Australian Government
Australian Communications and Media Authority

Australia's regulator for broadcasting, the internet, radiocommunications and telecommunications www.acma.gov.au

Understanding your Internet Quality of Service 2004–05

A report on the data rates and reliability of internet connections in Australia

Australian Communications and Media Authority
February 2006

Published by the Australian Communications and Media Authority
PO Box 13112
Law Courts, Melbourne, VIC, 8010

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Introduction

About this report

This report is intended to provide some insights into the performance Australian consumers' are experiencing in using their internet service.

The growth in the use of broadband services has led to consumers, policy makers and regulators, both in Australia and internationally, becoming increasingly interested in matters such as service availability; service quality and reliability; adequate and equitable bandwidth access; investment in access technologies; the range of service plans; and value for money. Indeed, the Australian government has specifically addressed a number of these issues through its National Broadband Strategy, which provides a policy framework for broadband development agreed by all levels of Australian government, and considerable funding support.

Given this, and because there was very little publicly available information about such matters at the time, the former Australian Communications Authority (ACA) decided last year to undertake some preliminary research in this area. This led to the publication of a report entitled 2003–04 *Understanding Your Broadband Quality of Service* report about aspects of internet service performance in Australia. This 2004–2005 report is a follow-up.

This 2004–2005 report has several improvements over the last year's report. That said, it must be noted at the outset that it continues to have some important limitations flowing principally from the sample size in some areas and, more importantly, the sampling methodology—which essentially relied on self-selection. While ACMA considers that the report contains several interesting insights and warrants publication as a contribution to public discussion, caution needs to be exercised in drawing any overly strong conclusions, or using its findings as the sole basis for public policy interventions.

ACMA will be considering whether the methodology can be further developed if a future publication along these lines is continued into next year. While there are no formal regulatory requirements that oblige ACMA to collect quality of service information from suppliers of broadband services, this is a matter of growing interest and ACMA is considering what is the most appropriate strategy for monitoring this area.

The importance of the internet

Increasing numbers of Australians are now spending more time using the internet and are demanding higher bandwidth access for a range of applications and services. As Australians become more reliant on the internet for work, commerce and leisure, the quality and reliability of internet services is becoming more important. This trend is demonstrated by the following data:

- The number of non-dial up internet connections in Australia grew from 861,000 to 1.8 million between March 2004 and March 2005 (ABS, *Internet Activity Survey*, at www.abs.gov.au). According to the ACCC (*Snapshot of Broadband Deployment Report*) broadband users grew to 2.18 million by 30 June 2005, up from 1.048 million at 30 June 2004.

- Broadband data volumes downloaded increased by 230 per cent in the 12 months to 31 March 2005 (ACMA *Telecommunications Performance Report 2004–05*).
- Eighty-five per cent of broadband households sampled and 65 per cent of dial-up households sampled accessed the internet daily, according to the results of the December 2004 Australian Online Survey by AC Nielsen Consult (*Sizing up the residential ISP market in Australia, Second Half 2004*).
- According to the AC Nielsen survey, 91 per cent of the sampled households that were using the internet find it important in their daily lives—compared to 64 per cent for television and 58 per cent for radio for the same households.

Results from the AC Nielsen Consult Survey suggest that overall satisfaction with internet services is high. Of the 25,117 survey respondents, 85 per cent were either 'satisfied' or 'extremely satisfied' with the services they received from their internet service provider (ISP), with broadband users expressing slightly higher satisfaction than dial-up users.

The survey showed that, for domestic broadband users, network reliability was the most important performance consideration and value for money the second most important consideration. Download data rate was also found to be a key consideration.

While satisfaction with internet services appears high, complaints to the Telecommunications Industry Ombudsman (TIO) about internet services increased significantly during 2004–05. Complaints about drop-out, log-on difficulties, outages and data rates, together with service connection, increased by 54 per cent from 10,388 in 2003–04 to 16,012 in 2004–05. While this is significant, it should be put in the context that broadband subscribers grew by 108 per cent over the same period.

Factors affecting internet service performance

Internationally, Internet access is widely regarded as a "best endeavours" service, given the inherent variability of its service provision. ACMA has sampled and examined data rates and other measures of quality of service to obtain a snapshot of services levels that are actually achieved by customers.

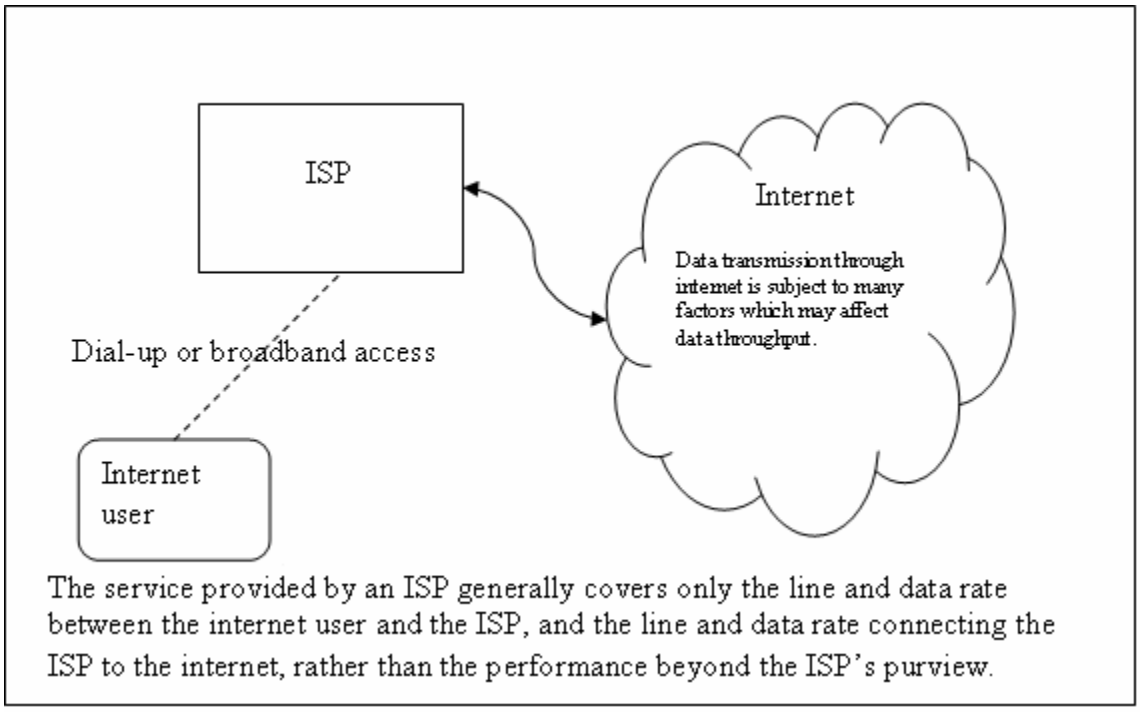
Internet performance and data rates received by customers vary depending on a range of factors. Data rates advertised by ISPs have traditionally been the nominal maximum data rate that is achievable under particular access plans[1]. The service provided by an ISP generally covers the line and data rate between the internet user and the ISP, and the line and data rate connecting the ISP to the internet, rather than the performance beyond the ISP's purview (see Figure 1).

Even for a service under an ISP's management, the advertised data rate is often not achieved and the access plan only indicates the maximum achievable or 'capped' data rate. As such, internet access plans are often advertised with the words 'achieve data rates of up to' 256 kbit/s, for example. Variable performance factors may arise from the customer, the ISP or from general internet architecture and include:

[1] ISPs artificially cap data rates for commercial product differentiation of access plans.

- the customer's PC, modem and software being of minimum specifications to support internet applications and being well configured and not infected by viruses, malware or spyware;
- the application of content used by the consumer (for example, email, music or video);
- the protocols used by internet applications (used for link management[2]), which utilise part of the internet connection data transmission capacity;
- capacity on shared domestic and international internet resources;
- capacity of ISP-provided resources such as backhaul and internet servers—lower ISP resourcing may be a legitimate business model based on intentional price-quality trade-offs for product differentiation, but may also be due to under-resourcing of service capacity or backhaul dimensions;
- the popularity and capacity of content providers' web resources; and
- 'packetisation' of information, which means that there are no dedicated data circuits and therefore variable rates at which data is transferred.

Figure 1: ISP controlled infrastructure



Information about internet technology types and some factors that affect internet performance is on the ACMA website at www.acma.gov.au and go to Internet > Internet quality of service.

[2] 'Packetisation' of data makes it necessary for packets to contain information extraneous to the payload so that the requested data is sent efficiently to the right destination. Packets generally consist of a header, payload, and footer.

Key findings

The findings in this report are subject to the main caveats noted previously. That said, they indicate that internet performance across different technologies, regions and access plans as measured by six key parameters (see below) show results that are generally consistent with the inherent variability and technical limitations of internet technology.

The speed with which users are able to download data is a key performance consideration and the study found that DSL and dial-up (which serve the majority of private Australian internet users) operated at an average of around 83 per cent and 74 per cent of advertised plan or modem rates respectively.[3]

In regional areas, DSL users generally experienced data rates consistent with major cities. This study suggests some regional performance variation in data rates for dial-up and ISDN access technologies; but, the sample sizes for regional areas in many instances are too small to draw reliable conclusions and these conclusions should be considered as illustrative only.

Internet service availability was found to be very high at 99.85 per cent or more across all technologies. This measures the probability of accessing a subscribed internet service.

DNS lookup times and latency were analysed this year for the first time and were found to be generally fast enough for the impact on most Australian internet users to be indiscernible.

What did the study measure?

To assist in providing some insights into aspects of the performance consumers are experiencing in using their internet service, ACMA focused its preliminary monitoring on the following six measures:

1. download data rates on a major city and regional basis;
2. upload data rates on a major city and regional basis;
3. data rate variation by time of day;
4. internet service availability;
5. domain name server (DNS) lookup times; and
6. latency.

How was the study conducted?

The report draws on test results for 2004–05 from 13,561 residential and small business users across Australia who supported 1,317,536 download tests. This is an increase on the 6,894 internet users sampled for the 2003–04 study. The tests measured the actual data rates and internet performance received by internet users. The study of these internet connections was conducted for ACMA by Telco One Pty Ltd using data from the TCP/IQ Line Speed Meter (LSM) from the period 1 July 2004 to 30 June 2005.

[3] There is no actual advertised data rate for dial-up internet access. Data rates are limited by the customers' modem maximum speed which is normally 56 kbit/s.

The study aimed to provide an insight into the type of performance internet users are receiving with reference to particular types of internet access plans (see Factors Affecting Internet Performance above). It should be noted that the data collected for this study is derived from a sample of internet users that have self-selected and such data is therefore not randomly generated (see Study Method in Appendix A). Data samples are also limited for some regional areas making it difficult to draw reliable conclusions in some instances. These instances are highlighted throughout the report. Readers should use caution when drawing inferences about the applicability of findings to Australian internet users more generally.

While the study records data rates received by customers it does not compare results against any pre-determined benchmarks of acceptable performance. However, it does provide customers with a useful mechanism to check the actual performance of their internet connection in different parts of Australia. The LSM is a free tool that can be downloaded from an internet website. It measures the performance over time of the connection between the customer's operating system and the internet. Customers can check connection performance or average performance across internet service providers (ISPs) and geographic regions (see Study Method in Appendix A).]

Can the results of this study be compared with last year's results?

The 2004–05 study, like its predecessor, investigates download and upload data rates as well as internet service availability. The sample size of the 2004–05 study, however, was larger with an additional 6,667 users sampled compared with the previous year. Care should be taken in comparing some aspects of this study with last year's study as follows:

- for download and upload data rates, different data filtering methods were used; and
- examination of data rate variation by time of day and domain name server (DNS) lookup time was not included in the 2003–04 study.

However, internet service availability results from this study can be compared with results from the 2003–04 study as the same study method was used.

The 2003–04 report is on the ACMA website at www.acma.gov.au and go to Internet > Internet quality of service.

Findings

Average download data rates

In this study, 'data rate' is taken to mean the speed achieved in transferring requested data from one point on a network to another.

Advertised data rates for internet services are used to enable customers to compare access plans and service offerings. There may be a difference between the advertised data rate of an internet access plan and the actual download and upload data rates experienced by customers.

The LSM records the customer's experience of downloading and uploading using the internet. It records the time taken to download a set of files selected randomly from a list of popular websites. Upload tests are conducted using similar standard file selection.

Key observations for download data rates are as follows:

- Digital subscriber line (DSL) connections, which are by far the most popular and fastest growing broadband internet access technology, performed consistently across three typical DSL access plans available in the market —generally at around 83 per cent of the advertised download data rate, with a low level of variability.
- Uncapped cable access plans[4] delivered high data rates (an average of more than 3,000 kilobits per second (kbit/s) for download and more than 180 kbit/s for upload), but data rates were highly variable. As in 2003–04, the variability for cable (variability ratio of 40%) exceeded that for DSL (variability ratio of 6%).[5]
- Integrated services digital network (ISDN) services displayed an average data rate of 82 per cent of the advertised (maximum) data rate, with moderate variability. ISDN services were less variable than cable, but more variable than DSL.
- Wireless broadband services displayed highly variable download data rates with an average of 62 per cent of the advertised download rate. However, this is not unexpected given the additional number of external factors affecting wireless performance such as variable radio conditions and interference.
- Dial-up services displayed download data rates averaging 74 per cent of the maximum modem rate.

Table 1 shows the average download data rates in 2004–05 for a range of access plan types. Each user's average data rate over the financial year was calculated, with the average of these results provided in column 3. Ideally, customers want their internet service to deliver high data rates (column 4) with low variability (columns 5 and 6). Column 7 to 9 show the number of users, tests, and ISPs for each technology.

[4] Download data rates are generally not specified for cable access plans. The term 'uncapped' refers to the data rate potential of cable not being artificially constrained by the ISP. Uncapped does not refer to download limits.

[5] Variability ratio = standard deviation /average download data rate. See Table 1.

Table 1: Average download data rates across Australia in 2004–05

1. Technology	2. Access plan—download/ upload (kbit/s) as advertised	3. Average download data rate (kbit/s)	4. Percentage of advertised data rate (%)	5. Standard deviation* from average data rate (kbit/s)	6. Variability ratio (%)**	7. Users	8. Tests	9. ISPs in sample
Cable	Uncapped	3,136	NA	1,257	40%	2,856	361,755	3
DSL	1500/256	1,191	79%	84	7%	4,031	427,827	54
DSL	512/128	423	83%	22	5%	3,319	293,304	70
DSL	256/64	215	84%	11	5%	1,409	89,801	54
ISDN	128/128	105	82%	22	21%	60	1,998	2
Dial-up	56/56	41	74%	11	26%	223	4,657	NA***
Wireless****	512/128	319	62%	142	44%	123	25,047	4

* The standard deviation is a statistical measure of the dispersion or spread of a sample around the average.

** Variability ratio = standard deviation (column 5)/average download data rate (column 3)

*** The number of ISPs for dial-up access is not available because this information was not collected during the LSM tests.

**** Includes iBurst and Navini technologies

NA: not available

Note: the results for satellite technology are not presented because the results are not considered reliable.

Average upload data rates

Uploading is the process of sending data from one computer to another on a network, for example, when you send an email or allow other internet users to retrieve files from your computer. Upload data rates are important to those who regularly update web pages.

Factors that affect download data rates, such as network bandwidth and simultaneous user traffic, also affect upload data rates. There are fewer test results for upload data rates because the LSM testing process for upload is more susceptible to failure because of proxy servers, firewalls and anti-virus software.

For all technologies, the percentage of advertised data rates ranged from 68 per cent for ISDN to 95 per cent for wireless. The three DSL access plans averaged 87 per cent of advertised data rates. The results for dial-up are considered unreliable and have been excluded.

Table 2 shows the average upload data rates in 2004–05 for each access plan type.

Table 2: Average upload data rates across Australia in 2004–05

1. Technology	2. Access plan—download/ upload (kbit/s) as advertised	3. Average upload data rate (kbit/s)	4. Percentage of advertised data rate (%)	5. Standard deviation* from average data rate (kbit/s)	6. Variability ratio (%)**	7. Users	8. Tests	9. ISPs in sample
Cable	Uncapped	189	NA	145	77%	430	63,855	2
DSL	1500/256	217	85%	15	7%	3,565	318,229	53
DSL	512/128	113	88%	8	7%	2,848	221,887	67
DSL	256/64	57	89%	4	6%	1,184	71,918	51
ISDN	128/128	87	68%	20	23%	57	1,395	2
Wireless***	512/128	121	95%	49	40%	112	19,560	4

* The standard deviation is a statistical measure of the dispersion or spread of a sample around the average.

** Variability ratio = standard deviation (column 5)/average download data rate (column 3)

*** Includes iBurst and Navini technologies

NA: not available

Note: the results for dial-up and satellite technology are not presented because the results are not considered reliable.

Regional variation in data rates

The performance of internet services in different regions is a key consideration for government and for regional users. This section reviews regional variation and performance trends in average data downloads and uploads across Australia.

Regional results are presented by 'Remoteness Area', an Australian Bureau of Statistics measure that identifies regions by their degree of remoteness, with the following classifications:

- major city;
- inner regional;
- outer regional;
- remote; and
- very remote.

The analysis of internet performance at the Remoteness Area level is restricted because sample sizes tended to decrease in line with the degree of remoteness. The results should be viewed in this context. Major cities with much higher population densities have a greater number of LSM users and findings are considered more robust than those for more remote areas.

Key download findings include the following:

- DSL download data rates varied little between geographic areas, with performance in regional areas generally consistent with major Australian cities, noting again there was limited data for remote areas.
- The most densely populated areas on the eastern seaboard of Australia achieved average DSL download rates of more than 80 per cent of advertised data rates.
- Average cable download rates were generally consistent across major cities and inner regional areas, although results are inconclusive due to small sample size.
- ISDN showed greater variation across major cities than DSL, although results should be considered as illustrative only.

Key upload findings include the following:

- Average upload rates for the three DSL access plans were generally consistent and exhibited little regional variability, ranging from around 80 to 90 per cent of the advertised rate.
- Average upload rates for uncapped cable access plans were consistent across major cities, with the exception of those in Queensland, where results were slightly lower.
- Cable, ISDN and dial-up showed some regional variation in upload rates compared with DSL, although there was no consistent pattern to this variation.

Table 3 shows average download data rates by geographic Remoteness Area while Table 4 outlines average upload data rates by Remoteness Area.

Table 3: Average download data rates by Remoteness Area*

State	Classification	Data rate	Percentage of advertised data rates				
		Cable uncapped (kbit/s)**	DSL 256/64	DSL 512/128	DSL 1500/256	ISDN 128/128	Dial-up 56/56
NSW	Major city	2849 (783)	84.5% (97)	83.3% (158)	80.8% (641)	91.7% (4)	72.7% (36)
	Inner regional	3017 (3)	86.4% (23)	83.1% (30)	78.8% (81)	77.9% (9)	62.2% (12)
	Outer regional	NA	84.6% (6)	85.0% (4)	77.0% (15)	NA	73.3% (6)
Vic	Major city	3013 (943)	84.5% (80)	82.6% (235)	80.4% (549)	86.3% (3)	74.7% (35)
	Inner regional	2595 (18)	85.7% (16)	83.8% (47)	79.9% (82)	83.4% (3)	72.0% (7)
	Outer regional	564 (2)	86.3% (3)	83.7% (8)	79.4% (8)	59.8% (2)	55.0% (3)
Qld	Major city	3291 (722)	83.0% (93)	82.2% (185)	78.9% (376)	80.2% (6)	79.0% (34)
	Inner regional	2804 (2)	84.6%(45)	82.7% (63)	80.0% (144)	82.6% (7)	75.0% (19)
	Outer regional	NA	85.6%(19)	81.0% (29)	74.7% (67)	95.9% (2)	71.4%(6)
	Remote	NA	NA	93.0% (2)	70.4%(2)	NA	NA
SA	Major city	3996 (191)	85.0% (47)	82.3% (42)	81.4% (193)	NA	69.2% (15)
	Inner regional	NA	85.1% (3)	85.4% (4)	82.4% (3)	97.3% (4)	62.3% (2)
	Outer regional	NA	NA	81.1% (3)	NA	77.4% (4)	NA
	Remote	NA	85.5% (2)	NA	NA	NA	NA
WA	Major city	2,414 (95)	84.5% (34)	83.5% (86)	77.2% (223)	NA	78.9% (9)
	Inner regional	NA	NA	82.7% (2)	75.9% (3)	NA	73.7% (2)
	Outer regional	NA	81.7% (5)	83.9%(8)	73.0% (26)	NA	NA
	Remote	NA	NA	NA	75.4% (2)	NA	NA
	Very remote	NA	NA	79.0% (2)	NA	95.8% (2)	NA
Tas	Inner regional	NA	77.7% (7)	84.5% (22)	77.8% (21)	NA	NA
	Outer regional	NA	86.6% (4)	NA	80.5% (2)	NA	43.0% (2)
NT	Outer regional	NA	83.7% (3)	NA	74.4% (7)	NA	72.3% (4)
	Remote	NA	NA	85.7% (3)	77.8% (6)	NA	NA
ACT	Major city	NA	87.4% (12)	82.8% (16)	80.1% (122)	NA	80.8% (4)

* The number of users that undertook LSM testing for each regional segment is shown in brackets. NA: not available.

** Average download data rates is presented here in kbit/s and not as a percentage of advertised data rates because download data rates for cable plans are generally not specified.

Table 4: Average upload data rates by Remoteness Area*

State	Classification	Data Rate	Percentage of advertised data rates				
		Cable uncapped (kbit/s)**	Cable UC/128***	DSL 256/64	DSL 512/128	DSL 1500/256	ISDN 128/128
NSW	Major city	207.76 (103)	162.3%(103)	89.6% (72)	88.5% (113)	86.2% (562)	57.8% (3)
	Inner regional	NA	NA	91.3% (24)	88.3% (21)	85.1% (71)	60.7% (8)
	Outer regional	NA	NA	89.1% (5)	88.6% (3)	81.6% (13)	NA
Vic	Major city	265.47 (127)	207.4% (127)	89.5% (80)	88.1% (86)	84.8% (478)	83.5% (3)
	Inner regional	658.04 (11)	514.1% (11)	84.1% (13)	88.8% (23)	84.0% (70)	68.6% (3)
	Outer regional	247.35 (2)	193.2% (2)	87.3% (3)	91.4%(2)	82.9% (9)	48.8% (2)
Qld	Major city	145.76 (109)	113.9% (109)	88.9% (72)	87.6% (77)	84.0% (341)	75.7% (6)
	Inner regional	NA	NA	89.9% (39)	87.0% (34)	84.4% (137)	63.5% (7)
	Outer regional	NA	NA	90.6% (11)	86.2% (33)	81.1% (22)	63.0% (2)
	Remote	NA	NA	NA	NA	72.6% (2)	NA
SA	Major city	175.73 (34)	137.3% (34)	90.3% (45)	86.7% (34)	85.6% (175)	NA
	Inner regional	NA	NA	89.5% (3)	93.8% (4)	80.6% (3)	79.1% (4)
	Outer regional	NA	NA	89.3% (2)	NA	NA	84.7% (4)
	Remote	NA	NA	NA	NA	NA	NA
WA	Major city	181.68 (27)	141.9% (27)	91.5% (40)	89.3% (55)	87.0% (186)	NA
	Inner regional	NA	NA	NA	89.5% (2)	75.7% (3)	NA
	Outer regional	NA	NA	91.8% (3)	93.7% (3)	81.2% (13)	NA
	Remote	NA	NA	NA	NA	83.9% (2)	NA
	Very remote	NA	NA	NA	84.2% (55)	NA	NA
Tas	Inner regional	NA	NA	83.6% (2)	88.5% (2)	80.4% (12)	NA
	Outer regional	NA	NA	88.8% (2)	NA	NA	NA
NT	Outer regional	NA	NA	86.6% (2)	NA	80.2% (12)	NA
	Remote	NA	NA	NA	89.5% (3)	82.5% (8)	NA
ACT	Major city	NA	NA	88.5% (9)	85.2% (13)	84.9% (110)	NA

* The number of users that undertook LSM testing for each regional segment is shown in brackets. Note: the results for dial- up and satellite technology are not presented because the results are considered unreliable. NA: not available.

** Average upload data rates is presented here in kbit/s and not as a percentage of advertised data rates because for this plan type upload data rate are generally not specified.

*** The upload results for cable appear to show an unexpected characteristic in that the sampled data is well in excess of the nominal 128 kbit/s specified in standard cable access plans. This may be possible if speed limits are not applied by ISPs.

Data rate variations by time of day

Data from the LSM was used to measure the performance of networks at different times of the day or week and across technologies and access plans. The reporting of this information is limited to where data is available and where data has been collected by the LSM.

Data rate variations by time of day are likely to be affected by a range of factors including:

- social behaviour (work and leisure patterns during the day); and
- technology type and the number of simultaneous users.

Findings from the analysis of data rates by time of day were as follows:

- There was less data rate variation during the day for DSL than any other technology. This may be because DSL is less likely to be affected by heavy or shared usage at any time of the day.
- The greater variability with cable was expected because the bandwidth of cable is shared between groups of users.
- There was some variability both ISDN download and upload data rates, although results show no discernable pattern.
- There was relatively limited variability in the download data rate for dial-up.
- There is more pronounced variability in upload data rates than download rates.

For detailed time-of-day results, see **Appendix B.**

Internet service availability

Both broadband and dial-up users naturally want a reliable internet service. A reliable service is especially important to users who rely on their internet connection to conduct business.

The LSM monitors network activity during the day by examining internet usage patterns in 10-minute blocks. It measures network 'outages' to gauge internet service availability. The testing method is outlined in **Appendix A**.

In 2004–05, there were 1,958 blocks of 10 minutes in which a significant outage was recorded. Table 5 shows internet service availability for technologies for which sufficient data was available. The results show that internet service availability for all tested technologies was very high at rates of 99.85 per cent or above.

Table 5: Internet service availability in 2004–05 by access technology

Technology	Internet service availability
Satellite (two-way)	99.99%
Satellite (one-way)	99.98%
ISDN	99.92%
DSL	99.89%
Cable	99.85%

Domain name server lookup times

DNS lookup time is another service characteristic that may impact on internet user experience, in addition to download/upload data rates and internet service availability. It is particularly important when browsing the internet.

DNS lookup (or resolution) is the matching of a universal resource locator (URL) to its corresponding internet protocol (IP) address. A long DNS lookup time can have the effect of a delay when nothing appears to be happening, followed by a web page appearing rapidly on the user's screen. Low DNS lookup times ensure fast web surfing.

DNS lookup times may be affected by factors such as:

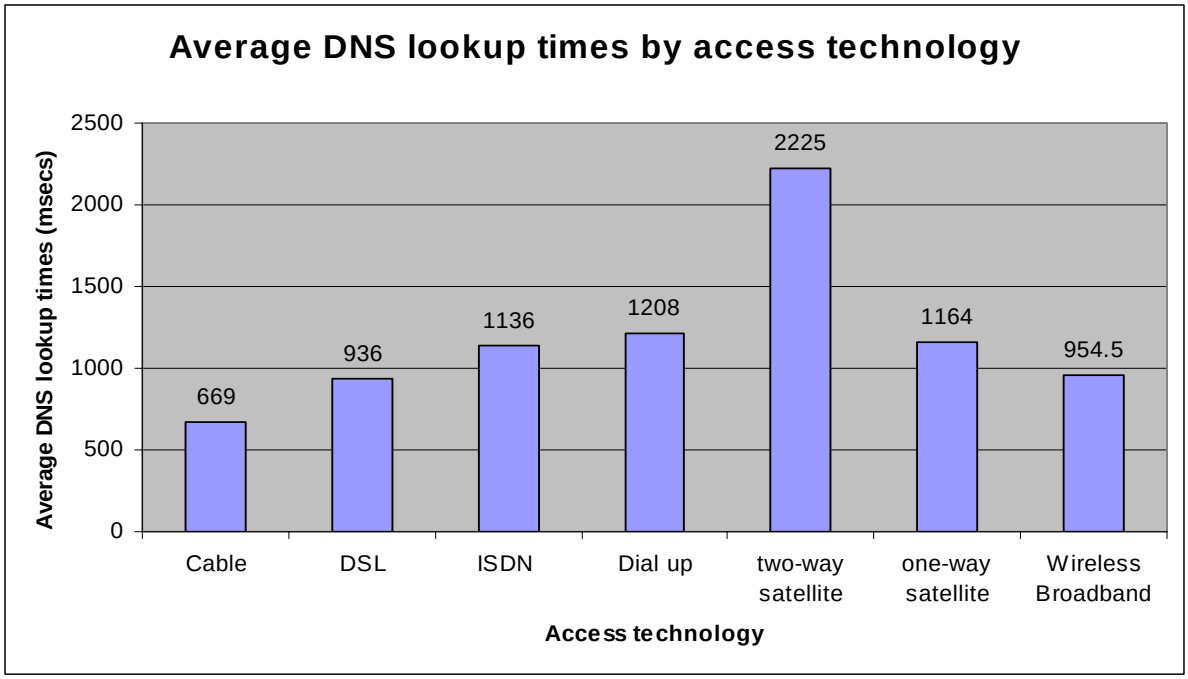
- the capacity of DNS servers;
- the time of day;
- large spam volumes (congesting DNS servers); and
- part network failure.

In this study, the DNS lookup time is defined as the time-lapse between the launch of a DNS lookup request and the receipt of the resolved IP address.[6] In conjunction with call home tests (for internet service availability), LSM user computers conducted DNS lookup time tests every 10 minutes. Each test attempts a query from a pool of 8,000 randomly selected domain names.

Examination of DNS lookup times found that lookup times were generally fast enough for the impact on the average Australian internet user to be indiscernible. Figure 2 shows that DNS lookup times were broadly consistent across most access technologies, with averages for most technologies ranging between 669 and 1,208 milliseconds (msecs). The average lookup time for two-way satellite services was higher at 2,225 msecs which is expected given the vast distances that data needs to travel between terrestrial relays and satellites in space.

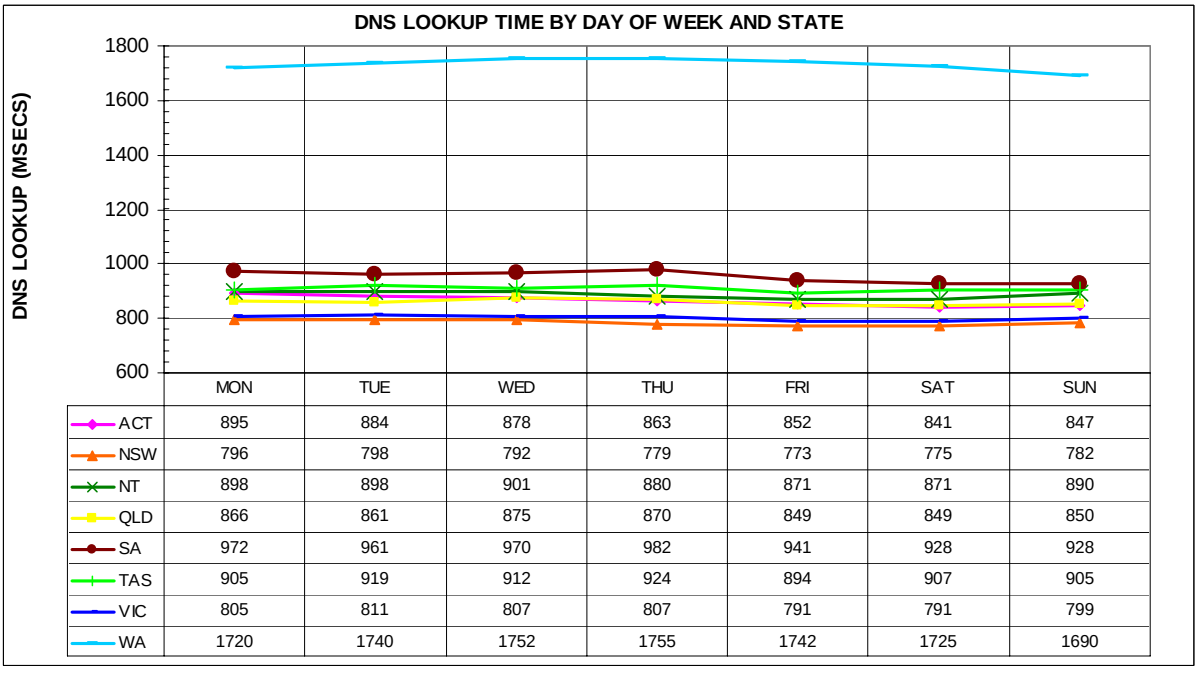
[6] This definition is a combination of the time a DNS server takes to lookup a corresponding IP address as well as the latency (the time lapse receiving and transmitting the data) of the request from the DNS requester to the DNS server and back to the requester.

Figure 2: DNS lookup time by access technology



The study also reviewed DNS lookup times by state or territory and found consistent performance times across Australia (see Figure 3). Most states and territories exhibited average lookup times of between 800 and 1,000 msecs. The exception was Western Australia, which exhibited a noticeably higher average lookup time of 1,750 msecs.

Figure 3: DNS lookup times by day of week and across states and territories



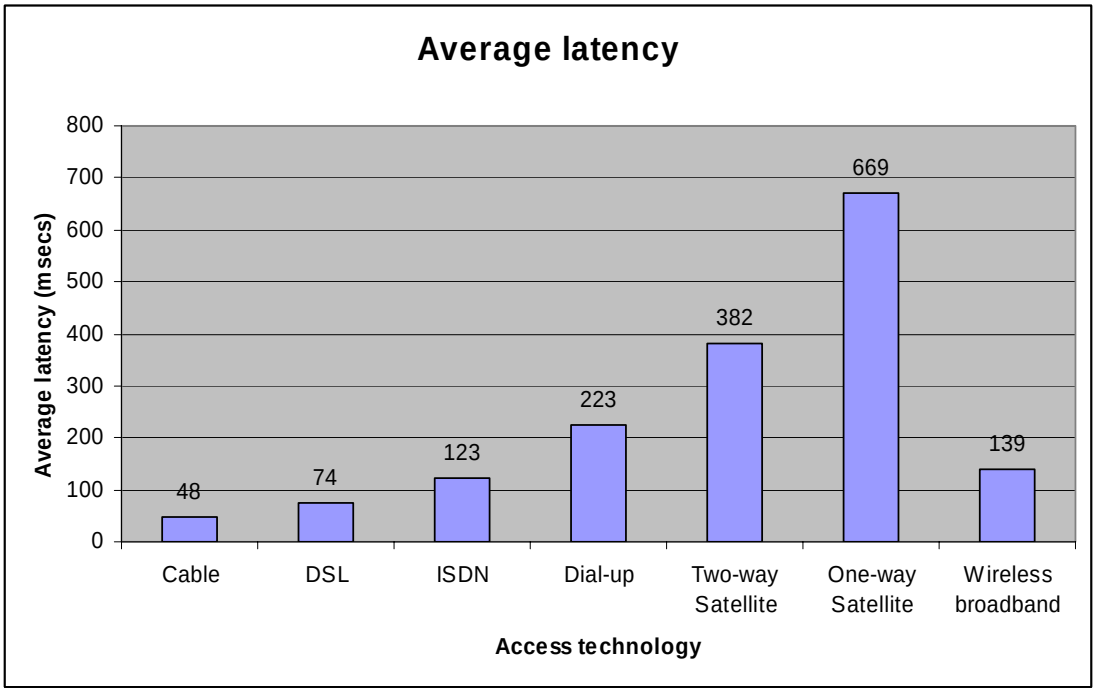
	MON	TUE	WED	THU	FRI	SAT	SUN
ACT	895	884	878	863	852	841	847
NSW	796	798	792	779	773	775	782
NT	898	898	901	880	871	871	890
QLD	866	861	875	870	849	849	850
SA	972	961	970	982	941	928	928
TAS	905	919	912	924	894	907	905
VIC	805	811	807	807	791	791	799
WA	1720	1740	1752	1755	1742	1725	1690

Latency

Latency is an indicator of the time delay of information to get through a network. It is tested by 'pinging' or bouncing packets off a specified IP destination. Low latency is important for applications such as voice over internet protocol (VoIP) and online gaming. Latency was assessed by timing the ping; that is measuring the time it takes for a packet to be sent to the LSM user and back to the TCP/IQ server (located in Brisbane).

Figure 4 below shows the average latency for each access technology. It indicates that average latency for the prominent access technologies; cable, DSL and dial-up is low at less than 223 msecs (or less than a quarter of a second). Average latency for internet access over satellite technology was found to be higher making it more difficult to support applications such as VoIP and gaming compared to other access technologies. Similar to DNS lookup times, longer latency for satellite technologies is expected given the design of this access technology.

Figure 4: Average latency by access technology



Appendix A: Study method

The measurement tool: the Line Speed Meter

Data for this study was collected using a measurement tool called the TCP/IQ Line Speed Meter (LSM). The LSM is free and can operate as a background task on any device that supports the Microsoft Windows operating system.

The LSM measures the performance over time of the connection between the user's operating system and the internet. The results of performance tests are transferred from the user's computer to an online database that can be accessed to check connection performance and to view average performance across ISPs and geographic regions.

Detailed information about the LSM is on the website at http://www.tcpiq.com (go to Home > Freeware > Line Speed Meter > FAQs).

The sample of internet users

The sample for this study is all LSM users in 2004–05 for whom there are complete details (for example, location, access technology and access plan) and for whom results are not considered to have been reported in error (for example, as a result of having misidentified their access plan at the set-up stage).

The sample of internet users in this study is not random because the LSM is downloaded only by users interested in testing their internet speeds. There has been significant growth in LSM registrations since 2003–04, which is attributed to 'word of mouth' referrals because the LSM is not advertised.

Table A.1 shows the number of user connections for each access technology. Table A.2 shows the number of download tests for each state and territory. The number of upload tests generally mirror the number of download tests. For the study of internet service availability, there were 16.04 million 'call home' tests (see below under 'Internet service availability'). The number of DNS lookup tests generally mirrored the call home tests. Notes have been included in the analysis of results where the sample of users is considered too small to draw reliable conclusions about performance.

Table A.1: Number of registered LSM users for each access technology, 2004–05

Access technology	Users	Percentage
DSL	9,577	70.6%
Cable	2,906	21.4%
Wireless	624	4.6%
Dial-up	244	1.8%
Two-way satellite	88	0.7%
ISDN	65	0.5%
One-way satellite (satellite downlink, dial-up uplink)	22	0.2%
One-way satellite (satellite downlink, ISDN uplink)	17	0.1%
Other	18	0.1%
Total	**13,561**	**100%**

Table A.2: Number of registered LSM download tests for each state and territory, 2004–05

State/territory	Tests	Percentage
NSW	511,631	38.8%
Qld	284,194	21.6%
Vic	280,878	21.3%
SA	89,796	6.8%
WA	75,429	5.7%
ACT	45,355	3.5%
NT	21,861	1.7%
Tas	8,392	0.6%
Total	**1,317,536**	**100%**

Testing method

Download data rates

The LSM tests download data rates by downloading specific files. It retrieves a list of files to download each week and targets compressed documents in the form '.jpeg', '.pdf' and '.gif' from local hosts. The data rates of the download are measured. Compressed documents are targeted because they cannot be compressed further by the modem.

Upload data rates

The LSM tests upload data rates by sending packets of data that are difficult to compress to known local servers on the internet and timing the response. Only websites that can efficiently handle the incoming traffic from the LSM are selected. The list of websites is automatically redistributed weekly to the LSM on all users' computers.

Internet service availability

LSM users can enable a 'perpetual survey' option that sets the LSM to 'call home' to the TCP/IQ website once every 10 minutes. Call home events are communications between the LSM user computers and the TCP/IQ server, informing it that they are online. Anomalies in the normal frequency of call home events were used to measure internet service availability.

Call home tests for each 10-minute period were logged and compared with the results of a 21-day period (between 10 days before and 10 days after). Results that are further than three standard deviations below the period average are deemed to be an 'outage' or a period of network unavailability.[7]

It is not possible to reliably measure network unavailability for individual LSM users using this method because network unavailability is only one of many reasons that may cause a call home test to fail to register a connection on the TCP/IQ server. Other

[7] These inferences are made with a 99.7 per cent level of confidence. Call home events act as a proxy for internet availability. Internet activity is taken to be a normal random variable. We can therefore invoke normalised statistical inferencing such as the use of confidence interval testing for network 'outages' or unavailability.

reasons for a call home test failure include a user's computer or modem being switched off, equipment failure or a broken link to the ISP.

Internet service availability is determined by monitoring call home test results for a group of users in a particular geographic region or for a particular plan. This is considered reliable because it is highly unlikely that all users in the group would have their computer switched off or be affected by equipment failure at the same time.

Domain name server lookup times

In this study, the DNS lookup time (measured in msecs) is defined as the time-lapse between the launch of a DNS lookup request and the receipt of the resolved IP address.[8] In conjunction with call home tests, LSM user computers conducted DNS lookup time tests every 10 minutes. Each test attempts a query from a pool of 8,000 randomly selected domain names.

Latency

Latency is the time delay of information to get through a network. It is tested by 'pinging' or bouncing packets off a specified IP destination (LSM users). Latency tests were conducted every 10 minutes. Data was averaged for the results produced in figure 4.

Data integrity

Data used in this study has been examined to remove results that may have been attributed to the wrong technology or access plan or cannot be attributed to a particular geographic location. This is a risk because the user is required to manually enter information about their connection when they install the LSM. The aim of data filtering is to eliminate test results that are highly likely to be in error as distinct from statistical outliers, which would indicate variable performance.

Before examining LSM test results to determine internet service performance, the raw data was filtered or 'cleaned' to ensure that results were not contaminated. The data was filtered in the following ways:

1. Data relating to countries other than Australia was removed.
2. Data not relating to the 2004–05 financial year was removed.
3. Data that lacked essential attributes such as the geographic location (postcode) of the user connection and an accurate time-stamp was removed. This was particularly important for the case study of download and upload data rates at different times of the day (see section 'Data rate variation by time of day'). Results from shared connections were also removed because those tests may have been skewed by the simultaneous internet activities of other users.
4. Data was removed that fell outside the range that would be expected for each access technology and access plan. Such data may have been included as a result of the user inaccurately describing their connection at the set-up stage or their access arrangements having changed subsequent to installation. This

[8] This definition is a combination of the time a DNS server takes to lookup a corresponding IP address as well as the latency (the time-lapse for receiving and transmitting the data) of the request from the DNS requester to the DNS server and back to the requester.

process also removes data that may have been included as a result of the ISP restricting the user's download data rates once the monthly download limit had been reached.[9]

Customised filtering was applied to each type of access plan by establishing a likely range outside which a result was considered to have been in error (see Table A.3). This was done by taking into account expected performance characteristics and standard access plan rates for that technology. In 2003–04, a uniform filter was applied across all access plan types, so comparisons between the 2003–04 and the 2004–05 study are difficult.

Table A.3: Data filter thresholds for 2004–05 study

Access technology	Lower download cut-off	Upper download cut-off	Lower upload cut-off	Upper upload cut-off
Dial-up	10%	150%	10%	300%
ISDN	10%	120%	10%	120%
DSL	60%	110%	60%	110%
Cable (uncapped)	1%	100%	1%	100%
Cable (capped/128 kbit/s)	1%	150%	1%	150%
Satellite one-way (dial-up)	10%	150%	10%	300%
Satellite two-way	10%	200%	10%	2000%
Wireless broadband	1%	200%	1%	200%

[9] This practice is known as 'shaping'. Some ISPs do not shape excess internet use, but instead charge for incremental downloads that exceed the monthly allowance.

Appendix B: Data rate variation by time of day graphs

Figure B.1: Average download data rates (kbit/s) for each hour of the day (cable and DSL 1500/256)

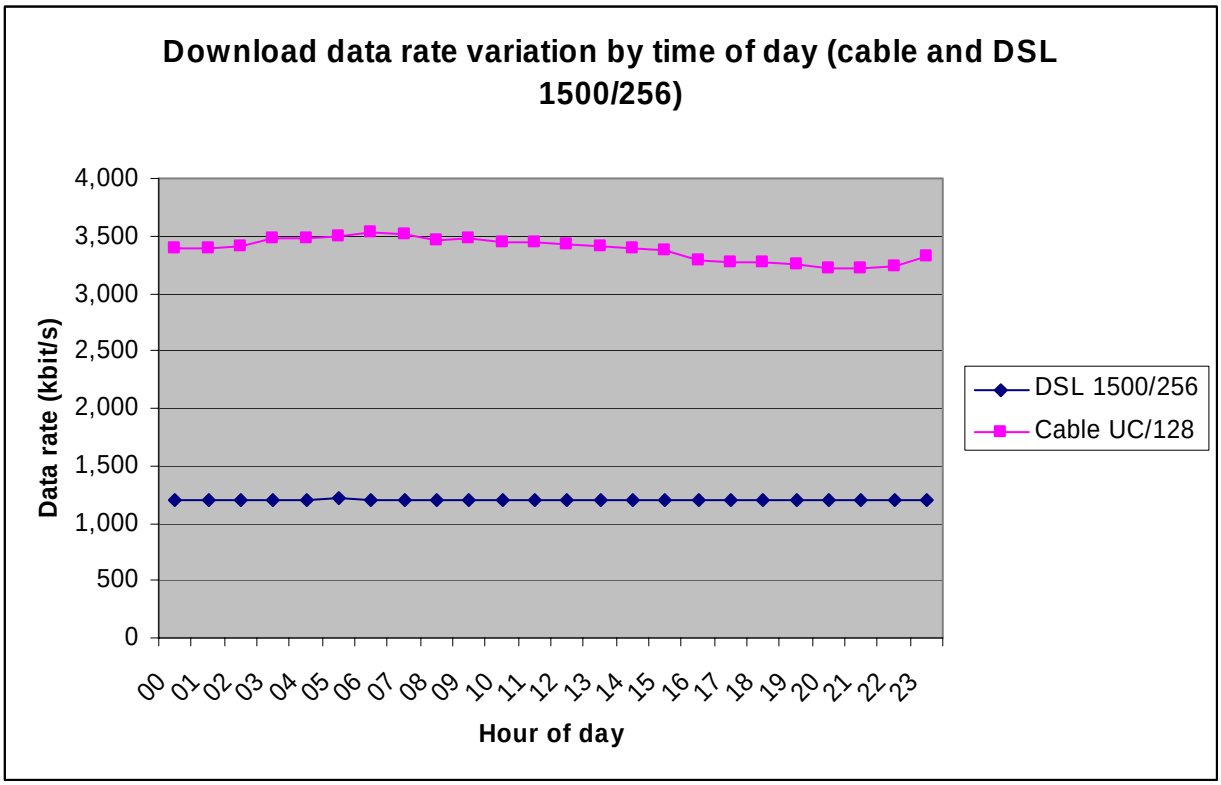


Figure B.2: Average download data rates (kbit/s) for each hour of the day (DSL, ISDN, dial-up)

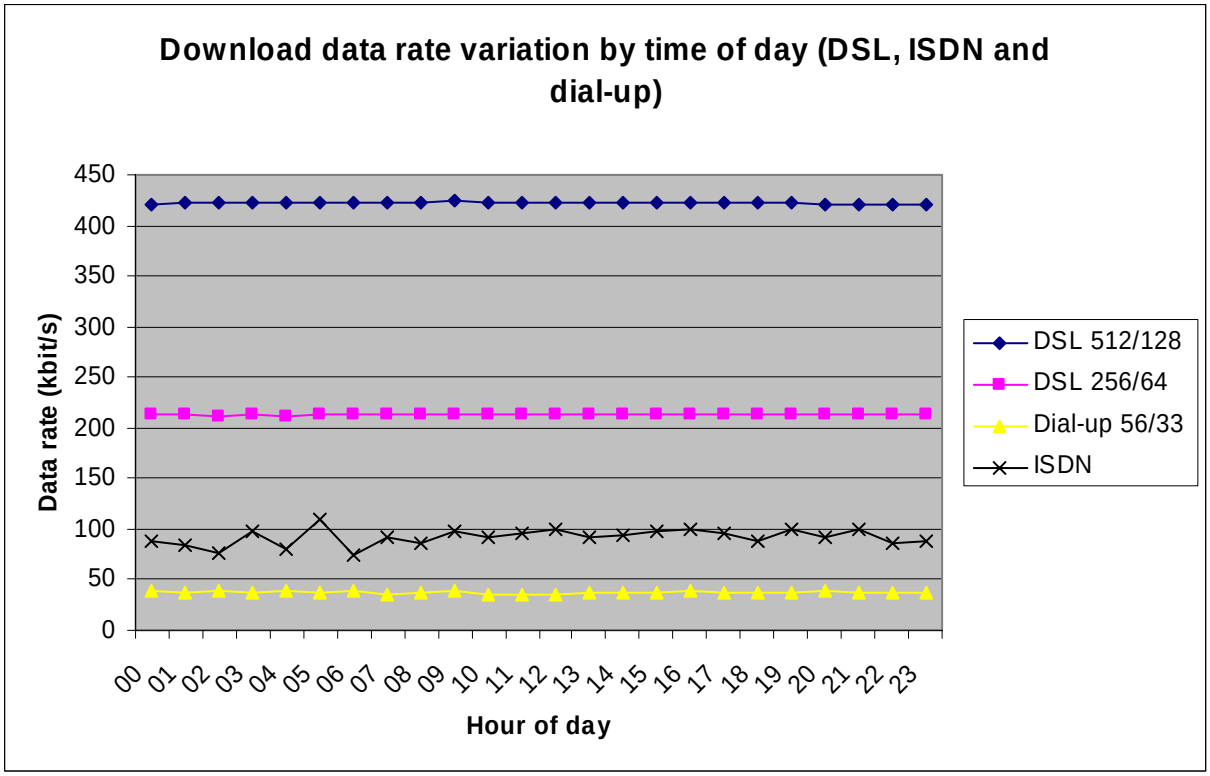
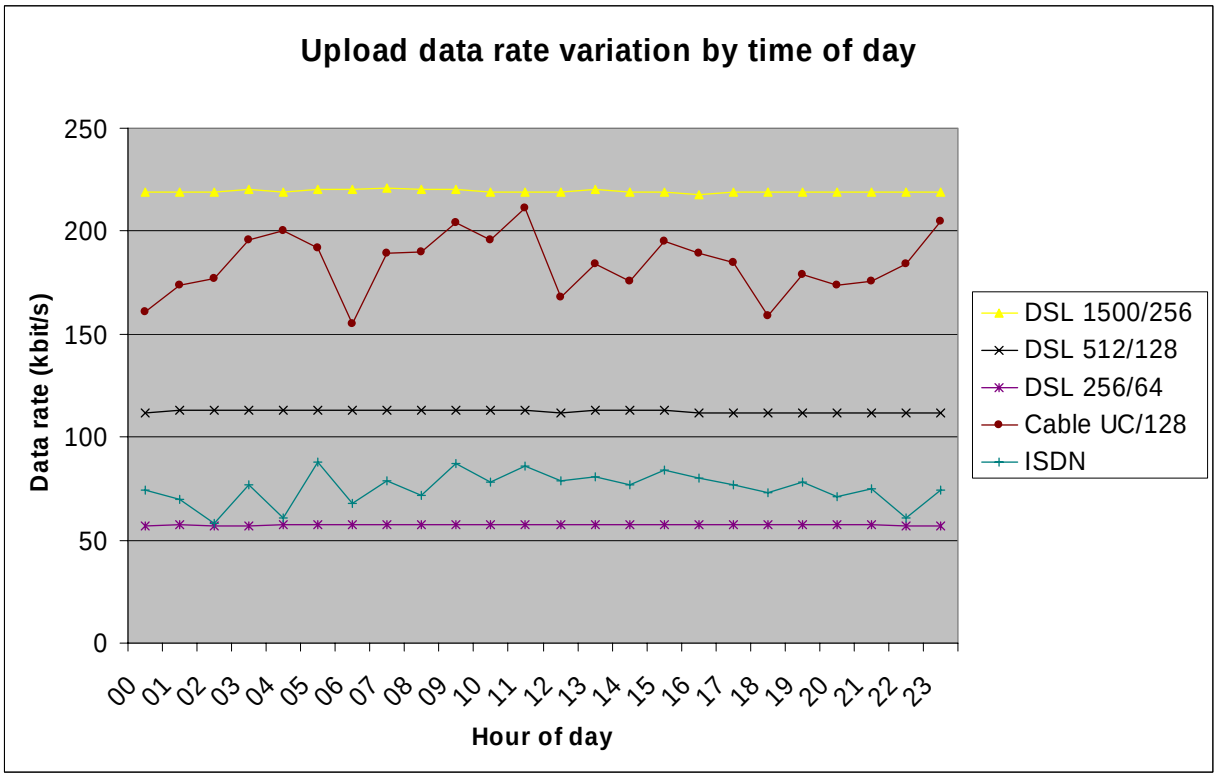


Figure B.3: Average upload data rates for each hour of the day



Glossary

ADSL	**asymmetric digital subscriber line** A transmission method allowing high data rate communication over existing copper wires. The downstream data (data downloaded by user) transmission rate is much higher than the upstream data rate.
bandwidth	In the internet industry, bandwidth refers to the capacity of a connection to carry information, while in radiocommunications it is the amount of radiofrequency spectrum used for a particular function.
broadband	General term used for any type of technology that provides a high data rate connection. Examples include ADSL, HFC cable and WiFi. Broadband services are usually 'always-on' and do not tie up a telephone line exclusively for data. Defined in this report to mean any internet connection with an access data rate greater than 256 kbit/s. Capable of supporting a variety of voice and data applications, such as voice telephony, internet access, pay TV and multimedia services.
byte	A set of bits that represent a single character. There are eight bits in a byte. While data transmission rates are usually measured in bits per second, data volumes are usually measured in bytes.
cable	Cable refers to a data connection that is delivered to a subscriber through channels in a coaxial cable or optical fibre cable to a cable modem installed externally or internally to a subscriber's computer or television set.
data rate	The volume of data that is able to be transmitted over a period of time. Data rates are usually measured in bits per second.
data traffic volumes	The volume of data transmitted in both directions between two points over a telecommunications service, over a period of time. It usually refers to the volume of data transferred between (to and from) an internet service provider and a subscriber and it is usually measured in bytes per month.
dial-up	Internet connection via modem and dial-up software utilising the public switched telecommunications network.
DSL	**digital subscriber line** Transmission technique that dramatically increases the digital capacity of telephone lines into the home or office. Describes several digital technologies for fast two-way data connections over the public switched telephone network, including ADSL.
DNS	**domain name server** Internet systems that enable names to be used for addressing websites and email.
fixed wireless internet access	Point-to-point microwave link, generally building-to-building or tower-to-building, which allows subscribers within the receiving building to access the internet. The sender and receiver must be within line-of-sight and no more than 22 kilometres apart.
IP	**internet protocol** Protocol for transmission of data over the internet.
ISDN	**integrated services digital network** Technology that enables digital transmission of voice and data over the public switched telephone network. Provides transmission of voice and data at up to 128 kbit/s.
ISP	**internet service provider** Service provider offering internet access to the public or another service provider.
KB	**kilobyte(s)** A thousand bytes. See 'byte'
kbit/s	**kilobits per second** Data communications transmission rate of 1,000 bits per second.

MB	**Megabyte(s)** One million bytes. See byte(s).
Mbit/s	**Megabits per second** Data communications transmission rate of one million bits per second.
mobile wireless internet access	Mobile wireless internet access via 'hotspots' using a microwave connection often referred to as WiFi. WiFi is most commonly utilised by laptop users, although it is also becoming increasingly popular within homes and businesses with multiple PCs.
msec	**millisecond** Unit of time used to measure DNS lookup times.
satellite	A satellite is a wireless receiver/transmitter that operates in orbit around the earth and acts as a microwave relay station, receiving signals sent from a ground-based station, amplifying them, and retransmitting them on a different frequency to another ground-based station. Satellites can be used for high-data rates transmission of computer data, even where the most basic utilities are lacking such as regional and remote locations.
shaping	Shaping is the practice among ISPs of intentionally reducing data rates (usually to about 64 kbit/s) when an internet plan download quota for the billing period has been reached.
WiFi	**wireless fidelity** Used generically to refer to wireless local area network (IEEE 802.11) technology providing short-range, high data rate connections between mobile data devices and access points connected to a wired network.