost and only efficient producers will survive. The theory of competition says also that anyone from anywhere might become involved in Australian streaming. The theory suggests that if a management team can establish its reputation in capital markets it can enter any field, including Australian streaming. To follow the possible strategies of players with deep pockets and broad ambitions requires firstly a framework that identifies key issues.

The first proposition is that capital is more idiosyncratic than the orthodox theory suggests. Once it is committed to a particular activity it can be described as sunk capital in that it is expensive to shift it from one use to another (see Williamson, 1986 for introduction). This means that the players most likely to affect streaming in Australia are those already engaged in related fields. Without reproducing the whole argument, the players will most likely come from those companies who currently produce critical inputs to streaming or purchase critical outputs or who compete with those that do.[22] Hence, a key part of this analysis is to determine which are the critical inputs and outputs of streaming.

However, it could be objected that market theory says further that because all inputs can be bought by those not in the field from those who are, the list of potential players extends well beyond the incumbents. The counter point is made forcefully by what is known as the theory of transaction costs. That literature argues that, in many cases, it is not economic to buy in from outside according to an anonymous, arm's length relationship. Rather, in some cases it is better to develop closer degrees of organisation and coordination, either by taking over or merging with the input supplier or by some other means such as detailed and long term contractual arrangements (Coase, 1937; et al). This might sound like commonsense but it is a point sometimes lost in discussion of the new technologies.[23] It returns us to the previous point: that the companies with the potential to influence streaming are those which provide critical inputs to or use outputs of streaming.

We can simplify further. On the output side, streaming is generally a consumption good and is not transformed by corporations into other goods or services. This means the general analysis can ignore the output side and focus the analysis on firms which provide key inputs. The influence might be exerted through corporate growth or through partnerships and mergers.

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22 The reason can be understood intuitively. It can also be stated more formally: that there is an interdependence between the assets that would be used for streaming and those that produce the inputs to or make use of the outputs from streaming and this is an interdependence not economically governed by competition. It is also clear that companies which compete with those making inputs or using outputs own assets which are interdependent with streaming. There is the remaining possibility of diversification but there too a relationship will exist between the activities of companies which might become engaged in diversification. Truly diversified growth, where the parties are independent, is very rare. Most often diversification involves an underlying interdependence eg a tyre manufacturer which makes rubber soled shoes or a gas producer which retails electricity, etc.

23 A case in point would be the recent DCITA report which deals with broadband (DCITA, 2001). In considering business models it states that "bandwidth has increasingly come to be regarded as a commodity and is traded like other commodities" (p 49). That is an exaggeration. Access to carriage infrastructure is one of the key transactions for streaming which we believe will rely on partnerships not market relationships.

There are five key groups of inputs to streaming: the infrastructure that carries the data stream; the hard and software needed to receive it; the content that makes it up; the service that makes the content available to users; and, the considerable financial resources required. Our proposition is that the corporate strategies which could affect the up take of streaming will likely involve companies who possess the assets to provide those key inputs.

The following Table 4.3.1 lists the activities in each of the streaming-specific elements, the two infrastructure groups being combined. Financial resources must also be added.

Infrastructure	Content	Service provision
Telcos	Film studios	Internet Service Providers
Cable companies	TV production companies	Carriage service providers
Electricity utilities	FTA broadcasters	
Software producers	Recorded music companies	
Hardware producers (network equipment suppliers, PC manufacturers, etc)	Subscription TV	
	Other online information and entertainment	

Table 4.3.1: Key Inputs to Streaming

In Appendix 2 we identify the major companies that operate in Australia predominantly in each area listed in the table. We find that none has significant operations across the board and so streaming will be influenced, if at all, by the strategies of consortia, mergers or other partnership arrangements among those major companies. As one executive has put it: “Alliances really are the key here: do not try to do it on your own” (Leptos, 2001).

One point needs a little amplification, that of corporate strategies which might slow the spread of streaming. There are some activities which would be threatened if streaming were to become commonplace and the companies involved might play a role in restricting or slowing the take up of streaming, especially if they also play a role by owning some of the key inputs. In this regard, one thinks immediately of the incumbent broadcasters: they hold much of the content, own competing assets and, some at least, have major positions in firms which provide inputs to streaming. Their competing interests need to be reflected in our approach, in the manner indicated below. Another set of competing interest over the longer term are those associated with the new transmission, processing and storage technologies which we have identified as future rivals to streaming, technologies like digital cable TV and broadband connected PC/TVs.

To complete this framework we need to develop it into a form which will aid in making assessments of likelihood. We have adopted a simple scoring system which lists the key criteria and assigns weights to them. The weighting system has been tested informally as a means of assessing different possible consortia and, while we do not reproduce that analysis here, it does seem to rank the possibilities in a sensible manner. Readers might like to run their own tests to assess that proposition.

Table 4.3.2 below summarises our proposed weightings.

Criteria	**Weighting**
Carriage infrastructure	5
User equipment	3
Content	5
Service provision	4
Resources	5

Table 4.3.2: Weighting system for Assessing Corporate Strategies

By way of definition, the *carriage infrastructure* refers to the assets needed to deliver streaming to the user. *User equipment* refers to the hardware and software needed to access the stream of data as described in section 2.4. Streaming *content* is fairly self explanatory. However, it should be noted that, while this overlaps greatly with content on other media, there will likely be a role for some dedicated content.

Service provision is a more generic category, referring to all customer-focussed expertise, although companies would score best if they currently provide services similar to those that would be needed to provide user access to streamed content eg telecommunications carriers, ISPs and ASPs (application service providers), utility companies, etc. The key requirements are those to cache and forward content, deal with uploaded data, monitor use, bill for use, etc.

The *resources* required to accelerate streaming is meant to cover the provision of all critical inputs at a minimum efficient scale and we expect that amount to be substantial. We have not attempted to make an accurate estimate but our rough assessment puts it in the ball park of that amount required to enter the mobile 'phone industry. This would make it in the order of A$700 million to service one-third of the market.[24]

In discussing possible corporate strategies we propose that the higher the score attaching to a company's core activities, the more likely it could lead a successful streaming consortium. This then excludes companies like RealMedia which deals with streaming software and companies who, for example, provide billing and customer services for telecommunications as the weight attached to those inputs are less than 5.

The next proposition is that companies who have nothing other than the resources will not make successful streaming service providers. The resources are a necessary but not sufficient condition for leading a streaming consortium likely to accelerate the process.

This then focuses attention on one of two possibilities: consortia grouped around either a telecommunications (and other related) infrastructure or around a content owner. As to the first, because most of Australia's streaming infrastructure companies are also telecommunications carriers or utility service providers, they have expertise in providing services similar to those needed for commercial streaming. Moreover, these companies are mostly large and well resourced and so would have or could obtain the finances which would be required.

However, on the other hand, such companies are focussed on other core business opportunities (such as telecommunications at home or abroad or dealing with the deregulated national electricity market) and, in any case, they generally lack guaranteed and/or exclusive access to content. There are also other problems with such infrastructure-centred consortia but we will deal firstly with the question of content.

We have already noted that ownership of appropriate content can itself form the basis of a streaming consortium. The key requirement would be to provide a broad range of content. It need not include all content that could be accessed by any other means but it must be rich and richly varied. The content could be owned (such as by Hollywood studios) or created or captured live as with sport. Ownership of such content could provide the basis to develop a successful streaming business but it is not strictly necessary. Instead, a company could specialise in aggregating content and then use control of that content to form an alliance or merger with a company which can

24 To indicate the calculation for DSL delivery:

1. using existing copper wires, 30% of which will need replacing and costing $500 per replacement (=0.3x$500)
2. each user needs 2xDSL modems (=$500)
3. ISP to upgrade switches, etc (=$1m per 10,000 users = $100/user)

Given no need to upgrade the backbone in most areas and given 2.9 million users by 2005, then at $750 per user the total is $2.17 bn or $706 m for each of 3 providers.

provide the infrastructure and related services. Equally, the content aggregator might be an infrastructure owner itself, such as has recently emerged with the Foxtel business in which Telstra is the dominant shareholder. Other midway strategies are possible like a content owner such as a Hollywood studio dealing with a service provider such as a video store chain and the two of them buying access to the infrastructure from a local telecommunications carrier.

In considering such possibilities we can get a hint of what is likely from the experiences in telecommunications and cable TV. In telecommunications, it has proved to be very difficult to obtain access to infrastructure on commercial terms, despite the regulation aimed to support such access. Similarly for cable TV, it has proved to be difficult for content owners to get access to cable networks to the point where it is simpler to sell the rights to content to infrastructure owners. Both cases suggest that the most likely means by which streaming could be advanced is by corporate strategies which involve the infrastructure owner as the content aggregator.

Our view is that this most likely possibility is still unlikely. The reason comes with the inclusion of competing interests. Any streaming consortium involving significant competing interests is unlikely to succeed and all streaming consortia we can think of are of that sort. In the short to medium term, the competing interests come largely from existing media interests such as broadcasters. But, as we have argued, streaming is only a response to existing conditions and, as technology advances, new competing interests will emerge. This longer term competition would frustrate, for example, any infrastructure-centred streaming consortium which also involved cable TV interests. Such a consortium will be more likely to develop its cable TV business than to accelerate streaming, if for no other reasons than that cable is a higher quality, more user friendly, lean back technology. This analysis rules out all of the prospects we consider to be otherwise likely.

Similarly, content owners who are also into broadcasting and cable will be unlikely to advance streaming as a business precisely because it competes with that company's existing and future businesses. The same point arises with developments in PC technologies which will allow content to be downloaded. Companies associated with those advances will own assets which also compete with streaming and they will likely prefer that route to the route of accelerating streaming.

In short, we do not believe that there are compelling corporate strategies which would overturn our assessment of the commercial constraints on offering streaming services as a business venture.

4.4 Conclusions

We now briefly summarise our conclusions.

The fundamental corporate constraint on streaming is the lack of a viable business model. This will slow but not of itself stop the spread of streaming.

However, for streaming to become a commonplace medium, it would need to provide strategic advantages to those companies or those consortia of companies which are able to accelerate it. We find no such advantages. Indeed, we find many strongly competing interests.

All this leads us to suggest that streaming will remain on the edges of mainstream media over the medium term. In the longer term it will be out-competed by the new and better technologies which we have described in section 2. The net result is that we find a lack of a business case and powerful competing interests so that there is no reason to believe that streaming will be accelerated beyond the estimates we have offered in section 3.

The only exceptions we would add to that concern the non-commercial uses of streaming which we have listed above. In addition, uncertainty attaches to our proposition that compelling content will not be made available for streaming. If that proves not to be the case, it is an important indication that this analysis is flawed and we suggest that the ABA maintains a watching brief over this issue.

Section 5: Regulatory Pressure Points

5.1 The Legislative Framework

This section brings together the definitions of relevant matters that come within the scope of the *Broadcasting Services Act 1992* (BSA) with some of the technical concepts which allow for streaming. We develop three diagrams as heuristic devices and apply them to understand the five case studies provided in the research brief.

The BSA regulates three broad types of services that provide media content: broadcasting services, datacasting services and Online services and we deal with each in turn below.

As shown in Diagram 5.1.1, the BSA regulates these services in two distinct ways: by access regulation, which requires that only licensed operators may provide broadcasting or datacasting services; and through content regulation, which specifies *content* requirements and/or limits on content that may be provided.

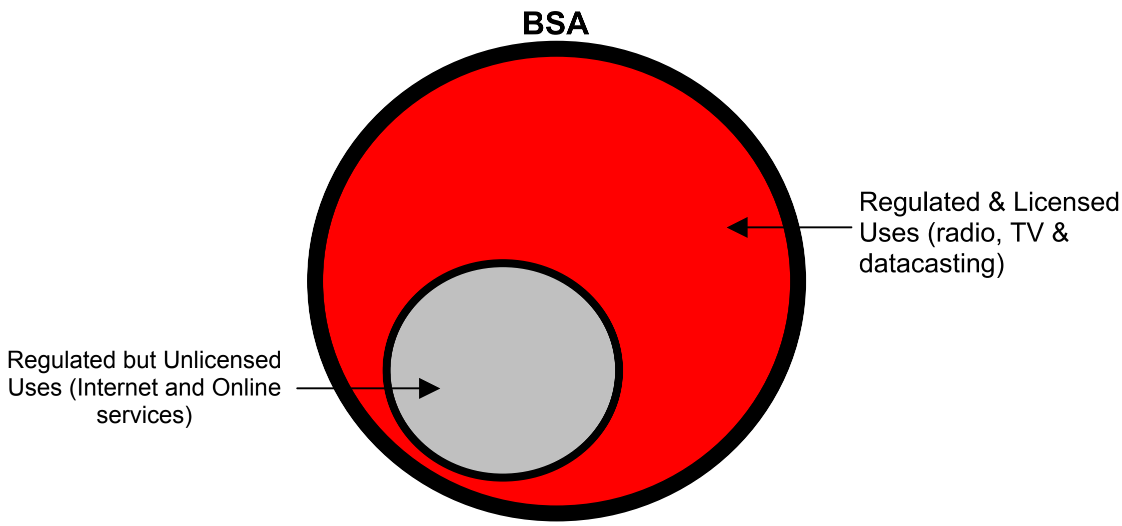

Diagram 5.1.1

We refer to both types of regulation below but are primarily interested in determining which streaming services are within and which are without the large circle of the BSA ie which are regulated and which are not under either method.

Under the BSA a broadcasting service basically delivers television or radio programs. However, and this is important for streaming, broadcasting does not include a service that provides no more than data or text nor services that makes programs available on demand on a point-to-point basis. In addition, the BSA enables the Minister to make determinations about what is or is not a broadcasting service and in September 2000 he did just that by deciding that a service which makes available television programs or radio programs using the Internet is not a broadcasting service.[25]

As we have noted above, from a technical perspective, Internet services are a subset of Online services. However, the BSA appears to use the terms 'Online' and 'Internet' interchangeably.[26] Under the Act, Online/Internet content is defined as information that is *kept on a data storage device* and is accessed, or available for access, using an *Internet carriage service*. Therefore it appears not to cover Online services which do not use an Internet carriage service, such as services using a dedicated, private delivery mechanism. In addition, the BSA explicitly rules out from this definition information that is transmitted in the form of a broadcasting service. Such content might not therefore be covered by broadcasting licence regulations or by Internet content regulation.

The third type of service covered by the BSA are so called datacasting services, defined as services that deliver specific categories of content, known as genres, in any form using the broadcasting services bands (BSBs). The genre restrictions mean that datacasting services are more limited than broadcasting services and require an individual datacasting licence.[27]

This discussion makes clear that there are three areas relevant to streaming but which are not or might not be covered by the BSA. They are:

- Live content accessed by using an Internet carriage service, but not kept on a data storage device;[28]
- Television and radio programs, being in the form of a broadcasting service, if accessed via an Internet carriage service;[29] and
- Any Online content not provided using an Internet carriage service.[30]

We can consolidate our discussion using two more diagrams. We have developed diagram 5.1.2 below to show the relationship of so called broadband technologies to the BSA.

25 The exception is when the Internet content is delivered across the broadcasting services bands. That is important as the discussion of datacasting shows below.
26 For example, while Schedule 5 of the BSA is entitled 'Online services', clause 1 of the Schedule makes clear that it actually regulates 'Internet content'.
27 Schedule 6 of the BSA is currently under review.
28 Part 6 of Schedule 5 allows the ABA to make rules, known as Online provider determinations, applying to Internet service providers and Internet content hosts relating to matters specified in regulations. Although no regulations have been made, it appears that such regulations could enable the ABA to determine that live matter was subject to the Online content regime.
29 This is also relevant to the discussion of datacasting services.
30 An Internet carriage service is defined as a listed carriage service that enables users to access the Internet.

Consider firstly the dark circle which describes the scope of the BSA. This gives the scope of regulation related to services delivered across the broadcasting services bands (BSBs), the upper grey circle, although note that other Acts such as the Radiocommunications Act also have an impact on use of the BSBs. Note also that the BSA covers services delivered by other means, especially by cable (such as cable TV) and DSL (such as Online services) so that the BSB services are a subset of the scope of the BSA.

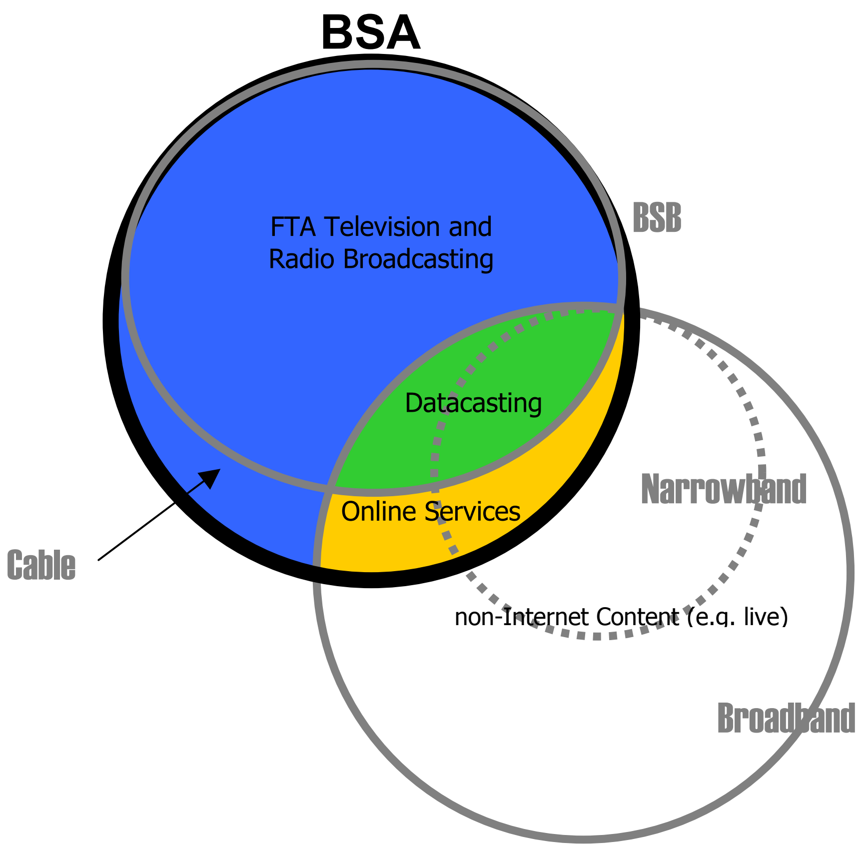

Diagram 5.1.2

Broadband, the lower, large grey circle, is defined as a means of delivering information in digital form at relatively high bit rates.[31,32] In general, streaming services do not use the BSBs (the only potential exception would be if streaming were provided as part of a Datacasting service).[33]

[31] Note that there is no clear dividing line between narrow and broadband but we adopt the range set by the US FCC (200kbs) and the EU (256kbs) as indicating the boundary. This is an amount which, with appropriate compression techniques, allows for FM radio quality audio or good quality but small screen video.

[32] Because everything that can be done with narrowband can also be done with broadband, we have included the latter as a subset of the former in the diagram.

[33] Note that the BSBs can carry the high data rates that fit with the definition of broadband. The point here is to distinguish between what is commonly known as broadcast and what requires broadcasting licences and services that also use high data rates but are not broadcast and do not require a broadcasting licence

A linked definitional matter is that related to Online. As alluded to above, the BSA makes Online and Internet synonymous and, in addition, the Online provisions of the BSA cover only Internet content which is stored on some memory device. This leaves a considerable area of broadband not covered by the Act which we describe on the diagram as non-Internet content ie Online services that are not Datacasting and are not stored content.

The purpose of the third diagram 5.1.3 is primarily to distinguish regulated from non-regulated content. Regulated content includes that covered by the BSA and is shown as the three sets, TV, datacasting and radio and by the Internet services covered by the content provisions of the Act. The scope of other Acts (such as the Classification (Publications, Films and Computer Games) Act) is everything else within the hatched line.

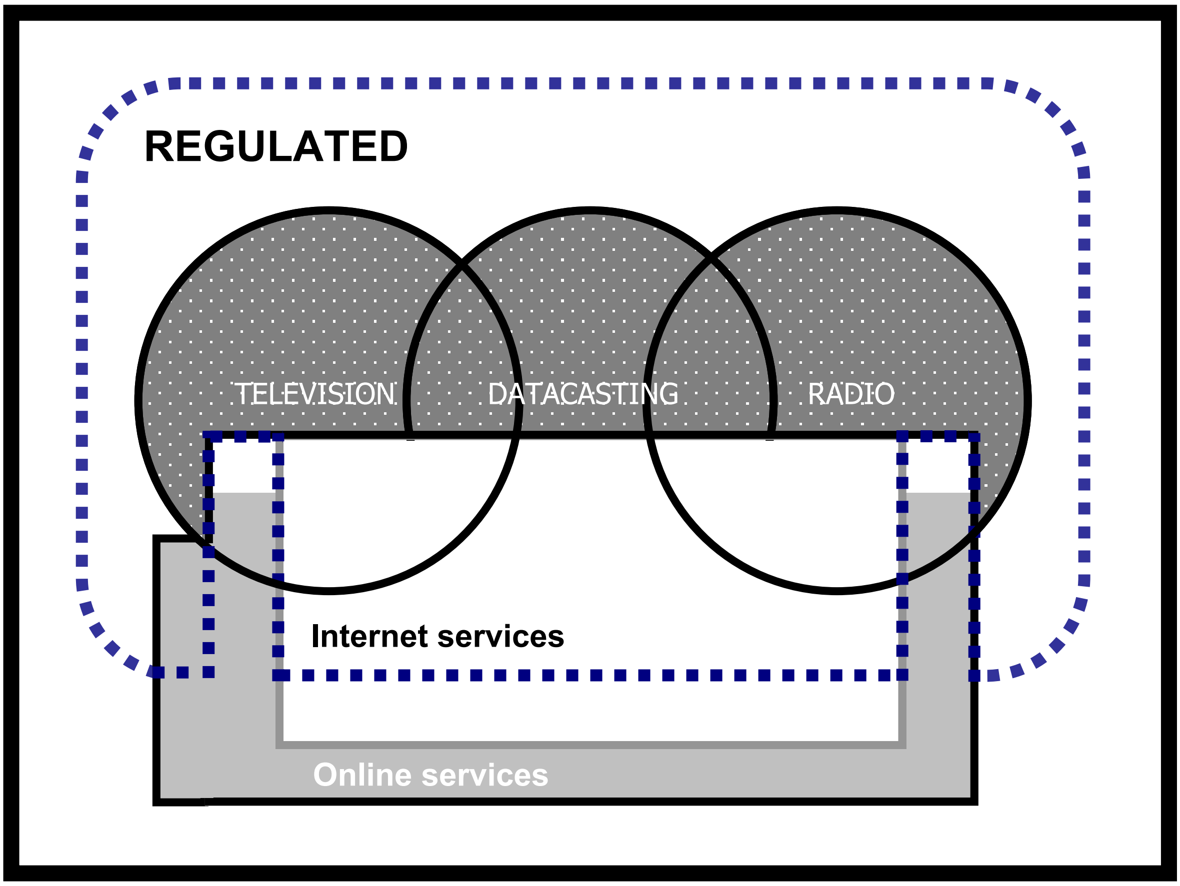

Diagram 5.1.3

To reiterate, all of TV and radio delivered not as part of an Internet service are regulated under the BSA both by licence and content requirements. All Datacasting is also covered similarly. Some Internet content is also covered by the BSA and is shown as being within the hatched line.

However, Online services and content which are not also Internet services and content as defined by the BSA might not be regulated under the Act and so the hatched line has two detours up into the circles describing television and radio. Indeed, when the distinction turns on the question of stored content provided via the Internet (= Internet content under the BSA) and live (= Online but not Internet) it is certain that it is not covered. The same is true when the distinction is based on the fact that some Online services do not require an Internet carriage service. Hence the hatched line's detour also places Online that is not Internet outside the regulatory framework.

Finally, when the content is transmitted in the form of a broadcasting service, the BSA might not apply, although elaboration of this matter is a legal question beyond the abilities of our research team.

This establishes the framework into which the regulation of streaming would fit. However, streaming is just a technology and it can offer a variety of services which need to be fitted within the framework so as to highlight the regulatory pressure points. We do this by expanding on the case studies which were introduced in Section 1.

5.2 The Case Studies

To illustrate the range of services offered, we will reproduce the diagram above and position on it the case studies raised in the brief. Each case study is denoted by a number shown on Diagram 5.2.1.

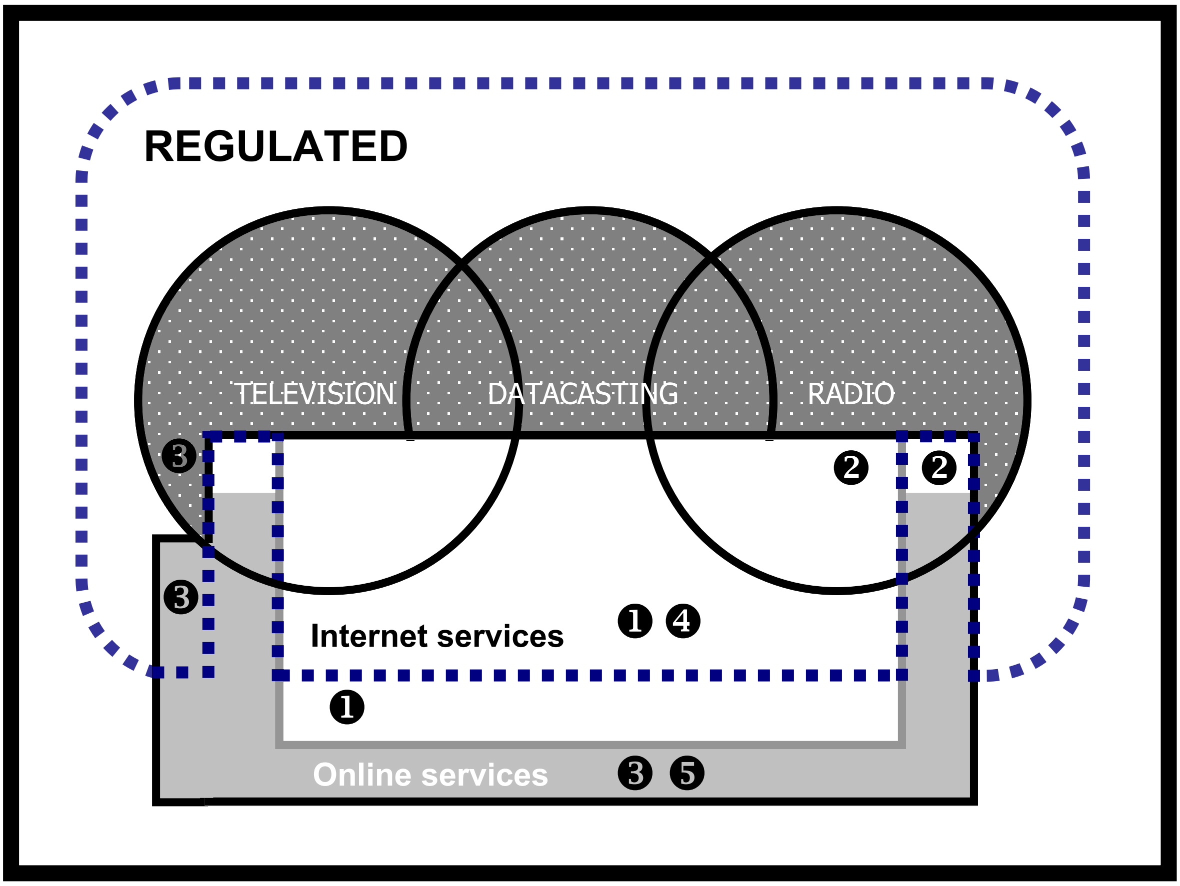

Diagram 5.2.1

1. The first of the case studies, signified by the number '1', is the so-called "webcasting of 'reality' shows" such as the webcast of the "Big Brother" in June 2001. That service falls into the category of Internet ie it is accessible to all via an Internet carriage service and the number '1' is therefore in the white rectangle but, when it is not stored before transmission, the Big Brother offering falls outside the hatched line which describes Internet content covered by regulation, when it is stored content it falls within the hatched line. Hence the number '1' appears twice on the diagram. This raises the regulatory issues associated with live content.

2. The second case study is so called Internet radio such as Thebasement.com.au which we have seen is a popular use of streaming at present. This appears to be covered by the BSA when it is providing access to stored content such as recorded music but not when it sends live content such as live music performances. In addition, because it appears to be transmitted in the form of a broadcasting service, it might also not be covered by the BSA. We therefore show the number '2' twice on the diagram, once inside the hatched line and inside the set of radio and once outside the hatched line but still inside radio. That some of the content at least is unregulated is something of an anomaly because all the content would be covered by the BSA if it were transmitted over the BSBs.

3. As previously discussed, TransACT offers a licensed pay TV service, indicated by the number '3' within the dotted TV circle. It also provides video-on-demand via a streaming technology across a dedicated fibre optic broadband platform. That is Online not Internet content, so is outside the BSA but within the grey not the white section. When it is stored content, it would be covered by the BSA but for the fact that it does not require an Internet carriage service. TransACT also provides live content, such as live TV programs, over their network and that too would not be covered by the BSA for the same reason ie an Internet carriage service is not needed.

This all means that the number '3' appears in the Online section outside the hatched line. The only equivocation we would add concerns the fact that some of TransACT's content could be regulated under the Classification Act. For this reason we have placed a third '3' inside the hatched area and within the Online services section. Finally, it is unclear whether TransACT's service is "in the form of a broadcasting service" or what the implications would be if it were.[34]

4. The fourth case is a virtual walled garden which is stored content accessible to all, on paying some members' entrance fee, via an Internet carriage service ie on a public access medium. As such a virtual walled garden is an Internet service, covered by the BSA. It is positioned on the diagram within the rectangle of Internet content and inside the hatched line as '4'.

5. The final category is that of "exhibitionists and voyeurs with web-cams streaming live" and is the easiest to position. Simply, it is not stored content and it is not accessible to all and so is Online content outside the BSA and shown on Figure 5.2.1 as the number '5'.

To complete this section we will induce some general points from the particular cases considered. They have illustrated that a key regulatory issue facing the ABA with regard to streaming arises when the content is live. When stored content is streamed it is covered, whether it is transmitted across the Internet or via some other Online medium. And, as we have said at a number of points above, it is in transmitting live content that streaming will remain important into the longer term.

The examples also indicate a second point, that streaming can be an appropriate medium for closed user groups to stream live content, either using the Internet of via a dedicated medium. In many cases this will be uncontroversial because the content will not be illicit and, because it will be relatively expensive and probably unprofitable, it will not be transmitted broadly. However, this is the route by which the least desirable live content will be made available and it is here that the greatest regulatory response might be needed.

34 These categorisations of TransACT's service in fact could apply to point-to-point services provided online even if not using streaming technologies

We see two major issues. Firstly, it might be impossible to respond to complaints about live streaming unless a copy of the stream is made. That could be made a requirement of live streaming but the issue is properly beyond the scope of this report. Secondly, we reiterate that one of the great difficulties here will be to separate live, closed group streaming from small number personal communications. Again, we are unable to make any clear recommendation on that matter.

The third and final point is that we are unclear what the BSA means by describing content "transmitted in the form of a broadcasting service" (BSA, Schedule 5, clause 3) as not included in the definition of Internet content. This might be because it is intended that it would then be covered by the licensing and/or content regulations relating to broadcasting. Equally, it might simply be an anomaly that leaves a gap in the coverage of the BSA.

5.3 Streaming, Broadband and Broadcasting

This final section places streaming within the larger framework of developments in other media technologies and their relation to traditional broadcasting.

Firstly, streaming, like some other technologies, provides the potential for accessing media on demand. By providing choice to users, streaming might be seen as inherently superior to and, ultimately, a substitute for broadcast. We are not of that view. Making choices takes time and there are positive recreational values in being unaware of and unable to choose what comes next. In addition, broadcasting is a communal act and so, for content such as official notices or during times of significant change or crisis, broadcasting will be preferred to media on demand.

Secondly, streaming is unlikely to be the preferred medium for content on demand; digital cable delivery and downloads across broadband to PCs with greater memories than today are more attractive and therefore are likely to be more widespread alternatives. Not only does cable TV and radio have content agreements in place but some of these alternative media also allow for interactivity which is attractive to users and to advertisers. Streaming will be a poor cousin to these new digital formats. In addition, cable TV will likely come bundled with other Online services and telephone. As a competing technology, streaming will not have a compelling rationale for consumers but might find a role as part of a bundle of offerings.

This is to say that, as a mass medium, streaming is a transitory and limited technology. Streaming techniques will always be required to deal with variability in and limits to transmission rates and will continue to be useful as a means of accessing live content where the jitter problem will remain. But streaming will not be the preferred means of accessing stored content and its high point as a service will be soon, brought on by the digitalisation of TV and radio broadcasting and by the spread of broadband and the next generations of PCs.

The only rider we would place on that has been raised above: streaming might be the technology of choice for small closed user groups with a special or a promotional purpose. Special interest users will pay the high prices involved to get access to the content they find compelling. Special purpose providers will pay the high cost to get promotional and other messages across to their clients and colleagues.

Finally, we would suggest that there are some critical issues over which the ABA could keep watch. Much of what we have predicted about the future role of streaming is predicated on the accelerating spread of broadband and a concomitant development of technologies and capabilities which will compete with streaming. The ABA might consider maintaining a watching brief over those development as, in our view, they will be critical in determining when the regulatory pressure points will emerge and how significant they will be.

In this regard the ABA might consider further research into the spread of broadband in Australia and particularly the role, if any, for the Commonwealth in promoting the roll out and up take.

The ABA might also request changes and extensions to current monitoring activities undertaken by other agencies such as the ABS. The key matters for which more detailed monitoring would be useful include:

- Additional ABS survey questions regarding new broadband connections: how many, what kind?
- A clearer, more consistent differentiation of broadband from narrowband
- Additional questions on the use of broadband connections, at home and at work
- New questions related specifically to streaming: frequency, length of sessions, etc
- Monitoring the age (and therefore storage capacity) of the stock of personal computers

Once time series have been developed for each of these items, the picture regarding streaming and broadband will become clearer, allowing the predictions we have made to be tested and refined.

Appendix 1 – Packet versus Circuit Networks

In the conventional broadcasting paradigm, content is delivered on the basis of one-to-any through a radio frequency or cable channel from a single transmission point to any user who chooses to watch or listen to a particular channel. Pay-TV changes this approach in a relatively trivial way, by making broadcasting channels selectively available by subscription or per-event payment. Technologically, this requires little more than enabling customer premises equipment to decode an encrypted premium signal. The user's choice of content is largely limited to the choice of channel.

Streaming services, on the other hand, come from a background of point-to-point telecommunications connectivity. In this context, there are two models – circuit and packet-switched networks. The first is a construct from telephony, the second comes from the networking of computers and has evolved into today's Internet.

Consider what happens when two people wish to speak by telephone. If they are the only two telephone owners, then it makes sense to simply provide a circuit between them, a dedicated resource by which one can call the other at any time. Introducing one or two more telephone users introduces some complexity for any-to-any connectivity, but this is manageable, as shown in figure A1.1. Adding a significant number of telephone users, however, quickly becomes unviable.

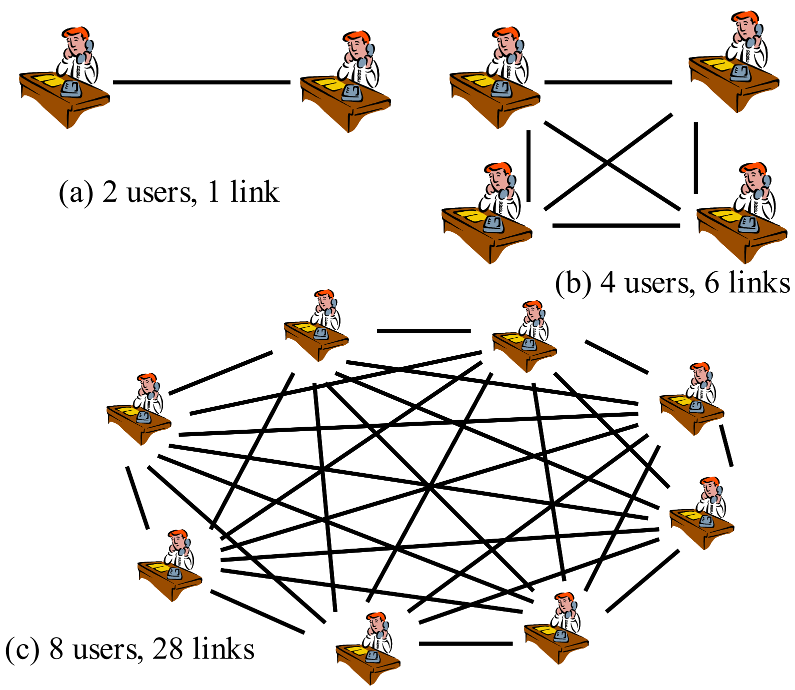

Figure A1.1
(a) One-to-one connectivity can be managed by a single cable.
(b) Adding one or two more users is more complex but manageable.
(c) The number of links required increases as the square of the number of telephones. This quickly becomes unviable.

A more manageable and viable solution is to aggregate the links from different users to a central point which can connect a circuit from one user to another as required. This connection, or switching, is the basis of today's local telephone exchange which only requires one link for each user.

As the telephone network increases in connectivity, more local telephone exchanges are needed. These exchanges are connected through an aggregated link known as a trunk, which can carry a certain amount of simultaneous phone calls between exchanges. Importantly, the capacity of the trunk, that is the number of simultaneous phone calls which can be switched from one exchange to another, is much less than the number of telephones at each exchange. This is in recognition of the fact that most users make a small number of short calls and that the trunk resource can be reallocated as needed. Most of the time there will be trunk capacity available for another call, although statistically it is possible that all trunk lines will be busy and a new telephone call will be blocked. A telephone network is typically dimensioned to provide connectivity 98% of the time during the busiest part of the day, following the trunk dimensioning theory developed by Agner Erlang in the early part of the twentieth century.

It should be apparent that once exchanges can be linked together, it is possible to create a circuit-switched network hierarchy, aggregating trunked telephone circuits into larger trunks across state or national borders or between cities. Figure A1.2 illustrates the hierarchical trunking concept

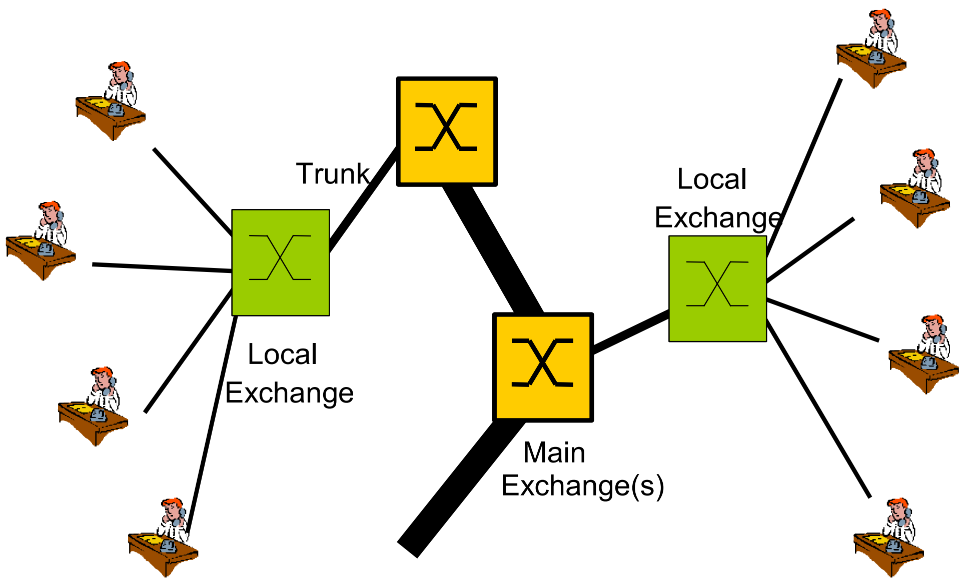

Figure A1.2 – the hierarchical trunking of the telephone circuit-switched network.

The circuit-switched model allocates resources for exclusive end-to-end connectivity for the duration of a telephone call. This has three implications:

1. The telephone exchanges only need to be told to allocate resources at the beginning of the call, and to release them at the end. Such signalling is therefore only important at the beginning and end of the call.
2. The resources are allocated exclusively and therefore there will be no interference from other users. If we used circuit-switched connectivity for data, this means that data could be sent without jitter and with minimal latency. To put this another way, Quality of Service is easily assured and, ceteris paribus, would be a good approach to stream video, especially if we consider that a telephone conversation could be thought of as a special case of bi-directional low latency audio streaming.
3. If a circuit resource is allocated but idle then network resources are essentially being wasted. For example, a voice telephone call typically only uses 30% of the capacity of the telephone circuit, taking into account that only one user talks at a time and the significant periods of silence in human speech.

When it comes to data services, however, a different approach is taken, primarily to make more efficient use of network resources recognising that computers tend to stay connected to a network but spend most of the time idle. This leads to the concept of packet switching which is based on the early days of networked computing when communications between computers were very short, consisting for example of a line of text at a time.

In the packet-switching paradigm, a similar hierarchical structure of trunked networks can be built. In this case, however, all computers are continuously connected to a packet switch, known as a router. Whenever a computer needs to send data, it forms the bits into a packet with a destination address and puts that packet onto the network. If the data is large it is broken into a sequence of packets which are all individually labelled and addressed. The routers then take each packet in turn, refer to the destination address and forward the packet to an adjacent router, which continues until the packet reaches its destination. Note that there is considerable redundancy in the packet network and that there are multiple paths to choose from.

This model has a number of implications. First, all computers are permanently connected and can both access and be accessed by other computers on the network at any time without the need to explicitly set up a circuit each time. Secondly, the use of network resources is more efficient, as network capacity need not be allocated to an idle circuit.

The question which arises is what happens when a network gets busy. Certain links between routers can become congested (and may also fail) and when this happens a router will redirect traffic through another path. This means that packets may not, and indeed probably will not, arrive at the same intervals at which they were sent; packets may arrive in a different order and indeed packets may be lost altogether.

For low data rate applications, especially the text applications of the 1960s, this was not a major issue and simply required a mechanism to reorder packets and to ask for copies of missing packets to be re-sent. For the multimedia-rich streaming applications in which we are interested, however, it is a different matter, as streaming requires, ideally, a constant and high-speed data rate. There is no time, for example, to ask for copies of missing or delayed data and so a reasonable period of time must be allocated by the receiver to receive packets to reassemble for presentation. This is, of course, one of the functions of the buffer which we have described in this report.

The packet system just described is referred to as a best-efforts service. The emphasis is on ensuring the delivery of data but with no guarantees as to timeliness. Some efforts have been made to improve the timeliness of packet data networks, these were described in Section 2 and tend to work on the basis of preferred packet scheduling, pre-allocation of network paths or the allocation of specific network resources. While these techniques can improve timely performance they nevertheless cannot guarantee the constant data rates demanded of streaming services.

The packet and circuit-switched worlds collide, of course, when it comes to connection of computers to the Internet by dialling into an ISP. In this case, the end computer is circuit-switched into a point of interconnect (the ISP) to the Internet. With the exception of streaming, most data services are well suited to the packet nature of the Internet – web browsing and e-mail for example, meaning that these applications are handled efficiently by the packet network but the “last mile” – the dial-up connection of the end user, is wasteful of network resources. A further complication is that Internet usage tends to encourage long connection times rather than short telephone calls, and as a consequence the assumptions behind trunking theory for telephony networks begin to break down. Streaming would be well-suited to the circuit connectivity of such a system except that the data rates of the telephone connection are narrowband, 64 kbit/s or less, and so the quality of streaming is impaired.

Two further matters should be mentioned. The first is that packet networks, exemplified by the Internet using the Internet Protocol, are designed to deliver data through a congested network and even through a damaged network. While it is possible to provide so much network capacity that congestion will never occur, the commercial reality is that network capacity will be supplied only to meet anticipated demand and that we should therefore expect that congestion is a fundamental characteristic of packet networks.

The second point is one of point-to-multipoint connectivity. In the circuit-switched domain, it should be clear that this is little more than linking multiple parties to a circuit, easily handled at the telephone exchange. In the packet network, "multi-casting" may be considered in two ways. The easiest solution is to transmit multiple copies of the same data, each to different destination addresses. This quickly leads to congestion and does not exploit the efficiencies to be gained from recognising that the same data is being repeatedly put onto the network. The other technique is to carry multi-address packets which are then carried and split as needed to reach the various destinations. While this technique makes more efficient use of network resources it is also much harder to manage and is an on-going research area. It is, however, applicable within a closed network environment of manageable size.

Appendix 2: Identities and links among existing corporations

This appendix lists the companies presently engaged in the activities which hold the keys to Australian streaming. They are all producers of the critical inputs to streaming described in Table 5.1 above. We also describe the major links that exist among them.

Most of this material is sourced from PC, 2000 and ACA 2002.

Infrastructure Providers	
Telcommunication companies	Telstra (50.1% government owned) Optus (Singtel: majority positions in Optus TV; minority positions in Content Co P/L)
Cable companies	TransACT Uecomm Nava-1 Network NextGen (Leighton Group) Australian Fibre Network AAPT (Telecom NZ) Powertel
Software producers	Real Player Microsoft
Hardware producers	IBM Apple/QuickTime
Electricity utilities	ACTEW Budde consortium
Content companies	
Film studios/distributors	Hoyts Fox Studios MGM
TV production houses	Prime Television
FTA broadcasters, television	Network Ten (CanWest Group: minority positions in Southern Cross Broadcasting, Telecasters Australia) Nine Network (PBL) Seven Network (Executive shareholders Ivan Deveson and Bob Campbell: majority positions in Colonial Stadium, Ticketmaster; minority positions in Skynews plus some content provision to Austar and Optus) Austar (minority positions in XYZ Entertainment, Content Company P/L, Weather Channel) ABC and SBS (includes SBS joint venture with Pan TV for World Movie Channel) WIN Television (TWT Holdings) Prime Network
FTA broadcasters, radio	Austereo Australian Radio Network

	Broadcast Operations Broadcasting Investment Holdings Southern Cross Broadcasting (Ten Network) ABC
Subscription TV	Foxtel (Telstra (50%); News (25%), PBL(25%) through SkyCable) Optus Television (SingTel) Australis Media Austar (News (74%)) East Coast
Recorded music companies	Festival records (News) Mushroom Records (News)
Newspaper and other media	Publishing and Broadcasting Limited (PBL, controlled by the Packer Family: minority positions in Fox Sports, ninemsn, Skynews, Media Entertainment Group) News Corporation (controlled by the Murdoch family): majority positions in Fox Sports, Fox Entertainment, Superleague; minority positions in AAP Information Services; Harper Collins and Skynews) Fairfax (controlled by the Fairfax family; newspapers plus minority positions in AAP Information Services, Strategic Publishing Group) APN News and Media (majority owner of Pan TV, Australian Radio Network P/L)
Online information and entertainment	F2 (Fairfax) C7 (Seven Network) Pacific Access (Telstra)
ISPs, CSPs	BigPond (Telstra; has content alliance with ninemsn) Ninemsn (50% PBL via ecorp and 50% Microsoft) OzEmail (UUNet) HotKey (Primus) Chariot Internet

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Glossary of terms

Bandwidth A term often used imprecisely. It means the range of frequencies that an electronic signal occupies. For a given delivery technology this range is a prime determinant of how fast data flows and the term is generally misused in this way to mean simply the rate of data throughput.

Broadband Refers to various delivery technologies (the Internet over phone lines, cable, satellite, mobiles) which can supply large amounts of information at fast rates. Broadband connections are always on ie there is no need to connect to a service provider to begin accessing information (cf narrowband below).

Broadcasting To send in all directions at the same time. A radio or television broadcast using the broadcasting services bands is content that is transmitted over airwaves for public reception by anyone with a receiver tuned to the right frequency.

Buffer A space for temporary storage of transmitted information that allows for collection and sorting. This enables the transmission to be presented in the correct order and at the correct speed as is required to view life-like video which has been stored remotely. The buffer is not a permanent store of the full transmission but continues to fill and empty until the entire file is viewed.

Bundling The combination of different services provided by a single means of delivery. For example, the provision of streamed media, Internet, telephony and/or broadcasting services, through a broadband or narrowband connection.

Compression Techniques to reduce the size of data files in order to save transmission or storage resources.

Convergence The idea that digitalisation will allow broadcast-like content to be accessed via the technologies used for communication. An example is the Internet providing a means of converging telephony and broadcasting.

DSL Digital Subscriber Lines. A technique which, through hardware, digitalises and then compresses data, allowing it to be sent over the existing telephony network at broadband rates. ADSL is asymmetric; ie. the downlink to the user is of a greater speed than the uplink from the user.

Fibre Optic A cable technology providing very high data rates using the passage of light rather than electrical signals. Used as the backbone for the public switched telephone network.

HFC Hybrid Fibre Coaxial cable. The ‘cable’ in cable TV.

Interactivity The ability of end-users to transmit information, usually via an Internet connection, as well as receiving it (via the Internet, cable, radiofrequency broadcasting, etc). Digital media (including set-top boxes and PCs) provide means for delivering interactive services to the user.

Internet A global collection of linked computers (networks) using common addressing rules to receive and deliver packets of information to each other, according to the Internet Protocols. Contrasts with the legacy circuit switching technology (see Appendix 1) and with private Online networks.

Multicasting A point-to-multipoint relationship achieved by sending a single message to several addresses.

Narrowband Various technologies which supply data at rates much lower than broadband and requiring prior connection to a service provider. Includes Internet services via the telephone system, typically at rates up to 56kbps.

Online Online is the condition of being connected to a network of computers or other devices. The term is frequently used to describe someone who is currently connected to the Internet but may also refer to someone accessing a private network of computers.

Server In general, a server is a computer program that provides services to other computer programs in the same or other computers.

Streaming A technique for transferring data such that it can be processed as a steady and continuous stream. With streaming, the file can start to be displayed or heard before the entire file has been transmitted.

VoD, NVoD Video-on-demand and near-video-on-demand. True VoD, allows customers to choose content and to specify the time of viewing with full video capability. NVoD, allows access to programming from a range of channels at varying times. NVoD is multicast and thus similar to Pay TV services.

Walled Gardens Private Internet-like networks in which clients can access premium broadband services, including streamed media. Users usually pay subscription fees and additional pay-per-view charges.

Web Server All web pages are stored on web servers of which there are every many throughout the world. When a user requests a web page, that page's address connects the user to the appropriate web server.