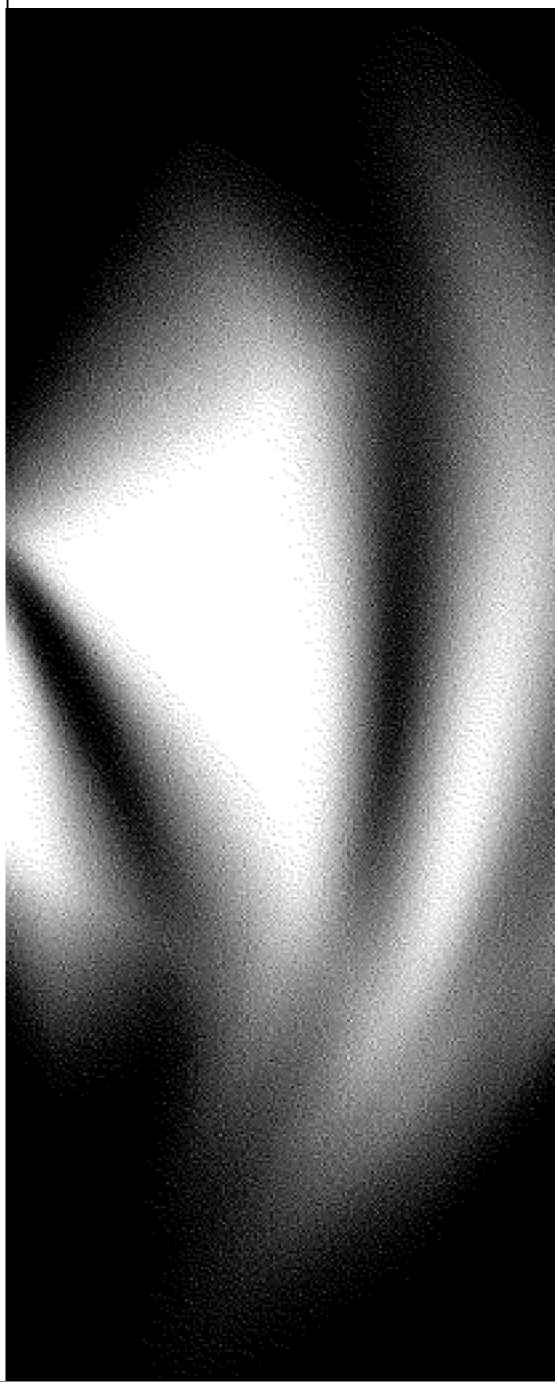
PRODUCTIVITY COMMISSION

International Benchmarking of Remote, Rural and Urban Telecommunications Services

International Benchmarking



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The Productivity Commission

The Productivity Commission, an independent Commonwealth agency, is the Government's principal review and advisory body on microeconomic policy and regulation. It conducts public inquiries and research into a broad range of economic and social issues affecting the welfare of Australians.

The Commission's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

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Foreword

There is continuing interest in Australia in the adequacy of remote and rural telecommunications services. This was the subject of last year's Besley Inquiry. This separate study by the Productivity Commission was undertaken to contribute further to public understanding of the issues, by comparing service and price relativities between remote, rural and urban areas of Australia with those overseas. It reveals that despite higher costs of servicing remote and rural regions in Australia — due to generally lower population densities — the accessibility, quality and price of telecommunications services in remote and rural areas relative to urban areas compare favourably to those observed in comparable overseas countries.

The study forms part of a continuing program of research benchmarking the performance of economic infrastructure industries. It is preceded by international benchmarking studies of telecommunications prices and research into the effect of differences in population distribution on telecommunications costs in a number of countries.

A workshop was held to discuss a work-in-progress draft of the report with invited industry participants, consumer groups and government officials. Feedback at the workshop led to a number of improvements to the study, including the updating of price comparisons to May 2001.

Research for the study was undertaken in the Economic Infrastructure Branch. The study benefited from the cooperation of participants in the telecommunications sector both within Australia and overseas, who either assisted the Commission directly or provided information to its consultant, Network Strategies Ltd. The Commission is grateful to all those who took part.

The Commission welcomes feedback on this report, consistent with its objective of improving the information base on key issues affecting Australia's economic performance and community living standards.

Gary Banks
Chairman

July 2001

Contents

Abbreviations

ABS	Australian Bureau of Statistics
ACA	Australian Communications Authority
ACCC	Australian Competition and Consumer Commission
ADSL	Asymmetric digital subscriber line
AMPS	Advanced mobile phone system
ARIA	Accessibility/Remoteness Index of Australia
AT&T	American Telephone and Telegraph
bps	Bits per second
BT	British Telecom
CAM	Customer access module
CAN	Customer access network
Can	Canadian
CDMA	Code division multiple access
CPE	Customer premises equipment
CPI	Consumer price index
CRTC	Canadian Radio-television and Telecommunications Commission
CSG	Customer service guarantee
D-AMPS	Digital-advanced mobile phone system
DDSO	Digital data service obligation
DoC	Department of Commerce (US)

DRCS	Digital radio concentrator system
DSL	Digital subscriber line
EDGE	Enhanced data for global system for mobile evolution
EU	European Union
FCC	Federal Communications Commission
FDMA	Frequency division multiple access
Gb	Gigabyte
GEO	Geostationary earth orbit (satellite)
GHz	Gigahertz
GPRS	General packet radio service
GSM	Global system for mobile
HCRC	High capacity radio concentrator
HDSL	High bit rate digital subscriber line
HFC	Hybrid fibre coaxial
Hz	Hertz
IP	Internet protocol
ISDN	Integrated services digital network
ISP	Internet service provider
ITU	International Telecommunications Union
kbps	Kilobits per second
kHz	Kilohertz
LAN	Local area network
LEO	Low earth orbit (satellite)

km	Kilometre
LMDS	Local multipoint distribution system
MB	Megabyte
Mbps	Megabits per second
MHz	Megahertz
MIT	Ministerial Inquiry into Telecommunications (NZ)
MMDS	Multichannel multipoint distribution system
MTT	Ministry of Transport and Telecommunications (Finland)
NTIA	National Telecommunications and Information Administration
NTN	Networking the Nation
NZ	New Zealand
OECD	Organisation for Economic Cooperation and Development
OFTEL	Office of Telecommunications (UK)
PC	Productivity Commission
POP	Point of presence
PSTN	Public switched telephone network
RADSL	Rate adaptive digital subscriber line
SDSL	Symmetric digital subscriber line
TCP	Transmission control protocol
TIO	Telecommunications Industry Ombudsman
TDMA	Time division multiple access
TSI	Telecommunications Service Inquiry
UK	United Kingdom

ULL	Unconditioned local loop
US	United States (of America)
USO	Universal service obligation
VDSL	Very high bit rate digital subscriber line
www	Worldwide web
2G	Second generation (mobile)
2.5G	2.5 generation (mobile)
3G	Third generation (mobile)

Key messages

- Rural and remote telecommunications users are generally no worse off relative to urban users in Australia than their counterparts in other comparable countries. This is despite the generally higher cost of providing services in sparsely populated areas of Australia relative to the situation in those countries.

Accessibility and quality

- The extent of PSTN (traditional telephone) quality advantage for urban over rural users in Australia was similar to that in Canada (the only other country with comparable data).
- Mobile coverage of Australia's rural population was estimated to be similar to that in New Zealand and greater than in the US, but less than that in Europe. No country regularly monitors the quality of mobile services in remote, rural and urban areas.
- The distance between the user and the local exchange is a major determinant of data transmission rates over the PSTN. Longer line lengths in remote and rural areas tend to result in lower data transmission rates in these areas.
- High speed access to the Internet is now available in all countries, but market penetration is low.
- Deployment plans are more far reaching for ADSL services (high speed over traditional telephone lines) in Australia than in most other countries studied, although deployment will not occur in remote and many rural areas in the foreseeable future. Countrywide satellite services are now provided in all the benchmarked countries.

Price

- Rural prices are similar to urban prices for PSTN voice services in Australia and in most other countries, although in all countries there could be a cost disadvantage for rural subscribers arising from their pattern of calls.
- Australian remote subscribers are currently disadvantaged when local calls are of long duration. However, after 31 July 2001, the price of remote relative to urban PSTN services will be less in Australia than in most other countries.
- In Australia, the overall price of one-way high speed satellite services in remote and rural areas is comparable to the price of ADSL services in urban areas, although the speed is lower. In Canada, the price of the satellite service is more than the ADSL price. In the US and New Zealand, it is less than the ADSL price.
- Most countries, including Australia, provide financial assistance for improvements to existing services or the introduction of new services in remote and rural areas.

Overview

In this study, the accessibility, quality and price of telecommunications services in remote and rural areas were compared with those in urban areas, in Australia and in other countries.

The study is separate from but complements the Government's earlier Telecommunications Service Inquiry (TSI) into the adequacy of services in metropolitan, regional, rural and remote areas. Its scope differs from the TSI, in that remote–rural–urban service and price relativities are specifically compared with those for other countries.

As with the Commission's previous benchmarking studies, this report contains findings with potential policy relevance (see facing page), but has no recommendations.

Scope

The telecommunications services included in the study were public switched telephone network (PSTN) voice services, mobile voice services, basic PSTN access to the Internet, and high speed access to the Internet (using ISDN, ADSL, HFC cable, satellite, MMDS and mobile). These services are used by households and small businesses (including farms).

Australia was benchmarked against Finland, France, New Zealand, Sweden, the United Kingdom and a number of Canadian Provinces and US States. Price comparisons relate to May 2001.

In recent years, governments in these countries have pursued policies of commercialisation and privatisation with a view to improving industry efficiency. Five of the eight benchmarked countries have now privatised their incumbent carriers. Regulatory policies have encouraged access to the incumbent's facilities by new entrants. This has tended to produce more competition, and choice, in urban areas than in remote and rural areas.

There is a dearth of information on access and quality of services in the remote and rural areas of most countries. Information for Australia and Canada — two countries with extensive areas of low population density — allowed the most comprehensive comparisons of rural and urban service quality. However, there was sufficient information in all countries to provide comprehensive price comparisons.

There are differences in the definitions of ‘remote’, ‘rural’ and ‘urban’ areas as well as performance measures by statistical and regulatory authorities among the benchmarked countries. These differences inhibit international comparisons of *absolute* service levels. As far as possible, they have been taken into account in the presentation and interpretation of *relative* service levels and prices.

Telecommunications costs and population distribution

One reason for the interest in telecommunications services in remote and rural areas is the relatively high cost of provision in these areas and the associated difficulty of ensuring a quality of service and price comparable with urban areas.

Rural population densities are lower in Australia than in the other countries studied. As a consequence, the costs of providing telecommunications services to rural areas, compared with urban areas, are higher in Australia.

Nevertheless, Australian remote and rural telecommunications users were found to be generally no worse off in quality and price terms relative to urban users than their counterparts in other comparable countries.

Accessibility of services

The PSTN is a mature network in Australia and most other developed countries. Indeed, the number of fixed PSTN access lines has begun to decline in some countries. However, increases in mobile phones have more than offset this decline.

Mobile coverage of Australia’s rural population was estimated to be similar to that in New Zealand and greater than in the US, but less than in Europe where population densities are much higher.

The Internet is almost as widely available as PSTN voice services, although the share of the population using it is much less. Internet penetration in Australia is around the middle of the benchmarked countries. About 40 per cent of metropolitan households in Australia had Internet access, compared with 32 per cent outside metropolitan areas.

The great majority of Internet subscribers obtain access through basic PSTN voice lines at relatively slow data transmission rates, especially in remote and some rural areas. New technologies are being introduced to provide higher speed access to the Internet (at least in one direction) than that available through the existing PSTN network (see table below).

Service options for access to the Internet

Urban	*Rural*	*Remote*
Basic PSTN	Basic PSTN	Basic PSTN
ADSL	ISDN	One-way satellite
HFC cable	MMDS	Two-way satellite
ISDN	One-way satellite	
MMDS	Two-way satellite	
One-way satellite	2.5/3G	
Two-way satellite		
2.5/3G		

Note One-way satellite services use the PSTN for sending data from the user (upstream transmission). Two-way satellite services are not reliant on the PSTN for upstream transmission. Third generation mobile services (3G) are not yet available.

The share of Internet subscriptions served by high speed technologies is relatively low in all areas of the benchmarked countries.

ISDN and one-way satellite technologies are deployed extensively in all the countries studied for which information was available. The US is the only benchmarked country to have deployed two-way satellite technologies.

HFC cable is deployed less widely in Australia than the majority of countries studied.

ADSL deployment plans are more far reaching in Australia than in the majority of other countries studied. However, deployment will not occur in remote and many rural areas in the foreseeable future.

Satellite services are now ubiquitous in all the benchmarked countries. Lower population densities and longer average line lengths adversely affect the cost and technical feasibility of deploying other high speed technologies in remote and many rural areas.

Quality of service

The extent of delays for rural residents in obtaining new PSTN connections is similar in Australia and Canada. Fault repair performance in rural areas was slightly lower than that in urban areas in both Canada and Australia. There is little or no monitoring in other countries of the quality of PSTN service that is reported separately for remote, rural and urban areas.

No country regularly monitors the quality of mobile services separately for remote, rural and urban areas.

Australia generally compares favourably with Canada, New Zealand, the UK and US in terms of countrywide measures of PSTN and mobile quality of service.

Transmission speeds for Internet access

The ability to connect to the Internet and stay connected, and the adequacy of data transmission rates, are the main issues affecting the quality of dial-up PSTN data service.

The distance between the user and the local exchange is a major determinant of transmission rates over the PSTN. The longer line lengths in remote and rural areas tend to result in lower data transmission rates in these areas.

Information on the distribution of PSTN data transmission rates indicates that the proportion of customer access lines with rates less than 28.8 kbps is larger in Australia than in North America or the UK. However, there may be some inconsistencies in the measures of transmission rates in the different countries.

Information on the distribution of line lengths suggests that lines tend to be shorter in Australia than in the US and Canada. This would tend to suggest higher transmission rates in Australia. On the other hand, the gauge and quality of copper cabling in the US may be more conducive to higher transmission rates. However, there was insufficient information to quantify the possible impact of factors such as line length and quality on relative data transmission rates across the benchmarked countries.

Prices

There is virtually no difference in the price of PSTN voice services in *rural* and *urban* areas in Australia nor in most of the countries included in this study, despite higher costs in rural areas. However, if the ratio of long-distance to local calls was higher for rural than for urban subscribers, then the total cost of telecommunications services would tend to be higher for rural subscribers.

In *remote* areas, PSTN subscribers who make long duration local calls were disadvantaged relative to *urban* subscribers when prices were compared at May 2001. However, after 31 July 2001, the price of remote relative to urban PSTN services will be less in Australia than in most other countries (provided prices in the other countries do not change in the interim).

Mobile prices do not differ between remote, rural and urban users in any of the benchmarked countries.

For high speed Internet access in each country, an ADSL service available to urban users was selected as the benchmark against which satellite prices in remote and rural areas were compared.

The overall price of one-way satellite services in remote and rural areas:

- in Australia was comparable to the price of ADSL services in urban areas;
- in Canada was more than the ADSL price in urban areas; and
- in the US and New Zealand was less than the ADSL price in urban areas.

ADSL subscribers receive a greater level of performance in terms of both upstream and downstream data transmission rates than satellite subscribers in these countries.

Government involvement

Most countries provide financial assistance for improvements to existing services or the introduction of new services in remote and rural areas.

Australia has been introducing contestability in the provision of telecommunications services to remote and rural communities.

1 Introduction

This study forms part of a series of international benchmarking studies of telecommunications services conducted by the Productivity Commission (PC).

Detailed inter-country comparisons of telecommunications prices and regulatory arrangements, as at February 1998 and June 1999, were published by the Commission in 1999 (PC 1999a and 1999b). In 2000, the Commission released a Staff Research Paper which examined the impact of differences in population distribution on costs in several of the countries included in the earlier benchmarking studies (Cribbett 2000). The current study compares telecommunications service outcomes in regions with different population densities.

1.1 Study objective

In undertaking this study, the Commission's aim was to investigate whether differences in quality and price between remote, rural and urban areas are larger or smaller in Australia than in other comparable countries. This is of interest because there is a commonly held perception that those living in the remote and rural areas of Australia are relatively disadvantaged in terms of their access to telecommunications services, the prices they pay for these services and the quality of service they receive.

This study does not draw any conclusions about the appropriateness of price and quality of services in different parts of Australia and the extent of any government interventions. However, the provision of information comparing Australia with other countries can provide useful insights to the formulation of policies designed to influence price and service quality in remote and rural areas.

The Commission's approach was to benchmark, in Australia and in other countries, the quality and price of telecommunications services provided in remote and rural areas against those provided in urban areas.

The Australian Government established an independent Telecommunications Service Inquiry (TSI) during 2000 to assess the adequacy of telecommunications services in metropolitan, regional, rural and remote areas. The Inquiry found that Australians are generally satisfied with telecommunications services, although a significant proportion of users in remote and rural areas have concerns with key aspects of service.

The Commission's objectives and approach in the present study differ from the TSI in several respects. This is illustrated by the following features of the Commission's study:

- remote–rural–urban relativities were examined specifically;
- Australian remote–rural–urban service and price relativities were compared with those for other countries on a comprehensive basis;
- only objective measures of service quality were used; and
- there are no policy recommendations.

There are difficulties with interpreting international comparisons of absolute quality and price levels, particularly arising from the impact of exchange rate fluctuations and differences in quality measures and demand patterns. These difficulties have been minimised by focusing on relative performance within countries.

Current Australian policies and government initiatives — such as, the introduction of contestability in the delivery of the universal service obligations in regional areas — were not evaluated. Nor were the efficiency, effectiveness or equity of Australian policies benchmarked against those in other countries. However, information on the demographic characteristics and institutional environment is presented where necessary to provide context to the benchmarks and international comparisons.

1.2 Scope

The *services* benchmarked were:

- Public switched telephone network (PSTN) voice services;
- Mobile voice services;
- PSTN data services for access to the Internet; and
- High speed data services for access to the Internet using integrated services digital network (ISDN), asymmetric digital subscriber line (ADSL), hybrid fibre coaxial (HFC) cable, multichannel multipoint distribution system (MMDS), satellites and mobiles.

The services examined were confined to those used by households and small business users (including farms). Large businesses were not examined because of their limited presence in remote and rural areas, their self-sufficiency in obtaining adequate services and the confidential nature of negotiated service agreements.

The *countries and service areas* selected for inclusion in the study were:

- Canadian Provinces of British Columbia and Alberta (served by TELUS), Ontario and Quebec (served by Bell Canada);
- Finland;
- France;
- New Zealand;
- Sweden;
- UK;
- US western States including California, Washington and Oregon (served by Bell Operating Companies and rural local carriers); and
- Some US north-eastern States (served by Bell Operating Companies and rural local carriers).

These countries and service areas were chosen with some or all of the following criteria in mind:

- member countries of the Organisation for Economic Co-operation and Development (OECD) with modern telecommunications networks;
- a variety of regulatory or institutional approaches to the process of liberalising telecommunications markets and introducing competition;
- geographic and socio-economic environment comparable to Australia; and
- availability of data (especially census data and telecommunications service data).

The availability of information in these countries and regions varied by service. Consequently, the relative levels of service and price were not compared for all services across all of the above countries and service areas.

1.3 Approach

Access to PSTN, mobile and Internet services and also to the newer technologies used for high speed data services was explored. Information on both *accessibility* or *coverage (supply)* and *market penetration (demand)* of services is reported where available. The accessibility of service to residential and small business users refers to the extent to which a service is supplied (‘deployed’ or ‘rolled out’) in a community by telecommunications carriers, and hence potentially available to the whole population. Market penetration refers to the subscriptions (‘take-up’) of such services and depends on the demand behaviour of individual users.

The newer technologies capable of providing high speed data access services vary in their suitability for serving remote, rural and urban areas. They are currently in the very early stages of being rolled out in most countries. Even where roll out has occurred, the take-up by consumers has been limited.

Service quality comparisons were made in terms of objective measures of the aspects of quality which might be expected to vary between rural and urban areas, such as the time to obtain a new PSTN connection or repair a fault. For mobile voice services, quality was measured primarily by call congestion and call drop-out. Quality issues relating to billing and privacy were not considered.

Subjective measures of user satisfaction with a particular aspect of service were not used. These measures depend on user expectations which may vary from country to country and even between regions within a country.

The quality of Internet services for residences and small businesses was limited mainly to the performance (data rate) capabilities of the customer access parts of the existing PSTN and the newer technologies. The customer access network (CAN) is the main service bottleneck and source of performance variation in remote, rural and urban areas.

International comparisons were not undertaken for the infrastructure beyond the CAN, including the Internet backbone, nor for Internet service provider (ISP) services because there is less reason for service differences between rural and urban areas. However, the importance of ISP performance relative to the performance of the CAN was investigated using case studies.

Price comparisons for PSTN and mobile voice services took into account connection charges, access rental, and local and long-distance call or usage charges. Information on differences in prices and in the availability of pricing plans for remote, rural and urban users is presented.

The effects of service levels on Internet user costs were examined. A comparison of ADSL and satellite was also undertaken to illustrate the relative price of high speed Internet access in remote, rural and urban areas.

The main outcomes of the study are the comparisons between Australia and other countries of *rural–urban* and *remote–urban* ratios or differences in indicators of accessibility, quality and price. For example, the price for the residential PSTN service may be the same for rural and urban customers in Australia, but higher for the rural compared with urban service in Finland, or lower for the rural compared with the urban service in some states of the US.

Use of the terms remote, rural and urban is sometimes imprecise and may affect the interpretation of relative service levels and prices. Official definitions vary to some extent among countries and among organisations within countries. The definitions used by the statistical and telecommunications authorities in the selected countries are summarised in table 1.1. In all countries, ‘urban’ includes towns and cities with a wide range of populations. Frequently, ‘urban’ is further classified. For example, in the US, continuously built-up areas with a population of 50,000 or more are referred to as ‘urbanised areas’. The statistical authorities in the countries studied do not have definitions for ‘remote’. However, the Australian Communications Authority defines as remote localities with populations less than 200.

Table 1.1 **Definitions of remote, rural and urban used in each country**

Country	*Population of localities*			
	200	*1000*	*2500*	*10 000 50 000 250 000*
Statistical authorities				
Australia	RURAL (to 1000)	URBAN		
Canada	RURAL (to 1000)	URBAN		
France	RURAL	URBAN		
New Zealand	RURAL (to 1000)	MINOR AND SECONDARY URBAN	URBAN	
Sweden	RURAL (to 200)	URBAN		
United Kingdom	RURAL (to 1000)	URBAN		
United States	RURAL (to 2500)	OTHER URBAN	URBANISED AREAS (50 000 and over)	
Finland	RURAL (to 200)	URBAN		
Telecommunications authorities				
Australia	REMOTE (under 200)	MINOR RURAL (200 to 2500)	MAJOR RURAL	URBAN
Canada	RURAL	URBAN (250 000 and over)		

Sources: The statistical authorities include the Australian Bureau of Statistics, Institut National de la Statistique et des Etudes, Statistics Canada, Statistics Finland, Statistics New Zealand, Statistics Sweden, UK Office of National Statistics and the US Census Bureau. The telecommunications regulatory authorities are the Australian Communications Authority and the Canadian Radio–television and Telecommunications Commission.

In North America, areas defined as urban by Statistics Canada and the US Census Bureau must have population densities of at least 400 persons per square kilometre and 1000 persons per square mile (equivalent to 386 persons per square kilometre), respectively. Other countries do not make explicit assumptions about the minimum population density of urban areas.

The term ‘regional’ is sometimes used to refer to towns and small cities in contrast to ‘metropolitan’ areas (such as the mainland capital cities in Australia). ‘Regional’ is therefore included within the broad definition of urban discussed above. There may be important differences in the accessibility and quality of some telecommunications services in regional and metropolitan areas. However, the differences between rural and urban, as defined in table 1.1, are probably more significant.

Data on average population densities in the rural and urban areas of countries are presented (where available), along with indicative information on the relative costs of providing and maintaining services in these areas, in order to assist in interpreting the rural–urban quality and price comparisons.

Information is also given on other factors affecting differences in services and prices within a country including:

- regulatory arrangements; and
- policies in the selected countries for providing and funding telecommunications services in high cost areas.

The Commission consulted extensively with industry and government officials during the study, including the convening of a workshop. A list of participants is given in Appendix A.

1.4 Data collection

The Commission sought and received extensive technical briefings from Telstra as well as general market information from the major participants in the Australian telecommunications industry.

Network Strategies Limited was engaged by the Commission to collect recent information on accessibility and market penetration, quality of service and price for voice and data services. Network Strategies and the Commission also obtained data directly from telecommunications carriers, regulators and other government authorities. A limited amount of data available from public sources such as web sites and published documents was also used.

For some of the indicators and countries, there were difficulties in obtaining the information, particularly separate data for rural and urban areas. The extent of the availability of data is illustrated in table 1.2. In some cases the information is not collected in a country because the degree of interest does not justify the cost of collection. In other cases, the data was confidential or was not provided to the Commission for some other reason.

1.5 Structure of the report

Information on the demographic environment of the countries in the study, the ownership structure and regulation of the industry and other forms of government intervention, which affect outcomes for rural and urban users of telecommunication services, is presented in chapter 2.

Accessibility, quality and price information for PSTN and mobile voice services are presented in chapters 3 and 4.

Chapter 5 includes information on the extent and quality of basic PSTN access to the Internet, including some international comparisons of data rates of the rural and urban parts of customer access networks.

Technology options for high speed data services, and the current and expected progress in deploying these options are described in chapter 6. Relative user outcomes in terms of price and performance for Internet access in remote, rural and urban areas are presented in chapter 7.

Table 1.2 **Availability of information for telecommunications services in remote, rural and urban areas, 2001**

	Australia	*Canada*	*Finland*	*France*	*New Zealand*	*Sweden*	*UK*	*US*
General								
population densities	✓	✓	✓	✓	✓	✓	✓	✓
rural government initiatives	✓	✓	×	×	/	/	✓	/
PSTN voice services								
penetration	/	✓	✓	/	/	/	/	/
quality of service	✓	✓	/	×	/	×	/	/
payphone access	/	✓	×	×	/	×	/	/
payphone serviceability	✓	×	×	×	×	×	×	×
price	✓	✓	✓	✓	✓	✓	✓	✓
Mobiles								
penetration	/	/	/	/	/	/	/	/
coverage	/	/	/	/	/	/	/	/
roaming	/	/	×	×	/	×	×	×
quality of service	/	/	×	×	/	×	/	×
price	✓	✓	✓	✓	✓	✓	✓	✓

(Continued next page)

Table 1.2 (Continued)

	Australia	*Canada*	*Finland*	*France*	*New Zealand*	*Sweden*	*UK*	*US*
Basic PSTN access to the Internet								
penetration	/	/	/	/	/	/	/	/
usage	/	/	/	×	/	/	/	/
local call access to Internet	✓	✓	×	✓	/	✓	×	/
distribution of line lengths	✓	/	×	×	×	×	×	/
distribution of data rates	✓	/	×	×	×	×	/	/
High speed access to the Internet[a]								
deployment	/	/	/	/	/	/	/	/
penetration	/	/	/	/	/	/	/	/
plans for future deployment	/	/	×	/	/	✓	/	/
prices	✓	✓	/	/	✓	/	/	✓

Note Quality of service information relates to January 2001 and price information to May 2001.

✓ Information available. In some cases the price information is uniform across the country (does not vary between remote, rural and urban).

/ Limited information available, usually on a countrywide basis or for parts of a country (for example, a group of states in the US or provinces in Canada). In some cases, information for rural and urban areas can be derived from countrywide data with the aid of additional information and assumptions. However, cross-country comparisons may be difficult because of measurement differences or inconsistencies (which is the case for Internet penetration measures, for example).

× Information unavailable — confidential, not collected or not accessible by the Commission.

a Includes ISDN, ADSL, HFC cable, MMDS, satellite and mobile. However, the indication that data are available countrywide may not necessarily apply to all the technologies.

Sources: Productivity Commission and Network Strategies 2001.

2 Demographic and institutional context

The deployment of telecommunications services in rural and urban areas of a country, and their price and quality, are related to the demographic and institutional context in which these services are provided.

Patterns of population distribution affect the relative costs of providing services in rural and urban areas. Government involvement in, and regulation of, the industry can have an impact on the accessibility, quality and price of services.

Information on rural and urban population densities and the various forms of government intervention is provided in this chapter to assist readers to understand some of the underlying reasons for remote, rural and urban service and price relativities presented in the following chapters.

2.1 Rural and urban population densities

One possible reason for the interest in telecommunications services in remote and rural areas is the relatively high cost of provision in these areas and the associated difficulty of ensuring a quality of service and price comparable with urban areas. The efficiency and equity considerations associated with cost differences have provided a challenge for government policy in many countries. This is particularly significant in countries such as Australia because of the disparity of population densities between rural and urban areas.

Population distribution and telecommunications costs

The relationship between average telecommunications cost per user and population density depends on the transmission technology — basic fixed wire or fixed wireless, mobile, high speed hybrid fibre coaxial (HFC) cable, asymmetric digital subscriber line (ADSL), and satellite.

The average cost per line of providing local public switched telephone network (PSTN) services in low-density areas of Australia, where there are less than two customer access lines per square kilometre, was found to be between six and ten times the average cost per line in the rest of Australia (Cribbett 2000).

There are also large differences in the costs of widespread provision of high speed data services in low-density and high-density areas using the new technologies. However, differences in costs are much less for satellite services than for the services delivered by the other technologies.

Remote, rural and urban price and quality relativities in Australia and the other selected countries should be interpreted in the context of the differences in service costs in these areas.

Differences in rural and urban definitions

As illustrated in table 1.1 (in chapter 1), the definitions of rural and urban areas employed by the official statistical authorities of the countries included in the study vary. Communities with a population of less than 1000 are defined as rural in four of the eight countries, including Australia. Communities of less than 2000 and 2500 are regarded as rural in France and the US, respectively. In Sweden and Finland, communities of less than 200 are defined as rural.

Differences in rural–urban definitions have implications for relative rural–urban population densities. In turn, differences in rural and urban population densities affect the relative cost of providing services between these areas.

Information on populations of towns of various size categories provided in Rowland (1999) was used to investigate the effect of having different definitions in Australia and the US for the lower limit of the population of an urban community.

The towns in the US with populations between 1000 and 2500 are estimated to account for about 3 per cent of the total US population. That is, only 3 per cent of the US population which is included in the US definition of rural would be regarded as urban under the Australian definition. Changing the lower limit for the population of an urban community in the US from 2500 to 1000, to bring it into line with the Australian lower limit, does not significantly alter the ratio of the average rural to the average urban population density in the US.

Some statistical authorities subdivide the urban category into cities and towns of different sizes. For example, the Australian Bureau of Statistics has ‘major urban’ (with populations of 100 000 or more) and ‘other urban’ categories. The US Census Bureau defines ‘urbanised areas’ to comprise one or more contiguous places and the adjacent densely settled surrounding areas (urban fringe) that together have a minimum of 50 000 persons. All other places of more than 2500 are designated 'other urban'.

Rural population densities

Rural population densities in Australia are much lower than in other OECD countries, according to information published by the World Bank. The average rural population density in Australia is less than six persons per square kilometre of arable land. This compares with between 15 and 100 persons per square kilometre in North American and European countries (see table 2.1).[1]

Table 2.1 **Rural population densities, 1999**

Country	*Total population*	*Share of population in rural areas*	*Rural population density*	*Non-arable land as share of total land*
	millions	per cent	persons per square km of arable land	per cent
Australia	19.0	15.3	5.7	93.4
Canada	30.6	23.0	15.0	95.3
Finland	5.2	33.3	83.8	93.9
France	59.1	25.3	80.3	66.2
New Zealand	3.8	14.7	34.0	93.9
Sweden	8.9	16.7	53.9	93.9
United Kingdom	59.1	10.6	106.8	76.0
United States	272.9	23.0	35.5	80.7

Note Definitions of rural areas used by the statistical authorities of the countries are given in table 1.1. In most cases, similar definitions are used. However, some small towns of a size included in the French and US definitions of rural areas, are included in the urban areas of most of the other countries, including Australia. This slightly increases the rural densities in France and the US relative to areas defined as rural in Australia. On the other hand, very small towns (below 1000 population) are included in the Finnish and Swedish rural definitions, which reduces the rural population densities of these countries compared with areas defined as rural in Australia.

Sources: Network Strategies 2001 and PC estimates.

The measures of population density in rural areas are based on highly aggregated data. In the total rural area of each country, there are different rural environments (intensive farming, plantations, tourist areas and so on), each with a different population density. In table 2.1, the rural population density estimates are effectively simple averages of the densities of component areas.

Over 15 per cent of the Australian population resides in rural areas, which is lower than North America and parts of Europe, but similar to Sweden and New Zealand.

1 Arable land excludes deserts, lakes, mountainous land, natural forests and tundra and also land abandoned as a result of shifting cultivation.

The rural Australian population includes a significant number of people dispersed around the fringe of cities and towns.

A large part of the Australian landmass is non-arable land, and therefore sparsely populated or uninhabited. This is also the case for Canada, New Zealand and the Scandinavian countries (see table 2.1). However, there are pockets of population in the remote areas of each of these countries, including Australia.

Urban population densities

Information published by Wendell Cox suggests that, for all urbanised areas with a minimum population of at least 50 000, Australian densities are comparable to those in the US (Wendell Cox Consultancy 2000). However, they are significantly lower than those in Canada and Europe (see table 2.2).[2]

Rowland (1999) presents information that allows separate comparisons of average population densities for different definitions of urban areas.[3] The average densities for all urban areas with a minimum population of at least 50 000 calculated using this data are 1370 persons per square kilometre for Australia and 1140 for the US. These density estimates are reasonably consistent with those reported by Wendell Cox.

If urban is defined to include all settlements with populations greater than 1000, which is the dividing line between urban and rural for most countries, the average urban density is about 840 persons per square kilometre in Australia and about 740 in the US. In both countries, population densities for larger cities are greater than for smaller cities and towns, according to the Rowland data.

Differences in urban and rural densities and costs

The ratio of the average urban density to the average rural density (in arable areas) is much greater in Australia than in Europe, New Zealand or the US. The ratio of urban to rural density is also large in Canada, but not as large as in Australia. This is illustrated in table 2.2, where urban areas are limited to cities with populations greater than 50 000 (referred to as ‘urbanised’ areas) and rural areas are as defined by the statistical authorities.

Towns and small cities (‘other urban’ areas) are not covered in table 2.2 because of a lack of data. Analysis of the Rowland data for Australia and the US indicates that

2 It has not been possible to obtain information on the average densities for all urban areas (that is, with populations above 1000) in each of the countries being considered.

3 That is, urban can be defined to include a range of settlement sizes.

these ‘other’ urban areas have significantly lower population densities than urbanised areas. However, the difference in population density between *rural* and *urbanised* areas is far greater than the difference between *other urban* and *urbanised* areas.

Table 2.2 **Relative population densities**

	Average density (persons per square kilometre)		Urban/rural density ratio	Rural/urban density ratio
	Urban areas	Rural areas[a]		
Australia	1278	5.7	224	0.0045
Canada	2625	15.0	175	0.0057
Europe	5093	80.0	64	0.0156
New Zealand	1278	34.0	38	0.0263
United States	1225	35.5	35	0.0286

Note Rural areas are defined as in table 2.1. Urban areas include cities with a population of 50 000 or more. [a] Arable land only.

Sources: Network Strategies 2001 and Wendell Cox Consultancy 2000.

The patterns of population distribution in Australia and most of the other benchmarked countries suggest that average costs of providing telecommunications services in rural areas (compared with costs in urban areas) will be greater in Australia than in the other countries.

In all countries, unit costs are relatively high in rural areas where population densities are low. In Australia, rural PSTN costs could be triple urban costs.[4] In the other countries, which have higher rural to urban population density ratios, the difference in rural and urban costs may be somewhat less than in Australia.[5]

Average costs in remote areas are much higher than those in the arable rural areas considered in the preceding discussion, for most telecommunications technologies. As mentioned earlier, all the countries studied have some population in remote areas. However, the remote populations in Australia and Canada are more distant from urban centres than is the case for most other countries. Therefore, the costs of serving remote areas are likely to be relatively higher in these countries.[6]

4 This ratio is illustrative and order-of-magnitude only. It is based on information from table 4.1 on page 26 of Cribbett (2000), and on table 2.2 above.

5 The European cost ratio may be reduced by relatively high population densities for both rural and urban areas, and because the cost variation with density is less at higher densities.

6 The average countrywide cost of providing telecommunications services varies considerably among countries, according to a previous study undertaken by the Commission (Cribbett 2000). Australia has a larger share of its population in very low density areas compared with other countries or regions. The impact of this characteristic of the geographic distribution of the

2.2 Industry ownership

Most of the benchmarked countries have a policy of encouraging competition and efficiency in the telecommunications sector. A variety of legislative and regulatory arrangements are being used to achieve this.

Competition and productivity has increased to a much greater extent in long-distance PSTN and mobile markets than in local service markets, and in urban markets than in rural markets. Large business may have benefited more from the price reductions induced by increased competition than residential and small business users because of their negotiating strength and access to volume discounts.

Universal service obligations (USOs) and price capping have been employed in some countries to help users in remote and rural areas to share (along with urban users) in the benefits of reduced costs that have been generated by technological developments and improved efficiency in the telecommunications industry. More recently, government funding has been targeted towards provision of enhanced services in remote and rural areas.

In the past, Australian and many overseas governments facilitated universal service objectives through their ownership of the incumbent telecommunications carriers. Typically, they required their carrier to charge uniform prices in all regions of a country — despite significant differences in the cost of providing services.

In recent years, governments have pursued policies of commercialisation and privatisation with a view to improving industry efficiency. As a consequence of these policies, most of the carriers in the countries being studied are now either fully or partially privatised (see table 2.3).

The Australian Government has indicated it does not intend to proceed to the full privatisation of Telstra until it is satisfied that arrangements exist to deliver adequate services, particularly in remote, rural and regional Australia. The services identified in the Telecommunications Service Inquiry (TSI) that had to be addressed were reliability, fault repairs and Internet access speeds.

Australian population would tend, by itself, to push up the average cost of providing telecommunications services. As explained in Cribbett 2000, there is a range of other factors which also affect average costs in each country.

Table 2.3 **Ownership structure of incumbent carriers, January 2001**

Country	*Carrier*	*Ownership*
Australia	Telstra	50.1 per cent government-owned
Canada	Bell Canada	fully publicly listed
	TELUS	fully publicly listed
Finland	Sonera	53 per cent government-owned (authorisation to sell)
	Finnet	association of listed and community or cooperatively-owned companies
France	France Telecom	55.5 per cent government-owned
New Zealand	Telecom New Zealand	fully publicly listed
Sweden	Telia	70.6 per cent government-owned
United Kingdom	British Telecom	fully publicly listed
United States	Verizon	fully publicly listed
	SBC Communications	fully publicly listed
	Qwest	fully publicly listed
	AT&T	fully publicly listed

2.3 Regulatory environment

The regulatory environment has a direct impact on the quality and price of telecommunications services in some countries. For example, USOs and price control policies may act to equalise service access and call charges in rural and urban areas. The quality of voice services in different areas of a country may be influenced directly by standard targets — customer service guarantees — and monitoring arrangements established by governments.

Regulation of competition has an indirect impact on service and price, particularly in urban areas. Regulatory intervention is often aimed at encouraging potential competitors to enter the industry by assisting them to gain access to incumbent facilities, as well as by discouraging anticompetitive conduct. It may also be aimed at increasing the range of services available.

Universal service obligations

In Australia and all of the benchmarked countries, there are universal service policies in place. In most of the countries the obligations are set out in legislation.

USOs generally require designated carriers to provide basic telephony services at affordable prices to sparsely populated high-cost regions. These services are usually provided to remote, rural and urban users at a uniform price.[7]

In Australia, the USO arrangements are set out in the *Telecommunications (Consumer Protection and Service Standards) Act 1999*. The main objective of the USO is to ensure that all Australians, wherever they live or carry on their business, have access on an equitable basis, to standard telephone and payphone services (PSTN services), and digital data services.

Telstra is currently the sole universal service provider in Australia. However, other carriers may be declared providers and be required to satisfy universal service obligations in the future.

USO funding arrangements tend to vary from country to country (see box 2.1).

Retail price controls

All of the countries covered by this study, except Finland, have some form of price regulation for telecommunications services. In Australia, Telstra is subject to a number of price control arrangements, applying to PSTN voice services and analogue calls to connect residential users to the Internet.

The current set of Australian price controls is effective from 1 July 1999 until 30 June 2002.[8] Controls include:

- A CPI-X per cent price cap on a broad range of services, including local calls, trunk calls, international calls, fixed-to-mobile calls, fixed line connections, line rentals, and domestic and international leased lines;[9] and

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7 Generally a uniform price implies that connection fees, rental costs, long-distance and local call rates are identical for both rural and urban users.

8 Since price control arrangements were first introduced in 1989, the Federal Government has conducted periodic reviews of the Telstra price control arrangements. The Australian Competition and Consumer Commission (ACCC) commenced the most recent review in September 2000 and reported to the Minister at the end of January 2001.

9 The ‘X’ factor is currently set at 5.5.

- A number of price sub-caps including a 22 cent per call cap on the provision of basic untimed local calls, and a cap of 40 cents per call for all Telstra public payphones. There are additional sub-caps relating to 'low spending' users.

Box 2.1 **USO funding arrangements in selected countries**

In Australia and Canada, the USO regimes provide for all carriers and hence their users to contribute towards the cost of servicing the USO. The purpose is to remove the competitive disadvantage a carrier with USOs may face in urban and long-distance markets.

In New Zealand, the USO, known as the Kiwi Share Obligation, is funded primarily by Telecom New Zealand but with a contribution from interconnection revenue paid by other carriers. That said, a Ministerial Inquiry into Telecommunications found that Telecom New Zealand made sufficient above cost of capital returns from users of the PSTN local services and other business activities, to adequately meet the cost of the USO from internal sources (MIT 2000).

Historically, the US has had a complicated system of universal service and customer rentals (access deficits) support, funded by charging higher rates for other relatively profitable services including business services, inter-exchange toll services and carrier access (interconnection) services.

As of January 2000, the Federal Communications Commission (FCC) changed the federal funding process for the high cost areas of non-rural companies — it is phasing in a new formula for estimating USO costs using a forward looking local cost model. However, the majority of cross subsidies remain (Network Strategies 2001).

Under European legislation, a fund can be established in an EU country where the costs of the USO are shared among all carriers, but only if there is a net cost which imposes an unfair burden on the USO provider.

In France, a national universal service fund was established in 1997. Net costs of overall geographic supply were compensated by interconnection surcharges until December 2000.

In Sweden, Finland and the UK, incumbent carriers must meet all universal service costs.

In contrast, price cap regulation applies to all carriers in Canada. This regime came into effect on 1 January 1998 for a four year period. It limits annual price increases for basic residential local telephone service, on average, to the inflation rate (Network Strategies 2001).

The main beneficiaries of USO arrangements and associated price controls are those living in remote and rural areas. Carriers tend to provide most PSTN services at a uniform price despite the higher cost of providing the identical service to these areas compared to urban areas. In the absence of price controls, remote and rural subscribers may have to pay more for basic telephony services than their urban counterparts.

Data services

Although USOs have traditionally been used to provide voice telephony services to all users, USOs have been extended to include the provision of data services in recent years. In part, this reflects the increasing importance of the Internet as a communication tool and the inadequacy of the PSTN (which was designed as a voice network) to provide acceptable data transmission rates in some remote and rural areas.

In Australia the USO was amended in 1999 to incorporate a digital data service. These new arrangements permit the declaration of multiple service providers if more than one carrier expresses an interest in providing these services. However, Telstra is currently the only declared carrier to provide both the general and special digital data service.

Under the general digital data service obligation (DDSO), Telstra is required to provide a two-way data transmission service broadly comparable to a 64 kilobits per second (kbps) data transmission rate (in each direction). This service is supplied by Telstra's integrated services digital network (ISDN).

The DDSO must be provided on request to at least 96 per cent of the population. Although Telstra must offer this service there are no pricing restrictions, in contrast to its PSTN obligation.

For the remaining 4 per cent of the population who do not have access to ISDN services, Telstra is required to make available a special DDSO broadly comparable to a one-way transmission rate of 64 kbps using satellite technology. Primarily these people are located in remote and rural areas or more than four kilometres from a metropolitan exchange or six kilometres from a country exchange (TSI 2000). They will be reimbursed up to $765 for the purchase of satellite receiving equipment.

By incorporating a digital data service into the USO, all Australians potentially have access-on-demand to Internet services with a downstream transmission rate to the user of at least 64 kbps. However, for many living in remote and rural areas of Australia, the choice of Internet access is limited to technology combining satellite (for downstream) and PSTN (for upstream transmission). In contrast, many in urban areas have a broader range of options for accessing the Internet including the PSTN, ISDN, ADSL, HFC cable and satellite. ISDN, ADSL and HFC cable technologies all supply relatively high transmission rates in each direction.

In the US, the universal service is intended to ensure, among other things, access to advanced telecommunications services for all Americans.[10] This is aimed at ensuring that those living in rural areas will be able to share in the buildout of advanced services to the same degree as those living in more densely populated areas. In addition, the *Telecommunications Act 1996* states that these services must be made available to all schools, health care providers, and libraries.

The US federal telecommunications regulator — the FCC — has defined advanced telecommunications capability as the ability to transmit data in either direction at a rate of at least 200 kbps. Where the data rate is asymmetric, a service is defined to be ‘high speed’ if it provides at least 200 kbps in one direction (FCC 2000c).

In a recent report released in the US, the rate of deployment of wireline broadband services in rural areas was recorded as being slower than in urban areas. In part, the slower deployment rate in rural areas reflects economic realities. For HFC cable and ADSL technologies, the cost to serve a user increases as the distance between users increases (NTIA 2000).

Under Canada’s USO, local exchange carriers are required, as part of the defined basic service objective, to provide users with low speed access to the Internet at local service prices. However, the basic service objective does not define the actual data transmission rate that must be supplied by carriers (CRTC 1999).

In New Zealand and the UK, the provision of data services within the USO is under review. In December 2000, the New Zealand Government recommended a number of changes to the Kiwi Share Obligation following a Ministerial Inquiry. One recommendation was to require carriers to upgrade the PSTN to provide basic Internet services of 9.6 kbps data capability to 99 per cent of residential lines and to provide 14.4 kbps data capability to 95 per cent of residential lines.

Regulation of competition

In Australia and the benchmarked countries, access to incumbent carrier services (those owning and controlling ubiquitous networks) by other service providers is required to provide for competition. This is required primarily because efficient use of many telecommunications services depends on ‘any-to-any’ connectivity, that is the ability for any user of the service to contact any other user, regardless of the carrier.

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[10] Advanced telecommunications is a high speed, switched, broadband telecommunications capability enabling users to originate and receive high-quality voice, data, graphics and video telecommunications. It is defined without regard to any specific transmission media or technology.

Access to the incumbent's network has provided opportunities for new entrants to contest both the PSTN (voice) and high speed data markets. Regulated access of the domestic PSTN generally involves the supply of originating and terminating services to new entrants.[11] In recognition of the increasing demand for high speed data services, some countries have attempted to facilitate their deployment, among other things, by unbundling the local loop to provide new entrants with greater flexibility on how and where to gain access (see box 2.2).

These arrangements tend to produce more competition and choice in urban areas than in remote and rural areas. Diseconomies in the provision of these services in remote and rural areas present a barrier to new entrants.

Another barrier to the competitive supply of PSTN voice services in remote and rural areas has been price caps. These have limited the potential for prospective entrants to cover the higher costs of servicing these users.

The competitive supply of high speed data services in remote and rural areas is adversely affected because of the technical and economic constraints on deployment of some high speed technologies in low density areas. In particular, ADSL is suited to line lengths of less than 4.5 km from the local exchange. There is also more scope in urban areas for new entrants to attract users and establish new markets because of higher population densities.

11 PSTN originating access is primarily used by new entrants to carry long-distance calls (both national and international) from the user (A-party) connected to the incumbent's PSTN network, to a point of interconnection with the new entrant's network for long-distance transmission. PSTN terminating access is used by new entrants for the termination of calls from the new entrant's network to a user (B-party) directly connected to the incumbent's network (ACCC 1999).

Box 2.2 Developments in unbundling the local loop for high speed data access in selected countries

In July 1999, the ACCC declared the unconditioned local loop (ULL) service to enable competitors to use Telstra's copper lines to deploy ADSL technology in order to supply both voice and high speed data services. ADSL deployment thus far has been mainly confined to urban areas (ACCC 2000).

Since the establishment of a regulatory access regime for high speed data services, a number of Australian service providers have entered the market. For example, in February 2000 Primus Telecommunications commenced deployment of high speed ADSL connections to CBD users in Sydney, Melbourne, Brisbane, Adelaide and Perth using Telstra's ULL (Braue 2000). Also, in November 2000 after an extensive product development period, iiNet, a Western Australian Internet service provider (ISP), successfully deployed ADSL products to business users predominantly located in the Perth metropolitan area (iiNet 2000).

Of the other benchmarked countries Sweden, Finland, Canada and the US have unbundled their local loop for high speed data access. However, the UK is expected to unbundle their local loop from July 2001.

In Sweden, unbundling of the Telia-owned local loop commenced in March 2000, enabling competing broadband carriers to either purchase packaged ADSL services, or lease the copper line and install their own ADSL system (Network Strategies 2001).

Although Telia dominates the deployment of broadband services, a new entrant was the first to offer residential ethernet services, targeting urban multi-tenanted buildings where fixed costs can be spread across a number of users and shared between the carrier, landlord and tenants.[a] This new development does not extend to users in sparsely populated rural areas (Network Strategies 2001).

In Finland, Sonera — one of the incumbent carriers — commenced offering ADSL access on unbundled local access lines in June 1998. Sonera expanded its ADSL infrastructure in 1999 and now offers ADSL access in nine cities. Elisa Communications also launched an ADSL service for users in the Helsinki metropolitan area in September 1999 (Network Strategies 2001).

In the US, the FCC's ruling in November 1999 to allow line sharing with the incumbent carrier, has encouraged competitive local exchange carriers and ISPs to launch residential-focused digital subscriber line (DSL) services. Prior to the ruling, alternative DSL providers had argued that the cost of installing a second line was a barrier to the extension of their services into the more price sensitive residential sector. Since this ruling a large number of commercial DSL providers have entered the market in major urban areas. Competition has developed not only in services sold direct to the end user, but also in wholesale DSL provision. A number of large intermediaries in the US have specialised in negotiating with the incumbent carriers for access to their local loop infrastructure and then reselling this access to ISPs (OFTEL 2000).

[a] Ethernet is the most widely installed local area network (LAN) technology. An ethernet LAN typically uses coaxial cable or special grades of twisted pair wires. The most commonly installed ethernet systems are called 10BASE-T and provide transmission rates up to 10 Mbps.

Contestability in the supply of universal service obligations

The Australian Government has recently made the provision of remote and rural services contestable in order to address the barriers faced by new entrants. The implementation of a pilot project in two rural areas and a competitive tender arrangement for remote areas are intended to promote competition, and reduce prices at the same time as improving service standards, and increasing the level of investment in infrastructure.

The two pilots for the competitive supply of services under the USO are a test of the arrangements before wider implementation. Both pilots involve new universal service providers competing with Telstra for subsidies (on a per service basis) to provide standard telephone services that would otherwise be uncommercial. On 11 May 2001 the Australian Communications Authority (ACA) released the draft *USO Contestability Guidelines* which outlines the application and approval process in detail (ACA 2001b).

A competitive tendering process has also recently been undertaken by the Australian Government to select a carrier to provide untimed local call access to around 40 000 services in the so-called 'extended zones' in remote and rural areas.[12] These zones cover approximately 80 per cent of the country.

The Federal Government announced in February 2001 that Telstra had been selected as the preferred tenderer under a contract worth $150 million. From 31 July 2001 Telstra will provide untimed local calls and untimed local call access to the Internet via Internet service providers at rates ranging from 14.4 kbps to 19.2 kbps. In addition, all extended zone users will be offered more expensive 'always-on' two-way satellite-based Internet services with a choice of data transmission rates and prices, the maximum available downstream transmission rate being 400 kbps (Alston 2001d).

The outcome from the Ministerial Inquiry into Telecommunications suggests it is unlikely in the immediate future that competitive tendering will occur in New Zealand.

The Canadian Government has not adopted the competitive tendering approach to local services in the remote areas as Australia has. However, competition will be

12 Most users in the extended zones currently must pay 22 cents for every five minutes, or part thereof, when making local calls. The local calls in all other parts of Australia are untimed.

introduced in long-distance PSTN services in the remote northern areas.[13] This is one of the last areas not yet open to competition in Canada.

Service quality

The monitoring and reporting of quality of service measures for PSTN (voice), mobile and Internet services is less common in the benchmarked countries than in Australia. Further, where reporting occurs, separate measures for rural and urban areas are rarely provided.

In Australia, the ACA is required by law to report and monitor the performance of carriers and carriage service providers (including ISPs). Performance standards for PSTN services are set out in the customer service guarantee (CSG). The CSG is a legislated consumer safeguard and requires all providers to meet certain agreed targets. There are financial penalties linked to non-compliance with agreed targets, this being unique among the countries studied.

In Canada, the Canadian Radio-television and Telecommunications Commission (CRTC) has specified standards for a number of different aspects of PSTN service quality to be met by carriers. Regular performance reports against the standards are expected. Like the ACA in Australia, the CRTC reports separate measures for rural and urban areas.

In the US, the FCC has set targets for providers of PSTN services, but they do not report outcomes on a rural–urban basis. The CRTC and the FCC do not link financial penalties to non-compliance. In Canada, the CRTC and carriers work cooperatively to address non-compliance. The FCC relies on publication as an incentive to improve performance (ACA 2000c).

Generally, monitoring and reporting quality of service measures for PSTN (voice) are more rigorous than for mobile and Internet services. In Australia, mobile and Internet services are less regulated than PSTN services.

Australia and the UK are the only countries to report on quality of service outcomes such as call congestion and call drop-out for mobile services. However, disaggregated outcomes for rural and urban areas are not reported separately.

[13] There are approximately 110 000 northern Canadians who live in the Yukon, the Northwest Territories, Nunavut and northern British Columbia.

Spectrum allocations and auctions

Since the mid 1990s, radio-frequency spectrum has been used to support the growing demand for a range of telecommunications technologies such as local multipoint distribution systems (LMDS), multichannel multipoint distribution systems (MMDS), satellite communications and mobile telephony.[14]

Wireless communication is often a cost effective alternative to wireline communications. For example, terrestrial radio and satellite technologies may be more cost effective in delivering telephony and data services to some remote and rural users.

In Australia, spectrum auctions are used for allocating spectrum licences for public telecommunications services.[15] This method is intended to ensure that the spectrum allocation goes to its most efficient use and to those who value it most highly (ACA 1998b). Many other OECD countries also auction spectrum for public telecommunications services.

In contrast, Finland (the first country to licence third generation (3G) mobile networks), has not used auctions but rather awarded the licences on the basis of the applicant's financial capability and operational plan (ITU 1999).

Spectrum licences have been allocated on a regional, urban and national basis in a number of countries. Where a regional mobile licence is issued, access to national roaming becomes an issue for users who want to use their phone outside the region. Tariffs may be higher if licences are regionally fragmented because of the necessity to pay roaming charges (ITU 1999).

In March 2001, Australia auctioned spectrum licences in the 2 GHz band to be used principally for 3G mobile telecommunications.[16] The spectrum was offered for auction in 58 lots for metropolitan and regional areas, with two of the lots for national coverage. The structure of the auction lots allowed a bidder to bid for a 'national' licence, an 'all-cities' licence or for spectrum in individual cities or areas, with a single bid. Competition limits set for the auction meant that bidders could not

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14 Radio-frequency spectrum is the spectrum over which wireless communication is possible (from 30 kHz to 3000 GHz).

15 A spectrum licence is a licence to operate radio communications devices within specific frequencies, areas and times. In Australia they are issued for a period of up to 15 years. Spectrum licences are tradeable and can be divided on the basis of area or bandwidth or both. They are not renewable but holders may re-apply (ACA 2000a).

16 The 2 GHz spectrum band has been mandated by the International Telecommunications Union for 3G mobile telephony.

acquire more than 25 per cent of the available spectrum in metropolitan areas and no more than 50 per cent in regional Australia.

Spectrum licences were allocated in all major regional areas in Australia in this auction. However, the rollout of 3G in regional areas will be driven by user demand for services and the need for service providers to generate commercial returns on their investments.

Although the US has opted for regional licences, there is a trend toward mergers and consolidation in the telecommunications industry which has the effect of aggregating regional licences. Also carriers such as Sprint PCS have purchased large parcels of regional spectrum in order to establish a national network (ITU 1999).

2.4 Remote and rural initiatives by governments

A range of initiatives are used by governments in Australia and the benchmarked countries to address telecommunications needs in remote and rural areas. The purpose of these initiatives is to reduce user costs and increase the prospects of deployment of telecommunications technologies that might not otherwise be supplied to these areas. Some of these initiatives are discussed below.

Australia

Since 1997 the Australian Government has provided almost $1 billion in funding assistance to improve remote, rural and regional telecommunications services. This funding was made available to services providers and not-for-profit organisations by letting contracts to deliver specific services. The funds were sourced from the proceeds of the partial sales of Telstra in 1997 and 1999 and are allocated through the Networking the Nation (NTN) and Social Bonus programs.

Under the original NTN program, $250 million was allocated from the proceeds of the first partial sale of Telstra in 1997. The NTN program is designed to bridge telecommunications gaps in the provision of services between remote, rural and urban Australia. Funds have been allocated for a diverse range of projects to improve mobile coverage, to provide training and raise community awareness of telecommunications and information technology applications, to the delivery of online services and information, and to the provision of new or enhanced infrastructure (TSI 2000).

Following the second partial sale of Telstra in 1999, the Federal Government announced a $1 billion package of Social Bonus programs. Around $671 million of the total package has been allocated for improvements to telecommunication services in remote, rural and regional areas.

A number of the Social Bonus programs, however, are delivered through NTN.[17] The Social Bonus program also provides targeted funding for specific projects falling outside NTN. These include:

- An allocation of $25 million over three years to provide continuous mobile phone coverage along designated major Australian highways.
- An allocation of $150 million over three years for infrastructure to provide untimed local calls within extended zones in remote Australia.
- An allocation of $70 million over five years to improve service delivery to small rural communities through the Rural Transaction Centres program. This program is intended to help small communities to establish centres that provide access to basic transaction services such as banking, post, phone, fax and Medicare Easyclaim. Up to 500 local communities with populations under 3000 are expected to benefit from this program.

In response to the TSI, the Australian Government announced in May 2001 that a funding package of $163.1 million would also be provided to upgrade telecommunications services in remote, rural and regional areas.[18] This upgrade includes expanding mobile phone coverage in remote areas as well as measures to improve PSTN service quality and provide faster access to dial-up Internet services (Alston 2001b).

Canada

Generally the CRTC, the telecommunications regulator, has been responsible for improving PSTN services to remote and rural areas. In 1999, the CRTC implemented a new standard to improve telephone services to approximately 13 000 Canadians without telephone services and close to 7700 without a single line service. It has also introduced competition into the long-distance voice call market

17 These include the Building Additional Rural Networks ($70 million), the Internet Access Fund ($36 million), the Local Government Fund ($45 million), the Remote and Isolated Islands Fund ($20 million), and the Western Australian, South Australian and Tasmanian elements of the Extended Mobile Coverage ($3 million).

18 This funding is not part of the NTN program but is additional to it. Of the $163.1 million, $147.4 million is new funding allocated in the 2001 budget and $15 million will be reallocated from the existing Social Bonus program.

and changed the way subsidies are collected to support the local residential telephone service in Canada's high-cost service areas.

In 1998 the Canadian Government announced the *Connecting Canadians* initiative — a package of programs, policies and services to provide all Canadians with greater access to the Internet. As part of this initiative the community access program, administered by Industry Canada, provides free or affordable public access to the Internet in remote and rural areas. Access is through schools, libraries and community centres.

In October 2000, the Canadian Government announced the establishment of the National Broadband Task Force to advise the government on how best to make high speed Internet services available to businesses and residents in all Canadian communities by the year 2004. Initial findings are to be reported in late spring 2001. The Task Force is an important next step in the *Connecting Canadians* strategy, and will pay special attention to providing high speed Internet access services to remote and rural areas of Canada.

Other initiatives include joint funding arrangements between federal and provincial governments, condominium partnerships that build their own local broadband networks, and strategic alliances between governments and the private sector. For example, in April 2001 Telesat Canada (an Ottawa based satellite company) received funds from the Canadian Space Agency for the development of a satellite that can beam many low-cost multi-media services, including high speed Internet access, to Canadian users.

The Agency has agreed to invest Can$54 million in the satellite technology with an additional Can$20 million coming from other Canadian industries. In exchange for its investment, Telesat Canada will provide the Canadian Government with an equivalent value in multi-media satellite services to support initiatives such as telemedicine, telelearning, teleworking, e-commerce, high speed Internet and government services to users in remote, rural and urban communities throughout Canada.

New Zealand

The New Zealand Government does not appear to provide explicit funding for telecommunications services in remote and rural areas. However, in response to a recent Ministerial Inquiry into the Telecommunications Industry, the Government has announced a number of measures intended to redress rural concerns. These include:

- An upgrade of the Kiwi Share Obligation to improve Internet access. This will enable New Zealanders living in rural areas to utilise one-way satellite (PSTN upstream) services.
- The establishment of a taskforce to facilitate solutions to electric fence interference with Internet access in rural areas.
- The establishment of an organisation to promote, among other things, access to bandwidth.

Sweden

The Swedish Government has accepted responsibility for ensuring that access to high bandwidth services are available nationwide, with no major differences between rural and urban areas in accessibility, charges and capacity.

In December 2000, the Ministry of Industry, Employment and Communications Broadband Committee announced a program to establish a nationwide broadband network, to reach 98 per cent of towns and villages. Towns of more than 3000 inhabitants comprising 70 per cent of the Swedish population, are believed to be attractive to commercial carriers in their own right. Smaller towns will be reliant on government funds which would be matched by the municipalities. Tax incentives would also be available in remote areas.

United Kingdom

In 2001 the UK Government announced the establishment of a £30 million fund to help deliver high speed Internet services across the country over the next three years. It is envisaged that this will enable broadband networks to be extended to a wider range of areas than would have been commercially viable. The national strategy will be implemented by local administrations and Regional Development Agencies (Network Strategies 2001).

It is also expected that local initiatives will support roll out of higher bandwidth facilities into areas where carriers may not currently plan to offer such services. For example, in Wales the Pathway Project was aimed at upgrading the telecommunications infrastructure in rural areas to allow access to advanced telecommunications services by the end of 2001.[19]

19 This project is run jointly by Powys County Council and the Welsh Development Agency and supported by EU Structural Funds.

Other ‘Assisted Areas’ may be in a position, within European investment rules, to receive funds for the provision of higher bandwidth services to public access points, schools and businesses in remote and rural communities. However, in very remote areas, technical and commercial constraints limit the options for delivery of higher bandwidth services.

In 2000, MLL Telecom was awarded a five year multi-million pound contract to establish a rural broadband wireless communication network for the three Welsh counties of Powys, Carmarthenshire and Ceredigion. The network will link the three county councils and twelve towns, for high speed Internet access and the delivery of regional information services (Network Strategies 2001).

United States

In the US, the Rural Broadband Loan Program and the Technology Opportunities Program have been established to promote the development and use of advanced communication services in rural areas.

Rural broadband loan program

The Rural Utilities Unit of the US Department of Agriculture announced in 2000, a new loans program to finance the construction and installation of broadband telecommunications services in rural America. The US Government made US$100 million in treasury rate loan funds available, for a one year pilot program, to encourage telecommunications carriers to provide broadband service to rural users where such service did not exist.

This program provides loan funds to communities of up to 20 000 inhabitants to help ensure rural users have the same quality and range of telecommunications services that are available in urban communities. Loan fund applications were to be processed and approved on a first-come first-serve basis throughout the financial year 2001 until the appropriation is utilised in its entirety.

Technology opportunities program

The technology opportunities program, which has some similar characteristics to the NTN program in Australia, provides matching grants on a competitive basis to State, local and tribal governments, health care providers, schools, libraries, police departments and community-based non-profit organisations. Around 65 per cent of the grants go to projects supporting rural areas.

These grants are used to:

- purchase equipment for connection to networks, including computers, video conferencing systems, network routers, and telephones;
- buy software for organising and processing information;
- train staff, users and others in the use of equipment and software;
- purchase communication services such as Internet access;
- evaluate the projects; and
- disseminate the projects' findings (NTIA 2000).

A number of US States have collaborated with the private sector in innovative ways in using these funds. For example, in an initiative known as 'Connecting Minnesota' the State Government has agreed that in return for allowing a Denver-based network developer access to interstate rights-of-way, the developer will spend over US$200 million installing 2200 miles of fibre optic cabling along Interstate and trunk highways, providing advanced telecommunications infrastructure to rural towns throughout Minnesota.

2.5 In summary

Underlying the interest in telecommunications services in remote and rural areas in Australia is the high cost of provision in these areas and the associated difficulty of ensuring a quality of service and price comparable with urban areas.

The ratio of the average rural density to the average urban density is lower in Australia than in all the other benchmarked countries. As a consequence, the costs of providing telecommunications services to remote and rural areas, compared with urban areas, are higher in Australia than in the other benchmarked countries.

USOs and associated price controls are used by governments in some of the benchmarked countries to ensure affordable PSTN prices, especially in remote and rural areas. In the absence of these policies, remote and rural users could expect to pay more for basic telephony services.

Pro-competitive policies have tended to produce more competition and choice in urban areas than in remote and rural areas. Barriers to market entry in remote and rural areas are created by:

- the diseconomies that arise when services are supplied by more than one provider in areas of low population density;

- price caps when they limit the potential for prospective entrants to cover the higher costs of servicing these areas; and
- technical and commercial constraints on deployment of some high speed technologies in low density areas.

The Australian Government has recently moved to address the barriers faced by new entrants. The provision of remote services was subjected to a process of competitive tender. Also, arrangements for the competitive supply of services are being tested in two regional areas.

Most countries provide financial assistance for improvements to existing services or the introduction of new services in remote and rural areas. For example, since 1997 the Australian Government has provided almost $1 billion in funding assistance to improve remote, rural and regional telecommunications services. An announcement to provide a further package of $163.1 million has recently been made.

Government funding programs in the benchmarked countries have facilitated improved PSTN services and Internet access, increased mobile coverage, assisted with the roll out of high bandwidth services, and provided training and raised community awareness of telecommunications and information technology applications.

3 Public Switched Telephone Services

Voice services delivered by fixed access public switched telephone networks (PSTN) are covered in this chapter. Users of these networks are predominantly connected through copper wires. However, some users in remote areas are connected by fixed radio systems such as Telstra's digital radio concentrator system (DRCS) or high capacity radio concentrator (HCRC).[1]

The PSTN has been progressively developed and expanded over many years and now provides voice services to the great majority of households and businesses in developed countries.

Differences or relativities in performance across remote, rural and urban areas are compared with equivalent relativities in other countries. These comparisons include the extent of customer access and the quality and price of PSTN voice services.

The comparisons should be interpreted in the context of the demographic and regulatory environments in each country, as discussed in chapter 2.

3.1 Penetration

The PSTN is a mature network in most developed countries, with the great majority of households having a telephone. There are more than 50 access lines per 100 population serving households and businesses in all the countries studied except New Zealand (see table 3.1).

The number of fixed PSTN access lines has begun to decline in some countries. In Sweden, the number of fixed lines per 100 population — the penetration rate — fell by 4.5 per cent between 1998 and 1999. However, total services (fixed lines plus mobile) per 100 people grew over the same period and is now above 130, one of the highest rates in the world (MTT 2000).

Information on telephony penetration is not generally available for remote, rural and urban areas because of the difficulty in matching the numbers of access lines,

1 For a few subscribers in urban areas voice services are delivered over hybrid fibre coaxial (HFC) cables.

households and people in these areas on a consistent basis. However, it has been estimated that the number of lines per 100 persons in *Australia* ranged from an average of 24 in areas below 0.01 persons per square kilometre, to 76 in areas with more than 10 000 persons per square kilometre (Cribbett 2000).

Table 3.1 **Fixed telephony penetration rates for selected countries, 1998**

Country	*Households with a telephone*	*Access lines per 100 population*
	per cent	number
Australia	96.4	51.2
Canada	98.4	63.4
Finland	96.0	55.4
France	98.0	57.0
New Zealand	96.0	47.9
Sweden	98.7	67.4
United Kingdom	95.0	55.6
United States	94.2	66.1

Note Penetration is measured as either the per cent of households with a PSTN telephone or the number of PSTN phones per 100 population. The concept here refers to total industry penetration and not penetration of the telephony market by a single carrier.

Source: ITU 1999.

One explanation of this variation may be that there are more business lines per head of population in more densely populated regions. It might also indicate that the number of households without a telephone line in low density areas is higher than average due to the higher price and greater difficulty to get a new line connection. The lower quality of PSTN service in these areas may also be a factor.

In *Canada*, the proportion of households having a telephone is estimated to be 98.7 per cent in urban areas (centres of 1000 persons or more with a population density of over 400 persons per square kilometre) and 98.5 per cent in rural areas, according to a survey by Statistics Canada which excluded remote northern territories (Network Strategies 2001).

In *Finland*, there are some significant variations in the penetration of PSTN lines among the regions. An island community in the south has 75 lines per 100 persons. There are about 65 lines per 100 persons and a population density of over 200 per square kilometre in the Uusimaa region (around Helsinki). On the other hand, in central Finland, with population densities of 20 to 40 persons per square kilometre, there are around 47 lines per 100 persons. There is a similar rate in Lapland, in the far north, where there is a population density of only 2 persons per square kilometre (Network Strategies 2001).

In the *United Kingdom*, the proportion of households with a telephone varies from 98 per cent in London to 89 per cent in Northern Ireland.

In the *United States*, Maine has a penetration rate of 98.5 per cent of households and Mississippi 88.8 per cent. It is likely that these variations are more reflective of differences in economic conditions than population densities because there are only small penetration rate differences between rural and urban areas in the US (Network Strategies 2001).

Payphones

There were about 78 000 *payphones* in Australia (including both Telstra and customer operated phones) compared with 10 million fixed PSTN lines connected to households and businesses. Australian surveys suggest that 30 to 35 per cent of households regard payphones as being very important. Payphones are much less important to small businesses, although 24 per cent of business respondents in remote areas rate them as very important (ACA 2000b).

There were about 4.2 payphones per 1000 persons in Australia. This compares with 5.5 to 6.5 in North America and the UK, and 1.3 in New Zealand (ACA 2000b).

In Canada, there were 20 to 30 per cent fewer payphones per 1000 persons in rural than in urban areas. Payphone penetration in remote areas is often zero but sometimes quite high (for example, in oilfield work camps). There were no data available on the distribution of payphones in remote, rural and urban areas in the other countries studied (Network Strategies 2001).

3.2 Quality of service

The following aspects of the quality of service of the PSTN are examined in this section:

- time to get a service connected or reconnected;
- frequency of reported faults;
- speed of repair of reported faults; and
- call congestion.

Measurement issues

The relative *time to get a service connected or reconnected* can be measured in several different ways, including:

- average actual number of working or calendar days;
- target or agreed number of days;
- per cent of connections or reconnections within target or agreed times; and
- average delay when target or agreed dates are not met.

The last of the above measures, although useful, is rarely used. The experience of subscribers in receiving a connection to the telephone network varies according to whether it is a reconnection of an in-place service, or the connection of a new service. The proximity of telecommunications cabling to the subscriber's premises affects the time it takes to obtain a new connection. Increasingly, new connections can be expected to be second lines to premises needed for access to the Internet.

Relative *frequency of reported faults* is normally measured on a per line per annum basis. The reported faults include those in the customer access network (CAN), local switching, long-distance switching and transmission, but not in customer equipment.[2] However, the faults reported by subscribers would have been predominantly sourced in the CAN.

The relative *speed of repair of reported faults* is measured as the average number of working hours or days to repair the fault. As with service connections and reconnections, there may be targets for fault repair. The percentage of faults repaired within the target period, and possibly, the additional delay when the target is not met, or the overall average delay, may be reported.

Call congestion is normally measured as the proportion of local and national long-distance calls where a connection cannot be established due to congestion. Congestion occurs when the capacity of the PSTN is exceeded, resulting in some call attempts being unsuccessful. Network loss may vary with time-of-day and distance of call. However, only aggregate measures for all domestic calls were of interest in this study.

The various approaches used to measure quality of service discussed above are summarised in table 3.2. Only Australia and Canada measure quality in rural and

2 The CAN is the network of lines connecting residential and business subscribers to the rest of the network (that is, the backbone network consisting of exchanges and long-distance high capacity lines).

urban areas separately on a reasonably comparable basis. The US has some regional measures of quality, which are also reported below.

Table 3.2 **Alternative PSTN service quality indicators**

Concept	*Quality of service measures*	*Comment*
Time to get new connection	Average number of working or calendar days Target or agreed number of days Per cent within target or agreed time Average delay when target or agreed date not met	May depend on the availability of cabling and other infrastructure
Time for reconnection	As above	
Frequency of faults	Number per line per annum	Reported by subscribers experiencing the fault
Time to repair a fault	Average number of hours or working or calendar days Target number of hours or days Per cent within target Average delay when target date not met	
Call congestion	Proportion of total calls that fail to establish a connection	International calls excluded

Australian performance

The Australian Communications Authority (ACA) measures the time to get a new service connected and the speed of repair of reported faults for remote, rural and urban areas. In the past, the ACA has reported performance against the agreed commitment date (that is, the percentage of connections or fault repairs on or before the agreed date). Now performance is measured against the customer service guarantee (CSG) standard, which is the government specified target date. The CSG applies to residential and small business subscribers.

Subscribers can claim compensation for each working day of delay beyond the CSG. This is designed to encourage carriers to minimise the length of additional delays if the CSG is not met. However, the effectiveness of this incentive may have been dulled by lack of user awareness. The ACA's consumer awareness survey indicated that only 32 per cent of residential respondents and 27 per cent of small business respondents had heard of the CSG. It is likely that not all of these were aware of the details of the scheme and the provisions for compensation (ACA 2000b).

In-place connections

An ‘in-place connection’ is a connection where the facility service is already physically intact and the carrier does not need to visit the property. The service has been cancelled and needs to be reactivated (ACA 2000c).

For in-place connections, where the carrier does not need to visit the property, carriers must be prepared to provide the connection within three working days of the request. For Telstra, 97 per cent of in-place connections were achieved within this target period Australia-wide in 1999-2000 (ACA 2000b).

Separate performance measures for remote, rural and urban areas are not available.

New service connections

For new service connections, the CSG has been structured to reflect the relative difficulty of providing a new service to remote and rural areas and especially to subscribers who are a significant distance from existing network infrastructure (see table 3.3).

In its reporting of quality of service performance, the ACA defines remote, rural and urban areas, as:

- *remote* — areas with a population less than 200 people;
- *minor rural* — areas with a population between 200 and 2500;
- *major rural* — areas with a population between 2500 and 10 000; and
- *urban* — areas with a population greater than 10 000.

The target connection times for remote and minor rural areas are less stringent than for major rural and urban areas. However, the percentages of households and businesses seeking, but not receiving, new connections within the CSG targets are smaller in remote and minor rural areas compared with major rural and urban areas. This offsets the disadvantage of longer target periods to some extent. Therefore the disadvantage for subscribers in remote and minor rural areas is less than suggested by the CSG targets.

Table 3.3 **New service connection times by area, Australia, 1999-2000**

Area	*Infrastructure available*[a]		*Infrastructure not available*[b]	
	Target period (working days)	*Per cent within target*	*Target period (working days)*	*Per cent within target*
Quality of service				
urban	5	90	20	82
major rural	10	92	20	76
minor rural	40	99	130	98
remote	40	98	260	99
Extent of disadvantage of rural and remote compared with urban subscribers				
major rural	5	-2	0	6
minor rural	35	-9	110	-16
remote	35	-8	240	-17

Note These figures apply to Telstra. Service connections delayed by circumstances beyond Telstra's control, such as wilful damage and natural disasters, have been excluded. Remote and rural disadvantages are derived as differences from urban — a longer target period or a smaller per cent of connections meeting the target. A negative value indicates an advantage. **a** Subscribers requesting a service are close to existing usable network infrastructure. **b** Subscribers are not close to existing infrastructure.

Source: ACA 2000b.

New CSG standards were implemented from July 2000. The changes included a reduction in the target from three to two working days for all in-place service connections, and from 40 working days to 30 working days for new connections in remote and minor rural areas, where infrastructure is available. After one year, the latter target will be reduced further to 15 days. Further, new arrangements for compensation when targets are not met were introduced.

Quarterly information over the first nine months of 2000-2001 reveals some fluctuations in performance. However, there is evidence of an improving trend overall (ACA 2001a).

Frequency of reported faults

The relative frequency of reported faults in 1999-2000 was 72 faults per 1000 Telstra services in operation (that is, 7.2 per cent per annum). Separate measures for remote, rural and urban areas are not regularly reported by the ACA. However, the Telecommunications Service Inquiry reported relatively high fault rates in some country areas in 1998-99 (TSI 2000, p. 231).

Repair of faults

Fault repair performance is probably somewhat less in rural than in urban areas (see table 3.4 for Telstra's performance). The CSG target is a day longer in rural areas and two days longer in remote areas. However, a higher percentage of faults are repaired within the rural target than within the urban target.

Fault repair performance is unambiguously worse in remote areas than in rural or urban areas. The target period is longer and the percentage within target is also less.

Quarterly information over the first nine months of 2000-2001 reveals some fluctuations in performance. However, there is a clear improving trend, particularly in remote and rural areas (ACA 2001a).

Table 3.4 **Time to repair faults, Australia, 1999-2000**

Area	*Target period (working days)*	*Per cent repaired within target*
Quality of service performance indicators in each type of area		
urban	1	82
rural	2	86
remote	3	72
Extent of disadvantage of remote and rural compared with urban subscribers		
rural	1	-4
remote	2	10

Note These figures apply to Telstra. Rural and remote disadvantages are derived as differences from urban — a longer target period or a smaller percent of connections meeting the target. A negative value indicates an advantage.

Source: ACA 2000b.

Congestion

The level of congestion experienced when making calls on Australian networks was very low. Typically, less than half a per cent of calls could not be established because of congestion (ACA 2000b, Appendix 2). For local calls, network loss was less for country areas than for metropolitan areas in 1999-2000 because country exchanges were less congested than city ones. For national long-distance calls, network loss was about the same in country and metropolitan areas.

Payphone serviceability and fault repair performance

Payphone serviceability and fault repair performance is regularly reported to the ACA. Since September 1999, 98 per cent of payphones have been available to make successful calls (either card or coin or emergency and 1800 calls). Fault reports were made at a rate of about 17 per payphone per annum in the year to September 2000, which is significantly higher than for residential and business access lines (probably as a result of vandalism).

The speed of repair of payphone services was less in non-metropolitan areas than in metropolitan areas (see table 3.5). The average time taken to repair public payphones in the September quarter of 2000 was 24 hours. Repair performance for payphones appeared to be a little lower than for residential and business lines.

Table 3.5 **Time to repair payphone faults, Australia, September 2000**

Area	*Per cent repaired within one working day*	*Per cent repaired within two working days*
metropolitan	71	90
non-metropolitan	58	79

Source: Network Strategies 2001.

Canadian performance

The Canadian Radio-television and Telecommunications Commission (CRTC) has specified an extensive range of quality of service standards to be met by incumbent carriers. Indicators of quality include the following:

- time required to provide access lines;
- fault frequency and repair rates;
- requests for service upgrades in rural areas;
- speed with which incumbent carriers switch a user's long-distance service over to a competitor;
- appointment keeping;
- ease with which subscribers can contact carriers; and
- user complaints.

In Canada, target periods are specified for *providing new services* and for *repairing out-of-service faults* in both rural and urban areas, as in Australia.[3] These targets are given in tables 3.6 and 3.7. The tables also include the percentage of services provided and faults repaired within the target periods for Bell Canada services in Ontario and Quebec. Fault repair performance is also given for TELUS services in British Columbia.

Urban areas are defined by the CRTC as those with more than 150 000 access lines, which is equivalent to a population of about 250 000. Rural areas are all those places with less than 150 000 access lines or less than 250 000 population. This

3 However, the CRTC also specifies the percentages of connections and fault repairs which should meet the target.

classification contrasts with that of Statistics Canada, which defines as rural those communities with a population of only 1000 or less, in line with the ABS definition (see chapter 1).

Table 3.6 **Time to get a service connected, Canada, January to October 2000**

Area	*Target period*	*Within target*
Quality of service performance indicators in each type of area		
	working days	per cent
urban	5	88
rural	10	92
Extent of disadvantage of rural compared with urban subscribers		
	difference in working days	percentage points difference
rural	5	-4

Note The data on performance against the targets (per cent within target) apply to Bell Canada services in Ontario and Quebec. Requests for service connections beyond the target period are excluded. It is assumed that reconnections are excluded from these figures and that the times for new connections are influenced primarily by connections of subscribers reasonably close to existing infrastructure. Rural disadvantage is derived as a difference from urban — a longer target period or a smaller per cent of connections meeting the target. A negative value indicates an advantage.

Source: Network Strategies 2001.

Table 3.7 **Time to repair faults, Canada, January to October 2000**

Area	*Target period*	*Repaired within target*	
		Bell Canada	*TELUS*
Quality of service performance indicators in each type of area			
	working hours	per cent	per cent
urban	24	73.3	78.4
rural	24	71.6	70.1
Extent of disadvantage of rural compared with urban subscribers			
	difference in working hours	percentage points difference	percentage points difference
rural	0	1.7	8.3

Note Rural disadvantage is derived as a difference from urban — a longer target period or a smaller per cent of connections meeting the target.

Source: Network Strategies 2001.

Northwestel, which provides services in sparsely populated Northern Canada, reports on its quality of service against the rural targets specified by the CRTC.[4] Its

4 Northwestel is a subsidiary of Bell Canada, providing telecommunications services in the Yukon, the Northwest Territories, Nunavut and northern British Columbia.

service provision performance was comparable to that of Bell Canada's performance in rural areas. On average, 81 per cent of faults were repaired by Northwestel within the 24 hour target during 2000, which was superior to Bell Canada and TELUS.

The CRTC specifies the following performance standards which should be met by the carriers:

- at least 90 per cent of services should be provided within the target period; and
- at least 80 per cent of faults should be repaired within the target period.

The reported performance in the tables is close to the standard for the time to provide service, but below the standard for fault restoration.

The relative *frequency of reported faults* in the nine months to September 2000 was just less than two faults per month per 100 Bell Canada lines (equivalent to about 22 per cent per annum).[5] This performance was within the standard of five faults per month per 100 lines specified by the CRTC. There was no difference in fault frequency between rural and urban areas.

United States performance

The Federal Communications Commission (FCC) reports quality of service information for the major local exchange carriers (including the Regional Bell Operating Companies). The information is generally reported for each carrier on a State basis.

Separate measures are available for metropolitan and non-metropolitan areas. They are not, however, disaggregated into remote, rural and urban areas. The many small rural telephone companies are not required to submit reports to the FCC.

The State public utility commissions take an interest in the quality of telecommunications services. However, the availability of data in remote and rural areas is limited, partly because the smaller carriers may not be required to report on their performance to the commissions.

FCC quality of service reports

In the US, *connection ('installation') performance* is measured in terms of per cent of installations completed on or before the commitment date and the average

5 Direct comparisons of the average fault frequency between Canada and Australia should not be made because of possible differences in the definitions of faults.

interval between the installation order and completion of the connection. A commitment date is provided when an order for service is received. The commitment period may depend on availability of facilities. It is commonly six working days, unless otherwise determined by negotiation.

There was very little variation in installation performance between metropolitan and non-metropolitan areas. This suggests that network facilities were available close to subscribers in all areas.

Commitment dates for installation in 1999 were met for more than 98 per cent of residential orders and more than 96 per cent of business orders in Maine, New Hampshire, California, Washington and Oregon (see tables 3.8 and 3.9).

Table 3.8 **Quality of service for residential subscribers in selected States of the US, 1999**

State or service area	*Installation commitments met (per cent)*		*Average Installation interval (days)*		*Fault frequency (faults per 100 lines per annum)*	
	Metropolitan	*Non-metropolitan*	*Metropolitan*	*Non-metropolitan*	*Metropolitan*	*Non-metropolitan*
Maine	98.8	98.5	1.1	1.1	12.6	14.9
New Hampshire	98.5	98.3	1.1	1.0	14.8	16.7
California	99.1	98.7	1.5	1.7	20.5	27.5
Washington	98.7	98.4	0.9	0.8	25.8	24.4
Oregon - QWest	99.1	98.7	0.7	0.7	24.2	23.2
Oregon - Citizens	**na**	97.6	**na**	4.7	**na**	1.8

Note Metropolitan refers to the Metropolitan Statistical Areas in each State. Non-metropolitan areas include many smaller urban centres as well as remote and rural areas. **na** Not applicable.

Source: FCC 2000a.

This data is assumed to include requests for new service, transferred service, additional line and change of service. The average installation interval was two working days or less for the Bell companies in most of the above-mentioned States, and less than four days in California.

The *frequency of faults* reported by subscribers of the major carriers in the selected US States varied between about 12 and 27 faults (‘trouble reports’) per 100 access lines per annum for residential lines and about 7 and 13 for business lines (see tables 3.8 and 3.9). Information on the time to repair faults affecting customer access lines was not made available by the FCC.

Table 3.9 **Quality of service for business subscribers in selected States of the US, 1999**

State or service area	*Installation commitments met (per cent)*		*Average installation interval (days)*		*Fault frequency (faults per 100 lines per annum*	
	Metropolitan	*Non-metropolitan*	*Metropolitan*	*Non-metropolitan*	*Metropolitan*	*Non-metropolitan*
Maine	97.4	97.4	1.9	2.0	7.1	7.4
New Hampshire	97.9	97.3	2.0	1.9	7.9	7.7
California	98.1	97.3	3.7	3.6	7.2	8.5
Washington	96.2	96.1	1.9	1.7	10.3	13.0
Oregon - QWest	96.6	96.7	1.3	1.3	10.9	12.7
Oregon - Citizens	**na**	92.6	**na**	7.5	**na**	0.76

Note Metropolitan refers to the Metropolitan Statistical Areas in each State. Non-metropolitan areas include many smaller urban centres as well as rural and remote areas. **na** Not applicable.

Source: FCC 2000a.

Oregon Public Utility Commission reports

In Oregon, the ten largest carriers are encouraged to provide quality of service reports, although the reporting process is still being developed. The ten small companies (below 1000 lines) were not required to report.

Installation commitment dates for most carriers operating in the State were met for at least 98 per cent of State-wide orders in most months of 2000.

The Oregon Public Utility Commission has a monthly target for the *frequency of faults* of two per 100 access lines for each wire centre (telephone exchange).[6] The fault frequency rates of medium-sized carriers in Oregon's rural areas, for which data are available, are generally well below this target and superior to Qwest (the regional Bell carrier).

Large and medium carriers in Oregon report the percentage of repairs completed within 48 hours on a monthly basis. In 2000, this was invariably above 90 per cent for all reporting carriers. Some of the smaller carriers claimed that 100 per cent of faults were repaired within the two day target.

6 The fault frequency rate should not be exceeded by more than three times during a sliding 12 month period.

International comparisons

There was sufficient regional disaggregation of quality of service measures for comparisons between Australia and Canada, and Australia and the US. Very little regional data were available for the other countries studied.

Australia and Canada

Comparisons of the relative rural–urban performance in Australia and Canada are affected by differences in the definitions of rural and urban areas. The Canadian CRTC definition of urban includes only those cities with populations of more than 250 000, all other areas being classified as rural. In contrast, the Australian ACA definition of urban includes cities with populations between 10 000 and 250 000, communities of less than 10 000 being categorised as either major rural, minor rural or remote.

In regard to *connection of new services*, the extent of the performance advantage in urban areas compared with rural areas in Canada is similar to the performance advantage in urban areas compared with 'major rural' areas in Australia, according to tables 3.3 and 3.6.[7]

The differences in rural and urban definitions would not greatly affect this conclusion. In order to put the Canadian rural–urban comparisons on to the same basis as the Australian major rural–urban comparisons, the following adjustments would have to be made:

- the inclusion of cities with populations between 10 000 and 250 000 in the urban category for Canada, which would be expected to raise average Canadian urban connection times slightly because the smaller cities might have slightly longer connection times;
- the exclusion of these cities from the Canadian rural category which would raise average Canadian rural connection times; and
- the exclusion of small towns and localities (below 2500) which would reduce average Canadian rural connection times.

Fault repair performance in rural areas is slightly lower than in urban areas in both Canada and Australia. In Australia, performance in remote areas is substantially lower than in urban areas.

7 'Major rural' is defined by the ACA, as discussed earlier.

Overall, fault repair performance in Australia appears to be generally comparable to that in Canada. The target period is slightly more demanding in Canada, but the proportion of faults repaired within the target period is higher for Telstra than for Bell Canada and TELUS.

Separate quality of service measures for remote areas have not yet been published in Canada, unlike in Australia. Recently, however, the CRTC has recognised the difficulties of servicing some of the most remote parts of northern Canada. A new 'remote' classification has been defined to be an area where:

- there are fewer than two full-time technicians; and
- the community is accessible only by air, or where a technician travelling to the community by road would normally take three hours or more for the round trip.

Some of Northwestel's exchanges have recently been reclassified from 'rural' to 'remote'.

The new Canadian (CRTC) definition of remote areas differs from the Australian (ACA) definition. The Canadian target period for fault repair in remote areas is five days and the performance standard 90 per cent. This target period is longer than the corresponding Australian target, which accords with a possible greater degree of 'remoteness' in the Canadian definition.

Australia and the United States

The reporting of regional differences in the quality of service in the US and in Oregon is summarised in table 3.10. The contrast in the approach to regional disaggregation in the US and Australia is seen in the table. US measures tend to be disaggregated by State, by metropolitan and non-metropolitan, or by exchange. There is no US equivalent to the minor rural and remote classifications used in Australian reporting of PSTN quality.

The reporting of the *time to connect new services* and the *time to repair faults* is more detailed in Australia.

On the other hand, *fault frequency* is regularly reported only on a State-wide and national basis in Australia. In some areas of the US, fault frequency (trouble report) rates are available at a local level (for small geographic areas).

In Oregon, fault frequency rates are presented for every exchange, every month. This allows subscribers in local areas to compare the fault frequency in their area with the rates for neighbouring localities in both rural and urban regions and with the State-wide average. The emphasis is on the frequency of faults, whereas in Australia the emphasis is on the speed of fault repair.

Table 3.10 **Regional disaggregation of quality of service measures**

Measure	*United States*		*Australia*
	FCC	*Oregon*	
Time to connect	By State as well as metropolitan and non-metropolitan for each carrier	State-wide for each carrier	Remote, minor rural, major rural, urban for new services Countrywide for in-place facilities
Fault frequency	By State as well as metropolitan and non-metropolitan for each carrier	Exchange	State-wide
Fault repair time		State-wide for each carrier By region for large carriers[a]	Remote, rural, urban

Note The FCC data is presented on an annual basis; Oregon information is published on a monthly basis; Australian information is available on a quarterly and annual basis. [a] The regions are relatively large, each containing a number of exchanges.

For the majority of subscribers, speed of connections may be better in the US than in Australia. On the other hand, Australian fault frequency performance may be superior to the trouble report rates for some US States. Speed of fault repair is reasonably similar in Oregon and Australia.

Overall, PSTN quality performance results for Australia appear to be broadly comparable to those in the US.

It is difficult to make precise comparisons of service quality between Australia and the US, primarily because of different definitions and concepts and different ways in which the data are categorised. For example, targets or standard periods in Australia are different in nature to the installation commitments in the US. New connections and reconnections are aggregated in the US (and included in 'installations'), whereas they are reported separately in Australia.

Other countries

Very little information was available on PSTN quality of service in the other benchmarked countries. In particular, objective quality measures for remote, rural and urban areas were not available.

In *Finland*, the average delivery time for a new telephone connection was 3.6 days in 1999. About 74 per cent of telephone line repairs were completed within a working day (MTT 2000). This performance is broadly in line with Australia's overall connection and repair performance, although the measures used are defined differently to those used in Australia. There is no information on the quality of service in the remote and rural areas of Finland.

In *New Zealand*, 88 per cent of nationwide service requests were met by the customer requested time (which is a different concept to the Australian target period).[8] About 98 per cent of new and in-place service connections were met within 24 hours (if requested) (Telecom New Zealand 2000). This appears to be superior to the performance of Australian service providers.

The average nationwide rate of fault reports in New Zealand for the 6 months to March 2000 was 24 per 100 lines per annum, much higher than for Australia. About 86 per cent of faults were repaired in less than 24 hours, at least as good as in Australia.

Several surveys of telecommunications users in rural locations in New Zealand were undertaken for a recent Ministerial Inquiry into Telecommunications. These revealed that line noise, electric fence interference, exchange over-loading (congestion), dropped calls and inadequate bandwidth were perceived to be significant problems by remote and rural subscribers. Some problems were related to increasing use of the Internet.

In the *United Kingdom*, available quality indicators relate to the efficiency of service provision, fault frequency and repair, handling complaints and billing accuracy. Average carrier-wide performance is reported. British Telecom (BT) completed about 97 per cent of its service orders by the date promised to the user, in the first half of 2000.

Residential subscribers were reporting faults at a rate of about 15 per 100 lines per annum and business subscribers about 12 per annum. About 73 per cent of residential faults were repaired within 9 working hours and 88 per cent of business subscriber faults were repaired within the standard target of 10 working hours (Network Strategies 2001).[9]

8 A 'requested' time is requested by the customer. A target is normally specified by the carrier or regulatory authority.

9 These performance measures relate to subscribers connected directly to BT, other measures are also published for indirectly connected subscribers (via another carrier).

The time taken to deliver new services in the UK appears to be broadly comparable to that in Australia. However, precise comparisons are not possible because of differences in target and commitment dates, and also in the way services are aggregated in the measures.

Overall, fault rates appear to be lower in Australia and the speed of fault restoration is comparable in the two countries.

3.3 Price

The price of PSTN voice services has the following elements:

- connection and reconnection fees;
- annual customer access rental; and
- call charges.

The structure of call charges is usually complex with different prices for local and long-distance calls, peak and off-peak calls, and calls of different durations.

In Australia, local calls are untimed with a fixed price per call, except for remote subscribers. Under the Untimed Local Call Agreement negotiated between the Australian Government and Telstra, remote subscribers will have access to untimed calls after 31 July 2001. Local calls generally have no charge in North America, and rentals constitute a relatively large share of the overall price.[10] Local calls are priced per unit of time in Europe.

In most countries, there are no differences in most of the price elements for remote, rural and urban subscribers.

Approach

Specified baskets of services reflecting the calling patterns of residential and small business subscribers have been priced in each country and service area. The lowest priced plans widely available and consistently offered by the incumbent carrier(s) in remote, rural and urban areas were used. The baskets include rental and call charges. The call patterns assumed for each basket are defined in tables 3.11 and 3.12.

This analysis was the basis for assessing differences in prices among subscribers in remote, rural and urban areas, for each country.

10 Many North American carriers also offer plans with local call charges and lower rentals.

Table 3.11 **Residential PSTN basket**

Type of call	*Annual number of calls*		*Call duration (minutes)*	
	Peak[a]	*Off-Peak*[b]	*Peak*[a]	*Off-Peak*[b]
Local voice	500	500	3	5
Long-distance[c]	80	80	5	20
Calls to mobiles	30	30	3	3
Calls to ISPs	80	80	20	30

[a] Peak period calls in the basket are assumed to be made in the daytime on weekdays in all countries. [b] Off-peak calls are assumed to be made after 8:00pm on weekdays, and on weekends. [c] Long-distance calls were further distributed among a number of distance ranges because prices of these calls varied with distance in some of the benchmarked countries.

Table 3.12 **Small business PSTN basket**

Type of call	*Annual number of calls*	*Call duration (minutes)*
Local voice	2500	3
Long-distance[a]	600	4
Calls to mobiles	400	4
Fax	500	3
Calls to ISPs	250	20

[a] Long-distance calls were further distributed among a number of distance ranges because prices of these calls varied with distance in some of the benchmarked countries.

The baskets are based on assumptions originally developed by the OECD. They are intended to be typical of residential and business subscriber call patterns.

Telephone use patterns vary across the countries included in the study and within a country between remote, rural and urban areas. Consequently, the baskets are not representative of all subscribers. However, the effect on the basket price of changing some of the assumptions about call patterns has been investigated.

Connection charges were not included in the analysis. Line connection charges generally do not vary within a country, provided the premises being connected are reasonably accessible to the existing network. However, additional work may be required in some locations. It was not possible to quantify this aspect of the connection cost as it is normally undertaken on a fee-for-service basis.

International differences in the definitions of local call zones are not expected to unduly influence price relativity comparisons unless there are significant differences in the relative size of these areas (that is, in the ratio of the lines in rural and urban local call zones).

International comparisons of prices are normally affected by the choice of currency exchange rate (for example, the current market rate or the purchasing power parity rate). However, this is not an issue for international comparisons of within-country price relativities.

Australian prices

Summaries of the percentage differences between rural and urban, and remote and urban, telecommunications prices in Australia are given in tables 3.13 and 3.14 for residential and small business subscribers, respectively.

In Australia, the monthly rental varied between residential and business subscribers and with the price plan chosen by subscribers (which allows a tradeoff between the fixed and usage components of the telephone bill). However, rental charges did not vary between remote, rural and urban subscribers (see tables 3.13 and 3.14).

On the other hand, voice call prices were location dependent to some extent. There were two sources of variation in Australian voice call prices associated with the location of callers. The first source of locational variation in call price was the availability of special inter-capital city rates for subscribers living in these cities. This impact was small.

The second source was the requirement for some remote subscribers to use a ‘pastoral’ call instead of the untimed local call available to subscribers in urban and rural areas. In May 2001, the price of a pastoral call was 22 cents for every 5 minutes or part thereof. This applied to many calls within so-called extended zones and calls to the community service town designated for each extended zone, which might be over quite long distances. These subscribers received a rebate of up to $160 per calendar year against their expenditure on pastoral calls.

Those living in the inner extended zones, which are small remote communities generally connected by copper cable, were able to make untimed neighbourhood calls within their communities, but not to adjacent outer extended zones.

Subscribers in remote areas may have been paying less per call than those in rural and urban areas for local calls because of the rebate mentioned above. The overall impact (on total rental and call expenditure) was that subscribers in remote areas paid less than those in rural and urban areas for the residential and small business baskets of calls specified in tables 3.11 and 3.12 (see tables 3.13 and 3.14).

For local calls of longer duration than indicated in tables 3.11 and 3.12, costs for remote subscribers increased substantially compared with those in rural and urban areas. For example, if the local call durations for residential subscribers were assumed to be 6 minutes in peak and 11 minutes in off-peak periods, instead of 3 and 5 minutes, respectively, subscribers in remote areas of Australia would pay

27 per cent more than urban subscribers for the overall service, instead of 16 per cent less.

Table 3.13 **Relative residential prices, Australia**

Based on basket in table 3.11

Price element	*Rural premium over the urban price at May 2001*	*Remote premium over the urban price at May 2001*	*Remote premium over the urban price at August 2001*
	per cent	per cent	per cent
Annual rental	0	0	0
Local calls	0	-67	25 to -50
Long-distance calls	1	1	-27 to -31
Calls to mobiles	0	0	0
Calls to ISPs	0	0	0
All	0	-16	-3 to -22

Note The remote and rural premiums are the extra price compared with the price paid in urban areas (per cent). Prices are based on Telstra's HomeLine Plus Plan. The estimates for the remote premium at May 2001 are sensitive to the assumptions about the duration of the local call. A range of results is given for August 2001 following the introduction of a new pricing structure — the results depending on whether or not a rebate will apply against the cost of some of the calls.

Source: PC estimates based on Network Strategies 2001.

Table 3.14 **Relative small business prices, Australia**

Based on basket in table 3.12

Price element	*Rural premium over the urban price at May 2001*	*Remote premium over the urban price at May 2001*	*Remote premium over the urban price at August 2001*
	per cent	per cent	per cent
Annual rental	0	0	0
Local calls	0	-16	20 to -6
Long-distance calls	0	0	-28 to -30
Calls to mobiles	0	0	0
Fax calls	0	-8	4 to 3
Calls to ISPs	0	0	0
All	0	-4	-3 to -9

Note The remote and rural premiums are the extra price compared with the price paid in urban areas (per cent). Prices are based on Telstra's Easy Saver Business Advantage Plan. The estimates for the remote premium at May 2001 are sensitive to the assumptions about the duration of the local call. A range of results is given for August 2001 following the introduction of a new pricing structure — the results depending on whether or not a rebate will apply against the cost of some of the calls.

Source: PC estimates based on Network Strategies 2001.

Remote subscribers would also have paid higher costs if their call pattern included a higher share of long-distance calls than the call patterns of other subscribers.

From 31 July 2001, subscribers in remote areas will be able to make untimed calls within extended zones and to adjacent extended zones.[11] Calls to designated community service towns, and to community service towns of adjacent extended zones, will be able to be made at a 'preferential' rate of 27.5 cents for every 12 minutes or part thereof. These calls could be quite important for remote subscribers.[12] .

Subscribers in remote areas making preferential calls will be able to receive a rebate against their expenditure on these calls. The size of this rebate is not yet known, but it is expected to be less than the $160 which currently applies in relation to pastoral calls. The preferential call will be replaced by an untimed call in one or two years when the network is upgraded sufficiently to accommodate the expected extra traffic.

The remote–urban price relativities in August 2001 after the introduction of the new pricing arrangements in remote areas are included in tables 3.13 and 3.14, for the baskets of calls specified in tables 3.11 and 3.12. A range of results is given — the first number assumes no rebate, and the second number assumes rebate arrangements similar to those currently applying. As mentioned previously, different outcomes will occur under different assumptions about call patterns. These are reported later.

International comparisons

Residential and small business subscribers in Sweden, France and the UK had the same rental and call prices, irrespective of whether they lived in remote, rural or urban areas. This also applied to residential subscribers in New Zealand and in the State of Oregon (US).

Rental prices generally differed between remote, rural and urban areas in Finland, Canada (Alberta, British Columbia, Ontario and Quebec), New Zealand (business only) and the US (businesses in Oregon and all subscribers in California, Maine and New Hampshire). Call prices were generally uniform across remote, rural and urban areas.

In Canada, Finland and the US, rental charges varied across exchange service areas. For this study, rents were selected for service areas representative of remote, rural

11 It has been assumed that Telstra's HomeLine Plan will be available to these subscribers with a local call price of 18.5 cents.

12 The benchmarking comparisons required assumptions about the relative numbers of untimed and 'preferential' rate calls.

and urban locations. The use of the terms remote, rural and urban in this context corresponds in broad terms to the definitions used by the ACA (Australia) (see chapter 1). However, there was an element of judgement in the allocation of rentals to remote, rural and urban areas because detailed population data were not available.

Although rents were sometimes relatively high in areas of low population density, as would be expected of rents related to costs, this was not the case for Maine and New Hampshire in the US.

Price differences for the total basket of services (including calls and rent) between rural and urban areas and between remote and urban areas are summarised, as at May 2001, in table 3.15 for the residential markets of all countries studied, and in table 3.17 for the small business markets. Price relativities are also included for Australia in August 2001 following the introduction of a new pricing structure — a range is given to reflect whether or not a rebate will apply against the cost of some calls in remote areas (as discussed earlier).

Differences in rental charges at May 2001 are reported in tables 3.16 and 3.18.

Rural-urban comparisons

The rural-urban comparisons are based on the call pattern assumptions in table 3.11 for residential services and table 3.12 for small business services. It was assumed that both rural and urban subscribers have the same call patterns.

Rural-urban differences in overall prices were zero in Australia and most other countries. In the case of Finland and New Zealand (business), substantial premiums in the rural rent (17 per cent and 22 per cent) translated into small premiums in the total basket price (including rent and calls) because the rental share of the total basket cost was relatively small. Rural-urban differences varied among States in the US. Rural rents, and hence basket prices, were lower than urban prices in Maine and especially in New Hampshire.

There could be a disadvantage for rural subscribers compared to urban subscribers arising from their call pattern rather than the pricing structure. If the ratio of long-distance to local calls was higher for rural than for urban subscribers, then the total cost of telecommunications services would tend to be higher for rural subscribers. An example in Australia might be the relatively large number of calls into the city by subscribers dispersed around the fringe of metropolitan areas. The prices of these calls were reduced by Telstra on 18 June 2001.

Table 3.15 **Relative residential prices, May 2001 (per cent)**

Country or service area	*Rural premium over the urban price*	*Remote premium over the urban price*		
		Assumptions (i)	*Assumptions (ii)*	*Assumptions (iii)*
Australia	0	-16	21	55
Australia (August 2001)[a]	0	-3 to -22	22 to 4	22 to 4
Canada (British Columbia)	-1	4	9	9
Canada (Ontario and Quebec)	13	-5	46	46
Finland	4	7	45	41
France[b]	0	0	**na**	**na**
New Zealand	0	0	37	37
Sweden	0	0	5	2
United Kingdom	0	0	20	12
US (California)	5	11	48	48
US (Maine)	-5	-8	31	31
US (New Hampshire)	-10	-13	28	28
US (Oregon)	0	0	44	44

Note The remote and rural premiums are in both cases the extra basket price (in per cent) paid compared with urban subscribers. The rural–urban comparisons are based on the call pattern assumptions in table 3.11. For the remote-urban comparisons, Assumptions (i) refers to the basket specified in table 3.11. Under Assumptions (ii), 200 local calls by remote subscribers have been redistributed to long-distance calls. Under Assumptions (iii), 200 local calls by remote subscribers have been redistributed to long-distance calls, and the local call durations in all regions have been increased from 3 to 6 minutes in the peak and 5 to 11 minutes in the off-peak. **a** A range of results is given for Australia (August 2001) following the introduction of a new pricing structure. The first number assumes no rebate. The second number assumes rebate arrangements similar to those currently applying. **b** Prices in France are uniform across the country. However, the price baskets for France were not evaluated because of incomplete information. **na** Not available.

Source: PC estimates based on Network Strategies 2001.

Table 3.16 **Relative residential rents, May 2001 (per cent)**

Country or service area	*Rural premium over the urban price*	*Remote premium over the urban price*
Australia	0	0
Canada (British Columbia)	-2	8
Canada (Ontario and Quebec)	22	-8
Finland	17	31
France[a]	0	0
New Zealand	0	0
Sweden	0	0
United Kingdom	0	0
US (California)	6	15
US (Maine)	-8	-11
US (New Hampshire)	-14	-19
US (Oregon)	0	0

Note The remote and rural premiums are in both cases the extra rental price (in per cent) paid compared with urban subscribers. **a** Prices in France are uniform across the country. However, the price baskets for France were not evaluated because of incomplete information. **na** Not available.

Source: PC estimates based on Network Strategies 2001.

Table 3.17 **Relative small business prices, May 2001 (per cent)**

Country or service area	Rural premium over the urban price	Remote premium over the urban price	
		Assumptions (i)	Assumptions (ii)
Australia	0	-4	16
Australia (August 2001)[a]	0	-3 to-9	10 to 3
Canada (British Columbia)	-1	9	54
Canada (Ontario and Quebec)	9	3	21
Finland	2	4	13
France[b]	0	0	**na**
New Zealand	5	5	15
Sweden	0	0	1
United Kingdom	0	0	9
US (California)	8	20	40
US (Maine)	-2	-3	25
US (New Hampshire)	-19	-25	-2
US (Oregon)	5	9	40

Note The remote and rural premiums are the extra basket price (per cent) paid compared with urban subscribers. The rural-urban comparisons are based on the call pattern assumptions in table 3.12. For the remote-urban comparisons, Assumptions (i) refers to the basket specified in table 3.12. Under Assumptions (ii), 500 local voice calls by remote subscribers have been redistributed to long-distance calls, 80 local fax calls have been redistributed to long-distance calls. **a** A range of results is given for Australia (August 2001) following the introduction of a new pricing structure. The first number assumes no rebate. The second number assumes rebate arrangements similar to those currently applying. **b** Prices in France are uniform across the country. However, the price baskets for France were not evaluated because of incomplete information. **na** Not available.

Source: PC estimates based on Network Strategies 2001.

Table 3.18 **Relative small business rents, May 2001 (per cent)**

Country or service area	Rural premium over the urban price	Remote premium over the urban price
Australia	0	0
Canada (British Columbia)	-2	19
Canada (Ontario and Quebec)	16	5
Finland	17	34
France[a]	0	0
New Zealand	22	22
Sweden	0	0
United Kingdom	0	0
US (California)	26	61
US (Maine)	-3	-5
US (New Hampshire)	-26	-34
US (Oregon)	8	14

Note The remote and rural premiums are the extra rental price (per cent) paid compared with urban subscribers. **a** Prices in France are uniform across the country. However, the price baskets for France were not evaluated because of incomplete information. **na** Not available.

Source: PC estimates based on Network Strategies 2001.

Remote-urban comparisons

The remote-urban price comparisons in tables 3.15 and 3.17 have been undertaken for several different sets of assumptions about call patterns. Under 'Assumptions (i)', both remote and urban subscribers have the same call patterns. However, as discussed earlier, these patterns differ for residential and small business subscribers as indicated in tables 3.11 and 3.12. Under 'Assumptions (ii)', subscribers in remote areas make fewer local and more long-distance calls than those in urban areas.

The diversity of remote-urban price differences is indicated in table 3.15 and table 3.17. The remote–urban price differences in Canada, Finland and the US were attributable to differences in rentals. In Australia, they were attributable to differences in call pricing.

Under 'Assumptions (i)', some subscribers in remote areas of Canada, Finland and the US paid more for telecommunications services than their counterparts in urban areas. Other remote subscribers in Canada and the US paid less than urban subscribers. Telephone subscribers in remote areas were relatively better off in Australia than in other countries because of the rebate they received.

Rents in Maine, New Hampshire, Ontario and Quebec may be low in exchange areas with small numbers of lines (and low line densities) in recognition of the smaller numbers of local calls and hence smaller subscriber benefit from free local calling in these areas.

A North American carrier has indicated that in the past prices may have been lower in some remote areas because network equipment was older and written down. Also, remote services have traditionally been subsidised. Equipment has been upgraded and rents have risen significantly in recent years. However, these services continue to be subsidised.

The probability that telephone subscribers living in remote areas make fewer short-distance calls and more long-distance calls than urban subscribers has implications for remote-urban differences in telephony costs. This issue was investigated by redefining the basket of calls for remote subscribers.

A higher proportion of long-distance calls would, by itself, produce a cost disadvantage for remote subscribers in nearly all countries, as indicated by a comparison of the 'Assumptions (i)' and 'Assumptions (ii)' columns in tables 3.15

and 3.17. The remote-urban comparisons based on Assumptions (ii) use separate baskets for urban and remote subscribers.[13]

Using the redefined remote basket (‘Assumptions (ii)’), the cost premiums for remote Australian subscribers were 21 per cent (above urban subscribers) for residential subscribers and 16 per cent for small business subscribers. The disadvantage for remote residential subscribers was less in Australia than in most other countries, under these assumptions. The premiums for Australian remote subscribers are expected to fall after 31 July 2001.

Impact of local call duration

In the case of residential subscribers, a further set of comparisons were undertaken (‘Assumptions (iii)’) in which the duration of the local call was increased, in addition to changing the call distribution for remote subscribers as discussed above.

Australian remote residential subscribers would face a much higher overall price than urban (or rural) subscribers if the average local call duration was increased. This was because local (pastoral) calls were timed in May 2001 for remote subscribers but not for urban subscribers, in Australia.

If the call durations were assumed to be 6 minutes in the peak and 11 minutes in the off-peak, instead of 3 and 5 minutes, respectively, subscribers in remote areas of Australia would pay 55 per cent more than urban subscribers for the overall service, as at May 2001.[14] As indicated in the ‘Assumptions (iii)’ column in table 3.15, this cost disadvantage relative to urban subscribers was greater than for all the other countries or service areas because of timed local calls in remote areas and untimed local calls in urban areas of Australia.

From 31 July 2000, the disadvantage for remote subscribers making long duration local calls will be significantly reduced by the introduction of untimed calls and preferential rate calls for these subscribers. For the call patterns represented by Assumptions (iii), the premium paid by remote subscribers will fall from 55 per cent to between 22 per cent (assuming no rebate) and 4 per cent (assuming rebate arrangements similar to those currently applying). The premium is then likely to be less than in most other countries (see table 3.15).

In much of North America and in New Zealand, residential local calls were free (or included in the rental) in remote and urban areas, which means that increasing local

13 The remote and urban baskets are the same for all countries, as required for consistent inter-country comparisons.

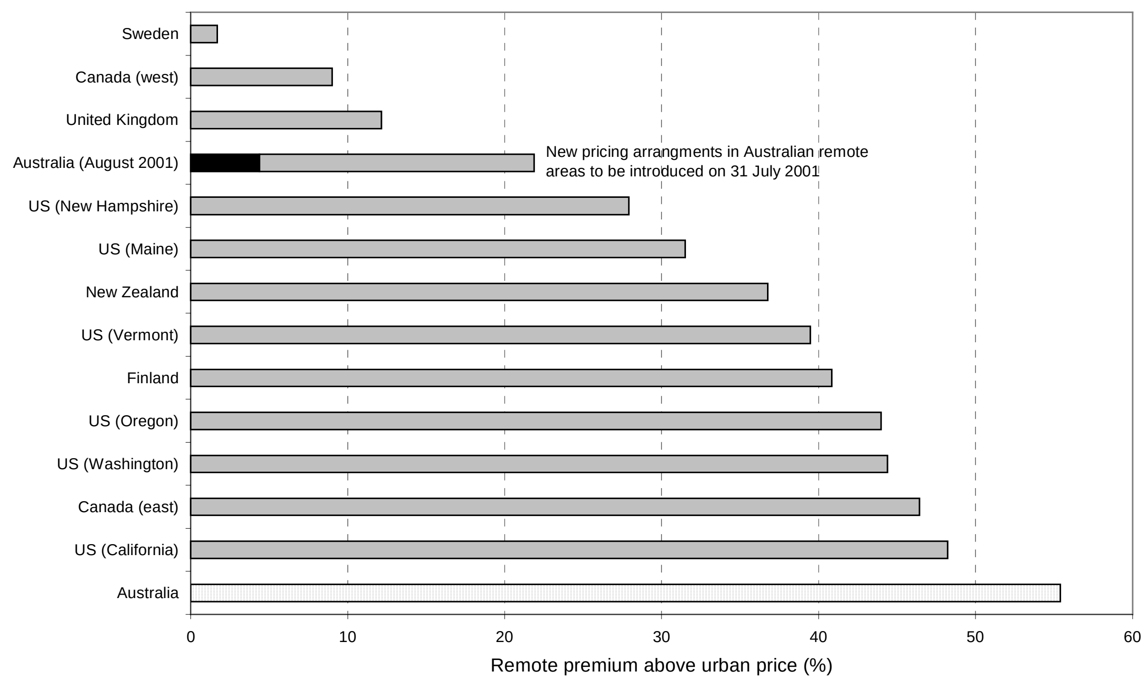
14 The average local call duration is assumed to be the same for subscribers in remote, rural and urban locations.

call duration had no effect on costs for subscribers in remote, rural or urban areas, and hence no effect on the remote-urban price relativities.

In Europe, where local call prices increased with duration in remote, rural and urban areas, the increase in local call duration reduced the remote–urban cost ratio. The longer duration local call had less effect on prices in remote areas than urban prices because there are fewer local calls in the remote basket.

The impact of the introduction of the new pricing arrangements from 31 July 2001 for Australian remote PSTN subscribers relative to remote subscribers in other countries under 'Assumptions (iii)' is evident in figure 3.1. As discussed in chapter 2, this initiative is to be supported by a substantial government subsidy.

Figure 3.1 **Remote–urban residential price comparisons, May 2001**



Note The remote premiums are the extra basket price (in per cent) paid compared with urban subscribers. The numbers of urban calls are given in table 3.11. For remote subscribers, the numbers and durations of calls are as in Assumptions (iii), table 3.15. A range of results is given for Australia (August 2001) following the introduction of a new pricing structure — the results depending on whether or not a rebate will apply against the cost of some of the calls. The black portion represents the relative price with rebate arrangements similar to those applying in May 2001. The complete bar represents the relative price with no rebate (the size of the rebate has yet to be determined).

Data source: PC estimates.

3.4 In summary

The PSTN is a mature network in Australia and most other developed countries. It generally provides high quality voice services to the great majority of the population in each of the countries studied.

Penetration

The number of fixed PSTN access lines is declining in several of the benchmarked countries. However, increases in mobile phones more than offset this decline. For example, in Sweden the number of total services (fixed lines plus mobile) per 100 people has risen to over 130.

There is some evidence that PSTN penetration rates in Australia and Finland were lower in sparsely populated areas than in urban areas. This might be because fewer business lines were required in these areas.

Quality of service

In Australia, the quality of PSTN service in *rural and urban* areas has been monitored by measuring performance against targets for the time to complete new connections and repair line faults.

Canadian regulators have performance targets and measures for service connection times and fault repair times in rural and urban areas which are comparable to the Australian measures.

In the US, Oregon has a performance target for fault frequency and most carriers operating in Oregon publish fault frequency rates for each exchange area. This allows subscribers in local areas to compare the fault frequency rates in their area with the rates for neighbouring localities in both rural and urban regions and with the State-wide average. In Oregon, public interest at the local level focuses on the frequency of faults. In Australia, the emphasis is on the speed of fault repair.

Most other countries do not report separately on the quality of service in rural and urban areas.

During the New Zealand Ministerial Inquiry into Telecommunications, surveys of subscribers revealed that line noise, exchange over-loading (congestion), dropped calls and limited bandwidth were perceived to be problems in remote and rural areas. These are different aspects of quality from those monitored in Australian remote and rural areas.

In general, average service connection times, fault frequency and fault repair times across Australia were comparable to the performance in countries such as Finland, New Zealand, the UK and the US.

In regard to the connection of new services, the extent of the performance advantage for urban subscribers over rural subscribers in Canada was similar to that in Australia. Fault repair performance in rural areas was slightly lower than that in urban areas in both Canada and Australia.

In Australia, service connection and fault repair performance in *remote* areas was significantly lower than that in urban areas. There is no comparable information for remote areas in other countries.

Price

There was no difference in PSTN prices for rural and urban subscribers in Australia nor in most of the countries and service areas included in this study. This was despite higher costs in rural areas, which were met to some extent by contributions from urban subscribers via USO policies and prices caps. The size of these contributions might be larger in Australia given the relatively low population densities and hence high average PSTN costs in Australia's rural areas.

If the ratio of long-distance to local calls was higher for rural than for urban subscribers, then the total cost of telecommunications services would tend to be higher for rural subscribers.

Remote subscribers in most countries might have been paying more for their telecommunications than urban subscribers, but generally only if a higher proportion of the calls of remote subscribers were long-distance.

The extent to which Australian remote subscribers might have incurred higher costs compared with urban subscribers was no more than in most of the other countries or service areas studied, provided local calls were of short duration. However, if local calls were of long duration, the extra cost incurred by Australian remote subscribers would be more significant than in other countries for prices as at May 2001. From 31 July 2000, new pricing arrangements will be implemented for remote areas of Australia, including the introduction of untimed calls. This will be supported by a government subsidy, and significantly reduce the disadvantage of remote subscribers who make long duration local calls.

4 Mobile voice services

Mobile telephones are becoming increasingly important as a communications tool. They offer greater flexibility than fixed telephony because a person is called and not a place. Mobiles are continuing to displace fixed services, with mobile penetration exceeding fixed service in some countries.

In this chapter, relative quality of service and price outcomes for users of terrestrial mobile voice services are examined for remote, rural and urban areas.[1] Measures of the two principal indicators of mobile quality of service — call congestion and call drop-out — are provided where available. Information on population and landmass coverage and penetration levels is also presented.

Emerging data enabled services or so-called 2.5 and third generation (3G) services, are discussed in chapter 6.

4.1 Mobile networks

Cellular mobile networks operate through a system of base stations or cell sites (including radio transmitters, receivers and switching equipment), which enable users to transmit and receive calls from any location while moving. Each mobile call uses a separate temporary channel to communicate with a base station. Geographic regions are divided into cells, with each cell having its own base station. The same channel can be used simultaneously by non-adjacent cells.

Many mobiles can communicate with a base station at the same time. However, mobiles must be in range of a base station. When a call is initiated, the message is transmitted via a radio signal to the closest base station. Calls are then routed through the mobile or fixed network depending on the intended destination.

The ability to transfer calls between base stations (handover) is a central feature of mobile networks which permits users to move within the network coverage area. The network tracks mobiles within a cell and as a user reaches the border of a cell

1 Mobile services have traditionally been offered via terrestrial (or land-based) networks. Mobile services utilising satellite networks have been introduced more recently.

the call is automatically handed over to another cell.[2] Calls may also be handed over where a cell has a high volume of traffic.

Mobile networks have evolved from the so-called first generation analogue networks to the current second generation digital networks. Successive generations of mobile networks have utilised new technologies to increase capacity and security of voice and data transmissions.

These networks have evolved under a number of proprietary, regional and national standards. There is no unique global standard and there may be a mix of analogue and digital networks coexisting in the same country (see box 4.1 for a discussion of the major standards currently in use).

All of the benchmarked countries are served by at least two competing terrestrial mobile networks (OECD 2000). Some areas in the US are served by up to seven networks and more than half of Canada's population has access to four networks.

Australia is served by four major terrestrial mobile networks — Telstra (GSM and CDMA), OPTUS (GSM) and Vodafone (GSM).[3] Until recently, Australia was also served by an analogue network (see box 4.2).

All three major carriers also offer satellite mobile services. Vodafone's Globalstar is the only system which has integrated terrestrial and satellite networks.[4] Calls made using this service default to the GSM network where it is available, and to satellite mode where no GSM signal is detected. There is no 'seamless' handover from GSM to satellite during a call which means that the user has to re-establish the call when moving outside the GSM area. When a call is initiated on the satellite service and then moves into a GSM area, the call remains on the satellite service.

2 As the call is handed over, the network assigns the call a new channel in a different cell.

3 In addition, One.Tel rolled out a GSM network in Sydney, Melbourne, Brisbane, Perth and Adelaide during 2000. Hutchinson (Orange) has rolled out and is offering services on its CDMA network in Sydney and Melbourne.

4 The Globalstar service employs 48 satellites in low earth orbit (LEO) and keeps an additional four in orbit as spares. LEO satellites provide greater clarity, quicker transmission, and use less phone battery power than geostationary satellite systems because they are relatively close to the Earth. Call plans are available and handsets cost between $899 to $2419.

Box 4.1 **Mobile network standards**

First generation mobile networks using analogue transmission were launched at the beginning of the 1980s. Second generation digital networks were introduced commercially in the 1990s. The introduction of digital technologies increased capacity through the more efficient use of the radio spectrum and made it possible to transmit data. The development of digital technologies also offered improved security and facilitated the introduction of smaller and lighter handsets.

There are a number of analogue and digital systems currently utilised in the benchmarked countries including:[a]

Advanced mobile phone system (AMPS) — an analogue standard utilising frequencies in the 800 to 900 MHz band (and more recently in the 1800 to 2000 MHz band). AMPS utilises frequency division multiple access (FDMA) technology to allocate the radio spectrum to users. With FDMA, only one subscriber at a time is assigned to a channel. The channel cannot be accessed by other conversations until the call is completed or handed over to a different cell.

Global system for mobile (GSM) — the first commercially available digital system, operates in the 900, 1800 and 1900 MHz frequency bands, utilising time division multiple access (TDMA) technology to allocate radio spectrum. By splitting the frequency into time slots, TDMA allows each user to access the entire radio-frequency channel for the period of a call. Users share the same frequency channel at different allocated time slots. The GSM standard was adopted by all European countries and other countries, including Australia. North American TDMA or D-AMPS is the digital enhancement of analogue AMPS technology utilising the 800 and 1900 MHz frequencies.

Code division multiple access (CDMA) — based on spread spectrum technology, CDMA is the latest cellular standard available for commercial use. With CDMA, spectrum use is improved, as all users occupy all channels at the same time. Conversations are distributed (or spread) over the whole radio band and each call is assigned a unique code that differentiates it from the other calls simultaneously carried over the same spectrum.

a There are a number of other proprietary standards that have been deployed in some of the benchmarked countries. For example, in Finland and Sweden, Nordic Mobile Telephone was deployed as a first generation analogue network utilising the 450 and 900 MHz frequency bands.

Source: ITU 1999.

Box 4.2 **Closure of the analogue network and deployment of CDMA**

Between 1987 and October 2000, Telstra operated an analogue AMPS network. In 1992 the Federal Government announced that the AMPS network would be closed on 1 January 2000. In response to concerns about coverage in rural areas, the Government decided that closure would take place in stages beginning with metropolitan areas and that full closure of the AMPS network would be delayed until the end of 2000.

Prior to the closure, the Government placed licence conditions on Telstra, which specified that Telstra had to provide terrestrial digital networks that together gave 'reasonably equivalent coverage' to the AMPS network in non-metropolitan Australia. To meet this requirement, Telstra began rolling out its CDMA digital network in August 1999.

During the closure of the AMPS network and the roll out of the CDMA network, the Australian Communications Authority (ACA) received a number of complaints from users regarding coverage levels, and network and handset performance. These concerns related to the lack of adequate coverage provided by the CDMA network in areas previously covered by the AMPS network, the incidence of call drop-outs, post dialling delays, incorrect call diversions and the break up of speech.

The ACA undertook to investigate these concerns, focusing on the coverage and quality of service of the CDMA network. In August 2000, the ACA concluded that, overall, former analogue users in regional areas could expect to receive reasonably equivalent coverage, if not better, from the CDMA network than previously experienced with the AMPS network. As advised by Telstra, the CDMA network covers 97 per cent of the population and 12.5 per cent of the landmass, compared with the AMPS network which covered 93.8 per cent of the population and 7 per cent of the landmass in 1998.

An assessment of Telstra's predicted coverage maps indicated that there were only a small number of areas not covered by CDMA that had previously been covered by AMPS and that a number of areas now had improved coverage. There were also a number of areas receiving mobile coverage for the first time. The ACA also concluded that the CDMA network provided a satisfactory level of service and that as users became more accustomed with the new network their satisfaction levels would increase. The ACA points to the slowdown in user complaints experienced toward the end of June 2000 as an indication that user discontent has declined with increased usage.

Sources: TSI 2000 and ACA 2000c.

4.2 Coverage and penetration

Estimates of coverage and penetration provide an indication of the extent to which the population has access to mobile services and the extent to which they use such services.

Coverage

The geographic area in which calls can be made or received on a mobile phone is known as the service or coverage area. Geographic coverage can be increased by installing base stations in new areas, or by installing equipment which extends the range of coverage provided by each base station. The various network standards have transmission characteristics that differentially influence the level of coverage available.[5]

The Telecommunications Service Inquiry (TSI) identified coverage as being the most significant mobile telecommunications issue raised in submissions and consultations (TSI 2000). In addition, during 1999-2000 coverage was the second most important issue raised to the Telecommunications Industry Ombudsman (TIO) for GSM networks (17.2 per cent of all complaints) and the most important issue with regard to the new CDMA network (57.9 per cent of all complaints) (TIO 2000).

Coverage is measured as the percentage of population covered or the percentage of landmass covered. Generally, carriers produce coverage maps to demonstrate the extent of coverage to users.

Countrywide estimates of population and landmass coverage are presented in table 4.1. Separate measures for rural and urban areas were unavailable.

Lack of coverage is likely to be more of an issue in rural areas than in urban areas as traffic volumes (related to population density) largely determine the number and location of base stations that are financially viable.[6] Coverage is generally comprehensive in large regional centres as well as in metropolitan areas.

5 For example, GSM base stations have a technical coverage limit of 35 km determined by the use of TDMA to manage frequency allocation. This can be extended, by modifying the configuration of the base station, to 70 or 120 km. Cell extension is generally more suited to open flat areas. Manufacturers have indicated that CDMA base stations have a cell radius of up to 100 to 110 km in ideal conditions.

6 Carriers have identified a number of factors as being important determinants of where networks are deployed including, capital and ongoing costs, local population numbers, commercial and tourist visitor numbers, vehicle traffic and current and forecast penetration data (TSI 2000).

Table 4.1 **Terrestrial mobile network coverage, December 2000**

Country	*Subscribers*	*Population*	*Landmass*
	million	per cent	per cent
Australia			
Telstra (GSM)	3.8[a]	94	5
Telstra (CDMA)	0.3[a]	97	12
Optus (GSM)	3.1[b]	93	**na**
Vodafone (GSM)	1.7[b]	92	4.3
Canada			
TELUS Mobility (Analogue)	1.3	95[c]	50[c]
Bell Canada (AMPS)	2.2	95[d]	11[d]
Finland			
Sonera (GSM)	1.9[e]	99	**na**
Radiolinja (GSM)	1.2[e]	98	**na**
France			
France Telecom(GSM)	12.3[b]	97	86
SFR (GSM)	9[b]	98	82
New Zealand			
New Zealand Telecom (D-AMPS)	1	97	**na**
Vodafone (GSM)	0.8	95	26
Sweden			
Comviq (GSM)	1.7	98	**na**
Telia Mobile (GSM)	3	98	**na**
United Kingdom			
BT Cellnet (GSM)	8.1[a]	99	**na**
Vodafone (GSM)	9.4[a]	99	**na**
United States[f]			
Verizon Wireless	28	90	**na**

a Subscriber numbers as at June 2000. **b** Subscriber numbers as at September 2000. **c** Relates to British Columbia and Alberta. **d** Relates to Quebec and Ontario. Bell Mobility's CDMA network covered around 70 per cent of the population as at December 2000. The CDMA network is being expanded to cover approximately 100 per cent of the population in Quebec and Ontario, over the next two years. **e** Subscriber numbers as at December 1999. **f** According to the FCC there are six operators providing nationwide mobile services. Estimates of population coverage were only available for the largest of these — Verizon Wireless. **na** Not available.

Sources: Network Strategies 2001, Telstra 2000a, MTT 2000, FCC 2000b.

Measures of coverage on a rural and urban basis were unavailable. However, it is possible to obtain an indicative estimate of rural population coverage from total population coverage measures, assuming that 100 per cent of the urban population is covered and using the population shares presented in table 2.1 (see chapter 2).

For example, approximately 97 per cent of Australia's total population is covered by the CDMA network. About 80 per cent of Australia's rural population is covered if it is assumed that 100 per cent of the urban population is covered and that the remaining 3 per cent that do not have coverage are in rural areas (see table 4.2).

Table 4.2 **Indicative estimates of population coverage for rural and urban areas**

Country[a]	*Rural*[b]	*Urban*[c]	*Total*
	per cent	per cent	per cent
Australia	80	100	97
France	92	100	98
New Zealand	80	100	97
United Kingdom	91	100	99
United States	57	100	90

Note For each country, total coverage estimates are based on the network providing the greatest population coverage (see table 4.1). 100 per cent of the urban population is assumed to have coverage. The remaining proportion of total population not covered is assumed to be rural. [a] Canada, Sweden and Finland excluded because of lack of data. [b] Rural is defined as per statistical authorities. In Australia, New Zealand and the UK rural defined is as areas with populations less than 1000, in France rural is defined as areas with less than 2000, and in the US rural is defined as less than 2500. [c] Urban defined as per statistical authorities. In Australia, New Zealand and the UK urban is defined as areas with populations over 1000, in France urban is defined as areas with over 2000, and in the US urban is defined as over 2500.

Sources: Productivity Commission estimates based on population coverage information taken from Network Strategies 2001, FCC 2000b and population shares in table 2.1 (chapter 2).

The assumption that 100 per cent of the urban population is covered is likely to be an overestimate as there are pockets within urban areas where coverage is unavailable. This implies that the derived rural population coverage may be underestimated. That said, these indicative estimates would suggest that coverage of Australia’s rural population is lower relative to that in Europe, similar to that in New Zealand, but superior to that in the US.

It should be noted that in the US, there are six operators with nationwide networks, with many other carriers providing services on a regional basis. The rural coverage estimates are based on the largest carrier with a nationwide network (Verizon Wireless). Consequently, there may be rural areas in the US with better coverage than that suggested by the estimates in table 4.2.

The estimates of rural population coverage are only indicative of the level of coverage that is available in remote and rural areas. Mobile users living in remote and rural areas will have differing experiences of mobile coverage. These estimates do not reveal anything about the quality of coverage.

The rural population estimates presented in table 4.2 are based on the statistical authority definitions of rural and urban. In the case of Australia, the UK and New Zealand, urban is defined as being areas with populations of 1000 or over. The assumption of 100 per cent coverage in urban areas is likely to be less robust when urban is defined in this way. If the definition of urban for these countries was similar to those for France (populations greater than 2000) and the US (populations greater than 2500), the estimates of rural coverage would be higher.[7]

In Australia's case if urban is defined as being areas with populations of more than 10 000 or more than 50 000, rural population coverage is estimated to be 87 and 91 per cent, respectively. In the case of the US, when urban is defined as being areas with populations of 10 000 or 50 000, rural population coverage is estimated to be 76 and 84 per cent, respectively.[8]

Domestic 'roaming' arrangements potentially improve coverage levels for individual users. Although calls from any mobile caller can be terminated on any other Australian mobile network, roaming allows users outside the coverage area of their service provider to initiate calls on other carriers' networks. The opportunities for roaming between networks can be limited by the availability of appropriate handsets. For example, it is not currently possible to roam between GSM and CDMA networks because dual mode handsets are not yet available.

Roaming agreements should provide individual users with greater coverage by giving them access to other carriers' networks. However, roaming between networks is not generally supported during a call. Under these circumstances a call will be disconnected and a new call will have to be established on the other network.

Currently, there are no mandatory requirements for roaming in Australia, although commercial roaming agreements have been negotiated between a number of carriers. In 1997, the Australian Competition and Consumer Commission (ACCC) undertook a public inquiry into whether domestic roaming should be 'declared'.[9] Although the ACCC considered that national coverage, and therefore roaming, is important for entry and competition, they concluded that the benefits of introducing mandatory roaming were outweighed by the costs (ACCC 1997).

Domestic roaming agreements are in place in both Canada and the US, usually to allow carriers to provide 'national' coverage. In the US, carriers are required to

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7 See table 1.1 for the different definitions of rural and urban.

8 Indicative coverage estimates are based on population shares obtained from Rowland 1999.

9 A decision by the ACCC to declare a service would mean that a carrier must supply that service to other service providers requesting access to that service in accordance with standard access obligations set out in the *Trade Practices Act 1974*.

offer ‘manual’ roaming — that is, before the user can make or receive a call they have to establish a relationship with the host carrier.[10]

In the UK, the Office of Telecommunications (OFTEL) has introduced a national roaming condition in the lead up to the introduction of 3G mobile services. The four current second generation mobile carriers, in the event they win 3G licences, will be required to negotiate national roaming with a new entrant who holds a 3G licence but not a second generation network.[11]

In Australia, two Federal Government initiatives are aimed at expanding terrestrial mobile coverage.

First, funding is available through the Networking the Nation (NTN) program to provide mobile coverage in areas without mobile services.[12] Such funding will not exceed 50 per cent of the capital cost, with the remainder being provided by the carrier, State governments and communities. Nor does the program fund recurrent costs.

The board administering the NTN program will also consider applications which involve handset subsidies for satellite mobile telephony services, in recognition that for some communities this may be the most practical or cost effective way that they can be provided with a mobile telephone service.[13]

Second, Vodafone has been awarded a contract to establish a continuous mobile phone service along 9425 km of 11 of Australia’s major highways. Vodafone is required to offer inter-carrier roaming to allow users of all other GSM networks to initiate calls on the service (Alston 2001a). This should contribute to increased coverage and may also lead to other roaming agreements being established between carriers.

In addition, in response to the TSI, the Federal Government is providing additional funding to further improve and extend coverage in areas without terrestrial mobile services. Assistance will be provided to fund the capital cost of base stations in population centres of 500 and above, as well as for identifying alternative means of

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10 In contrast ‘automatic’ roaming means all that is required is to turn on the phone to originate or terminate a call on another carrier’s network.

11 3G mobile networks will provide enhanced multimedia services such as high speed access to the Internet.

12 See chapter 2 for a discussion of the NTN initiative.

13 As at 20 June 2001, just under $19 million of NTN funds had been allocated to improving mobile coverage in remote, rural and regional Australia (Alston 2001c). The latest round of applications for funding were due to be considered by the NTN Board on 21 June 2001.

providing greater access to mobile services in areas without terrestrial access (Alston 2001b).[14]

Penetration

Access to mobile services can be measured through penetration rates (number of subscribers per 100 persons). Consistent countrywide penetration rates were available for all benchmarked countries (see table 4.3). However, penetration data on a remote, rural and urban basis was not readily available.

Table 4.3 **Mobile penetration rates for selected OECD countries, 1999**

	Mobile subscribers per 100 persons	*Fixed lines per 100 persons*	*Mobile and fixed lines per 100 persons*
Australia	34.4	52.1	86.5
Canada	23.0	63.5	86.5
Finland	65.2	55.1	120.3
France	36.4	57.9	94.3
New Zealand	23.0	49.0	72.0
Sweden	62.0	67.8	129.8
United Kingdom	40.8	55.7	96.5
United States	31.2	66.1	97.3

Source: MTT 2000.

There was significant growth in mobile communication services in the 1990s. By the end of 1999, there were 360 million mobile subscribers across OECD countries (OECD 2001). Finland had the highest penetration of mobiles (see table 4.3), with mobile services surpassing fixed services in 1998. Sweden also has a very high penetration of mobile phones.

The high growth rates of mobile subscriptions means that penetration rates are increasing quickly in most countries. For example, the ACA estimated that mobile penetration in Australia reached 42 subscribers per 100 persons by 30 June 2000. On the basis of Australian Bureau of Statistics and carrier data, the ACA forecasts that mobile penetration will surpass fixed services penetration during 2001 (ACA 2000c). In Canada, mobile penetration had reached 29.6 subscribers per 100 persons by 31 March 2001 (CWTA 2001 and Statistics Canada 2001).

14 The government has committed $88.2 million over three years. $79.2 million was allocated from the 2001 budget and $9 million was transferred from the Rural Transactions Centres Program. Included in the $82.8 million is $7 million already committed to improving terrestrial CDMA coverage in Western Australia through the WirelesSWest project.

4.3 Quality of service

Quality of service outcomes are influenced both by network performance and user behaviour (see box 4.3).

The Commission identified and sought information on the following indicators of service quality:

- *call congestion* — the failure by the mobile network to accept a bid to establish a call;
- *call drop-out* — the discontinuation of a call by the network during the communication phase because of a deterioration in the strength of the radio signal;
- *service unavailability* — a measure of network downtime where users are unable to access the network; and
- *post dial delay* — the time that elapses between completion of dialling and connection. These delays occur because the network needs to establish the location of the mobile user before a connection can be made.

In most of the benchmarked countries, carriers are not required to collect service quality measures. Only Australia and the UK have regular performance reporting of quality of service outcomes. However, these are confined to measures of call congestion and call drop-out. Separate measures for rural and urban areas are not collected or reported for these countries. Some call congestion and call drop-out data was obtained from carriers in New Zealand and Canada.

Australian performance

In the TSI, few submissions and consultations identified mobile quality of service issues as being significant (TSI 2000). In addition, complaints to the TIO about network performance (such as call congestion and drop-outs) accounted for 5.3 per cent of all complaints for GSM networks and 10 per cent for CDMA during 1999-2000 (TIO 2000).

Box 4.3 **Factors affecting mobile quality of service**

Mobile networks operate off radio technology which uses line of sight between base stations to form the overall mobile service coverage area. Network performance will largely depend on the capacity (to accept call attempts), strength of the radio signal and how well the network manages call handover to a better channel when the signal is degraded either because the handset is too far from a base station or because of interference.

Some of the factors that may influence network performance in both rural and urban areas include:

Terrain — can make transmission more difficult, resulting in a failure to get a signal or calls dropping out. Mountains, valleys, trees, tunnels and high rise buildings can all interfere with the radio signal being emitted by the base station and the mobile phone.

Movements within the coverage area — the tendency of mobile users to move about while engaged in a call may result in them moving into areas of low signal strength which may lead to the premature termination of a call. Call drop-outs will be more likely at coverage boundaries within remote and rural areas and 'deep' in building areas such as underground car parks. Moreover, as users move around, the call is handed from one base station to another. If the mobile moves into another radio cell which has no free channels available to continue carrying the call, the call is dropped when handover to the other cell fails to take place. This is likely to be more of a problem in peak calling periods in high traffic areas.

Interference — can result from a mobile being too close to a number of base stations and receiving conflicting information from them. It can also be caused by signals bouncing off buildings or large metal objects such as trucks or trains and in some cases interference can come from other high power radio equipment.

Weather — can affect performance of radio links used to connect base stations to the rest of the network.

Capacity — limits the size of the user base in a mobile service area able to access the service at a particular time. Where base stations are at capacity, bids to establish a call may not be accepted (congestion) or calls may be dropped. This is likely to be more of a problem during peak calling periods or during major events such as sporting events.

The ACA reports call congestion and drop-out measures for each of the major carrier's GSM networks by State. The call congestion rate is measured as the total number of congestion events that prevent call connection to or from a mobile handset as a proportion of the total number of new call requests.

During 1999-00, call congestion rates varied marginally between carriers and across States (see table 4.4). Call congestion rates for all carriers and States were well below one per cent and in most cases below half a per cent.

Table 4.4 **Call congestion by operator — Australia, July 1999 to June 2000 (per cent)**

	Telstra (GSM)		*OPTUS (GSM)*		*Vodafone (GSM)*	
	minimum	*maximum*	*minimum*	*maximum*	*minimum*	*maximum*
NSW	0.49	0.81	0.17	0.38	0.42	0.75
Victoria	0.31	0.73	0.03	0.18	0.10	0.32
Queensland	0.24	0.62	0.05	0.07	0.04	0.30
Western Australia	0.27	0.48	0.02	0.53	0.02	0.25
South Australia	0.25	0.36	0.01	0.06	0.02	0.24
Tasmania	0.22	0.85	0.00	0.04	0.00	0.32
Northern Territory	0.14	0.37	0.02	0.14	0.00	0.31
ACT	0.32	0.46	0.07	0.28	0.04	0.47

Note The call congestion rate is measured as the total number of congestion events that prevent call connection to or from a mobile handset as a proportion of the total number of new call requests. The table presents the minimum and maximum quarterly congestion rate reported for each network in each State for the reporting period.

Source: ACA 2000c.

The ACA measures call drop-out as the sum of the total number of 'radio-frequency fail events' and the total number of 'handover fail events' as a proportion of all mobile calls which are successfully connected.

During 1999-00, call drop-outs varied marginally between carriers and across States (see table 4.5). Call drop-outs for all carriers and States were between one and two per cent.

Table 4.5 **Call drop-out by operator — Australia, July 1999 to June 2000 (per cent)**

	Telstra (GSM)		*OPTUS (GSM)*		*Vodafone (GSM)*	
	minimum	*maximum*	*minimum*	*maximum*	*minimum*	*maximum*
NSW	1.93	1.99	1.63	1.87	1.48	1.60
Victoria	1.60	1.65	1.45	1.70	1.38	1.47
Queensland	0.95	1.36	1.19	1.38	1.23	1.47
Western Australia	1.17	1.27	1.09	1.24	1.13	1.32
South Australia	1.25	1.31	0.93	1.11	1.08	1.29
Tasmania	1.36	1.45	1.97	2.18	1.64	1.85
Northern Territory	1.01	1.21	1.26	1.42	1.31	1.45
ACT	1.17	1.25	1.02	1.05	0.98	1.13

Note The call drop-out rate is measured as the sum of the total number of 'radio-frequency fail events' and the total number of 'handover fail events' as a proportion of all mobile calls which are successfully set-up. The table presents the minimum and maximum quarterly call drop-out rate reported for each network in each State for the reporting period.

Source: ACA 2000c.

International comparisons

OFTEL regularly publishes call success rates for the digital networks of the four UK mobile carriers on a national and regional basis. Each carrier tests its own network in accordance with an agreed set of criteria. The surveys show the percentage of test calls connected and completed successfully, and percentages of successful call set-ups and held calls. To be considered successful, a call must be set-up and held for two minutes.

Successful call connections and successfully held calls are the inverse of measures of congestion and call drop-out respectively. For ease of comparison with the Australian data, table 4.6 presents the inverse UK measures for BT Cellnet and Vodafone.

Table 4.6 **Call congestion and call drop-out — United Kingdom, October 1999 to March 2000 (per cent)**

	BT Cellnet			*Vodafone*		
	calls connected and completed	*call congestion*	*call drop-outs*	*calls connected and completed*	*call congestion*	*call drop-outs*
East Anglia	95.2	4.1	0.7	98.9	0.6	0.5
London	96.6	1.6	1.8	96.0	2.8	1.2
Midlands	97.4	1.4	1.2	96.8	1.8	1.4
Northern England	97.2	1.5	1.3	96.5	1.7	1.8
Northern Ireland	93.8	3.4	2.8	95.8	3.0	1.2
Scotland	95.4	2	2.6	96.3	1.8	1.9
South East England	96.4	1.7	1.9	97.3	1.4	1.3
South West England	96.2	2.3	1.5	97.2	1.5	1.3
Wales	94.8	3.6	1.6	90.4	6.2	3.7
National	96.5	1.9	1.7	96.4	2.1	1.6

Note The quality of service measures published by OFTEL show the percentage of test calls connected and completed successfully and the percentages of successful call connections and held calls. To be successful, a call must be set-up and held for 2 minutes. Successful call connections and successfully held calls are equivalent to the inverse of measures of congestion and call drop-out respectively. For ease of comparison with Australian data, the inverse measures are presented in this table.

Source: Network Strategies 2001.

Call congestion rates (equivalent to the inverse of successful call connections) for both carriers ranged between 0.6 and 6.2 per cent. In most regions, congestion rates were over 1.5 per cent.

Call drop-out rates (equivalent to the inverse of successfully held calls) for both carriers ranged between 0.5 and 3.7 per cent. In most regions call drop-out rates ranged between 1 and 2 per cent.[15]

There is little systematic variation between regions with high and low population densities. However, this cannot be properly assessed without more detailed data for rural and urban areas.

Australian call congestion measures of below one per cent compare favourably with the equivalent measures for carriers in the UK, New Zealand and Canada. Australia also compares favourably in terms of call drop-out rates (between one and two per cent) against carriers in the UK, New Zealand and Canada.[16]

Consequently, quality of service outcomes for Australian mobile users, across the country as a whole, are equivalent if not better than those of users in the benchmarked countries for which data were available.

The nature of mobile networks suggests that it is reasonable to expect rural areas to have lower congestion rates than metropolitan areas given the lower density of users and traffic volumes, although this is difficult to assess in the absence of regional measures.

Call drop-out rates are likely to be more significant in rural areas than in urban areas because urban areas have contiguous areas in which users may move between without passing in and out of range. The ‘islands’ of coverage experienced in rural areas make it more likely that users could move in and out of coverage areas during a call. This pattern of coverage arises because of the high cost of covering sparsely populated areas.

Government initiatives aimed at improving mobile coverage, including funding under the NTN program, in response to the TSI and the contract to provide continuous coverage along major Australian highways, should also contribute to reducing the incidence of call drop-outs.

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15 More recent information released by OFTEL for the April to September 2000 period is limited to measures of calls connected and completed, which is a combination of the call set-up and held call measures. The results were not disaggregated by carrier and show the rate that each of the four carriers either reached or surpassed, both at the national level and in each region. The results ranged from 84.6 per cent of calls connected and completed successfully to 97.9 per cent.

16 The call drop-out measure for the UK is less stringent than in Australia, as calls only have to be held for 2 minutes.

4.4 Prices

Carriers typically offer mobile users a range of call plans, which they can match to their usage. In many cases, call plans lock users into a contract period, largely to recover the cost of handsets.

There are a number of elements to the pricing of mobile voice services:

- the price of a handset;
- connection fee;
- monthly access fees; and
- call charges (time-based and call set-up).

Carriers do not generally offer plans based on geographic area. Consequently, call plans should be available equally to users in both rural and urban areas.

In most cases, call charges are not distance based.[17] Call charges might vary depending on who is being called. For example, some carriers offer reduced call charges or free calls where calls are made to other users on the carrier's network. These options would be equally available to users in both rural and urban areas.

4.5 In summary

Mobiles are increasingly important as a communications tool and mobile users have high expectations about where they can use their mobile phones.

Coverage

Coverage measures provide an indication of the accessibility of mobile services. In terms of overall measures of coverage, Australia generally compares favourably with respect to population coverage. However, the proportion of landmass coverage in Australia is much lower than in more densely populated countries such as France.

Coverage of Australia's rural population was estimated to be less than that in Europe, similar to that in New Zealand and greater than in the US. These estimates are based on a number of assumptions and are indicative only.

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17 In Australia, there are some Optus pricing plans that have distance-dependent tariffs for some types of calls. For example, Optus' GSM service has two rates (less than 165 km and more than 165 km) for calls from a mobile to a PSTN service.

Quality of service

Quality of service outcomes will be influenced both by network performance and user behaviour. Australia and the UK are the only benchmarked countries to publish measures of mobile service quality regularly. However, some measures were obtained from other sources for New Zealand and Canada.

Australia generally compares favourably in terms of countrywide measures of call congestion with carriers in the UK, New Zealand and Canada. The lower density of users and traffic volumes in remote and rural areas suggest that these areas may have lower call congestion rates relative to urban areas.

Countrywide measures of call drop-out in Australia also compare favourably with the UK, Canada and New Zealand. The 'islands' of coverage experienced in rural areas make it more likely that users could move in and out of coverage areas during a call and experience a higher incidence of dropped calls.

In the absence of detailed regional measures it is difficult to assess whether relative quality of service outcomes for remote, rural and urban mobile users in Australia differ to those for users in the other benchmarked countries.

Prices

Prices do not differ between remote, rural and urban users in any of the benchmarked countries.

5 Basis PSTN access to the Internet

The Internet is becoming an increasingly important tool in the information society, used for such day to day activities as education, business and financial transactions, personal correspondence, research and information gathering and job searches. Access to the Internet for people in remote and rural areas provides an opportunity to gain access to services that in some cases are not provided locally.

A key issue for remote and rural Internet users is whether they can gain access at reasonable transmission rates and price. Transmission rates have a significant influence on the types and responsiveness of applications that can be accessed.

The nature of access to the telecommunications network, and hence the Internet, has a significant impact on data transmission rates. Most remote, rural and urban users currently access the Internet via the public switched telephone network (PSTN). The PSTN was originally designed to carry voice traffic and is only able to transmit data at relatively low rates (below 56 kbps).

The distance between the customer and the local exchange (line length) is a major determinant of transmission rates over the PSTN. The distribution of line lengths from the local exchange has a major bearing on outcomes for remote, rural and urban Internet users. Longer line lengths in remote and rural areas are likely to result in lower data transmission rates.

Although other factors also affect data transmission rates, their impact is less likely to differ between remote, rural and urban users and there is greater scope to minimise their influence. For example, users may be able to improve their data transmission performance by upgrading their modems. However, there is no scope for users to influence the performance of the telecommunications infrastructure.

Where users are unable to access the Internet for the cost of a local call, data transmission constraints, which have the effect of increasing the duration of calls, affect costs.

The increasing demand for higher bandwidth services for Internet applications is likely to exacerbate perceptions of disadvantage in remote and rural areas. High speed access to the Internet is discussed in Chapter 6.

5.1 Accessing the Internet

The Internet is a worldwide collection of computer networks — physically linked by telecommunications infrastructure — using a common set of telecommunications protocols (TCP/IP) to communicate.[1]

Global and nationwide backbones interconnect the networks of Internet service providers (ISPs).[2] An ISP allows users to connect to the Internet by providing the interface to the backbone. ISPs also provide other services including electronic mail and web hosting.

Users access the Internet either through a dial-up or permanent connection. Most users accessing the Internet over the PSTN have dial-up connections, with larger users, such as businesses and governments, utilising permanent connections. Dial-up users connect to their ISP through the local exchange, either directly or indirectly via a customer access module (see figure 5.1).[3] ISPs typically have a number of points of presence (POPs), distributed across their area of operation.[4]

That part of the PSTN between the user and the local switch is commonly referred to as the customer access network (CAN). Copper wire is the most common transmission medium used in the CAN. However, other media such as terrestrial radio or satellite are also used, particularly in remote and rural areas. Digital data from a user's personal computer is converted by the modem to an analogue signal that can be carried over the CAN (see box 5.1). [5]

1 A protocol architecture is the layered structure of hardware and software that supports the exchange of data between systems and supports applications, such as electronic mail and file transfer. At each layer of an architecture, one or more common protocols are implemented in communicating systems. Each protocol provides a set of rules for the exchange of data between systems. The transmission control protocol (TCP) reassembles individual packets in the correct order and the Internet protocol (IP) sends packets of information to their destination.

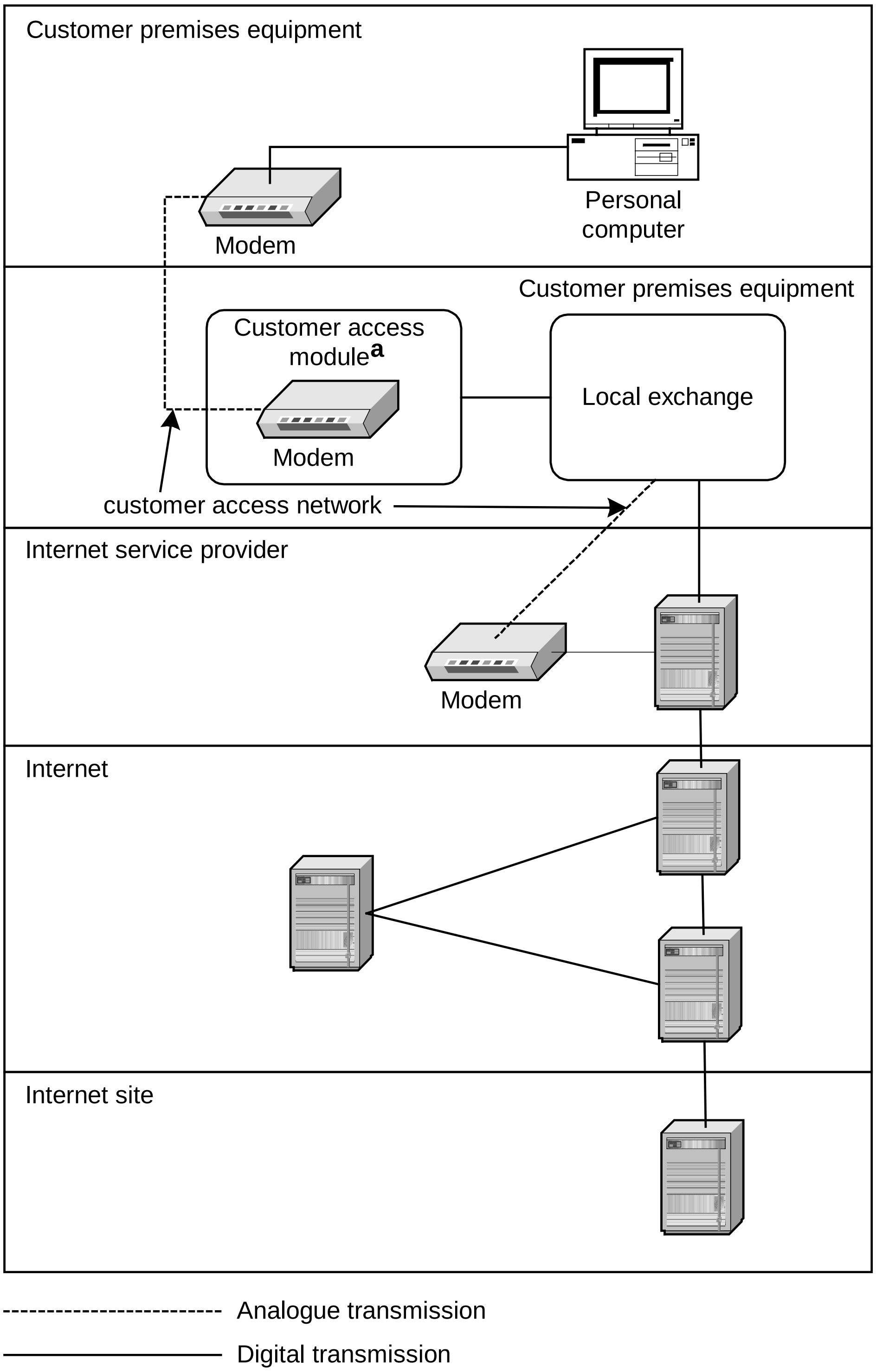
2 A backbone can be defined as a high speed line or series of connections that forms a major pathway within a network.

3 Today networks do not have 'local exchanges' in the traditional sense. On the Telstra network, for example, some users are connected to a customer access module which may be located in a traditional exchange or may be a two metre tall green box on the footpath in the local area.

4 POPs consist of telecommunications equipment including modems, routers, servers and switches.

5 Transmission of data inside computers and across networks involves the movement of bits. A bit, the smallest unit of data stored in a computer, has a discrete binary value of zero or one.

Figure 5.1 **Accessing the Internet**



[a] Modern telephone networks do not have 'local exchanges' in the traditional sense. On the Telstra network for example, some users are connected to a customer access module which may be located in a traditional exchange building or may be a two metre tall green box on the footpath in the local area.

Source: Adapted from Telstra 2001a.

Box 5.1 **Transmitting data over the Internet**

Modems convert digital data into an analogue signal for transmission along the CAN to the local exchange. At the local exchange the analogue signal is reconverted to a digital signal for transmission over the remainder of the telecommunications network.

Depending on the architecture of the telecommunications network and the type of access the ISP has to the network, there may be additional analogue to digital conversions as the information travels over the network (see figure 5.1).

Packet-switching is used to transmit data across and between networks.[a] Messages are divided into portions called packets. These packets carry identification, destination address and other information, that enable other computers on the network to know whether the data is destined for them or how to pass it on to its intended destination. Routers in the telecommunications network and the Internet backbone direct which path the packets should take.

The component packets of a message can therefore be transmitted independently of one another and can travel via different paths to their end destination, where they are reassembled into the original message. This increases the efficiency of the network, because it is not necessary to dedicate transmission capacity along a single path through the network.

[a] Voice is carried over the PSTN by means of circuit-switching which involves the transmission of signals between two points along a dedicated path (circuit). The circuit remains in use for the entire period of the call.

5.2 Internet penetration and use

Demand for the Internet, like any other service, is a function of service availability, price and quality of service, as well as socio-demographic factors such as income and education levels.[6] Differences across remote, rural and urban areas will, in part, reflect the different price and quality of service outcomes experienced by users.

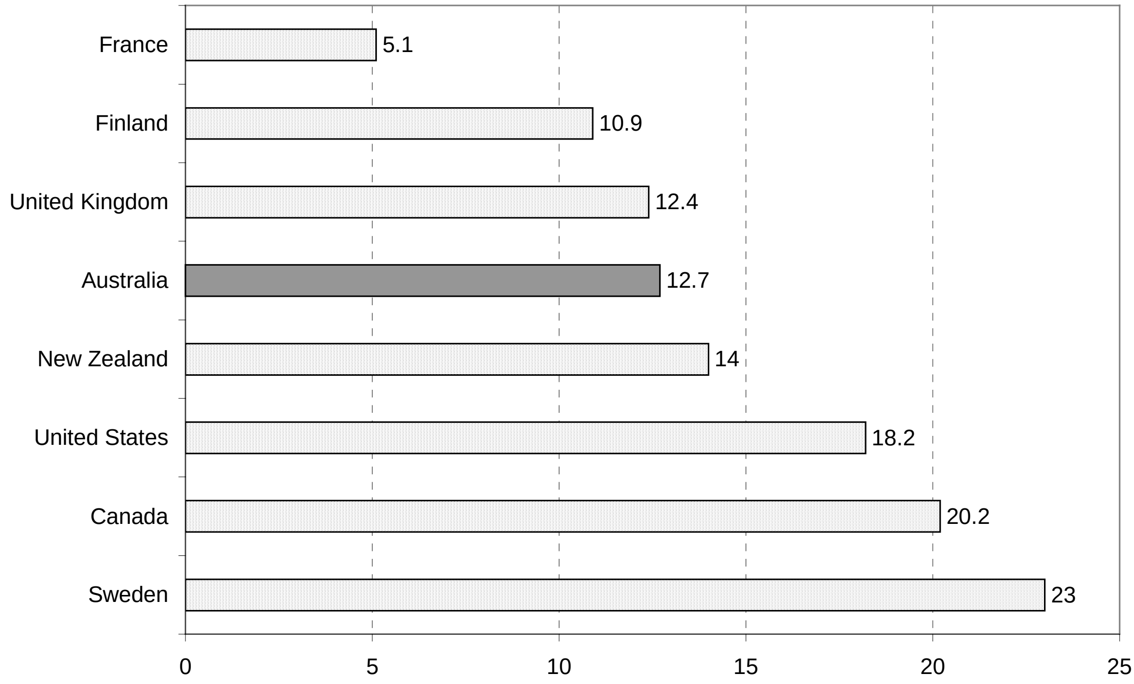
Penetration

Internet penetration can be measured as the number of Internet subscribers per 100 population. This measure has the potential to underestimate actual Internet use by ignoring non-subscribers who access the Internet from locations such as schools, universities, the workplace or Internet cafes.

6 For a discussion of the impact of socio-demographic factors on Internet penetration, see Hellwig and Lloyd 2000.

Countrywide penetration rates were available for all benchmarked countries (see figure 5.2). However, penetration data on a remote, rural and urban basis were not readily available.

Figure 5.2 **Internet subscribers per 100 population, 1 January 2000**



Source: OECD 2001.

Uniform call prices across Sweden is seen as a major driver of the high Internet take-up in that country. The low penetration in France has been attributed to the impact of competition from the established Minitel system, in addition to low household computer penetration. Minitel is a system of text-only terminals connected to France Telecom's PSTN network, offering access to a range of fee-based on-line services.

Some information on regional Internet penetration was available for Australia and the US, from different sources. According to the latest *Use of the Internet by Householders Survey* (ABS 2001b), 37 per cent of Australian households had access to the Internet as at November 2000. Households in metropolitan areas were more likely to have access — 40 per cent of metropolitan households had Internet access compared with 32 per cent outside metropolitan areas.

As at August 2000, 41.5 per cent of all US households had Internet access — 42.3 per cent of households in urban areas had access to the Internet compared with 38.9 per cent in rural areas (DoC 2000).

This suggests that the gap between rural and urban take-up of the Internet is much smaller in the US than in Australia.

Internet use

There are four broad categories of services that people access via the Internet:

- Information — the Internet is used to obtain publicly available information by accessing web sites maintained by organisations and individuals;
- Entertainment — the Internet is a distribution channel for entertainment. Music can be downloaded, radio stations accessed and users can download games and play against each other over the Internet;[7]
- Communication — the Internet provides an alternative method of communicating across long-distances. It is possible to transmit large amounts of data, and communicate with a number of people simultaneously, primarily in the form of email. The Internet can also be used for voice telephony, and video conferencing. Also, employees working from home can use the Internet to access their company's proprietary network; and
- E-commerce — the Internet provides businesses with the opportunity to attract potential customers, to deal with established customers and to undertake business to business and business to customer transactions. For example, customers can use the Internet to place orders, do their banking and pay bills.

Some of these activities require real time access to the Internet at data transmission rates towards the limit of the PSTN's capability.

In Australia, access to the Internet by households is expanding rapidly. Almost 32 per cent of all adults (4.4 million) accessed the Internet from home in the 12 months to November 2000. About 85 per cent of these adults accessed the Internet at least once a week (ABS 2001b).

A small proportion of the adult population used the Internet to access government services (12 per cent of all adults) or to pay bills or transfer funds (12 per cent of all adults). In the 12 months to November 2000, 10 per cent of Australian adults had purchased or ordered goods or services for private use via the Internet (11 per cent in metropolitan areas compared to 6 per cent of adults in other areas).

7 The introduction of high speed access to the Internet through mediums such as HFC cable and the digital subscriber line family of technologies increases the opportunity for users to access video on demand and real time broadcasting (see chapter 6 for a discussion of these technologies).

In the US, about 80 per cent of people with Internet access reported using email regularly and about 60 per cent used the Internet to search for information. About 30 per cent reported shopping or paying bills regularly on-line in 2000 (DoC 2000).

5.3 Factors affecting quality of service outcomes

The perceived quality of Internet services can be expected to be influenced by the ability to connect and maintain the connection, the adequacy of data transmission rates and the ease of accessing particular sites or content. These dimensions of quality are influenced by the performance of:

- telecommunications infrastructure (including the CAN, exchanges and the Internet backbone);
- the ISP;
- servers hosting content; and
- equipment at the customer end.

Service connection

To access the Internet, a user needs an account with an ISP and a connection to the telecommunications network. This may involve renting a second telecommunications line if a separate connection for Internet use is required. Where a new telecommunications line needs to be installed, service connection measures for the PSTN will be relevant (see chapter 3).

Call connection

The ability of a dial-up user to connect to the Internet depends both on access to the ISP and access to the PSTN. The primary causes of connection problems are a lack of capacity in lines and modems at the ISP or congestion in the PSTN. The latter is captured by direct measures of PSTN congestion — congestion in Australia was very low and was less for non-metropolitan areas than for metropolitan areas in 1999-2000 (see chapter 3).

Having made a connection, users may lose that connection (call drop-out) as a result of a problem with the telecommunications network, a problem with the ISP's equipment, or a problem at the customer end (for example, if call waiting is enabled, an incoming call could result in the Internet connection being dropped). Information on call drop-outs is not collected for Australia, making it difficult to assess relative incidence by area or in relation to the source of the problem.

Data transmission rates

A key issue for users accessing the Internet over the PSTN is the rate at which they receive and transmit data. Data transmission rates — usually measured in kilobits per second (kbps) — affect the time taken for a user to receive and transmit data. Transmission rates are also critical to functionality because the data rate determines the types of applications that a service can support (see table 5.1). A higher data transmission rate allows users to access a wider range of applications and to run those applications more quickly.

Table 5.1 **Impact of PSTN data transmission rates on response times**

Indicative data transmission rates (kbps)	*Response times (minutes and seconds)*			
	Short E-mail (1 kilobyte)	*Simple web page (20 kilobytes)*	*Complex web page (100 kilobytes)*	*Large file download (1 Megabyte)*
Copper wire				
2.4	4	1 min 7 sec	5 min 34 sec	58 min 16 sec
9.6	1	17	1 min 24 sec	15 min 34 sec
14.4	1	12	56	10 min 43 sec
28.8	1	6	28	5 min 52 sec
56	1	3	15	2 min 30 sec
Radio				
7.8 (DRCS)	2	22	1 min 46	17 min 56 sec
19.2 (HCRC)	1	9	43	7 min 17 sec

Note Response times depend on downstream data transmission rates (kbps) and the type of the task (kbytes). Data rates and Internet response times are affected to varying degrees by the telecommunications infrastructure (including the CAN, exchanges and Internet backbone), the performance of the ISP, the performance of servers hosting content and the equipment at the user end.

The successful transmission of data depends on the quality of the signal being transmitted and the characteristics of the transmission medium (see box 5.2).

Most users with dial-up connections would access the Internet via a copper based transmission medium (the twisted copper pair CAN). The PSTN was designed primarily as a voice network using frequencies between zero and four kilohertz. Analogue modems that make use of this bandwidth have maximum theoretical downstream (from the ISP to the user) rates of less than 56 kbps and upstream (from the user to the ISP) rates of 33.6 kbps.[8]

Data transmission rates are also a function of the distance the signal has to travel over the transmission medium. As the length of copper increases, the weaker the

8 Downstream refers to data being sent from the ISP to the user and upstream refers to data being sent from the user to the ISP. Maximum data rates are limited by the voice frequency bandwidth and the level of noise on the copper wire.

signal (attenuation) and the increased possibility for electromagnetic interference (see box 5.2). However, attenuation can be reduced through the use of thicker gauge copper wire, such that faster rates are possible over the same length of copper. Transmission rates are also a function of the:

- age of the copper line;
- material used in its installation;
- quality of joints; and
- proximity of lines to electrical inference (for example, from other cables or electric fences).

Box 5.2 **Data transmission rates and bandwidth**

The data rate, measured in bits per second, is the rate at which data can be transmitted.

Data are transmitted from one location to another by means of analogue or digital electromagnetic or optical signals. The bandwidth, measured in cycles per second or Hertz, of the signal refers to the range of frequencies making up the signal and containing most of the information being transmitted.

The available bandwidth of a transmission medium such as the user access line determines the data transmission rate and hence the amount of information that can be carried across the access line per unit of time.

Various transmission impairments limit the available bandwidth of an access line and reduce the data transmission rate that can be received by a user. These include attenuation, delay distortion and various types of noise.[a] These limitations arise from the physical properties of the transmission medium.

Attenuation is a measure of the reduction in signal strength as it travels along any transmission medium and is typically expressed as a constant number of decibels per unit of distance. For wireless media, attenuation is a more complex function of distance and the characteristics of the atmosphere. Attenuation, which increases with frequency, is an important factor because:

- a received signal must have sufficient strength so that the electronic circuitry in the receiver can detect the signal; and
- the signal must maintain a level sufficiently higher than noise to be received without error.

[a] For a technical discussion of transmission impairments see Stallings (2000).

Source: Adapted from Stallings 2000.

Other transmission media such as terrestrial radio technologies (digital radio concentrator system (DRCS) and high capacity radio concentrator system (HCRC)) are sometimes used in some remote and rural areas for dial-up Internet access.

These systems are used to extend the reach of the CAN in the delivery of voice services and have limited data capabilities. The average DRCS data transmission rate is 7.8 kbps and 19.2 kbps for HCRC.

Other factors that influence the data transmission rates that users can achieve relate to customer premises and ISP equipment and the Internet backbone. For example, transmission rates are affected by user and ISP modem choice (see box 5.3 for a discussion of the impact of modems on transmission rates), whether the connection between the ISP and the exchange is digital, the type of data being transmitted and the ISP's connection to the Internet backbone.

Box 5.3 **Modems**

Modems transform digital signals into analogue signals and vice versa for transmission. Earlier modem standards assume that both the user and ISP have analogue connections to the PSTN, limiting transmission rates to 33.6 kbps.

'Quantisation noise' occurs when an analogue signal is transformed into a digital signal and the analogue signal level does not coincide with a discrete digital level. That is, there are 256 different digital signal levels and if the analogue waveform is being sampled at a point that is not exactly equal to the discrete digital level then an approximation is made. This approximation, called quantisation noise, lowers the rate of data transmission.

The more recent V.90 standard is predicated on the CAN being the only analogue portion of the downstream transmission path.[a] Digital interconnection between local exchanges, ISPs and the telephone network removes the need for additional analogue to digital conversion resulting in the elimination of quantisation noise.

With the elimination of quantisation noise, downstream data reach the local exchange at 64 kbps. At the exchange a digital to analogue converter transforms digital data into an analogue waveform, with no loss of data rate, for transmission along the CAN. Transmission impairments along the CAN, specifically noise, the length of the CAN and limitations placed on transmit power levels by regulatory agencies, reduce the maximum rate received by users to below 56 kbps.

Transmission along the CAN from the user end (known as upstream transmission) requires digital to analogue signal conversion limiting transmission rates to 33.6 kbps.

a The presence of multiple analogue to digital conversions in the CAN causes V.90 modems to revert to V.34 working. Under ideal conditions V.34 modems support data transmission rates of 33.6 kbps.

Source: Adapted from Copper Pair Communications Inc 2000.

The importance of some of these factors relative to the impact of the telecommunications network were investigated for this study. For this purpose, case studies seeking information from four ISPs operating in a number of regions across Australia were undertaken (see box 5.4).

Box 5.4 **Factors influencing Internet quality of service**

The Commission's consultant sought information from a number of ISPs on various aspects of ISP and telecommunications network performance. The ISPs surveyed included CAMS (located in the outer fringe of Melbourne), Northnet Internet Services (providing services to the New England region of NSW), Outback Queensland Internet (based in Longreach) and Penola Internet Services (operating around the Penola area in South Australia and across the Victorian border).

The case studies identified a number of factors that influence quality of service, relating both to user and ISP equipment and the telecommunications infrastructure. The following comments made by the ISPs illustrate the impact of some of these factors.

Customer premises equipment (CPE)

- Some of the problems reported by users were due to inappropriate computer configuration. These problems tended to be one off.
- The quality of the user's modem was a significant factor, with the more expensive external modems being more reliable than the cheaper software driven internal modems.
- Some instances of low transmission rates were found to be caused by the use of extension leads within user premises.
- A small number of users experience call drop-outs, typically caused by hardware conflicts, call waiting being active, other computer applications or faulty modems.

Telecommunications infrastructure

- Some of the problems experienced were attributed to the telecommunications network or the environment, such as moisture from rainfall causing problems with the telephone lines.
- Users of Outback Queensland Internet experienced problems with call drop-out, due to noisy lines specifically relating to DRCS services.
- Users of CAMS' 33.6 kbps service achieving connections of consistently less than 33.6 kbps tended to be those further from exchanges. A similar inverse relationship between transmission rates and distance from the exchange was evident among Penola Internet Services' users.
- Several of the ISPs also suggested that data transmission rates for some users were affected by the age and quality of the copper cabling in the customer access network.

ISP equipment

- One ISP acknowledged that call congestion at the busiest times on weekdays (8.30am-9.30am and 4.30pm-6.30pm) was the result of a lack of their own capacity. Augmentation of capacity would require a major upgrade.

Source: Network Strategies 2001.

The comments in box 5.4 reflect the views of a small sample of ISPs and should not be regarded as representative. That said, the case studies do highlight the range of factors that determine quality of service outcomes for remote, rural and urban users of the Internet. Moreover, they reveal that line length and the quality of telephone lines are perceived to be important factors influencing transmission rates for dial-up connections over the PSTN.

The impact of customer premises equipment and ISP performance could be the same, regardless of whether users are situated in remote, rural or urban areas. Moreover, the impact of these factors can be mitigated to some extent by upgrading equipment or switching to a better performing ISP. Consequently, the telecommunications infrastructure (line length and quality) will be a significant determinant of relative data transmission rates in remote, rural and urban areas.

5.4 Data transmission rate relativities

A key issue for remote and rural users is whether they can access the Internet at transmission rates that allow them to take full advantage of the applications and services available. This issue may become more prominent as the Internet increasingly fills the void of services, such as banking, for example, that in some cases are no longer provided locally in remote and rural areas.

The distribution of basic PSTN data transmission rates is an important measure for comparing relative outcomes for remote, rural and urban Internet users.

Comparisons of data transmission rates within a country

Information on the data transmission rates achieved in remote, rural and urban areas was only available for Australia (see table 5.2). This information suggests that 60 per cent of users in remote and rural areas can obtain data transmission rates of at least 28.8 kbps compared to 75 per cent of users in urban areas.

The indicative data transmission rates in table 5.2 differ significantly from those reported in the Digital Data Inquiry (ACA 1998a). The Digital Data Inquiry reported that 60 per cent of urban and provincial lines achieved transmission rates of 28.8 kbps and only 30 per cent of lines in remote and rural areas achieved such rates.

The data transmission rates estimated for the Digital Data Inquiry assumed the use of a V.34 modem. The assumption in table 5.2 is that a V.90 modem is used. This significantly increases the proportion of lines that could achieve transmission rates above 14.4 and 28.8 kbps in both rural and urban areas.

Table 5.2 **Cumulative distribution of PSTN data transmission rates, Australia (per cent)**

Data transmission rate	*Lines in urban and provincial areas*[a]	*Lines in remote and rural areas*[b]
kbps	per cent	per cent
2.4	100	99
9.6	99	90
14.4	95	85
28.8	75	60

Note The table presents Telstra data on the per cent of customer lines with data rates at least as great as that indicated. Data transmission rates assume the use of a V.90 modem. Excludes facsimile transmissions, that have different transmission characteristics. [a] Urban and provincial is defined as exchanges which service population centres of more than 2500. [b] Remote and rural is defined as exchanges that service population centres of less than 2500.

Source: Network Strategies 2001.

V.90 modems improve rates only where the ISP is digitally connected to the telecommunications network (for example, via integrated services digital network) and where users have PSTN connections with only one analogue to digital conversion. Where there is more than one analogue to digital conversion, V.90 modems revert to V.34 working and lower transmission rates, consistent with those reported in the Digital Data Inquiry. The use of electronics in the CAN introduces additional analogue to digital conversions.

In Australia, the lower data transmission rates achieved in remote and rural areas compared to urban areas largely reflect the impact of longer lines, the use of terrestrial radio technologies and the use of electronic systems (necessitated by long lines) which introduce additional analogue to digital conversions.

Some of these factors affect data transmission rates in urban areas, but to a lesser extent. Line lengths in rural areas tend to be longer because exchanges in these areas cover a wider area and service fewer users compared to urban exchanges.

The information obtained from the ISP case studies suggests that rural users within towns, and close to exchanges, can achieve data rates and quality similar to users in urban areas. Remote users are at a severe disadvantage if they use terrestrial radio technologies (such as DRCS or HCRC) for accessing the Internet. For those using DRCS, email may be the only application that is practicable given the limitations of data transmission rates.

Comparison of data transmission rates across countries

Data on transmission rates in countries other than Australia were only available on a countrywide basis. Consequently, comparisons have to be made on that basis.

Although approximately 73 per cent of customers in Australia were reported to have data transmission rates of least 28.8 kbps, this is well below the estimates for Canada (close to 100 per cent), the UK (90 per cent) and the US (80 per cent).[9]

One possible reason for the differences in countrywide data transmission rates is inconsistencies in the assumptions used to measure data transmission rates. For example, the data rate estimates depend on the type of customer and ISP modems assumed to be in use. The impact on indicative data rates for Australia of different assumptions about modem use (use of V.90 versus V.34 modems) was discussed in the previous section.

Other explanations for differences in transmission rates across countries, as well as within countries, are related to network characteristics. Two of the more significant factors are average length of customer access lines and the gauge and quality of copper cabling both of which influence data rate capabilities. For example, the use of higher copper gauges in North America compared to Australia would result in comparatively faster data transmission rates over the same line lengths.

Further insights into relative transmission rates within and across countries may be gained from the distribution of line lengths and the quality of copper cabling.

Line length distributions

Distance from the exchange is a factor that can vary between remote, rural and urban areas. As reported in the case studies, this factor has a significant impact on transmission rates.

Information on the distribution of line lengths was available for Australia on a rural and urban basis, with carrier-wide information received for Western Canada and large parts of the US (Verizon, GTE and Qwest). Although this information is not consistent in terms of line length groupings or year of measurement across countries, useful comparisons can be made.

Distribution of line length information for Australia is presented in table 5.3 on a rural and urban basis. On a cumulative basis, 99 per cent of urban lines in Australia

9 The estimate for Canada relates to British Columbia and Alberta (TELUS).

were less than 5 km in length, while only 87 per cent of lines in remote and rural areas are less than 5 km in length.

Table 5.3 **Distribution of lines by line lengths in Australia, 1986 (per cent)**

Line length range	*Urban*	*Remote and rural*
km		
< 1	36	36
1 – 3	52	36
3 – 5	11	15
5 – 10	1	9
> 10	0	4
Total	100	100

Source: Network Strategies 2001.

Australian line length data relate to the mid-1980s. There have been some changes to network design since this time. However, Telstra reports that these changes have generally reduced line lengths in both rural and urban areas. Urban areas are still characterised by shorter average line lengths.

Available distribution of line length information for North American carriers is presented in table 5.4. On a cumulative basis, 72 per cent of Bell Atlantic and TELUS lines are less than 4.5 km in length across all areas.

Table 5.4 **Distribution of lines by length, North American carriers[a]**

United States						*Canada*	
Bell Atlantic[b]		*GTE*[c]		*US West*[d]		*TELUS*	
km	per cent	km	per cent	km	per cent	km	per cent
< 1.5	22	< 3.6	64	< 3.1	52	0 – 1.0	16
1.5 – 3.1	29	3.6 – 5.5	20	3.1 – 7.6	40	1.0 – 3.5	36
3.1 – 4.6	22	5.5 – 7.3	8	7.6 – 30.5	8	3.5 – 4.5	20
4.6 – 6.1	12	7.3 – 11.0	4			4.5 – 5.5	16
> 6.1	15	> 11.0	4			5.5 – 10.0	4
						> 10.0	8
Total	100		100		100		100

a Bell Atlantic, GTE and Qwest data as at September 1997. TELUS data as at June 2000. **b** The Bell Atlantic service area includes New Jersey, Pennsylvania, Delaware, Maryland, Washington DC, Virginia and West Virginia. **c** The GTE service area includes Alabama, Arizona, Arkansas, California, Florida, Hawaii, Illinios, Indiana, Iowa, Kentucky, Michigan, Nebraska, Nevada, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Virginia, Washington and Wisconsin. **d** The US West service area includes Arizona, Colorado, Idaho, Montana, New Mexico, Utah, Wyoming, Iowa, Minnesota, Nebraska, North Dakota, South Dakota, Washington and Oregon.

Sources: Network Strategies 2001 (Canadian data) and FCC 1997 (US data).

The absence of separate information on rural and urban line lengths for North American carriers makes it difficult to comment on line length relativities across countries. However, the available data suggest that Australian remote and rural users have shorter lines compared to subscribers generally in the US and Canada — 72 per cent of remote and rural lines in Australia are less than 3 km, whereas 51 per cent of Bell Atlantic's lines are less than 3.1 km and 52 per cent of TELUS' lines are less than 3.5 km (see tables 5.3 and 5.4).

The information on the distribution of line lengths would, by itself, suggest that the proportion of customers with data transmission rates of at least 28.8 kbps should be greater in Australia than in North America. That this does not appear to be the case, indicates either measurement inconsistencies or the existence of offsetting factors affecting the bandwidth of the CAN.

Quality of copper cabling

In the ISP case studies attention was drawn to the impact of the quality of the CAN on the level of service, including data rates, experienced by Internet users. One ISP described an exchange area as having poor quality access lines. It was noted that it was one of the first areas in the region to be copper wired — around 40 years ago — and now experiences problems believed to be due to the age of the copper.

In contrast, another ISP commented that a number of its users, with older lines utilising higher quality copper, experienced superior data rates to those achieved on normal copper, despite relatively large distances between the exchange and user.

Over 30 per cent of the copper in Australia's PSTN network is older than 30 years and more than 5 per cent predates 1950. In addition, the CAN in Australia is based on a tapered design which means that the multi-pair cables that leave an exchange are broken down into ever smaller groups of copper pairs as they approach the user's premises (Ergas 2000). This is in contrast to the approach used in the US, where there is less tapering. The tapering involves the introduction of joints which have an adverse impact on data transmission rates.

Given the paucity of data it was not possible to draw any conclusions about the relative outcomes for remote, rural and urban users in Australia compared to the other benchmarked countries. Specifically, the international comparisons were limited by the lack of directly comparable data on the distribution of transmission rates within countries, uncertainty about the assumptions used to estimate countrywide transmission rates and the lack of information on the relative importance of various physical factors such as line length and quality.

5.5 Impact on user costs

The cost of using the Internet typically includes the following elements:

- ISP subscription charges;
- ISP usage charges, based on connection time or data volume;
- PSTN fixed charges for connection and line rental; and
- PSTN call charges, either fixed per call or time-based.

ISPs offer plans ranging from a per hour usage fee to unlimited use for a fixed monthly fee or a combination of fixed and usage fees, with a basic charge covering usage up to a specified number of hours or data volume plus a usage charge for excess hours or data volumes above a specified monthly limit.

PSTN costs associated with Internet use vary with the data transmission rate available to the user in those situations and locations where the PSTN charge is time-based. The longer it takes to transfer data and the greater the likelihood of a call drop-out, the higher the cost of using the PSTN. The data transfer rate also affects the cost of ISP services to the user if the pricing plan used includes a time-based component.

Applications such as business research, education and e-commerce typically require longer duration calls in remote and rural areas than in urban areas because of bandwidth constraints of the CAN, which have the effect of slowing down the transmission of information.

Variations in PSTN costs

PSTN call charges potentially have a significant impact on the relative cost of accessing the Internet for remote, rural and urban users. The major determinant of the PSTN charge for accessing the Internet will be the location(s) of an ISP's point of presence (POP) in relation to the user.

If a POP and user are in the same local call zone, connections can be made for the cost of a local call. If this is not the case, users have to pay long-distance charges to access the Internet.

Alternatively, users can also take advantage of virtual POPs where they are utilised by their ISP. Virtual POPs allow users to access an ISP as though it were within the same local call zone at the cost of a local phone call. However, the additional costs incurred by the ISP in making this service available are typically passed on to the user as part of their charge.

Australian PSTN costs

Until recently, some remote and rural Internet users in Australia were unable to access an ISP for the cost of an untimed local call and incurred time-based charges. The inability to access the Internet for the cost of a local call combined with reduced data transmission capabilities of the CAN, had the potential to increase the cost of accessing the Internet significantly for some remote and rural users (see box 5.5).

On 5 April 2001, Telstra introduced national access numbers which gave all Australians access to Telstra's BigPond Internet Plans for the cost of an untimed local call. Telstra also offers a number of wholesale products (for example, Megapop) that allow other ISPs to offer Internet services for the cost of a local call.

This Telstra initiative brings forward some of the impact of the Untimed Local Calls agreement between Telstra and the Federal Government. Under the agreement those living in the so-called 'extended zones' will have access to untimed local calls for dial-up Internet and voice services.

These initiatives, by providing all Australians with the opportunity to access an ISP for the cost of a local call, eliminate the cost disadvantages illustrated in box 5.5.

In addition, in its response to the Telecommunications Service Inquiry the Federal Government announced that it would enter into a joint venture with Telstra to assist residential and small business users to achieve effective dial-up Internet transmission speeds equivalent to at least 19.2 kbps over the PSTN. Special arrangements will apply to Internet users in the outer extended zones through the Untimed Local Calls agreement.

Box 5.5 **Impact of different data transmission rates and PSTN charges on the cost of using the Internet in Australia, March 2001**

Prior to April 2001, some remote and rural users were unable to access the Internet for the cost of a local call. This was a significant factor in influencing relative outcomes for remote, rural and urban Internet users.

The flow-on effects of different data transmission rates on the cost of using the PSTN to access the Internet varied with the type of charge incurred by remote, rural and urban users. The following table combines the response time information presented in table 5.1 with the different charges for dial-up PSTN access to the Internet to illustrate the potential impact on user costs.

Indicative transmission rates (kbps)	*Response times*	*PSTN call charges for 1 Mbyte download ($)*					
		local call	*community call*[a]	*pastoral call*[b]	*long-distance (STD) rates*[c]		
					50-85 km	*85-165 km*	*>165 km*[d]
Copper wire							
2.4	58m 16s	0.22	6.05	2.64	10.71	13.62	14.79
14.4	10m 43s	0.22	1.29	0.66	2.15	2.68	2.90
28.8	5m 52s	0.22	0.81	0.44	1.28	1.57	1.69
56	2m 30s	0.22	0.47	0.22	0.67	0.80	0.85
Radio							
7.8 (DRCS)	17m 56s	**na**	**na**	0.88	0.88	0.88	4.70
19.2 (HCRC)	7m 17s	**na**	**na**	0.44	0.44	0.44	2.04

Note Cost estimates relate solely to charges for connecting to the PSTN. Reduced call charges offered under pricing plans are excluded. Only peak PSTN charges are included. **a** Community calls are long-distance calls (up to 50 km) charged on a per minute basis (10 cents peak and 4 cents off-peak), plus a 22 cent call connection fee. They can apply between certain areas such as between developed fringes of outer metropolitan areas and capital cities, and from regional areas to the community service town. **b** Pastoral calls are available to remote users and are charged at the rate of 22 cents per 5 minutes or part thereof. **c** For some users incurring STD rates, Telstra's Rural Connect Plan, which allowed users to access the Internet for the cost of a local call would have been more cost effective. For example, if using Rural Connect the same download at 2.4 kbps would cost $4.71 and at 14.4 kbps would cost $1.05 (includes ISP charges) irrespective of distance. **d** Excludes intercapital STD rates. **na** Not applicable.

Users with low data transmission rates who were unable to access the PSTN for the cost of a local call were at a significant disadvantage relative to those who could. Those living in remote areas with only radio access were potentially at a significant disadvantage, even if they could access an ISP's POP at pastoral call rates or take advantage of Telstra's Rural Connect Plan.

Source: PC estimates.

Location of Australian ISPs

According to the latest *Internet Activity Survey* (ABS 2001a) there were 696 ISPs supplying Internet access services in Australia at the end of December 2000. Of these, six were classified as very large (more than 100 000 subscribers), 31 as large (between 10 001 and 100 000 subscribers), 171 as medium (between 1001 and 10 000 subscribers), 359 as small (between 101 and 1000 subscribers) and 129 as very small (100 or less subscribers).

Some of the larger ISPs would be operating on a national basis, with a number of POPs. Many metropolitan based ISPs compete for subscribers in local call zones with large populations. Local rural or regionally-based ISPs are likely to be distributed across many exchange areas, each being a local call zone with a relatively small population.

People living in remote and rural areas are likely to be served by fewer ISPs than those living in urban areas. Information from the ABS's *Internet Activity Survey* indicates that, of the 3.9 million Internet subscribers in Australia, 90 per cent accessed a POP located in a 'highly accessible' region, 7 per cent accessed a POP in an 'accessible region' and 2 and 1 per cent accessed POPs in 'moderately' or 'very remote or remote' regions, respectively (ABS 2001a).[10]

Other benchmarked countries

The structure of local call charges varies across the benchmarked countries. In the US and Canada, local calls are free and in New Zealand they are free for residential subscribers. In the European benchmarked countries local calls are timed.

In many OECD countries, the size of the local calling area has tended to rise over recent years — partly because a growing number of telecommunications carriers are offering the same rate to call any domestic location (OECD 2000). In Sweden, for example, Telia has eliminated long-distance charges, which suggests universal access to an ISP for the cost of a local call.

In other countries such as France and New Zealand, national access numbers have been introduced for use of the Internet. France Telecom began to offer national access reserved for the Internet from 1996. Access was available for the same price as a timed local call even if there was no ISP with a POP in a particular area.

10 The Accessibility/Remoteness Index of Australia (ARIA) was developed by the National Key Centre for Social Applications of Geographical Information Systems at the University of Adelaide. The ARIA defines remoteness in terms of accessibility to defined service centres. 'Highly accessible' regions have relatively unrestricted access to a wide range of goods and services, 'accessible' regions face some restrictions in access to goods and services, 'moderately accessible' regions face significant restrictions, 'remote' regions have very restricted access to goods and services and 'very remote' regions have very little accessibility to goods and services.

In New Zealand, Telecom New Zealand attempted to separate Internet traffic from telephony traffic by introducing a special access number which enabled access for the cost of an untimed local call. Users can continue to dial in using their ISP's existing local telephone number. However, after the first 10 hours of usage per month, residential customers incur NZ$0.02 per minute charge.

In Canada, 99.9 per cent of Internet users in Bell Canada's territory have local call access to an ISP. In May 1997, only 140 'very small' exchanges did not have local call access to an ISP, and by December 2000, this number had decreased to around 41 exchanges. Of these, 35 were described as 'remote', with no year-round road access.

In Alberta, all urban users, between 95 to 100 per cent of rural users and around 70 per cent of remote Internet users can access more than one ISP with a local toll free call. Most Canadians appear to have choice in selecting an ISP offering a local POP. In a submission to the Canadian Radio-Television and Telecommunications Commission (CTRC) on November 1999, the Canadian Association of Internet Providers estimated there was over 900 ISPs operating in Canada, many operating in local and regional areas.

As part of Canada's universal service obligation requirements, local exchange carriers are required, as part of the defined basic service objective, to provide subscribers with low speed access to the Internet at local toll free call rates. Where carriers are unable to do so they must provide the CRTC with service improvement plans designed to remove any such barriers to accessing the Internet.

In the US, research undertaken by Downes and Greenstein on the distribution of POPs showed that in 1999 more than 92 per cent of the US population had access via a local phone call to seven or more ISPs (Greenstein 1999). The same researchers concluded that no more than 5 per cent of the population was without access to a competitive ISP market.

5.6 In summary

The Internet is potentially more important to those in rural areas as it provides an opportunity to gain access to services that in some cases are no longer provided locally. A key issue for these users is whether they can access the Internet at reasonable transmission rates and prices.

The ability of Internet users to connect and stay connected, and the adequacy of data transmission rates, are the main issues affecting the quality of dial-up PSTN service.

The various aspects of service are influenced by customer premises equipment, ISP equipment and the telecommunications infrastructure. Customer premises equipment and choice of ISP are within the control of the user or have little effect on relative outcomes for remote, rural and urban users. On the other hand, the performance of the telecommunications infrastructure is not within the user's control and varies between remote, rural and urban users.

The distance between the user and the local exchange is a major determinant of transmission rates over the PSTN. The longer line lengths in remote and rural areas are likely to result in lower data transmission rates in these areas.

Information on the distribution of PSTN data transmission rates indicates that the proportion of customer access lines with rates less than 28.8 kbps is larger in Australia than in North America or the UK. However, there may be some inconsistencies in the measures of transmission rates in the different countries, and the impact of other factors relating to network design also needs to be considered.

Information on the distribution of PSTN line lengths suggests that Australian remote and rural users have shorter lines compared to users generally in the US and Canada. This would tend to suggest higher transmission rates in Australia. On the other hand, the gauge and quality of copper cabling in the US may be more conducive to higher transmission rates.

However, there was insufficient information to quantify the possible impact of factors such as line length and quality on relative data transmission rates for remote, rural and urban users across the benchmarked countries.

Recent Telstra initiatives now mean that all Australians have dial-up access to the Internet over the PSTN for the cost of an untimed local call.

6 High speed access to the Internet

The public switched telephone network (PSTN) has been progressively upgraded to improve the quality of voice service and to accommodate the growing demand for data services. However, the level of data services has been constrained by limitations of the customer access network (CAN) — the connection between the telecommunications backbone network and the end user.

Superior speed data services are available. However, services that take advantage of digital transmission techniques and improvements in cable technology are more expensive.

A number of new high speed technologies are being deployed, or are planned to be made available, in the countries and service areas studied. These technologies offer a variety of data rates faster than the PSTN. The technologies examined in this chapter are integrated services digital network (ISDN), asymmetric digital subscriber line (ADSL), hybrid fibre coaxial (HFC) cable, satellite, multichannel multipoint distribution system (MMDS) and mobile.[1]

Information is presented on general factors that influence carrier decisions to deploy services and customer decisions to subscribe to services in remote, rural and urban areas. Information is provided on the current extent of deployment, deployment prospects and penetration of high speed technologies in these areas of the benchmarked countries and service areas.

The technology options and prices comparisons for Internet access by users in remote, rural and urban areas in Australia and other countries are discussed in the following chapter.

1 High speed technologies are a mixture of transmission mediums and transmission technologies. The transmission medium is the medium over which information is sent, for example, copper wire, HFC cable, fibre optic cable, satellite radio and terrestrial radio. The transmission technology determines the protocol with which information is sent over the transmission medium, for example, ISDN or ADSL.

6.1 Technology options

The CAN generally comprises copper wires (see figure 5.1 in chapter 5). In its basic configuration for voice transmission, only low speed data transfers are possible over the CAN.

Technology options for improving data transmission rates over the CAN include ISDN and ADSL. Other options using alternative networks include HFC cable, satellite, MMDS and mobile. These technologies can be classified as fixed or shared-fixed rate technologies (see box 6.1) and are briefly described below.

Box 6.1 **Fixed and shared-fixed rate technologies**

Fixed rate technologies include ISDN and ADSL and use the existing copper wire. Shared-fixed rate systems include HFC cable, satellites, MMDS and mobile.

Fixed rate technologies offer users data transmission rate options that do not vary with the number of simultaneous Internet users. In contrast, the bandwidth available, and hence data transmission rate received by any user using a shared-fixed rate technology, is dependent on the number of simultaneous users.

Theoretically, a single user using a shared-fixed rate technology could access the entire bandwidth of the transmission medium, achieving data transmission rates well in excess of all fixed rate technology offerings. In practice, shared-fixed rate technology providers generally impose data transmission rate ceilings. These ceilings limit the maximum data transmission rate received by users. The presence of transmission rate ceilings mean the data transmission rate received by each user may remain constant as the number of simultaneous users increases. This would occur up to a threshold number of users. An increase in simultaneous users beyond that point would result in a decrease in the bandwidth available to each user and a reduction in their data transmission rate.

ISDN

ISDN is a set of standards for digital transmission over copper wire and other access media. The end-to-end connectivity technology allows both voice and data over the same network.

The basic ISDN service for residential users is a fixed rate technology consisting of two 64 kilobits per second (kbps) channels and one 16 kbps channel (referred to as B and D channels respectively). ISDN supports data transmission rates of 64 or 128 kbps. However, simultaneous voice and data transmission reduces data transmission rates to 64 kbps. The lower speed channel is used to carry control and signalling information.

ISDN is not generally available or cost-effective on line lengths longer than 5 km from the local exchange.[2]

ADSL

ADSL is a technology (line coding) that enables simultaneous voice and data transmission over copper wire networks such as the CAN. ADSL is one of many digital subscriber line variants.[3]

ADSL is currently considered the DSL variant that best meets the high speed data transmission (along with voice) requirements of residential and small business users into the near future. ADSL is asymmetric in that it uses most of the available bandwidth (see box 6.2) to transmit data to the user (downstream transmission) and only a small part for transmission from the user (upstream transmission).

ADSL satisfies the asymmetric nature of most multi-media communication in which large amounts of information flow toward the user and only a small amount of interactive control information is returned. Moreover, ADSL has greater user coverage than other DSL variants over existing lines.

ADSL is generally provided to users at fixed data rates. Downstream options range from 256 kbps to about 2 megabits per second (Mbps) and 64 kbps to 680 kbps upstream. ADSL is generally offered over line lengths less than 4.5 km from the local exchange.

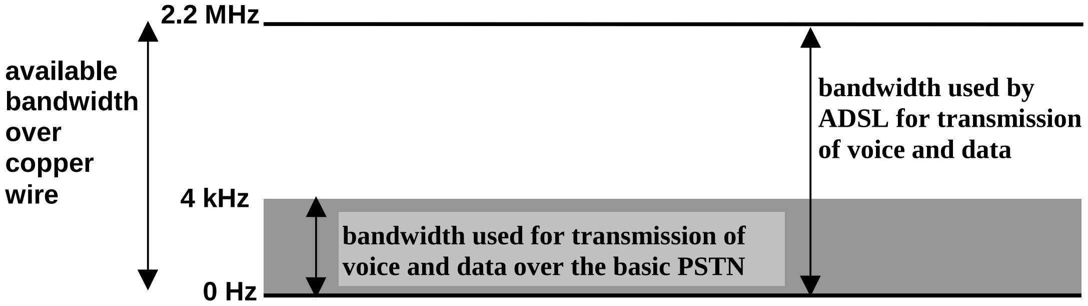
2 Changing network design has seen the gradual introduction of customer access modules (CAMs), see figure 5.1 in chapter 5. Line lengths refer to the distance between the user and the CAM or local exchange. CAMs extend fibre optic cable from the local exchange closer to the user and are currently incompatible with ISDN and ADSL technologies. They are expensive to install and maintain and are more widely deployed in urban areas than remote and rural areas.

3 DSL variants, referred to as xDSL, also include rate adaptive DSL (RADSL), high bit rate DSL (HDSL), symmetric DSL (SDSL) and very high bit rate DSL (VDSL). Refer to the Paradyne Corporation 2000 for a detailed discussion of DSL variants.

Box 6.2 **ADSL and the copper wire**

Analogue modems make use of the voice channel — frequencies between 0 and 4 kilohertz (kHz) in the copper wire — allowing data transmission rates up to 56 kbps (see chapter 5).

ADSL supports higher data transmission rates by utilising a greater proportion of the available bandwidth of copper wire.



ADSL modems divide the bandwidth of the copper wire into three frequency segments:[a]

- 0 – 4 kHz — frequencies assigned for voice communication;
- 4 – 20 kHz — buffer between voice and data frequencies to prevent interference; and
- 20 kHz – 2.2 MHz — frequencies assigned for data transmission.

ADSL can support downstream data transmission rates of 6 Mbps for line lengths up to 2 km with transmission rates falling to 1.5 Mbps at 3.5 km.

The use of higher frequencies by ADSL results in a greater rate of signal attenuation (see box 5.2 in chapter 5), reducing the distance over which data transmission rates can be supported. To eliminate differences in data transmission rates received by users at different distances from their local exchange, carriers generally offer ADSL and ISDN at fixed data transmission rates.[b] Carriers determine data transmission rate options available to potential users.[c] For example, Telstra offers ADSL services at three downstream rate options — 256 and 512 kbps and 1.5 Mbps. Users requiring the higher transmission rate options incur higher charges.

[a] Some ADSL modems divide the bandwidth into four segments providing separate frequency segments for upstream and downstream data transmission. [b] The local exchange must be ISDN or ADSL enabled. Telecom New Zealand offers a 'best efforts' ADSL service. This service targets downstream transmission rates at 2 Mbps and upstream transmission rates at 250 kbps. However, actual data transmission rates received by users will vary based on a number of factors including their distance from the local exchange. [c] To access an ISDN or ADSL service, users generally have to be located within 4.5 km or 5 km of an ADSL or ISDN enabled local exchange, respectively.

Source: Adapted from ADSL Forum 2000.

HFC cable

Cable is well established as a medium for providing one-way analogue television broadcasting. High speed interactive Internet access over HFC cable involves upgrading cable, usually resulting in a hybrid system of traditional coaxial and fibre optic technologies.

HFC cable has a greater bandwidth than copper wire. However, HFC cable data transmission rates are constrained by its shared architecture (see box 6.1). Neighbouring cable users share the capacity of the cable serving the neighbourhood.[4]

In practice, data transmission rates achieved by HFC cable users are similar to those of ADSL, in part due to the imposition of data transmission rate ceilings by HFC cable service providers.[5]

Satellites

Satellites have been used since the late 1950s, principally for weather forecasting and television broadcasting. More recently, they are being used for mobile voice communication and high speed Internet access.

The breadth of satellite coverage largely depends on the number of satellites in operation and their distance from the earth's surface — the further from the earth's surface the greater the coverage.[6]

The satellite footprint is a shared resource as satellites can only support a limited number of interactive communications links simultaneously.[7] Downstream data transmission rates received by users depend on the type of satellite, customer

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4 Cable users are connected by HFC cable to cable nodes. Each cable node represents a cable neighbourhood. Fibre optic cable is usually used for the connection upstream of the cable node.

5 For example, Telstra's HFC cable residential pricing plans are capped at 256 or 512 kbps for downstream transmission and 64 or 128 kbps for upstream transmissions. Telstra offers an uncapped Business Deluxe plan, however users incur higher monthly rental charges.

6 Satellites can broadly be classified as geostationary earth orbiting (GEO) or low earth orbiting (LEO). GEO satellites are situated approximately 35 800 km above the earth and can accommodate downstream data transmission rates of around 400 kbps. These data rates are below those achievable via LEO satellites which operate closer to the earth's surface. LEO satellites have the added advantage of accommodating portable wireless customer equipment. However, as LEO satellites operate closer to the earth's surface, many more satellites are required for global coverage.

7 The satellite footprint refers to the extent of satellite coverage.

equipment, the number of simultaneous users and ceilings placed on transmission rates by satellite providers.

Most current satellite services support one-way transmission from the satellite to the user with the PSTN used for upstream transmission. Upstream transmission usually involves an analogue modem transmitting information from the user to a terrestrial base station and then to the satellite.

One-way satellite service providers generally offer downstream transmission rates of around 400 kbps, with terrestrial upstream transmission rates limited by the characteristics of the CAN (see chapter 5). Low upstream data transmission rates are a significant factor limiting customer subscription to one-way satellite services in many remote and rural areas. Many customers in these areas receive upstream data transmission rates well below 33.6 kbps.

Two-way satellite services hold considerable appeal as they are not constrained by a terrestrial link. These technologies are available in the US via StarBand Communications Inc.[8] Services are planned for Australia and other countries in the near future.[9] Upstream data transmission rates via these technologies are likely to be similar to current ADSL upstream offerings.

MMDS

MMDS is a terrestrial radio technology that operates in the ultra-high frequency portion of the radio spectrum between 2 and 3 Gigahertz (GHz). Traditionally, MMDS has been used for television broadcasting. However, MMDS is increasingly being used in the provision of high speed access to the Internet.

MMDS requires a clear path between the user's digital transceiver and a radio transmission tower.[10] Under optimal conditions, MMDS can operate at a radius of around 50 km covering an area of 7850 square kilometres. MMDS providers generally offer services to residential users at fixed downstream data transmission rates between 512 kbps and 2 Mbps.

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8 Potential users need to have a clear line of sight to the southern sky to receive the StarBand service.

9 As part of Telstra's successful tender to provide untimed local calls and untimed local call access to the Internet in 'extended zones' in remote and rural Australia, all extended zone users will be offered an 'always on' two-way satellite based Internet service with a choice of access speeds and prices from 31 July 2001 (Alston 2001d).

10 The digital transceiver is used to complete the wireless connection between the user and the radio transmission tower.

MMDS offers upstream data transmission either via the PSTN or, more recently, by using the digital transceiver to send signals directly to the radio transmission tower. One-way MMDS (PSTN upstream) usually involves an analogue modem limiting upstream data transmission rates below 33.6 kbps while current two-way MMDS service providers offer upstream data transmission rates around 256 kbps.

Local multipoint distribution system (LMDS) is a terrestrial radio system that supports significantly higher data transmission rates than MMDS. Higher data transmission rates are achieved via the utilisation of higher radio frequencies which in turn limit technology offerings to customers residing within a 3 km radius of a radio transmission tower. Coverage limitations coupled with technology costs usually confine LMDS to large commercial users in major urban centres.

Mobile networks

Mobile networks have evolved from employing analogue technologies designed for voice communications to digital technologies supporting Internet access (along with voice communications).

Second generation (2G) mobile technologies include global system for mobile communication (GSM) and code division multiple access (CDMA). They employ digital voice encoding and a mixture of circuit-switching and packet-switching techniques supporting data transmission rates around 9.6 kbps and 14.4 kbps, respectively.

Data transmission rates are rapidly increasing, allowing the prospect for high speed Internet access. Current mobile technologies are the so-called 2.5G mobile systems, in which the data service overlays existing GSM voice networks. These include general packet radio services (GPRS) and enhanced data for GSM evolution (EDGE). These technologies support downstream data transmission rates of up to 114 kbps and 384 kbps, respectively.[11]

Emerging digital mobile technologies are so-called third generation (3G) mobiles. Employing more advanced switching technologies than 2.5G technologies, they offer the prospect of downstream data transmission rates up to 2 Mbps from fixed locations. These data rates allow for video streaming and location based services.[12]

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11 Initially, carriers are likely to offer GPRS and EDGE technologies at data transmission rates well below 114 kbps and 384 kbps, respectively.

12 See FCC 2000b for a detailed discussion of the evolution to 3G mobile systems.

Summary of data transmission rates

The high speed technologies examined in this study offer a variety of data transmission rates. These rates allow a wide range of applications and services that are not adequately supported by basic PSTN access to the Internet, particularly in remote and rural areas. See table 6.1 for examples of response times for some Internet operations.

Table 6.1 **Impact of transmission rates on response times**

Technology	*Indicative digital data downstream rates (kbps)*	*Response times (seconds)*	
		Complex web page (100 kilobytes)	*Large file download (1 Megabyte)*
Copper wire			
ISDN B channel	64	13	132
ISDN 2xB channel	128	7	66
ADSL	512	2	17
Cable			
HFC cable	512	2	17
Satellite			
GEO	400	3	21
LEO[a]	2000	1	5
Terrestrial radio			
MMDS	1500	1	6
LMDS	38 000	1	1
Mobile			
GPRS – 2.5G[b]	48	18	175
EDGE – 2.5G[a]	384	3	22
CDMA2000 – 3G[a]	2000	1	5

Note Response times relate to the downstream data transmission rates indicated for each high speed technology. However, actual data rates and Internet response times may be adversely affected by the telecommunications infrastructure (including the CAN, exchanges and Internet backbone), the performance of the ISP, the performance of servers hosting content and the equipment at the user end. **a** Not yet available in any of the countries studied. **b** GPRS offers the potential for data transmission rates up to 114 kbps. However, current user offerings are likely to provide data rates closer to 48 kbps.

Source: PC estimates.

6.2 Factors affecting deployment and penetration

The deployment of high speed technologies is primarily a commercial decision based on the cost of deployment in a region and the expected returns on the investment. Deployment typically involves higher costs and lower expected revenues in remote and rural areas than in urban areas. Consequently, high speed technologies are usually first deployed in urban areas.

The factors that influence carrier decisions to deploy technologies and customer subscription decisions in these areas are outlined in this section.[13]

Regulatory environment

The regulatory environment established by governments relates primarily to the arrangements for access by service providers to the existing facilities and services of incumbent carriers. Regulatory arrangements affect the competitive environment faced by high speed technology providers. For example, unbundling the local loop is expected to encourage new entrants into the ADSL market and, hence, increase competition (for a discussion of local loop unbundling in selected countries see box 2.2 in chapter 2).

The prospects for market entry, with the assistance of access arrangements, are likely to be greater in urban areas than in remote and rural areas.

Supply factors

Factors affecting the cost and supply of high speed technologies include population densities and natural characteristics of the existing PSTN. Low population densities usually increase the average cost per service in an area because the higher fixed costs must be recovered from fewer users.

Line characteristics of existing networks impact on the cost of deploying some high speed technologies. Of particular significance are the technical limitations of deploying ISDN and ADSL technologies over long line lengths in remote and rural areas. In addition, loaded lines are unsuitable for the deployment of ISDN and ADSL.[14] Loaded lines are more prevalent in remote and rural areas reducing the prospects for ISDN and ADSL deployment in these areas.

Demand factors

There are a number of factors that influence consumer decisions to adopt high speed technologies, once they have been deployed. Socio-demographic factors such as income and education levels have been found to be significant determinants of

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13 For a discussion of some of these factors see TSI 2000 and Telstra 2000b.

14 Loading involves altering the electrical characteristics of the copper wire. This enables the provision of voice telephony over much greater distances. Loading adversely affects copper wire's performance at frequencies higher than the voice band making it unsuitable for ISDN and ADSL applications (TSI 2000).

whether people are connected or have access to the Internet. The extent to which these factors differ between remote, rural and urban areas is unknown.[15]

Consumers usually consider both performance and price in choosing a particular service from among the available options. Basic PSTN access offers the lowest price and performance. Several higher price and performance options are usually offered by the higher speed technologies.

Consumer choices will also be influenced by the range of applications that consumers wish to access. The demand for high speed technologies is a derived demand in that it is generated because consumers wish to access high bandwidth applications. Users interested in only accessing email, for example, are not going to be as interested in subscribing to high speed technologies as those interested in accessing real time weather maps.

It is reasonable to expect that Internet users in remote and rural areas could in the future have a greater need for high speed technologies than those in urban areas. The Internet has the potential to provide virtual access to a range of services sometimes not provided in rural areas by traditional means. Given the lower levels of service received by remote and rural users via basic PSTN Internet access (see chapter 5), the value of high speed technologies should be greater in these areas than in urban areas.

For most of the high speed technologies, providers generally do not differentiate prices by location (see table 6.2). However, where there are price differences, Internet users in remote and rural areas face higher prices than those in urban areas.

Government initiatives

Government initiatives provide incentives for increasing the deployment and subscription of high speed technologies in remote and rural areas. For example, in Australia the Federal Government has allocated funding through Networking the Nation (NTN) to promote high speed technology deployment in schools and libraries in areas with no high speed technologies. NTN funding is also allocated to increase remote and rural awareness of technologies and encourage their use (see chapter 2 for a detailed discussion of the NTN initiative).

[15] For a discussion of some of these factors see Hellwig and Lloyd 2000.

Table 6.2 **Remote, rural and urban price differences for high speed technologies, January 2001**

	Australia	*Canada*	*Finland*	*France*	*NZ*	*Sweden*	*UK*	*US*
ISDN	x	✓	■	x	✓	x	x	x
ADSL	x	x	x	x	x	x	x	x
HFC cable	x	x	■	x	x	x	x	■
MMDS[a]	■	■	**na**	**na**	**na**	**na**	**na**	x
One-way satellite	✓	x	■	x	✓	■	x	x
Two-way satellite	**na**	**na**	**na**	**na**	**na**	**na**	**na**	x
2.5G	x	**na**	x	**na**	**na**	**na**	x	**na**
3G	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**

Note Most technologies will not be deployed in remote areas, nor in some rural areas in the foreseeable future. The information about price differences for a technology relate to customer locations served by that technology. x — no remote, rural and urban price differences exist. ✓ — remote, rural and urban price differences exist. **na** Service is not currently available in the country. ■ — Information unavailable. [a] Relates to one-way MMDS and two-way MMDS technologies.

Source: Network Strategies 2001.

6.3 Deployment and penetration

Information was sought on deployment and penetration for the two largest carriers within each benchmarked country and service area. These were defined as:

- *Service deployment* — the percentage of population in remote, rural and urban areas that could have access to the particular service if they chose to subscribe; and
- *Penetration* — the percentage of population in remote, rural and urban areas with active connections to the service.

This deployment and penetration information was available only on a countrywide basis. However, when coverage limitations are considered, remote, rural and urban comparisons are possible.

Deployment

The current extent of deployment and future deployment plans at the countrywide level are presented in table 6.3 for each of the technologies examined in this study. ISDN, ADSL, HFC cable and satellite services have been deployed in all countries, while MMDS has generally been deployed only in countries with lower population densities. Australia, Finland, Sweden and the UK are the only countries where 2.5G mobile technologies have been deployed. The US is the only country to have deployed two-way satellite technologies.

The vast majority of the population in Australia and the UK have access to ISDN. Customers unable to access ISDN are likely to reside in remote and rural areas.

The deployment of HFC cable across countries tends to be focussed on major urban areas. The exceptions are the US and Canada, where many rural households have access to HFC cable services. In Australia, HFC cable deployment is concentrated in the capital cities along the eastern coast, potentially providing services to 35 per cent of Australian households.

Table 6.3 **Extent of deployment of high speed technologies (per cent of population), January 2001**

	Australia	*Canada*	*Finland*	*France*	*NZ*	*Sweden*	*UK*	*US*
ISDN	96	■	■	■	■	■	99	80
ADSL[a]	81 (2002)	85 (2002)	■	80 (2003)	60 (2000)	26[c] (2000)	50 (2001)	■
HFC cable[b]	35[c]	89[c]	57[c]	13[c]	8[c]	60[c]	50	92[c]
MMDS[d]	■	■	**na**	**na**	**na**	**na**	**na**	■
One-way satellite	100	100	100	100	100	100	100	100
Two-way satellite	**na**	**na**	**na**	**na**	**na**	**na**	**na**	90[e]
2.5G[f]	94	**na**	99	**na**	**na**	98	99	**na**
3G	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**

[a] Planned levels and completion dates (in brackets) of ADSL. [b] Cable service providers are currently upgrading cable networks to HFC cable in all countries. Data provides an upper limit to the current level of HFC cable deployment in all countries. [c] Per cent of households. [d] Relates to one-way MMDS and two-way MMDS technologies. [e] Potential users require a clear line of sight with the southern sky. [f] 2.5G mobile technologies overlay GSM networks in Australia, Canada, Sweden and the UK. Per cent of population calculations relate to GSM rather than 2.5G mobile technologies, which may overstate actual levels of 2.5G population coverage. **na** — Service is not currently available. ■ — Information unavailable.

Sources: PC estimates based on Network Strategies 2001 and StarBand Communications Inc 2001a.

ADSL technologies are currently being deployed in all of the countries and service areas studied. Under current deployment plans, ADSL is expected to be available to urban customers in all countries.[16] Some rural users in Canada and Australia may also have access. However, Internet users in remote areas of the countries studied will not have access largely because of the line length limitations associated with ADSL technologies (see section 6.1).

Australians living in remote, rural and urban areas are not disadvantaged in terms of line length compared with North Americans. Around 70 per cent of line lengths in north-eastern US and western Canada are less than 4.5 km in length (see table 5.4 in chapter 5). For Australia in 1986, 88 per cent of urban and 72 per cent of remote and rural lines are less than 3 km in length (see chapter 5).

16 Information on the level of commitment to ADSL deployment plans in each country and service area was not available.

Deployed one-way satellite technologies are available to 100 per cent of the population in all of the countries and service areas studied. Two-way satellite technologies are available to 90 per cent of the population in the US.

Australia, Finland, Sweden and the UK are the only countries studied to have so far deployed 2.5G mobile technologies. Each of these countries has overlayed its GSM voice network with 2.5G technologies providing near ubiquitous population coverage. However, based on mobile coverage estimates it is likely that the proportion of the rural population in Australia able to access 2.5G technologies is lower than in Finland, Sweden and the UK (see table 4.1 in chapter 4).

Japan will be the first country to introduce 3G technologies in mid-2001. The majority of countries are likely to deploy 3G technologies between 2003 and 2005. The number of cell sites required for providing 3G technologies is likely to be three times the number required for 2G technologies, increasing the costs of deployment and reducing deployment prospects in remote and rural areas.

Countrywide penetration

Available penetration data for individual high speed technologies are presented in table 6.4. Penetration is measured by the total number of services, including both residential and small business users, expressed as a per cent of the population.

Table 6.4 **Countrywide penetration (subscribers as a per cent of population)**

	Australia	*Canada*	*Finland*	*France*	*NZ*	*Sweden*	*UK*	*US*
ISDN[a]	<1[b]	<1[b]	<3[b]	<1[b]		<2[c]	<1[b]	<1[b]
ADSL	■	1[d]	■	<1[e]	<1[f]	<1[g]	<1[h]	<1[i]
HFC cable	■	<2[b]	■	<1[j]	<1[f]	<1[g]	■	<2[l]
MMDS[j]	■	■	**na**	**na**	**na**	**na**	**na**	■
One-way satellite	■	■	■	■	■	■	■	<0.2[i]
Two-way satellite	**na**	**na**	**na**	**na**	**na**	**na**	**na**	<0.1[k]
2.5G	■	**na**	■	**na**	**na**	■	■	na
3G	**na**	**na**	**na**	**na**	**na**	**na**	**na**	na

[a] Information relates to basic rate ISDN services. [b] Penetration as at December 1999. [c] Penetration as at December 1998. [d] Penetration as at September 2000. [e] Penetration as at April 2000. [f] Penetration as at November 2000. [g] Penetration as at September 2000. [h] Penetration as at 2000. [i] Penetration as at June 2000. [j] Penetration as at September 1999. [k] Penetration as at March 2001. **na** — Service is not currently available. ■ — Information unavailable.

Sources: PC estimates based on Network Strategies 2001, OECD 2001 (ISDN), FCC 2001b and StarBand Communications Inc 2001b (two-way satellite in the US).

As information in table 6.4 indicates, high speed penetration is low for all countries when expressed as a per cent of the population. Of more interest is the extent to which high speed technologies have penetrated the Internet market — penetration being measured by the total number of high speed services, including both residential and small business users, expressed as a per cent of total Internet subscribers (see table 6.5).

Table 6.5 **Countrywide penetration (subscribers as a per cent of total Internet subscribers)**

	Australia	*Canada*	*Finland*	*France*	*NZ*	*Sweden*	*UK*	*US*
ISDN[a]	5.2[b]	1.3[b]	26.8[b]	18.3[b]	■	5.9[c]	7.4[b]	1.8[b]
ADSL	■	4.7[d]	■	2.1[e]	1.9[f]	1.5[g]	0.2[h]	1.9[i]
HFC cable	■	6.0[b]	■	1.5[j]	1.9[f]	1.5[g]	■	4.5[i]
MMDS	■	■	**na**	**na**	**na**	**na**	**na**	■
One-way satellite	■	■	■	■	■	■	■	0.1[i]
Two-way satellite	**na**	**na**	**na**	**na**	**na**	**na**	**na**	0.05[k]
2.5G	■	**na**	■	**na**	**na**	■	■	**na**
3G	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**

Note Total Internet subscriber information relates to 1 January 2000. [a] Information relates to basic rate ISDN services. [b] Penetration as at December 1999. [c] Penetration as at December 1998. [d] Penetration as at September 2000. [e] Penetration as at April 2000. [f] Penetration as at November 2000. [g] Penetration as at September 2000. [h] Penetration as at 2000. [i] Penetration as at June 2000. [j] Penetration as at September 1999. [k] Penetration as at March 2001. **na** — service is not currently available. ■ — information unavailable.

Sources: PC estimates based on Network Strategies 2001, OECD 2001 (ISDN), FCC 2001b and StarBand 2001b (two-way satellite in the US).

Whichever way it is measured, the penetration of high speed technologies has been low. The largest high speed technology penetration has been ISDN in Europe. However, ISDN, an established higher speed technology, had low penetration rates in North America, Australia and New Zealand. Possible reasons for this are the high price of ISDN relative to the usefulness of the data transmission rate improvement over and above basic PSTN access and the high price of voice calls. The majority of ISDN subscribers are small business users.

ADSL and HFC cable penetration is low. Canada had the highest proportion of users accessing the Internet via ADSL or HFC cable (over 10 per cent), the US had over 6 per cent, while the benchmarked European countries were below 4 per cent (see table 6.5). Information for Australia was not available.

ADSL and HFC cable services are beginning to emerge as technologies that might meet the requirements of Internet users better. For example, data compiled by the FCC suggest recent strong growth in penetration in the US, albeit from a very low base (see box 6.3). In addition, Canadian ADSL and HFC cable penetration in 2000 increased by 433 and 189 per cent, respectively (NBI/MSA 2001).

Box 6.3 **The uptake of high speed technologies in the US**

Congress directed the Federal Communications Commission (FCC) and the state authorities to encourage the deployment of advanced telecommunications services in the US on a timely and reasonable basis. To assist in the evaluation of deployment, the FCC embarked on a formal data collection program to gather standardised information about subscribership to high speed services, including both wireline and wireless services.

The FCC requires high speed technology providers with greater than 250 high speed service lines (or wireless channels) in a given State to participate. The FCC definition of a high speed technology includes technologies that support data transmission rates of 200 kbps or greater in at least one direction. Providers are required to report their total number of high speed lines (or wireless channels) by type of technology for each State.

As of 30 June 2000, there were 3.12 million subscribers to high speed technologies.[a] HFC cable is the preferred high speed technology for access to the Internet, accounting for 70 per cent of all high speed services. ADSL commands 25 per cent of the market with satellite and other wireline technologies making up the residual.

The growth in high speed technology subscription over the 6 month period to 30 June 2000 has been significant. ADSL had the greatest percentage increase at 164 per cent, with satellite technologies having the lowest growth rate at 28 per cent. The aggregate growth for all high speed technologies was 74 per cent.

Technology	*Number of high speed services (at 30 June 2000)*	*Share of high speed services*	*Growth in the number of high speed services (from 1 January to 30 June 2000)*
	million	per cent	per cent
ADSL	0.77	25	164
Other wireline[b]	0.10	3	123
HFC cable	2.18	70	55
Satellite and terrestrial wireless[c]	0.06	2	28
Total	3.12	100	74

[a] Subscribers relate to residential and small business subscribers. The FCC also reports levels of subscription for large business users. [b] Other wireline refers to fibre and traditional technologies used for digital transmission over copper wire. These technologies are generally used by large commercial users. [c] Includes both one- and two-way satellite technologies. Examples of terrestrial wireless technologies include MMDS and LMDS.

Source: FCC 2000d.

Although there is little published information, it is known that penetration rates for satellite services are very low. One-way satellite penetration rates in urban areas of all countries have been low as a result of competition from other high speed technologies. The low levels of one-way satellite penetration in remote and rural areas may be the result of high prices and poor upstream transmission performance offered by these services. Two-way satellite services have recently been deployed in the US.

Penetration data for 2.5G mobile technologies are not available as these technologies have only recently been deployed in a few of the countries studied.

6.4 In summary

High speed technologies for access to the Internet include ISDN, ADSL, HFC cable, satellite, MMDS and mobile. These technologies offer users a range of data transmission rates.

Lower population densities and longer average line lengths in remote and rural areas adversely affect the cost of deploying some high speed technologies in these areas. As a consequence, remote and rural users are unlikely to have the same degree of technology choice as urban users.

ISDN and one-way satellite technologies are deployed extensively in all the countries studied for which information was available. The US is the only benchmarked country to have deployed two-way satellite technologies.

HFC cable is deployed less widely in Australia than most of the countries studied. HFC cable networks are well established in a number of major urban centres in Australia but there appears to be little prospect for services being extended to remote and rural areas.

Most countries have plans for extensive ADSL deployment. ADSL deployment plans are more far reaching in Australia than the majority of other countries studied. However, deployment is unlikely in remote and many rural areas of Australia in the foreseeable future.

ISDN penetration of the Internet market is higher in Europe than in North America, Australia or New Zealand. Small business accounts for the majority of these subscriptions. North America has achieved higher levels of ADSL and HFC cable penetration than the other benchmarked countries.

The share of Internet subscriptions commanded by high speed technologies is low in all the benchmarked countries. However, recent North American surveys indicate strong growth in ADSL and HFC cable subscriptions.

7 Outcomes for Internet users

In many respects, Internet access is becoming an essential service. As such, the relative price and speed of the service in remote, rural and urban areas will have important social and equity consequences.

The focus of this chapter is outcomes for Internet users in remote, rural and urban areas. These are examined in terms of the availability of services, data transmission rates and prices. The discussion draws on information contained in chapter 6 on the deployment of high speed data technologies. It also complements the discussion about basic PSTN access to the Internet in chapter 5.

Comparisons are undertaken of the price and speed of Internet services in remote, rural and urban areas for the public switched telephone network (PSTN) and several high speed technologies. In undertaking these comparisons, the service widely available in each area and offering the best cost–performance option for users was selected — ADSL for urban users and satellite for remote and rural users. These high speed technologies are described in the preceding chapter.

Internet prices reported in this chapter include both the telecommunications and the Internet service provider (ISP) charges associated with the particular service. For some services these charges are bundled together and cannot be separately identified.

Remote, rural and urban definitions follow those of the Australian Communications Authority (see table 1.1 in chapter 1).

7.1 Internet options

The relative outcomes for Internet users in remote, rural and urban areas depend on the service options available in those areas, their performance and the overall cost of using services.

Options

High speed service options differ for remote, rural and urban areas. Basic PSTN access to the Internet is almost universally available to all users. However, accessibility and the performance of high speed services are affected by:

- line length or coverage limitations constraining the deployment prospects for asymmetric digital subscriber line (ADSL), integrated services digital network (ISDN) and multichannel multipoint distribution system (MMDS) services in remote and rural areas (see chapter 6); and
- the cost of deployment in remote and rural areas with low population densities (see chapter 6).

An indication of the range of options potentially available to remote, rural and urban users is presented in table 7.1. All users are unlikely to have access to all of the listed service options. Urban Internet users have the greatest range of service options for accessing the Internet (see table 7.1). Many rural users may have a number of options for Internet access, while remote users must currently rely on satellites for accessing the Internet at high data rates.

Table 7.1 **Service options generally available for access to the Internet by area**

Urban	*Rural*	*Remote*
Basic PSTN	Basic PSTN[a]	Basic PSTN[a]
ADSL	ISDN	One-way satellite[b]
HFC cable[c]	MMDS	Two-way satellite[d]
ISDN	One-way satellite[b]	
MMDS	Two-way satellite[d]	
One-way satellite[b]	2.5/3G[e]	
Two-way satellite[d]		
2.5/3G[e]		

Note Basic PSTN data transmission rates are likely to vary between remote, rural and urban areas. In general, urban Internet users are likely to experience higher data transmission rates than remote and rural users (see chapter 5). **a** Includes wireless mediums for basic PSTN access to the Internet. For example, high capacity radio concentrator system (HCRC) and digital radio concentrator system (DRCS). **b** One-way satellite services use the PSTN for sending data from the user (upstream transmission). **c** Hybrid fibre coaxial cable. **d** Two-way satellite service offerings are currently available only in the US. These satellite services do not rely on the PSTN for upstream transmission. Users require a transmitting antenna to send information directly to the satellite, bypassing the PSTN. **e** 2.5 and third generation (3G) mobile services. 3G mobile services are not yet available.

Performance

In this section, performance is examined in terms of the data transmission rate received by users.

Internet access services offer a variety of fixed and variable data transmission rates. Users may be offered several pricing plans, with more expensive plans providing higher data transmission rates. However, a number of these plans may not be accessible in remote and rural areas.

Basic PSTN access to the Internet provides variable data transmission rates with remote and rural users often experiencing lower data rates than urban users (see chapter 5).

Other aspects of Internet performance include the ease of accessing particular web sites and content, the time taken to receive service connection and the ability to establish and maintain an Internet connection (in the case of dial-up services). These dimensions of performance are influenced by the telecommunications service provider, the telecommunications infrastructure (including the customer access network (CAN), exchanges and the Internet backbone), the ISP, the servers hosting content and the equipment at the customer end. For a discussion of the impact of some of these factors on basic PSTN access to the Internet see section 5.3 in chapter 5.

Internet costs

In accessing the Internet, users may face charges for PSTN usage, high speed technology service connection and use and ISP service charges. The nature and structure of these charges varies with the telecommunications service technology used (see table 7.2).

Several of the services involve use of the basic PSTN for the transmission of data either in both directions or away from the user. The PSTN charge depends on whether users can access an ISP for the cost of a local call.

Most service connection and rental charges do not differ by user location, although professional installation charges for satellite services may be higher in remote and rural areas (see table 6.2 in chapter 6). However, the ability of users to subscribe to various services differs between remote, rural and urban areas.

Monthly rental charges for high speed services generally relate to the transmission rate offered and use. Users face higher monthly charges for plans offering higher levels of performance and larger megabyte (MB) allowances.

Table 7.2 **Price elements for each service**

Service	*Basic PSTN*[a]		*High speed technology service*		*ISP service*
	Local	*Long-distance*	*Connection*[b]	*Use*	
Basic PSTN	local call charges	timed call charges	**na**	**na**[c]	monthly charges; excess usage charges[d]
ISDN	local call charges	timed call charges	initial costs	monthly charge; usage charges[e]	monthly charges; excess usage charges[f]
HFC cable	**na**[g]	**na**[g]	initial costs	monthly charge; excess usage charges[h]	bundled with technology charges
ADSL	**na**[g]	**na**[g]	initial costs	monthly charge; excess usage charges[h]	bundled with technology charges
One-way satellite	local call charges (upstream costs)	timed call charges (upstream costs)	initial costs	monthly charge; excess usage charges[h]	monthly charges; excess usage charges[b]
Two-way satellite	**na**[i]	**na**[i]	initial costs	monthly charge	bundled with technology charges

[a] Basic PSTN charges are either local call or long-distance call charges. [b] Connection charges in addition to those for an existing voice service. Initial costs may include equipment purchase and professional installation, new connection charges, and PSTN upgrades. [c] PSTN line rental charges are shared with the voice service. ADSL and one-way satellite services also incur PSTN line rental charges in addition to technology usage charges. [d] Excess usage charges may be based on hours of Internet usage (time-based) or volume of information transferred (volume-based). [e] Users face time-based technology service charges. [f] Excess usage charges are generally time-based. [g] HFC cable, ADSL and two-way satellite services do not incur dial-up charges. [h] Service options may include volume-based excess usage charges. However, monthly charges generally reflect service performance rather than usage. Users incur higher monthly charges for services offering higher levels of performance. [i] Two-way satellite services do not use the PSTN. **na** Not applicable.

Users accessing the Internet via the basic PSTN and ISDN incur ISP charges in addition to the connection and rental charges for the telecommunications service. ISP charges are based on the amount of time connected to the Internet (time-based charging) or the amount of information transferred (volume-based charging). In the case of HFC cable and ADSL services, providers bundle ISP and technology service charges. Some satellite service providers bundle ISP and satellite service charges.

ISP charges are generally not influenced by user location. However, remote and rural users are less likely than urban users to be able to access an ISP for the cost of a local call and generally will have less competition between ISP's. These users may incur higher telecommunications charges for accessing the Internet.

7.2 Price comparisons for services in Australia

A range of service options and prices for Internet access in remote, rural and urban areas of Australia are presented in table 7.3.[1] Service prices are as at May 2001 and take into account the impact of recent Telstra initiatives. Service prices are based on the price structures presented in table 7.2. ISP and telecommunications charges were obtained from Telstra and the particular service was chosen on the basis that it minimised the cost to remote, rural and urban users.

Information is also presented on the data transmission rates for each service.

Basic PSTN access

The price of basic PSTN access to the Internet did not differ between Australian remote, rural and urban areas (see table 7.3).

The performance (data rate) of basic PSTN access to the Internet differs between remote, rural and urban areas. Slower transmission rates in remote and rural areas increase the time taken to complete Internet functions. However, remote and rural Internet users are able to access ISP plans offering unlimited hours of Internet access (with volume-based charging), such that performance differences do not translate into price differences.

1 ADSL, HFC cable and one-way satellite users incur volume-based charges for Internet access — charged for each MB above a monthly allowance. The use of time-based charges in table 7.3 may underestimate the monthly cost of Internet access for these users.

Table 7.3 **Options for Internet access in Australia, May 2001**

Service	*Internet user location*	*Transmission rate (kbps)*		*Prices ($ per month)*		
		Downstream[a]	*Upstream*	*10 hours*	*25 hours*	*40 hours*
Basic PSTN	Nationwide	<56[b]	<33.6[b]	18[c]	27[d]	28[d]
ISDN[e]	Nationwide	64	64	82	121	160
ADSL[f]	Urban	256	64	94	94	94
	Urban	512	128	110	110	110
	Urban	1500	256	137	137	137
HFC cable[f]	Urban	256	64	59	59	59
	Urban	512	128	77	77	77
	Urban	uncapped	uncapped	76	76	76
One-way satellite[g]	Urban[h]	64	<33.6[a]	70	71	72
	Rural[h]	64	<<33.6[a]	72	73	74
	Remote[h]	64	<<<33.6[a]	76	78	79
	Remote[i]	64	<<<33.6[a]	69	70	71
One-way satellite[j]	Urban[h]	400	<33.6[a]	103	104	105
	Rural[h]	400	<<33.6[a]	105	106	107
	Remote[h]	400	<<<33.6[a]	109	110	112
	Remote[i]	400	<<<33.6[a]	102	103	104

Note Prices were based on the lowest priced plan widely available in the relevant market. Assumptions regarding the number of Internet sessions were based on Internet usage not the location of the Internet user or the service used — 5, 10 and 15 sessions for users accessing the Internet for 10, 25 and 40 hours per month, respectively. Service cost determination is based on the price structures described in table 7.2. PSTN line rental charges are excluded from basic PSTN, ADSL and one-way satellite service charges as they are shared with the voice service. ADSL and cable prices are based on a 12 month contract. One-way satellite prices were based on an 18 month contract. Individual fixed equipment and installation costs were ammortised over a five year period. Basic PSTN and one-way satellite costs exclude the cost of an analogue modem and costs associated with new or in-place connections. ISDN installation costs include upgrading a single PSTN line to provide an ISDN service. Satellite prices are based on Internet users utilising the satellite downstream and PSTN upstream connections for the entire session. [a] The data transmission rate received by the user. [b] Data transmission rates received by Internet users depend on many factors including the length of the customer access network (see chapter 5). Urban Internet users receive downstream (upstream) PSTN transmission rates <56 kbps (<33.6 kbps). In general, rural users receive lower average PSTN data transmission rates than urban users (<<). Remote Internet users receive lower average PSTN data transmission rates than rural and urban users (<<<). [c] The Telstra BigPond Regular Plan. [d] The Telstra BigPond Home Essential Plan. [e] Telstra OnRamp Home Highway ISDN service. Calculations based on one 64 kbps channel. The service covers about 96 per cent of the population. [f] Telstra offers ADSL and HFC cable residential Plans at three different transmission rates. Telstra ADSL and HFC cable Blast Off Plans offer users 256 kbps downstream. Internet users face a 250 MB allowance. Cost per additional MB is $0.189 up to 5 gigabytes (Gb) and $0.179 per MB after 5 Gb. Telstra ADSL and HFC cable Freedom Deluxe Plans offer users 512 kbps downstream. Users face no download limits but are subject to an ‘acceptable use policy’. Telstra’s Business Deluxe Plans offer ADSL users 1.5 Mbps downstream. Cable users face uncapped data transmission rates — the data rate received by each user is the maximum available network transmission rate at any given time (see box 6.1 in chapter 6). Telstra Business Deluxe users face a 500 MB allowance. Cost per additional MB is $0.189 up to 5 Gb and $0.179 per MB after 5 Gb. [g] The Telstra BigPond Basic Sat Plan — uses the PSTN for upstream transmission. Users access a package that combines satellite and ISP charges for a lower total charge. [h] Users purchase a 65/85 cm satellite dish and require professional installation, the fees for which vary between remote, rural and urban areas. [i] Under the special digital data service obligation (SDDSO) remote Internet users unable to access an ISDN service may be eligible for a 50 per cent rebate (up to $765) on the cost of the satellite dish and installation. [j] The Telstra BigPond Giga Sat Plan — uses the PSTN for upstream transmission. Users access a package that combines satellite service plus ISP charges for a lower total charge.

Sources: PC estimates based on Telstra 2001b.

ISDN

The price of ISDN did not differ between remote, rural and urban areas of Australia (see table 7.3). Some remote and rural populations may not be able to access ISDN services (see table 6.4 of chapter 6).

ADSL and HFC cable

The deployment of ADSL and HFC cable is limited to urban areas in Australia. However, HFC cable deployment in urban areas of Australia is less general than the proposed level of ADSL deployment.

Service providers offer a number of ADSL and HFC cable plans to urban users. Service plans offering higher levels of performance incur higher monthly rental charges. HFC cable was cheaper than ADSL for current marketed levels of performance. However, actual performance levels experienced by cable users are influenced by its shared architecture (see section 6.1 of chapter 6).

One-way satellite

The price of one-way satellite services was found to be higher for Australian remote and rural users than urban users (see table 7.3). The cost disadvantage resulted from higher professional installation charges in remote and rural areas.[2]

The remote–urban satellite cost disadvantage in table 7.3 may be an underestimate for some remote populations. Remote populations must pay for travel costs associated with professional installations. These costs have not been included in the calculations.

Through the special digital data service obligation, Internet users unable to obtain an ISDN service may be eligible for a 50 per cent rebate on the cost of purchasing and installing a satellite dish. This rebate is likely to offset the higher charges associated with remote satellite installations.

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2 In general, the price of satellite installation is independent of the size of the dish. The exception is the price of satellite dish installations in remote areas — $590 for the 65/85 cm dish and $1166 for the 1.2 m dish. Remote one-way satellite users face installation prices over 3.5 times greater than rural users and 5 times greater than urban users for a 1.2 m dish. In addition to these charges, remote one-way satellite users must pay for travel costs associated with professional installation.

Government and Telstra initiatives

The prices for Internet services in rural and, especially, remote areas were lowered by Telstra in April 2001. Prior to April, the ability of remote and rural users to access an ISP with an untimed local call was a significant factor influencing the relative prices of remote, rural and urban Internet access. Remote–urban and rural–urban price comparisons for basic PSTN and one-way satellite services in January and May 2001 are presented in box 7.1.

The price reduction in April occurred with the introduction of Telstra’s initiative to provide nationwide untimed local call access to the Internet. This brought forward one part of the Government’s initiative to provide untimed local calls in the extended zones in remote and rural Australia for both voice services and Internet access.

In addition, the Telstra initiative provided remote and rural Internet users with the ability to access ISP plans that reduced the cost of Internet access. Previously these plans were only available to urban users.

Telstra is offering a wholesale dial-up access service, MegaPop, that allows users to access other ISPs for the cost of an untimed call.

Box 7.1 Remote, rural and urban price comparisons, January and May 2001

Prior to April 2001, the price differences between remote, rural and urban areas for Internet access via basic PSTN and one-way satellite services were much greater than indicated in table 7.3. Price comparisons for January and May 2001 are presented in the table below.

Service	*User location*	*Data rate*	*Rural or remote premium over urban price*			
		Downstream[a]	*10 hours per month*		*25 hours per month*	
			January	*May*	*January*	*May*
		kbps	per cent	per cent	per cent	per cent
Basic PSTN	Rural	<<56[b]	0	0	18	0
	Remote	<<<56[b]	162	0	334	0
Satellite[c]	Rural	64	2.5	2.5	8	2.5
	Remote	64	9	9	14	9
	Remote[d]	64	50	**nr**	120	**nr**
Satellite[e]	Rural	400	2	2	6	2
	Remote	400	6	6	10	6
	Remote[d]	400	34	**nr**	85	**nr**

Note Figures were calculated from Telstra prices in January and May 2001. Remote and rural prices are expressed as a per cent addition to urban prices. Remote one-way satellite price calculations exclude the special digital data service obligation (SDDSO). The inclusion of the SDDSO would reduce the remote–urban satellite price premium for some remote users. **a** Data transmission rate received by the user. **b** Data transmission rates received by Internet users depend on many factors including the length of the CAN (see chapter 5). Urban Internet users receive downstream (upstream) PSTN transmission rates <56 kbps (<33.6 kbps). In general, rural users receive lower average PSTN data transmission rates than urban users (<<). Remote Internet users receive lower average PSTN data transmission rates than rural and urban users (<<<). **c** The Telstra BigPond Basic Sat Plan — uses the PSTN for upstream transmission. **d** Remote users unable to access an ISP for an untimed local call (only applicable for January 2001 calculations). These users access Telstra's Rural Connect Plan (described below). **e** The Telstra BigPond Giga Sat Plan — uses the PSTN for upstream transmission. **nr** Not relevant.

In January 2001, basic PSTN and one-way satellite prices were higher for remote and rural users than urban users because of:

- a lack of local call access to an ISP for some remote and rural users;
- the inability of some remote and rural users to access certain ISP pricing plans that reduce the prices of basic PSTN and one-way satellite Internet access; and
- higher prices for professional one-way satellite installation in remote and rural areas.

Those remote and rural Internet users unable to access an ISP for the cost of a local call could join Telstra's Rural Connect Plan. This plan bundled ISP and call charges offering users a lower hourly charge than would be incurred via timed community or other long-distance call charges coupled with an ISP plan.

In May 2001, remote and rural Internet users only incurred higher prices than urban users for professional one-way satellite installation. The removal of usage dependent charges in remote and rural areas eliminated the high premiums paid by these users in January 2001, especially for high levels of use.

7.3 International comparisons

For the international comparisons, high speed services were selected on the basis of their extent of deployment, performance and price in remote, rural and urban areas in all countries and service areas studied.

ADSL is the likely cost-effective option for high speed Internet access for urban Internet users in most countries. Although current HFC cable service options offer a similar transmission rate at a lower price than ADSL, the latter is expected to become more widely available (and offer higher levels of performance) than cable services in the urban areas of most countries. In addition, the performance of HFC cable tends to deteriorate as penetration expands, but this is not the case with ADSL.

Many remote and rural populations across the countries studied have access to ISDN, while some populations have access to MMDS. Two-way satellite services are only available in the US. However, all Internet users have access to one-way satellite services — a lower cost and higher performance option than ISDN in the rural areas of countries.[3] One-way satellite services are the only high speed Internet option available to all remote Internet users.

ADSL prices in urban areas were compared with satellite prices in remote and rural areas in benchmarked countries and service areas for which information was available. ADSL services were selected based on their coverage of urban areas and provision of downstream data transmission rates similar to those provided by satellite services. ADSL information was available for all countries and service areas studied. However, satellite information for high speed Internet access was available only for Australia, Canada, New Zealand and the US.

The relative cost and performance of ADSL services in urban areas and satellite services in remote and rural areas differs greatly across countries (see table 7.4). Monthly Internet costs for ADSL and satellite users were based on 10 Internet sessions and 25 hours of Internet use. Pricing elements for ADSL and satellite services follow those described in table 7.2.[4]

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3 Some rural users in the US can access Sprint's two-way MMDS service. MMDS users face monthly charges around US$50 for Internet access. These charges are higher than one-way satellite charges, however upstream data transmission rates are greatly improved via two-way MMDS services (see table 7.4).

4 Telecommunications costs that are not specific to accessing the Internet have not been included. For example, line rental charges have been excluded from one-way satellite calculations as they relate to both voice and data traffic over the PSTN. Costs associated with installing an additional line for one-way satellite services have also been excluded from calculations.

Table 7.4 Price and performance comparisons of ADSL and satellite services in remote, rural and urban areas, May 2001

	Internet user location	Monthly charge	Data transmission rate	Satellite disadvantage Price[a]	Performance[b]
			kbps	per cent	kbps
Australia					
ADSL[c]	Urban	A$110	512		
One-way satellite[d]	Rural/Remote	A$110	400	0	112
Canada					
ADSL[e]	Urban	Can$40	960		
One-way satellite[f]	Rural/Remote	Can$77	400	93	560
Long-distance call[g]	Remote	Can$167	400	318	560
New Zealand					
ADSL[h]	Urban	NZ$102	2000		
One-way satellite[i]	Rural/Remote	NZ$42	400	-59	1600
United States					
ADSL[j]	Urban	US$51	640		
One-way satellite[k]	Rural/Remote	US$41	400	-20	240
Two-way satellite					
Starband[l]	Nationwide	US$80	500	57	140

Note All satellite options (excluding Starband in the US) use the PSTN for upstream data transmission. Monthly charges are based on 10 Internet sessions and 25 hours of Internet usage. Fixed charges are amortised over a five year period. Discounts associated with carrier preselection for long-distance calls have been excluded from calculations. Satellite plans were chosen on their accessibility to remote and rural populations and data transmission rates. ADSL services were chosen based on their coverage of urban areas and provision of downstream data transmission rates similar to those provided by satellite services. Satellite and ADSL cost determination is based on information provided in table 7.2. In Australia and New Zealand all users can access an ISP for the cost of a local call. In Canada and the United States some remote users may incur long-distance (timed) charges for Internet access. **a** Calculated as the difference between the satellite and ADSL monthly charges expressed as a per cent addition to the ADSL monthly charge. Higher positive numbers indicate greater levels of disadvantage for satellite Internet users compared with ADSL users. **b** Calculated as the difference between the satellite and ADSL downstream data transmission rates. **c** Telstra Freedom Deluxe ADSL Plan. **d** Telstra's BigPond Giga Sat Plan. Users access a package that combines satellite and ISP charges for a lower total charge. In addition, users incur Telstra's remote price for installation and A$0.22 per call dial-up. **e** Bell Canada Sympatico ADSL Plan. **f** Bell ExpressVu DirecPC Satellite Plan (includes professional installation). Users access Bell Canada Sympatico Regular ISP Plan. Local calls are free in Canada. **g** Bell Canada's First Rate Savings Plan. Users receive 800 minutes of calling anywhere in Canada for CAN$20 and then pay CAN$0.10 per additional minute. **h** Telecom New Zealand Jetstream 400 ADSL Plan. This is a 'best efforts' rather than a fixed rate ADSL service. ADSL users may receive data rates well below 2000 kbps largely depending on the length of the CAN. **i** Ihug Ultra Swift 30 Satellite Plan (includes ISP and installation charges). Local calls are free in New Zealand. **j** Verizon Online DSL Enhanced Plan. This plan is broadly representative of ADSL plans available to urban users in the US. **k** Hughes Corp DirecPC Executive Surfer Satellite Plan (includes ISP installation charges). This service is available nationwide. Local calls are generally free in the US. **l** Starband provides an 'always-on' two-way satellite service. Upstream data transmission rates range from 40-60 kbps. Monthly charges via Echostar's DISH Network (a wholesale service provider) include installation but exclude ISP charges.

Sources: PC estimates based on Telstra 2001b, Sympatico-Lycos Inc 2001, ExpressVu 2001, Telecom New Zealand 2001, ihug 2001, Verizon Wireless Communications 2001, DirecPc 2001 and StarBand Communications Inc 2001c.

Cost

In *Australia*, the cost of Internet access via one-way satellite for remote and rural users was similar to the cost of ADSL for urban Internet users.

The majority of remote and rural one-way satellite users in *Canada* paid Internet access prices 75 per cent higher than urban ADSL users. A few remote users incurred long-distance charges for accessing an ISP. These users paid significantly higher prices for Internet access than urban ADSL users (see table 7.4).

In Canada, the Canadian Radio-television and Telecommunications Commission (CRTC) is addressing the inability of some Internet users to access an ISP for the cost of a local call through the universal service obligation (USO). The USO requires local exchange carriers, as part of the defined basic service objective, to provide their subscribers with low speed access to the Internet at local service rates (CRTC 1999). In cases where this is not being met, carriers must provide the CRTC with service improvement plans.

New Zealand remote, rural and urban Internet users were able to access an ISP for the cost of a local call via the use of a special prefix (0867 or 0873).

New Zealand satellite users paid less for Internet use than urban users of ADSL services. However, the transmission rate is significantly less than that of an ADSL service. Urban populations also have the option of subscribing to the one-way satellite service.

Many *United States* remote and rural one-way satellite users incurred lower prices for Internet access than urban ADSL users. Some remote one-way satellite users may have incurred long-distance charges for accessing an ISP. They could have bypassed telecommunications charges by subscribing to two-way satellite services. Subscribers of two-way satellite services pay a higher price but receive a higher level of performance than users of one-way satellite services. Two-way satellite users incurred prices 57 per cent higher than urban ADSL users.

Performance

ADSL services provide higher levels of performance than satellite services in terms of both upstream and downstream data transmission in all countries, for the plans considered in table 7.4. The level of satellite disadvantage (for the selected services) in terms of downstream performance ranges from 112 kbps in Australia to 1600 kbps in New Zealand (see table 7.4). Upstream data transmission rates are fixed for the selected ADSL plans but vary among Internet users for one-way satellite options depending on the characteristics of the CAN. Many remote and rural Internet users are located at relatively long-distances from their local exchange, reducing maximum upstream data transmission rates to substantially below 33.6 kbps (see chapter 5).

Slow PSTN data transmission rates for remote and rural Internet users may result in one-way satellite services taking longer to complete a specific task on the Internet than would be the case for ADSL services in urban areas. This could increase costs with time-based ISP and telecommunications charges.

7.4 In summary

Basic PSTN access to the Internet is generally available nationwide in the countries and service areas studied. However, a greater range of high speed services is available to urban populations than to remote and rural populations.

In Australia the price of basic PSTN and ISDN services did not differ between remote, rural and urban areas. Remote and rural one-way satellite Internet users incurred slightly higher prices than urban users. One-way satellite price differences occurred because of the higher cost of professional installation in remote and rural areas. ADSL and HFC cable are usually only available in urban areas. ADSL is expected to become more widely available in urban areas than HFC cable and may be deployed in some rural areas.

An international comparison was undertaken of price and performance differences in remote, rural and urban areas. For each country, an ADSL service available to urban users was selected as the benchmark against which satellite prices in remote and rural areas were compared.

The overall price of one-way satellite services in remote and rural areas:

- in Australia is comparable to the price of ADSL services in urban areas;
- in Canada is more than the ADSL price in urban areas; and
- in the US and New Zealand is less than the ADSL price in urban areas (but slower).

The ADSL service in New Zealand is superior (in terms of data transmission rate) to the ADSL services considered in Australia, Canada and the US.

The overall price of two-way satellite services in the US is over 50 per cent higher than the price of ADSL services in urban areas.

ADSL users receive a greater level of performance in terms of both upstream and downstream data transmission rates than satellite users in all countries. The relative importance placed on price and performance would determine the extent of overall disadvantage (if any) faced by remote and rural Internet users of satellite services relative to urban users of ADSL services in Australia and other countries.

Most of the performance difference between ADSL and one-way satellite services relates to the use of the PSTN for upstream data transmission. Two-way satellite services offer the potential for providing remote and rural Internet users in Australia with comparable levels of performance to ADSL in both directions. These services are already available in the US and are expected to be introduced in Australia soon.

A Participants

Organisations and individuals contacted by the Commission in the course of the study are listed below.

Australian Communications Authority

Australian Consumers' Association

Cable and Wireless Optus

Commonwealth Treasury

Communications Research Unit

Consumers' Telecommunications Network

Consultel

Department of Communications, Information Technology and the Arts (DCITA)

Farmwide

Gibson Quay

Internet Society of Australia

Network Economics Consulting Group (NECG)

Network Strategies

Teligen

Telstra

Vodafone

www.consult

A workshop was held on 25 May 2001 to provide a forum for the discussion of the study methodology and the presentation of results. A work-in-progress draft of the report was circulated prior to the workshop on a ‘confidential not for quotation’ basis.

The organisations who were represented are listed below.

Australian Communications Authority

Australian Competition and Consumer Commission

Australian Telecommunications Users Group

Balanced State Development Working Group

Cable and Wireless Optus

ComTech

Communications Research Unit

Consumers’ Telecommunications Network

DCITA

National Farmers Federation

Network Strategies

NECG

Telstra

Vodafone

Glossary

Items in bold are included individually in the glossary.

Acceptable use policy	A policy users must agree to in order to be provided with an access service. Potential users must agree not to use the service as part of violating any law, along with other obligations. In addition, ISPs are increasingly using these policies to prevent the excessive use of services offering an unlimited volume of information transfer. Generally, individual users are benchmarked against other users and if a user exceeds the usage factor specified by the ISP they may be disconnected from the service.
Access line	Connection from the customer to the local exchange for access to the telephone network.
ADSL	*Asymmetric digital subscriber line*. A **packet-switched** technology (line coding) that enables simultaneous voice and data transmission over **copper wire** networks such as the **CAN**. It supports significantly higher data transmission rates in the **downstream** direction. ADSL is one of many DSL variants referred to as **xDSL**.
AMPS	*Advanced mobile phone system*. The **analogue** cellular mobile phone system which operates in some countries and operated in Australia until 2000. AMPS allocates radio frequencies into two **channels** using **FDMA**; one for sending and one for receiving calls. AMPS networks in some countries have been upgraded to **D–AMPS**.
Analogue	A signal for which the amplitude (strength) and frequency (tone) varies continuously. In contrast to **digital**.

Any-to-any connectivity	A network has this feature when subscribers to one network are able to call and receive calls from subscribers to an alternative network.
Attenuation	A measure of the reduction in signal strength as it travels along any **transmission medium**, typically expressed in decibels per unit of distance.
Backbone	A central network that connects several other, usually lower **bandwidth**, networks. The backbone network usually comprises a high capacity **transmission medium**, such as fibre optic or coaxial cable.
Bandwidth	The range of frequencies, expressed in hertz (**Hz**), that can pass over a given **transmission medium**. In general, the greater the bandwidth the more information that can be sent through a **transmission medium** in a given amount of time.
Bit	The smallest unit of data stored in a computer. Has a discrete binary value, either 0 or 1.
bps	*Bits per second*. The number of **bits** transmitted or received each second.
Cable	Refer to **hybrid fibre coaxial cable**.
Call congestion	The failure by the network to accept a bid to establish a call.
Call drop-out	The discontinuation of a call by the network during communication phase.
CAM	*Customer access module*. On the Telstra network for example, some customers are connected to a CAM which may be located in a traditional exchange building or may be a 2 m tall green box on the footpath in the local area. CAMs extend **fibre optic** cable closer to the customer and are currently incompatible with **ISDN** and **ADSL** technologies.

CAN	*Customer access network*. The access network connecting customers to the **CAM**. In Australia, the CAN essentially comprises a fixed network of copper wire pairs.
Carrier	A business that is the owner of telecommunications network facilities and operates under licence.
CDMA	*Code division multiple access*. A **digital cellular mobile** phone technology developed to be compatible with the **analogue AMPS**. Signals are spread across the entire available **spectrum** and are not confined to that part which would be allocated to an individual **channel,** allowing multiple calls to be placed on one channel.
CDMA2000	A standard for **3G cellular mobile** technology.
Cellular	A mobile communications service in which voice or data is transmitted by radio frequencies. The service area is divided into cells each served by a transmitter. The cells are connected to a switching exchange which is connected to the PSTN network.
Channel	A channel is a separate path through which information can flow. The **bandwidth** of a communications channel is a major factor influencing the amount of information that a channel can carry.
Circuit-switching	Temporary direct connection of two or more **channels** between two or more points in order to provide exclusive use of an open channel. A discrete circuit path is set up between the incoming and outgoing lines, in contrast to **packet-switching**, in which no such physical path is established.
CLEC	*Competitive local exchange carrier*. A North American term referring to a business that competes with established local telephone **carriers** by providing its own network and switching. The term arises from the US *Telecommunications Act of 1996*, which was intended to introduce competition among both long-distance and local phone service providers.

Copper wire	The main **transmission medium** used in telephony networks to connect a telephone and other apparatus to the **local exchange**. Copper wires generally support data transmission rates below 56 **kbps** unless combined with an enabling technology such as **ADSL**.
CPE	*Customer premises equipment*. Telephone or other equipment that is located at the customer's premises. CPE includes telephone handsets, ADSL modems and cable modems.
CSG	*Customer service guarantee*. Requirement under Australian legislation that **carriers** meet minimum standards in the supply of standard telephone services and some enhanced call features. Customers receive financial compensation where performance requirements are not being met.
D–AMPS	*Digital–advanced mobile phone system*. The digital version of **AMPS**. D-AMPS adds **TDMA** to AMPS to get three **channels** for each AMPS channel.
DDSO	*Digital Data Service Obligation*. In Australia, the **USO** was amended in 1999 to incorporate a digital data service. Under the general DDSO, Telstra is required to provide on request a two-way data transmission service, broadly comparable to 64 **kbps** basic rate **ISDN** service to at least 96 per cent of the population. Although Telstra must offer a 64 kbps service there are no pricing restrictions, in contrast to its **PSTN** obligation.
Digital	Communications procedures, techniques and equipment that encode information as either binary '1' or '0'. In contrast to **analogue**.
Downstream transmission	The transmission of information towards the customer, either along the **CAN,** or using alternative networks, for example, **HFC cable, satellite**, **MMDS** or **mobile**.

DRCS	*Digital radio concentrator system*. An ageing radio technology used in some remote areas for voice and very low speed data transmission. The average data transmission rate for DRCS is 7.2 kbps. In Australia DRCS is currently being replaced by **HCRC**.
EDGE	*Enhanced data for GSM evolution*. A **packet** based data protocol for cellular phones that overlays GSM networks. EDGE is a so-called 2.5G technology and supports downstream data transmission rates up to 384 kbps.
Electromagnetic interference	Disruptions to the operation of electronic components, devices and systems resulting from devices that generate electromagnetic fields in the radio frequency spectrum.
FDMA	*Frequency division multiple access*. **AMPS** utilises FDMA technology to allocate radio spectrum to users. With FDMA, only one subscriber at a time is assigned to a **channel**. The channel cannot be accessed by other conversations until the call is completed or handed over to a different cell.
Fibre optic	Refers to the **transmission medium** and **transmission technology** associated with sending and receiving information as light pulses along a glass, plastic wire or fibre medium.
Fixed rate technologies	Technologies offering customers data transmission rate options that do not vary with the number of simultaneous users, for example, **ISDN** and **ADSL**.
GEO satellite	*Geostationary earth orbiting satellite*. GEO satellites are situated approximately 35 800 km above the earth with current user offerings accommodating **downstream** data transmission rates of around 400 **kbps**. With a rotation period normally of 24 hours these satellites appear stationary over any location on earth.

GPRS	*General packet radio service*. A **packet** based data protocol for **cellular** phones that overlays GSM networks. GPRS is a so-called **2.5G** mobile system and supports **downstream** data transmission rates up to 114 **kbps**.
GSM	*Global system for mobile*. A **digital cellular** mobile technology based on **TDMA**.
HCRC	*High capacity radio concentrator*. A radio technology used to extend the reach of the **CAN** in some remote and rural areas. HCRC supports voice and data communications. The average data transmission rate for HCRC is 19.2 **kbps**.
HFC cable	*Hybrid Fibre Coaxial cable*. A network consisting of **fibre optic** cable supplemented with coaxial cable for the connection to the customers' premises. Data transmission rates are constrained by its **shared fixed-rate** architecture.
Hz	*Hertz*. A unit of frequency, equal to one cycle per second.
Internet	Physically, a collection of **packet-switched** networks interconnected by **routers** along with protocols that allow them to function logically as a single, large, virtual network.
IP	*Internet Protocol*. The method (or protocol) with which information is sent from one computer to another on the **Internet** — involves dividing information into **packets**. Individual packets can be sent, if necessary, by different routes across the Internet. **IP** works in conjunction with **TCP**.

ISDN	*Integrated services digital network*. A set of standards for digital transmission over **copper wire** and other access media. ISDN is a **circuit-switched** technology which allows both voice and data over the same network. The basic ISDN service for residential or small business customers consists of two 64 **kbps channels** and one 16 kbps channel (referred to as B and D channels respectively).
ITU	*International Telecommunications Union*. An agency of the United Nations, established to provide standardised communications procedures and practices including frequency allocation and radio regulations on a worldwide basis. Parent of the ITU-T (telecommunications), ITU-R (radio), and ITU-D (developing nations) committees.
LEO satellite	*Low earth orbiting satellite*. LEO satellites support higher data transmission rates than **GEO** satellites as they operate closer to the earth's surface — no more than 1500 km. LEO satellites have the added advantage of accommodating portable wireless customer equipment. However, as they operate closer to the earth's surface, many more satellites are required for global coverage.
Line density	The density of **access lines** in terms of numbers of lines per unit area. Line densities influence the cost of providing telecommunications services. Remote and rural areas are characterised by lower line densities than urban areas.
Line length	The length of **access lines** between the end user and the **CAM**. Longer line lengths support lower data transmission rates. In general, the distribution of average line lengths are reported on a countrywide or carrier-wide basis.

LMDS	*Local multipoint distribution system*. A terrestrial radio system utilising radio frequencies around 25 to 40 **GHz** capable of providing interactive video, high speed Internet along with voice services. LMDS supports significantly higher data transmission rates than **MMDS**. The utilisation of higher radio frequencies usually limits technology offerings to customers residing within a 3 km radius of a transmission tower.
Loading	Involves altering the electrical characteristics of the **copper wire**. This enables the provision of voice telephony over much greater distances. Loading lowers copper wire's performance at frequencies higher than the voice band making it unsuitable for **ADSL** and **ISDN**.
Local exchange	The exchange (or switching centre) to which a customer is directly connected.
Local loop	Same as **CAN**.
Local loop unbundling	Regulation enabling competitors to use the **access lines** of other **carriers** in the provision of voice and or high speed services.
MMDS	*Multichannel multipoint distribution system*. A terrestrial radio system utilising radio frequencies between 2 and 3 **GHz**. Traditionally, MMDS has been used for television broadcasting. However, MMDS is increasingly being used in the provision of two-way high speed access to the Internet. Under optimal conditions, MMDS can operate to a radius of around 50 km. MMDS supports lower data transmission rates than **LMDS** with current customer **downstream** offerings around 2 **Mbps**.
Mobile networks	Include **2G**, **2.5G** and **3G** technologies. Mobile networks have evolved from employing **analogue** technologies designed for voice communications to **digital** technologies supporting **Internet** access (along with voice communications).

Modem	A device that converts (modulates) a **digital** signal into an **analogue** signal for transmission along the **CAN** to another modem — signals are then converted back (demodulated) to digital signals for the digital device (usually a computer).
Noise	Noise is unwanted electrical or electromagnetic energy that degrades the quality of **analogue** and **digital** signals. For digital signals, noise can degrade data transmission rates. While in voice communications, noise sounds like a faint hissing or rushing. **Fibre optic** cable is less susceptible to noise than other **transmission mediums**.
NTN	*Networking the Nation*. A Federal Government grants program in Australia providing funding to support activities and projects designed to address a range of telecommunications needs in remote and rural areas.
Packet	A unit of data that is routed between an origin and a destination on the Internet or any other packet-switched network. A portion of each packet is used to store the destination address.
Packet-switching	A method of transmitting messages through a communication network, in which long messages are subdivided into short packets. Each packet is passed from source to destination through intermediate nodes. At each node, the packet is received, stored briefly, and then passed on to the next node. The packets are then reassembled into the original message at the receiving end.
Penetration	Number of subscribed services within a geographic area as a per cent of the population.

POP	*Point of presence*. A geographic location where an **ISP** can be accessed by a customer. POPs consist of a range of telecommunications equipment including **modems**, **routers**, servers and switches. Whether the nearest POP is within a customer's local call area affects the cost of accessing the service. Normally used in dial-up access to the Internet.
Population density	Population per unit area. Population densities influence the cost of providing telecommunications services.
Post dial delay	The time that elapses between completion of dialling and connection. Potentially an important issue for **cellular mobile** networks, where the location of customer is constantly changing and the network needs to establish the location of the customer before a connection can be made.
PSTN	*Public switched telephone network*. The infrastructure for basic fixed telecommunications services (including telephones, **CANs**, switches, local and trunk lines, and exchanges). It enables any customer to call and communicate with any other customer.
Roaming	Domestic 'roaming' arrangements can potentially improve coverage levels for individual mobile subscribers. Under roaming agreements, users of one carrier are able to initiate calls from their mobile handsets on an other carrier's network, where such agreements exist. The opportunities for roaming between networks can be limited by the availability of appropriate handsets. For example, users are unable to roam between **GSM** and **CDMA** networks. Roaming between networks is generally not supported during a call.

Router	On the Internet, a router is a device or software in a computer, that determines the next network point to which a packet should be forwarded toward its destination. The router is connected to at least two networks and decides which way to send each information packet based on its current understanding of the state of the networks it is connected to. A router is located at any gateway (where one network meets another), including each POP.
Service deployment	Measures the percentage of population within a geographic area that could have access to the particular service if they chose to subscribe.
Service unavailability	A measure of network downtime where customers are unable to access the network.
Shared-fixed rate technologies	Technologies offering customers data transmission rate options that are dependent on the number of simultaneous users, for example, **HFC cable**, **satellites**, **MMDS** and **mobile**.
Spectrum	The **bandwidth** of a communications system, expressed in terms of the frequencies it can carry.
TCP	*Transmission Control Protocol*. TCP works in conjunction with **IP**. IP sends individual **packets** of information to their final destination. TCP then reassembles individual packets in their correct order.
TDMA	*Time division multiple access*. **Digital cellular mobile** phone technology. Each cellular **channel** is divided into three time slots in order to increase the amount of data that can be carried. TDMA is used by D-AMPS and GSM. However, these networks implement TDMA in slightly different ways.
Telephony	Generic term describing voice telecommunications.

3G	*Third generation*. A near future **cellular** technology employing more advanced switching techniques than **2.5G** technologies. 3G technologies offer the prospect of **downstream** data transmission rates up to 2 **Mbps** to fixed locations. These data rates allow for video streaming and location based services.
Traffic	Messages sent and received over a communications **channel**. Also, a quantitative measurement of the number of messages and their duration, expressed in call minutes or other units.
Transmission medium	The medium over which information is sent, for example, **copper wire**, **HFC cable**, **fibre optic** and **radio**.
Transmission technology	Determines the protocol with which information is sent over an **transmission medium**, for example, **ISDN** or **ADSL**.
2G	*Second generation*. Existing **digital cellular** standard providing voice and low speed **Internet** access. 2G technologies include **GSM** and **CDMA**. They employ digital voice encoding and a mixture of **circuit-switching** and **packet-switching** techniques supporting data transmission rates around 9.6 **kbps**.
2.5G	*2.5 generation*. An evolutionary **cellular** standard on the way to **3G** technologies. 2.5G technologies include **GPRS** and **EDGE** and employ **packet-switching** techniques with the potential to support data transmission rates up to 384 **kbps**.
ULL	*Unconditioned local loop*. Same as **local loop unbundling**.
Upstream transmission	The transmission of information from the customer, either along the **CAN** (towards the **local exchange**), or using alternative networks, for example, **HFC cable, satellite**, **MMDS** and **mobile**.

USO	*Universal service obligation*. Legislation which generally requires designated carriers to provide basic telephone services, payphones and prescribed carriage services on a countrywide and equitable basis.
Virtual POP	Virtual *point of presence*. Allows users to access an **ISP** as though it were within the same local call zone and therefore at the cost of a local phone call. However, the additional costs incurred by the ISP in making this service available are typically passed on to the user as part of their charge.
xDSL	Generic term for digital subscriber line technologies (such as **ADSL**), which enable high speed access to the Internet over **copper wires**.

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