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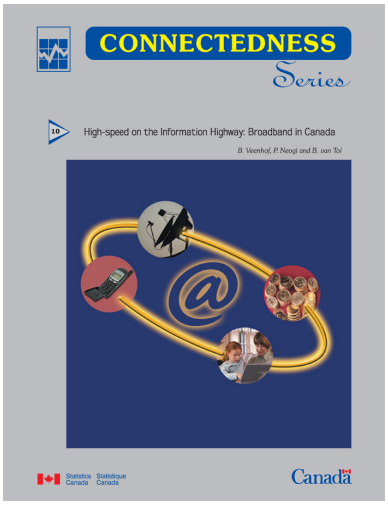
High-speed on the Information Highway: Broadband in Canada



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Abstract

This paper is Statistics Canada's first comprehensive quantification of the demand for and supply of broadband Internet technologies. It draws from various data sources to examine the use of broadband by households and industry, as well as broadband supply and availability.

Canadians are among the world's leaders in broadband use. Nearly half (49%) of all regular home Internet use households had a high-speed Internet connection in 2001. This proportion increased from east to west, with 61% of regular home Internet use households connecting using broadband in British Columbia, compared to 39% in the Atlantic provinces. For the private sector, 2002 marked the first year in which the majority (58%) of enterprises using the Internet connected using broadband technologies. The Information and Cultural Industries continued to be leaders in broadband penetration (86%). Analysis by enterprise size further revealed that broadband use was higher among large firms.

Cable operators and telecommunications services providers have invested substantially in infrastructure upgrades in order to be able to offer broadband services. Broadband access services have also been an important source of revenue growth for telecommunications services providers offering broadband over Digital Subscriber Line (DSL) facilities, cable operators, and other Internet service providers (ISPs) who derive the majority of their revenue from the sale of Internet access.

Many communities, located mostly in rural and remote areas, do not yet have broadband services available, due to the smaller customer base and higher costs associated with deploying infrastructure over long distances. A number of initiatives are underway in order to address broadband deployment in rural and remote communities.

High-speed on the Information Highway: Broadband in Canada

By B. Veenhof, P. Neogi and B. van Tol

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1. BROADBAND IN CONTEXT

Just as the introduction of personal computers and the Internet have had a profound impact on the use of information and communications technologies (ICTs), broadband has the potential to revolutionize the ways in which we use these technologies. Broadband expands the realm of *how much* information can be sent over a computer network and *how readily* that information is available. It enables applications that are simply not possible with "dial-up" methods of Internet access, which use a telephone line and standard modem. Such bandwidth-hungry applications, including video-conferencing, tele-medicine, educational multimedia, movies-on-demand and games, have always been at the heart of the Internet promise.

While the emergence of broadband in Canada is a relatively recent phenomenon, much of the technology behind broadband networks is not new. Whether we realize it or not, many Canadians have already used broadband if they use computers connected to a network, typically at work or at school. As the technology continues to evolve, however, so do the technology users. Many Canadian households and small businesses are now beginning to embrace broadband technologies, which were previously reserved for large institutions in the public and private sectors. In fact, Canada is a leader in the use of the most common broadband access technologies – cable modems and Digital Subscriber Lines (DSL) – and ranks second only to Korea among OECD member countries (OECD 2002a).

However, many parts of the country, particularly rural and remote areas, currently do not have access to broadband Internet services, other than those offered by the more expensive and relatively slower (compared to wireline methods, such as cable and DSL) satellite. The geographical distribution of the Canadian population presents a major challenge to the provision of these services, largely due to the high cost of upgrading and extending infrastructure to customers dispersed over very long distances. Paradoxically, the need for access to broadband communications is often greater in remote areas than in urban centres, since the real potential of broadband lies in its ability to further reduce time and distance as cost factors. As well, broadband technologies are expected to convey benefits to groups that have traditionally faced higher costs of access by reasons of geography. For example, it would be easier for a local business to use web sites to extend the marketing and sales of its products beyond the traditional community to reach national and global markets, the provision of public services, including the delivery of health and education services, could be enhanced, and already available services such as Internet shopping, electronic banking and electronic newspapers could grow further (NBTF 2001).

The Government of Canada has proposed the goal of making high-speed, broadband Internet access widely available to all communities in Canada by 2005, and has launched the Broadband for Rural and Northern Development Pilot Program as a first

step to achieving this goal (Industry Canada 2003). Broadband deployment is also a key part of the "Strengthening Communities" objective identified in Canada's Innovation Strategy. Communities are recognized for their potential to attract innovation and investment, stimulate job creation and generate wealth (Industry Canada 2002). A number of provincial/territorial and municipal government programs with similar goals have also been launched.

This study marks Statistics Canada's first comprehensive quantification of the demand for and supply of broadband technology. Section 2 presents the conceptual framework for the analysis, including some key functional characteristics of broadband technology and its definition. Section 3 profiles broadband use, drawing from the *Household Internet Use Survey* and the *Annual Cable Television Survey to* examine the first available data on broadband use by Canadian households. The use of broadband by the private sector is also presented using data from the *Survey of Electronic Commerce and Technology*, and includes analysis of penetration by industry type and firm size. The supply of broadband is the focus of Section 4, as data from the *Annual Cable Television Survey,* the *Survey of Telecommunications,* and the *Annual Survey of Internet Service Providers and Related Services* are used to profile concentration and revenue sources in the industry. Once patterns of use and factors affecting broadband supply have been established, the study concludes with a discussion of some of the challenges facing its widespread deployment in Canada. This includes issues related to deployment in rural and remote areas.

NOTE TO READERS

Broadband Internet technologies and associated concepts have evolved over a short period of time and are captured to differing degrees in existing Statistics Canada surveys. To ensure thoroughness of coverage, this analysis draws from several sources. The *Household Internet Use Survey (HIUS)* measures regular point of access to the Internet by location, type, frequency and intensity of use. Beginning in 2001, households were asked to indicate whether their Internet connection at home was a high-speed connection.

Data on broadband are also collected for private sector enterprises by the *Survey of Electronic Commerce and Technology (SECT)*. In 2001, about 21,000 enterprises were asked to indicate all the methods used to access the Internet (regular dial-up, cable, DSL, etc). Enterprises were then classified as narrowband or broadband, based on their responses.

For the supply of broadband technology, this analysis draws on three Statistics Canada data sources – the *Annual Cable Television Survey*, the *Annual Survey of Internet Service Providers and Related Services*, and the *Annual Survey of Telecommunications*. For more information on all of the data sources, visit **http://www.statcan.ca/english/concepts/index.htm.**

For the purposes of this study, the term 'broadband' refers to cable, DSL and other high performance broadband systems (including high-speed T1 lines used by some businesses). Although they represent a very small fraction of broadband subscribership, ISDN and wireless methods are also included. It should also be noted that the terms 'broadband' and 'high-speed' are used interchangeably throughout the text, as are the terms 'dial-up', 'narrowband' and 'low-speed'.

2. DEFINING BROADBAND

Originally an engineering term, broadband refers to the amount of information that can be carried between a sender and a receiver over a telecommunications channel. There exists little consensus on how exactly to define broadband, though. The term often means one thing to an individual user, perhaps something quite different to a policy maker, and again something else to a network engineer. The use of broadband implies that a lot of information can be transmitted when compared to traditional methods of accessing the Internet, typically referred to as "narrowband" or "dial-up" using a telephone line and standard modem. But our notions of how much information constitutes "a lot", as well as the technologies themselves, are both evolving. It comes as little surprise then that a study done for the National Broadband Task Force (NBTF)[1] found that the term "broadband" is not very precise, ranging from transmission speeds of 200 kilobits per second (kbps)[2] (FCC 2002) to as high as 30 Megabits per second (Mbps) across the 14 countries that were studied (NBTF 2001).

2.1 Functional characteristics

Because of the variation in definitions and the changing nature of the technology and user requirements, rather than defining broadband in terms of data transmission rates, the NBTF elected to adopt a more functional definition: that broadband should be defined as "a high capacity, two-way link between an end-user and access network suppliers capable of supporting full motion, interactive video applications" (2001). Based on 2001 technology, it specified that a 2-way transmission speed of 1.5 Mbps would be required to meet this standard, although this requirement would change as emerging applications evolve. It must be emphasized that this remains a future target rather than a definition that can currently be used for statistical analysis.

Similarly, for the purposes of this paper, adopting a "functional" approach to the definition of broadband is helpful. Due to a variety of factors that will be discussed shortly, accurate and consistent comparisons based on the speed of various broadband technologies can be difficult. Broadband technologies can, however, be distinguished from the more traditional method of "dial-up" Internet access by several key functional characteristics. These include access speed, 2-way transmission, and 'always-on' connectivity. Each of these characteristics affects the types of applications broadband can support and the way the Internet is used.

By improving **access speed**, or the rate at which information is transferred between networks and computers across the Internet, broadband technologies are capable of sending large files several times faster than can be achieved using a dial-up Internet account. Although the access speed of the most common broadband technologies (i.e., cable modem and DSL) may vary with the effects of distance, number of users and configuration (April 2000), a significant gap remains between these technologies and dial-up Internet access[3].

Broadband technologies also have the potential to offer **2-way** transmission capabilities. The majority of the applications used on the Internet today require a faster downstream than upstream bandwidth. For example, when browsing through websites users typically receive more information than they transmit. High upstream or "send" rates are critical however for those users who wish to operate a website or an Internet server over their computer, or send large files such as those containing real-time video. Although high "send" rates are not a feature of all broadband technologies today, these technologies are continuing to develop and some users already have or will have the option to purchase such packages (e.g. SDSL, or "symmetric" DSL). The need for high upstream

1 -- The National Broadband Task Force (NBTF) was commissioned in January 2001 to advise the Canadian government on possible approaches to making broadband Internet services available to businesses and residents in all Canadian communities. Its recommendations can be found in the official report (NBTF 2001), available online at: http://broadband.gc.ca

2 -- Computers read information as bits, a series of "1"s and "0"s. A dial-up 56K modem is designed to transmit data at 56 kbps (1kb=1000 bits), while broadband can typically achieve rates of several Mbps (1Mb=1,000,000 bits). Bits should not be confused with "Bytes", a unit of measure equal to 8 bits. For most Internet technologies however, theoretical maximum speeds are not always achieved and real transfer times may be slower for a variety of reasons.

3 -- It should be noted that access speed does not necessarily translate into end-to-end bandwidth, due to congestion of shared networking resources, retransmissions, or limitations of content servers to deliver sustained transfer rates for multiple concurrent users of a web site.

capacity may change over time as applications taking advantage of the 2-way transmission capability evolve.

The "**always-on**" feature of broadband is also significant. Some applications, for example the ability to continually interact with family, co-workers, or patients, make having a permanent connection a distinct advantage. Unlike dial-up connections, the Internet is always immediately available, and there is some evidence that this changes patterns of Internet use. Always-on connections tend to be more reliable, and without the need to re-connect with each use, users also tend to seek information from the Internet more frequently than those using dial-up (ZDNet News 1999, quoted in CDT 2000).

Given the issues identified above, this study defines broadband as *all Internet connection methods other than traditional "dial-up" access through a standard modem*. Thus, the analysis will compare dial-up (or "narrowband") technologies with all other methods of Internet access grouped together as "broadband" (cable modem, DSL, ISDN, wireless).

Box 1: Defining Broadband

For the purposes of this study, broadband is defined as all methods of Internet access *other than* dial-up. This approach has been adopted for several reasons:

- Fundamental differences in functional characteristics (speed, 2-way transmission capability and "always-on" connectivity) that are shared by most broadband technologies and cannot be attained using standard dial-up methods;
- The range in concepts and data availability do not permit detailed assessments of different types of broadband technology across available survey sources;
- The most common broadband technologies, cable and DSL, are affected to differing degrees by factors such as distance, number of users and configuration, making it difficult to develop meaningful comparisons between these technologies based on performance;
- Classification in to two analytical categories (dial-up or "narrowband" versus broadband) facilitates ease of comparison and analysis.

Broadband includes the two most common forms of access, namely cable modem and DSL, but also ISDN and wireless access methods. Basic rate ISDN is an Internet access method that uses a bandwidth which is typically slower than the most common broadband technologies identified above, but cannot be analyzed separately from cable and DSL due to data limitations. Although a significant technology in some parts of Europe, ISDN penetration is extremely low in Canada with 113,300 subscribers (and not all of whom necessarily use this service for Internet access), representing 0.4% of the Canadian population (ITU 2002). The penetration of wireless methods (including stationary or "fixed" terrestrial and satellite systems), while still emerging, is also not yet material (Statistics Canada 2002).

3. PROFILE OF BROADBAND USERS

3.1 Canadians among broadband leaders

Broadband use is emerging as a common feature in many Canadian households, and the rate at which its use is growing has been rapid in those areas where services are available. Recent data show that close to one-quarter (23.7%) of all Canadian households had a high-speed Internet connection in 2001, representing nearly half of all regular home Internet use households (Table 1)[4].

The numbers reveal two important findings. First, unlike the case of many other countries where traditional dial-up access methods remain the dominant and, in some cases, the only source of Internet access commercially available, the overall numbers and proportions of households using high-speed and low-speed connections in Canada are almost equal. In fact, in some provinces high-speed connections exceed low-speed ones. Second, the proportion of high-speed Internet subscribers in Canada tends to increase from east to west. British Columbia has emerged as a leading province in broadband use. Over 60% of regular home Internet users connect using broadband, accounting for close to one-third of all households. In all Western provinces the proportion of high-speed subscriber households outnumbers the proportion of households using traditional dial-up methods of Internet access.

Canadians are establishing themselves as among the most connected in the world. The high-speed numbers reported here support the observation that Canada has one of the highest broadband penetration rates (Table 2), with more than double the number of subscribers on a per capita basis than the OECD average (OECD 2002a). Among non-OECD countries, high levels of broadband penetration (similar to the rate in Canada) have also been reported in Hong Kong and Taiwan (ITU 2003).

Regarding the types of broadband technologies used by Canadian households, further detail can be provided on cable modem subscribers from the *Annual Cable Television Survey*. The cable industry has experienced steady growth in the number of high-speed cable Internet subscribers. Since this number was first tracked in August 1999, subscribership has grown from approximately 364 thousand to over 1.75 million at the end of 2001.

4 -- Some Canadians have their household Internet connection paid for by their employer. A reliable estimate of the number of households with such arrangements cannot be drawn at this time.

Table 1.
Speed of regular home Internet use, 2001

Province of household	High-speed	Low-speed	Regular home Internet use	High-speed as a % of regular home Internet use
		% of all households		
Atlantic provinces	15.4	23.6	39.9	38.6
Quebec	17.9	24.1	42.7	42.0
Ontario	25.1	27.3	53.4	47.1
Manitoba/Saskatchewan	22.5	18.7	41.6	54.1
Alberta	28.7	22.3	51.8	55.4
British Columbia	32.6	19.7	53.7	60.8
Total	**23.7**	**24.1**	**48.7**	**48.7**

Note: High and low speeds do not necessarily add to regular home Internet use due to non-response for type, speed or cost of connection. Regular home Internet use households are households where the respondent indicated that at least one household member uses the Internet at home in a typical month.
Source: Statistics Canada, Household Internet Use Survey, 2001.

Table 2.
Canada a leader in broadband use among OECD countries (as at June 2002)

Country	DSL lines	Cable modem subscribers	Broadband subscribers/100 inhabitants
	thousands		
Korea	5,735	3,287	19.2
Canada	1,331	1,848	10.3
Sweden	344	128	6.8
Denmark	233	122	6.7
Belgium	362	259	6.3
United States	5,083	9,200	5.8
Iceland	13	0	4.8
Austria	136	208	4.2
Japan	3,301	1,626	4.0
Netherlands	192	432	3.9
Swtzerland	101	180	3.9
Germany	2,500	39	3.2
OECD countries	**21,990**	**18,642**	**3.9**
European Union	**6,123**	**2,240**	**2.3**

Note: Includes residential and business subscribers.
Source: OECD 2002a.

Growth has also been rapid in the United States. The number of cable lines in service in December 2001 (7.06 million) was five times the number reported in December 1999 (1.41 million) (FCC 2002). While the remarkable growth in cable Internet use experienced in Canada and the United States is similar, in Canada the proportion of households is much higher. Nearly 15% of homes with access to cable Internet had adopted it as of August 2001, while the penetration rate in the United States reached only 8% (Statistics Canada 2002). Some observers suggest that early recognition of market opportunities among Canadian cable companies, intense competition between broadband providers, and significantly lower prices for cable Internet service in Canada are among the factors contributing to this trend (Akin 2003).

Within Canada, broadband by cable is most popular in the Western provinces and territories (Table 3). This finding is consistent with patterns observed in the overall high-speed Internet numbers from the *Household Internet Use Survey* (reported in Table 1). With a penetration rate of 14%, Ontario ranks close to the national average, while the Atlantic provinces and Quebec lag in terms of the share of homes adopting as a percentage of homes capable of receiving the service. Although penetration rates are lower in the Atlantic provinces and Quebec, these regions experienced the largest percentage growth in subscribers to Internet by cable between 2000 and 2001, with the number in the Atlantic provinces more than doubling over this one-year period.

High-speed Internet by cable was also much more popular in large communities (defined as Census Metropolitan Areas), with progressively lower penetration rates in medium-size and small communities (Table 4). The vast majority of homes subscribing to Internet by cable (85%) were located in large communities. Nonetheless, relative growth in subscribership was highest in small communities where Internet by cable is available. In these communities, the number of homes subscribing grew 270.3% over the 2000-2001 period alone.

A large community is defined as a Census Metropolitan Area (CMA). A CMA is a very large urban area, together with adjacent urban and rural areas that have a high degree of economic and social integration with that urban area. A CMA has an urban core population of at least 100,000 based on the previous census. A medium-size community is defined as a Census Agglomeration (CA). A CA is a large urban area, together with adjacent urban and rural areas that have a high degree of economic and social integration with that urban area. A CA has an urban core population of at least 10,000 based on the previous census. A small community is defined as a Census Division located outside a CMA or CA.

Table 3.
Internet by cable varies by region

Subscribers to Internet by cable	1999	2000	2001	% change 99/00	% change 00/01
		(thousands)			
Atlantic provinces	11.0	23.0	50.5	109.1	119.6
Quebec	55.0	119.1	226.0	116.5	89.8
Ontario	142.0	305.2	506.1	114.9	65.8
Western provinces and territories	156.0	339.0	605.2	117.3	78.5
Total	**364.0**	**786.4**	**1,387.9**	**116.0**	**76.5**
Subscribers to Internet by cable/ homes with access to Internet by cable		*(%)*			
Atlantic provinces	..	8.8	10.8	..	22.1
Quebec	..	6.4	9.6	..	50.9
Ontario	..	10.4	14.0	..	35.2
Western provinces and territories	..	13.4	20.4	..	52.8
Total	**7.6**	**10.3**	**14.8**	**35.5**	**43.0**

Note: Data reported in this table are as of year-end August 31.
.. Figures not available.
Source: Statistics Canada (2002) "Broadcasting and Telecommunications Service Bulletin, Cable, Satellite and Multipoint Distribution Systems, 2001", Catalogue No. 56-001-XIE, Vol. 32 No. 3, November 2002.
Statistics Canada (2001) "Broadcasting and Telecommunications Service Bulletin, Cable, Satellite and Multipoint Distribution Systems, 2000, Catalogue No. 56-001-XIE, Vol. 31 No. 3, August 2001.

Table 4.
Internet by cable adoption by community size

Subscribers to Internet by cable	1999	2000	2001	% change 99/00	% change 00/01
		(thousands)			
Large communities	..	696.2	1,174.7	..	68.7
Medium-size communities	..	80.1	175.8	..	119.5
Small communities	..	10.1	37.4	..	270.3
Total	**364.0**	**786.4**	**1,387.9**	**116.0**	**76.5**
Subscribers to Internet by cable/ homes with access to Internet by cable		*(%)*			
Large communities	..	10.6	15.6	..	47.2
Medium-size communities	..	8.9	11.7	..	31.7
Small communities	..	7.1	10.3	..	45.8
Total	**7.6**	**10.3**	**14.8**	**35.5**	**43.0**

Note: Data reported in this table are as of year-end August 31.
.. Figures not available.
Source: Statistics Canada (2002) "Broadcasting and Telecommunications Service Bulletin, Cable, Satellite and Multipoint Distribution Systems, 2001", Catalogue No. 56-001-XIE, Vol. 32 No. 3, November 2002.
Statistics Canada (2001) "Broadcasting and Telecommunications Service Bulletin, Cable, Satellite and Multipoint Distribution Systems, 2000, Catalogue No. 56-001-XIE, Vol. 31 No. 3, August 2001.

Currently, a reliable estimate of the total number of DSL subscribers cannot be separately measured from existing Statistics Canada broadband survey sources[5]. However, a high level of competition exists between cable and DSL high-speed Internet services in Canada. Although cable modem providers have traditionally held a larger share of the broadband access market, the family of DSL technologies has been recently gaining ground. One advantage that DSL offers household consumers is that access bandwidth is dedicated to each individual subscriber rather than shared with other users. Other factors, such as distance from the telephone company central office and line noise can affect access and the speed of DSL users' connections, but unlike cable users they do not experience lower access speeds at peak usage times – typically afternoon and evening hours.

The continued increase in total residential subscribership to both cable and DSL has resulted in an overall decline in the proportion of dial-up access subscriptions. However, dial-up subscriptions continued to grow in absolute terms at a rate of 6% in 2001 (ITU 2003).

The popularity of Internet activities requiring high bandwidth, such as online gaming (24.4%), music downloads (23.3%), and education and training (22.9%) among Canadian households has also likely had a strong influence on broadband penetration in Canada (ITU 2003). Using the Internet for work-related purposes at home may also encourage high-speed technologies (and in some cases, may be sponsored by the employer). Using the Internet to work from home was reported by 1.5 million Canadian households in 2001.

3.2 Use by private sector business

There are a number of broadband applications that are particularly relevant in the business world. Many of these applications take advantage of the high transfer rates and permanent connectivity that characterize broadband technologies, and have the potential to change the way firms do business. These include video-conferencing, tele-work, and online sales and purchasing. Although these applications are all at various stages of development and use, what they have in common is the requirement to send, and sometimes receive, large files quickly and reliably.

The Canadian government envisions new opportunities for businesses in both the B2B (business-to-business) supply chain as well as B2C (business-to-consumer) markets (NBTF 2001). Part of the appeal of broadband in the business world lies in its ability to transform operations from paper-based to electronic systems. Applications which have been developed allow, for example, the integration of front-office functions such as sales with other office systems, including stock and order processing (Broadband Advisory Group 2003). Conversely, those businesses that are slower to adopt the technologies may have difficulty competing with businesses taking advantage of the efficiencies broadband offers, particularly in a global marketplace.

Aside from the competitive position of Canadian businesses internationally, the benefits of broadband will likely be uneven within Canada. Some industries may stand to benefit more than others, and broadband use may vary across sectors, as observed with other Internet technologies internationally (OECD 2002b), and within Canada (Peterson 2001, Charles, Ivis and Leduc 2002). Adoption of broadband networks by small- and medium-size enterprises (SMEs) in particular is viewed as critical because of the potential for helping them reach broader markets (Canadian E-Business Opportunities Round Table 2002, OECD 2002a).

The following section presents a profile of business broadband use by industry and firm size using data from the *Survey of Electronic Commerce and Technology* (SECT).

5 -- Estimates of DSL subscribership are available from other sources. As at the end of 2001, the CRTC estimates there were 924 thousand Canadian households accessing the Internet via DSL (CRTC 2002). The OECD estimates the number of DSL subscriber lines in Canada at 1.3 million as of June 2002 (OECD 2002a). Numbers from a TeleChoice North American DSL market survey report 1.3 million DSL lines in Canada as of the first quarter, 2002 (TeleChoice 2002). For the same time periods, the OECD reports 5.1 DSL line s in the United States and TeleChoice, 4.9 million. Overall, these numbers suggest that DSL penetration, as with cable, is considerably higher on a per capita basis in Canada than in the United States.

Box 2: Firm Size

The SECT collects information on the number of full-time employees (FTE) of the enterprise, which is used to delineate business by firm size. It is recognized that firm size – small, medium or large – is industry-specific, and what may be considered a large firm in some industries may be small in others. Considering the detailed tabulations needed, constraints related to data confidentiality and quality do not permit the delineation of size categories for each industry. Two groupings are used:

Table 5.
Firm size classification (FTE)

	Small	Medium	Large
Manufacturing industries	0-19	20-499	500+
All other industries	0-19	0-99	100+

3.3 Towards broadband Internet access

Among enterprises that access the Internet, broadband technologies are being used in growing numbers and there is a shift away from traditional dial-up Internet access methods. While 36.6% of firms using the Internet continue to use dial-up as their only method of access, this figure is down considerably from 59.6% in 2000. Meanwhile, the proportion of private sector enterprises using high-speed connections has risen steadily. In fact, by 2002, the proportions of enterprises using dial-up versus high-speed connections had nearly reversed from 2000 (Table 6). High-speed DSL/ISDN lines were the most popular type of broadband Internet access used by private sector businesses in 2002. Their rate of use is also growing more quickly than other methods.

Table 6.
Type of Internet connections used by private sector enterprises

Connection type *(fastest method of access)*	**2000**	**2001**	**2002**
	% of Internet-use enterprises		
Regular dial-up line using a standard modem	59.6	46.8	36.6
High-speed (Cable, DSL/ISDN lines, T1 line or greater)	34.7	48.4	58.4

Note: High-speed includes the more expensive T1 lines. While not widely used by businesses in total (4.6% in 2002), T1 lines serve as an important access method, particularly among large firms with the need for a high capacity Internet service. Although penetration is low, the higher capacity of these lines means that they can be expected to carry a large share of total Internet business traffic.

Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2000-2002.

3.4 Broadband use varies widely across industries

Overall, most private sector enterprises using the Internet do so through broadband (58.4%). In fact, in 14 of 19 industries studied in 2002, most firms used broadband technology (Chart 1). This represents a considerable increase from only one year earlier when less than half of private sector firms used broadband (48.4%).

The Information and Cultural Industries continue to be the leading sector in broadband penetration (85.7%). This is consistent with the observation that information and cultural industries have emerged as leaders of other types of information and communications technologies (ICTs) in Canada, including personal computers, websites and Internet use in general (Statistics Canada 2001).

This sector consists largely of publishing industries, including software publishers, motion picture and sound recording, broadcasting, information services and data processing, but also includes telecommunications and Internet service providers (Statistics Canada 1998). Perhaps not surprisingly, information and cultural industries are also leaders in the use of high capacity broadband services (20.2% use a T1 connection or greater) and have the highest proportion of enterprises involved in more advanced e-business applications such as online purchasing (59.9%). They are also leaders in online sales (18.8% of firms), second only to private sector Educational Services (21.3%).

Other broadband leaders include Utilities, Finance and Insurance, and Professional, Scientific and Technical Services. Strong penetration in the Finance and Insurance industries is expected, since they are one of the more Internet-intensive industries internationally (OECD 2002b)[6].

6 -- Also, some financial institutions may have already established their own closed proprietary networks that are not captured in the existing survey.

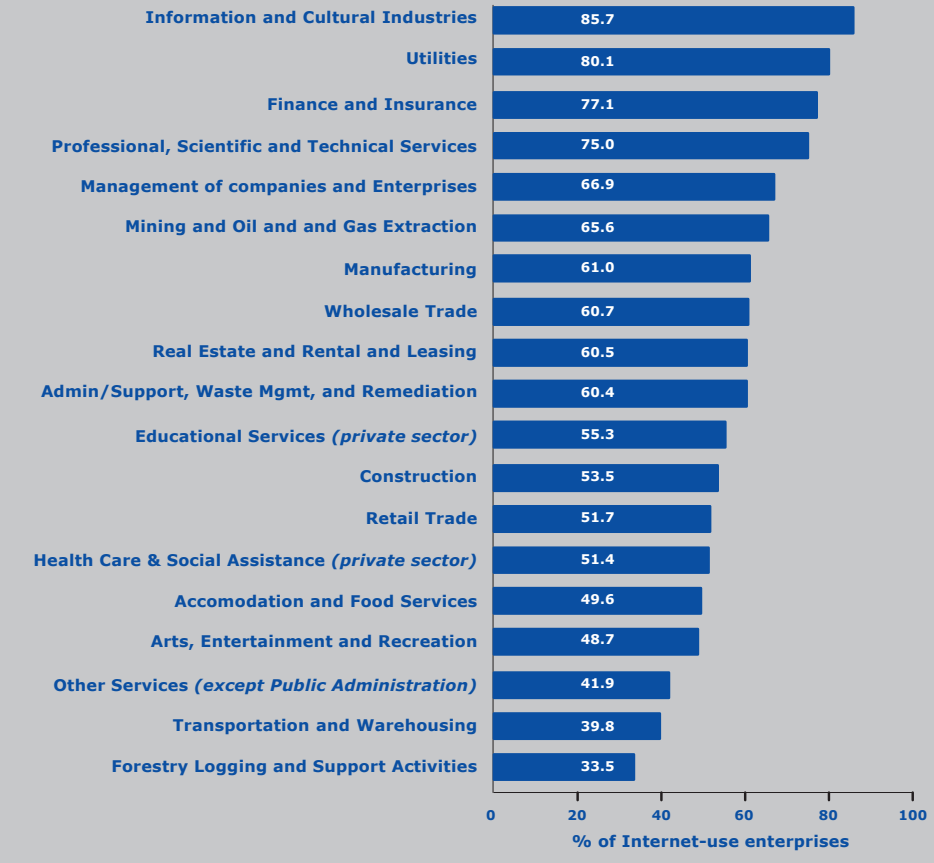

Chart 1.
Percentage of private sector enterprises accessing the Internet through broadband, by industry, 2002

Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2000-2002.

Industries falling clearly behind in broadband penetration include Forestry Logging and Support Activities, and Transportation and Warehousing. Firms in these industries may be less likely to use broadband due to a range of perceived barriers to broadband or Internet use generally. For instance, a slightly higher proportion of firms in Forestry Logging and Support Activities felt that their goods did not lend themselves to Internet transactions (56.3% of Internet users who do not use e-commerce) than the rest of the private sector (48.7%). In addition, some of these firms operate in remote locations not served by broadband. Almost twice as many respondents in the Forestry industry (9.6%) stated that the Internet available to them was too slow, than in the rest of the private sector (5.8%).

In some respects, industry patterns of broadband use reflect those of Internet penetration found in an earlier study (Charles, Ivis and Leduc 2002). However, it should be noted that some industries with high Internet penetration rates, such as private sector Educational Services (94.9%) and Arts Entertainment and Recreation (86.7%) registered low broadband penetration rates (55.3% and 48.7%, respectively) (Table 7). The reasons for this are not yet fully understood. While firms in these industries may use the Internet for a variety of reasons, the value of implementing broadband technology may not be perceived as being as important, or affordable, to their business. Conversely, an industry that ranks low in Internet use – Management of Companies and Enterprises (59.0%) ranks in the top group of broadband users, with 66.9% of those enterprises using broadband.

While the proportion of firms using the Internet in the Utilities sector remained largely unchanged, this sector experienced a marked increase in the percentage of firms using broadband in 2002 (80.1%, up from 55.6% in 2001). Other industries with notable increases in broadband penetration included Mining and Oil and Gas Extraction, and Arts, Entertainment and Recreation.

Table 7.
Comparison of Internet and broadband penetration by industry

	Use of Internet (% of all enterprises)		Use of broadband (% of Internet-use enterprises)	
Private sector industry	**2001**	**2002**	**2001**	**2002**
Information and Cultural Industries	92.9	96.7	81.5	85.7
Utilities	93.7	93.0	55.6	80.1
Finance and Insurance	82.0	78.5	71.5	77.1
Professional, Scientific and Technical Services	90.7	92.4	62.2	75.0
Management of Companies and Enterprises	63.1	59.0	52.7	66.9
Mining and Oil and Gas Extraction	77.6	81.8	40.4	65.6
Manufacturing	82.4	88.5	50.4	61.0
Wholesale Trade	81.7	86.0	46.2	60.7
Real Estate and Rental and Leasing	53.4	64.7	57.3	60.5
Admin. and Support, Waste Mgmt. and Remediation	80.0	73.1	49.2	60.4
Educational Services *(private sector)*	93.0	94.9	56.6	55.3
Construction	70.5	68.5	38.9	53.5
Retail Trade	65.2	72.1	40.9	51.7
Health Care and Social Assistance *(private sector)*	70.4	74.6	41.8	51.4
Accommodation and Food Services	48.0	58.1	41.1	49.6
Arts, Entertainment and Recreation	81.5	86.7	27.2	48.7
Other Services *(except Public Administration)*	58.6	67.6	41.1	41.9
Transportation and Warehousing	57.4	63.7	29.9	39.8
Forestry Logging and Support Activities[1]	68.2	64.3	19.4	33.5
Total private sector	**70.8**	**75.7**	**48.4**	**58.4**

[1] *Crop and animal production industries, fishing, hunting and trapping industries are excluding.*
Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2000-2002.

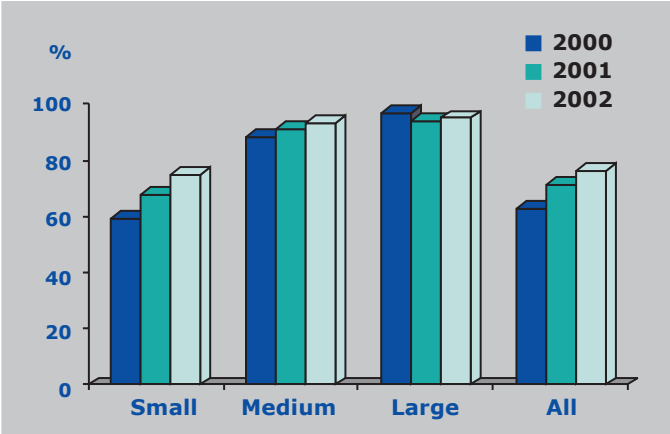

Chart 2.
Percentage of private sector enterprises connected to the Internet, by firm size, 2000-2002

Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2000-2002.

3.5 Broadband use highest among large firms

Additional analysis by enterprise size reveals a number of distinct patterns. While historically there exists an identifiable gap between small, medium and large size firms in basic Internet connectivity (Chart 2), this gap appears to be magnified with respect to broadband connectivity (Chart 3).

Medium and large firms have high levels of basic Internet connectivity but the proportion of medium-size firms using broadband is substantially lower than that of large firms. The data show, however, that as of 2002 this gap began to narrow considerably. While the proportion of large firms using broadband appears to have leveled, small and medium-size enterprises (SMEs) are still very much in the process of developing their broadband use.

Further insights are obtained when industry and firm-size analyses are combined (Chart 4). Among the leading industries in broadband penetration, firm size does not seem to matter as much as in other industries. SMEs in these leading industries display penetration rates not much lower than those of the large firms. This, however, cannot be interpreted as a general finding that industry matters more than firm size. Looking across all industries, it is evident that broadband penetration among large firms is rather comparable, but sizeable gaps between SMEs exist.

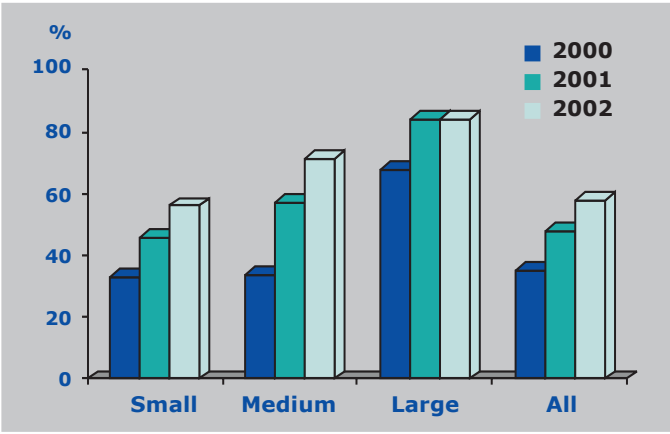

Chart 3.
Percentage of private sector enterprises accessing the Internet through broadband, by firm size, 2000-2002

Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2000-2002.

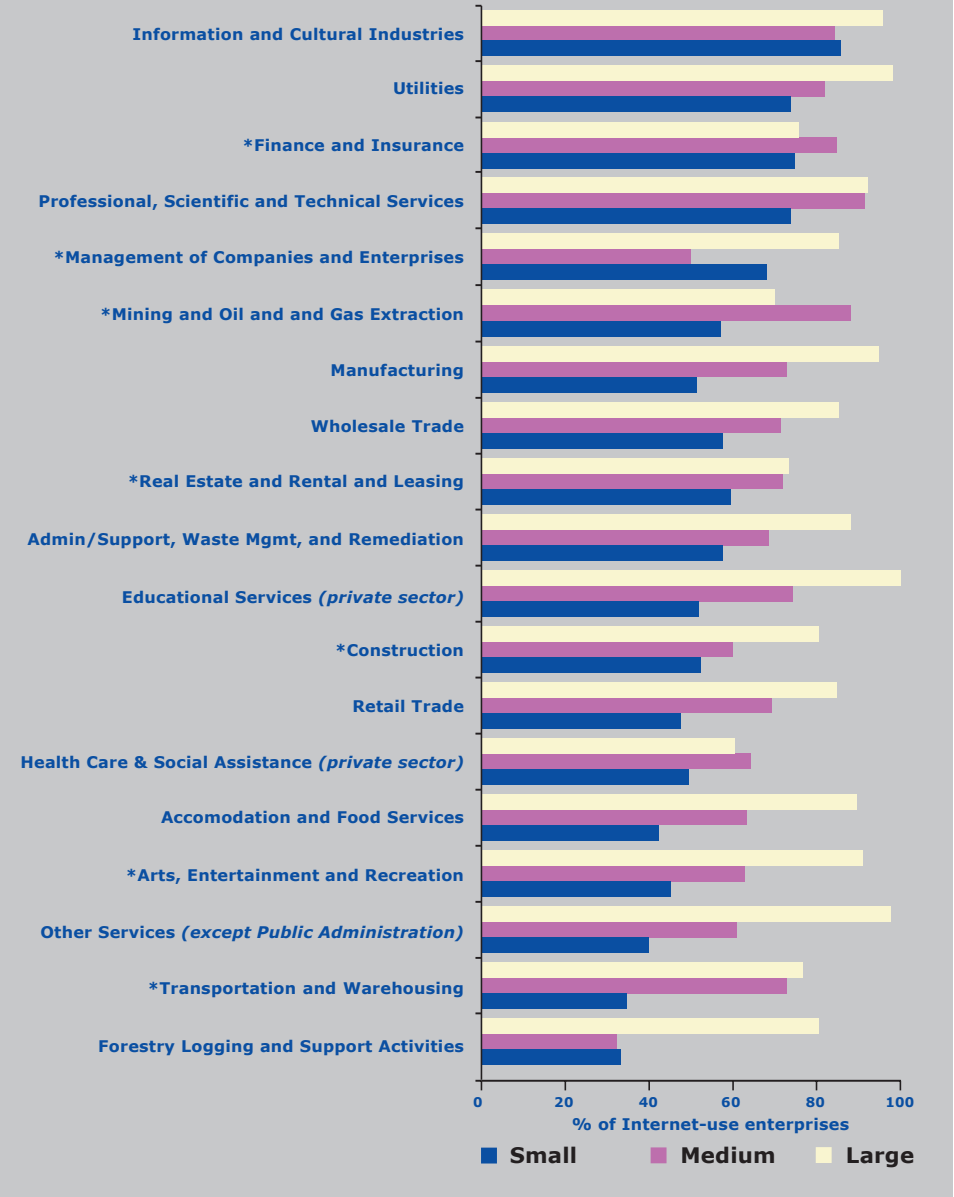

Chart 4.
Percentage of private sector enterprises accessing the Internet through broadband, by industry and firm size, 2002

**Lower reliability estimates due to sample size.*

Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2000-2002.

A case in point is the Manufacturing industries. Here, broadband penetration rates among large firms (94.8%) are on par with those of large enterprises in the Information and Cultural Industries (95.9%). However, while small firms in the Information and Cultural Industries also show high rates of broadband use (85.5%), this rate is substantially lower for small Manufacturing firms (51.3%). This disparity accounts largely for the overall differences observed between the two industries.

From an international perspective, access to the Internet, regardless of mode of connection, is also highest for larger enterprises (OECD 2002b). These findings underscore the fact that, in terms of basic broadband connectivity, it is within SMEs that Canadian business has perhaps the most room to grow.

Some of the factors that help explain lower broadband penetration among SMEs, aside from cost, may include a general uncertainty about benefits, or skepticism toward the productivity claims of those marketing broadband. One of the anticipated efficiencies of broadband is that it will link SMEs more effectively into business supply chains. While immediate payoffs may be realized in the wider industry, it

has been noted that SMEs may observe returns indirectly and over a longer time frame (Broadband Advisory Group 2003).

Another challenge facing SMEs is, quite simply, that high-speed Internet access may not be available to them. Although the majority (86%) of Canadians live in areas where broadband is available, many communities, mostly smaller ones, are currently not served by broadband network providers (Industry Canada 2003). Availability is an issue that confronts small enterprises more often than large ones, since enterprises located in remote locations are typically smaller in nature.

Those SMEs operating in rural or remote locations may also face higher access costs, competition from larger networked corporations offering direct-to-consumer online services, and the loss of human resources as workers leave in the face of declining economies (Community Information Technology Institute 2001). However, at the same time as increased competition for their traditional local markets presents a challenge, rural SME operators may also view broadband as an opportunity to reach wider markets themselves.

Issues regarding broadband availability and deployment will be discussed in more detail in the sections that follow.

4. BROADBAND SUPPLY: TRENDS, ENABLERS AND DRIVERS

4.1 Suppliers of broadband services

Firms for which the provision of Internet access is the primary source of revenue can generally be classified into the Internet Service Providers (ISP) industry of the North American Industry Classification System (NAICS)[7]. For this reason, they will be referred to as "primary ISPs". Cable television companies provide access using cable modems, while DSL Internet access is a small but growing source of revenue for telephone companies. For these two industries, Internet access services represent part of their revenue but, by definition, is not the primary source.

An increasingly large share of primary ISPs' operating revenue is generated from the provision of broadband access services (38% in 2001, up from 26% in 2000). By contrast, the proportion of their revenue from narrowband access (dial-up) declined from 60% to 49% over the same period. Services other than the sale of Internet access, such as web site hosting, generally represent a smaller share of ISPs' revenue (13% in 2001) (Archibald 2003).

While the majority of business for the cable industry centres around cable television, much of the recent revenue growth is due to the introduction of broadband services. Growth of Internet by cable services contributed to the 8.8% revenue increase per subscriber that cable operators experienced between 2000 and 2001. In total, cable Internet accounted for 12% of the revenues of the systems offering them in 2001. Those companies that upgraded their networks to include broadband services, such as digital cable and Internet access, were also more competitive, generating 17% more revenue per subscriber than those cable operators not offering these services (Statistics Canada 2002).

Internet access services have also been the fastest growing market segment for the wireline telecommunications industry. The fact that operators had to turn to alternative sources of revenue in the face of declining long distance revenues and limited growth in local telephone services made investment in broadband upgrades particularly important (Statistics Canada 2003).

Although the broadband market is a competitive one, it is primarily served by incumbent facility-based cable and telephony carriers. While the CRTC has mandated both resale and third party access to cable and DSL facilities, alternative providers maintain a small market share of high-speed access subscriptions[8]. Incumbent cable and telephone

7 -- For detailed industry descriptions, see Statistics Canada (1998).

8 -- For more information regarding third-party access to DSL facilities and cable, consult CRTC Letter Decision (September 21, 2000), Order 2000-983 (October 27, 2000), and Telecom Decision CRTC 99-11 (September 14, 1999) (CRTC 2000, 1999).

companies already have a large, established infrastructure and this provides a competitive advantage – in 2001 they accounted for 84% of high-speed Internet market revenues (CRTC 2002). The concentration of market share is also illustrated by the fact that, in 2001, the four largest market participants accounted for 51% of all residential Internet subscribers (CRTC 2002). As well, among primary ISPs, 4% accounted for 79% of total operating revenues in 2001. The number of ISP firms is also declining as a result of competition and mergers (Archibald 2003).

In light of fierce competition, and in conjunction with the infrastructure required to provide Internet services, the concentration of large firms in the Internet access market is not surprising.

4.2 Upgrading to broadband infrastructure

Firms that offer broadband invest heavily in infrastructure upgrades and equipment. For cable systems, existing cable, designed for one-way delivery of television programming, is upgraded to a hybrid fiber coaxial (HFC) network. Fiber optic cable (which carries signals using light instead of electricity) is installed in place of traditional co-axial cable to feed into "nodes", which serve different neighbourhoods or localized areas (CSTB 2002). Within these areas the network is divided into a series of smaller, upgraded coaxial segments which run to the homes. Throughout the system, one-way signal amplifiers are removed and replaced by two-way units that can handle data going in both directions (Kruger and Gilroy 2001). These changes provide both higher performance and the 2-way communications capacity necessary for broadband. In order for the system to function cable companies must also install additional equipment, including a cable modem termination system (CMTS) at the head end, while the user requires a cable modem to gain access (CSTB 2002).

Similarly, telephone companies offering DSL do so by upgrading the existing twisted copper pairs. These wires are made capable of carrying broadband through the advanced coding of DSL systems. In fact, ADSL ("asymmetric DSL") can provide broadband Internet using the same wire used to provide regular telephone service. A new piece of equipment called a DSL access multiplexer (DSLAM) is installed, which works by pulling upstream data off the wire before it gets discarded by existing telephone voice circuits, and also adds downstream data at frequencies above the traditional voice signal. This means that telephone and Internet service are available simultaneously. DSL can carry data at speeds of about 1.5 Mbps, a capacity much higher than traditional voice or dial-up service, for a distance up to 5.5 km (18,000 feet) (TSACC 2001). Higher rates can also be carried over shorter distances.

Most of the costs associated with the upgrading of the infrastructure consist of "fixed" costs. These are sometimes also referred to as the "dollars-per-mile" costs of installation, and are particularly significant given the cost of labour and access to right-of-way, especially where infrastructure must be buried (CSTB 2002). "Variable" costs vary with the number of subscribers. Some examples include additional equipment and installation costs at individual customer premises, and customer support and maintenance (CSTB 2002).

Although it is currently not possible to produce reliable estimates of the money invested specifically for broadband upgrades, it is possible to measure the extent to which these upgrades have been completed.

These upgrades have translated into improved availability of broadband, at least in the areas already served by cable. By 2001, 84.6% of homes passed by cable (9.4 million homes) had access to broadband Internet. By comparison, 66.0% of homes passed by cable in the United States had access to high-speed Internet by cable in 2001 (Statistics Canada 2002).

Internet access is only one of a suite of broadband services, including digital set-top boxes, digital television, pay-per-view or video-on-demand, and cable telephony that can potentially be offered as a result of these upgrades.

Table 8.
Completion of upgrades necessary to offer Internet by cable, by community size

Homes with access to Internet by cable as a percentage of homes with access to cable	2000	2001	% change 00/01
Large communities	85.7	96.1	12.2
Medium-size communities	47.3	77.6	64.3
Small communities	10.8	27.0	150.9
Total	**69.8**	**84.6**	**21.1**

Note: Data reported in this table are as of year-end August 31.
Source: Statistics Canada (2002) "Broadcasting and Telecommunications Service Bulletin, Cable, Satellite and Multipoint Distribution Systems, 2001", Catalogue No. 56-001-XIE, Vol. 32 No. 3, November 2002.

In Canada, differences in upgrades by community size are worth noting. For instance, while the upgrades necessary to offer broadband services were completed in 96.1% of large communities (CMAs) by 2001, this service was available in only 27.0% of small communities (defined as Census Divisions located outside CMAs or CAs) (Table 8). This, however, represents a considerable improvement from 2000 when network upgrades to offer broadband by cable were completed in only 10.8% of small communities. Further, the rate at which upgrades are occurring in small communities is increasing relative to that in large communities, where availability is nearly complete.

It is estimated that by 2001, approximately 70% of all telephone lines in Canada were DSL-enabled, with DSL service available in a total of 860 Canadian communities (ITU 2003).

For those areas not served by cable or DSL there is a different set of challenges for broadband deployment. Geographical factors such as population density and dispersion can substantially drive up the cost of cable Internet deployment in rural areas, largely due to dollars-per-mile construction costs. Other broadband access technologies, including satellite and wireless methods, may be more attractive options due to their lower costs to serve subscribers in areas with low subscriber densities (rural and remote communities) (CSTB 2002) and reduced problems associated with right-of-way management. However, choices about particular technologies are not likely to be uniform in nature but will reflect a variety of economic and geographic factors in rural areas. Challenges to broadband deployment in these areas are discussed in more detail in the next section of this paper.

4.3 Broadband availability

Although Canadians have emerged as world leaders in broadband use and a majority of the population lives in areas where broadband access services are already available, significant challenges remain with respect to deployment in rural and remote areas.

Broadband availability is heavily concentrated in urban areas of Canada. According to the latest data collected in the context of Industry Canada's Broadband for Rural and Northern Development Pilot program (Industry Canada 2003), access to high-speed Internet via DSL and/or cable modem services was available in some 1,525 communities, representing about 86% of the Canadian population and 28% of Canadian communities. As discussed, these areas are home to most Canadians, yet 72% of Canadian communities, located mostly in rural and remote areas, do not yet have broadband services available.

The cost of providing broadband services in these areas is typically higher than in urban areas. Given a smaller customer base and the fact that customers are dispersed over greater distances, building the infrastructure needed to provide broadband services often does not make economic sense for broadband providers. This is illustrated by the fact that cable Internet providers, for example, have completed the upgrades necessary to offer high-speed Internet by cable in nearly all large communities, but in only a fraction (27%) of small communities (Statistics Canada 2002). Telephone penetration is almost universal, meaning DSL services are an option in some rural areas, but their deployment also faces an important technical limitation. While utilizing existing twisted copper pair telephone wires, the additional equipment that is installed to carry DSL signals only allows the signal to travel up to 5.5 km (18,000 feet) from the telephone company's central office switch for ADSL services, depending on the condition of the wires, and even shorter distances for higher bandwidth DSL services.

For these reasons, wireless broadband delivered by satellite or terrestrial systems, may present an attractive option in rural and remote areas. Despite very high initial deployment costs, satellite is not constrained by "dollars-per-mile" costs of installation (CSTB 2002). However, market penetration is not yet material, in large part because satellite providers are recent market entrants, and prices are relatively high for many consumers. Further, many offerings currently provide only 1-way access, meaning that a dial-up connection is necessary for return signals (CRTC 2002).

A variety of models are explored to accelerate broadband deployment, making use of varying arrangements of public and private funding (ITU 2003, CRTC 2002). Two of the broad strategies underlying these models include "infrastructure support", where incentives are offered to broadband providers to expand service, and "community aggregation", where demand is pooled among various groups that could potentially benefit from broadband services (NBTF 2001, ITU 2003). For more, see Box 3.

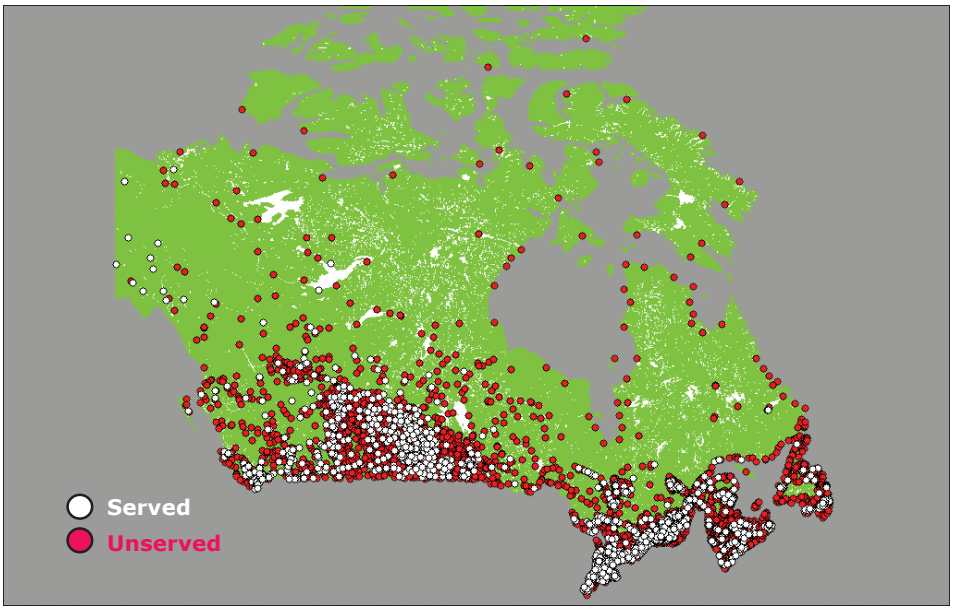

Figure 1.
Geographic distribution of served and unserved communities, July 2003

Note: Information on communities is based on conglomerations of dissemination areas as defined by Statistics Canada, with a naming convention based on postal codes. The data come from the 2001 Census. For further information, please refer to http://broadband.gc.ca

Source: Industry Canada 2003.

Box 3:
Promoting Broadband Deployment in Rural and Remote Areas

Numerous federal, provincial/territorial and municipal initiatives have sprung up to promote broadband deployment. At the federal level, Industry Canada's Broadband for Rural and Northern Development Pilot Program is targeted to unserved communities by matching grants to fund infrastructure provision and the stimulation of private sector investment.

Examples of initiatives which have relied on public funds include: British Columbia's SPAN/BC (Shared Provincial Access Network) that opens up a provincial network once used exclusively for public sector traffic to communities unlikely to be served by private networks in many locations, including towns and educational institutions (SCBC 2002); Alberta's SuperNet, a partnership between the provincial government and private sector firms to link schools, libraries, health care facilities and government offices in many communities; Saskatchewan's CommunityNet, a partnership between the provincial government and the private sector to provide broadband service to public sector institutions in many communities; Manitoba's 'Rural and Northern Telecommunications Infrastructure' and 'High-Speed Internet Access for Public Institutions' programs; Ontario's 'Rural Economic Development' (RED) and 'Connect Ontario: Broadband Regional Access (COBRA)' programs; Quebec's 'Villages branchés du Québec' program to deploy broadband network infrastructure to schools and municipalities. Prince Edward Island has also established a provincial broadband network, while New Brunswick created a deployment strategy called 'eNB.ca', investing in government services and business transactions over the Internet and aiming to upgrade most schools and colleges to broadband by 2003.

In addition to directly funding or subsidizing the deployment of broadband infrastructure, public funds have also been used to support the development of new broadband applications and online content, and to offer tax credits for research and development among equipment manufacturers in Canada (CRTC 2002).

In some cases, service providers and groups of individuals have also banded together to create affordable access independent of public funding. This may happen when groups such as members of municipalities, school boards, or condominiums, for example, determine that building their own private broadband network is cheaper than purchasing services from a private provider. This can be achieved in part due to the emergence of relatively inexpensive networking equipment and the ability to "piggyback" on to existing fibre builds (which often contain unused fibre that is available for purchase or lease at attractive rates) (CRTC 2002). Other groups of individuals are forming cooperatives, using short-range wireless networking ("Wi-Fi") in unregulated spectrum frequencies to share Internet access (CRTC 2002).

Although there remain a significant number of communities unserved by broadband throughout Canada, the variety of approaches currently being applied to deploy broadband technologies offer encouragement that communities will often have, at the very least, some choice about the means of provisioning access. As evidenced by the range of programs already in place, the future directions of broadband technologies and the means of funding their deployment are not likely to be uniform in nature, but will instead reflect a variety of economic and geographic factors in rural and remote areas.

5. KEY FINDINGS AND FUTURE WORK

Canadians have emerged as global leaders in broadband adoption. Nearly half of all regular home Internet users already have a broadband connection. Within Canada, the incidence of broadband use tends to increase as one moves from east to west. The rate of adoption of these technologies, primarily delivered by cable and DSL, continues to grow at a rapid pace while the door to other broadband platforms in future remains open.

Canadian businesses are also taking advantage of broadband. The potential of these technologies, particularly in terms of business efficiency, is reinforced by the fact that broadband has emerged as a standard business tool among large enterprises throughout the private sector. The pattern among small and medium-size firms is less consistent. They have substantially lower rates of adoption, although there is some evidence to suggest that small and medium firms are "catching up". The ways in which barriers to broadband use among small firms (and indeed, all firms) are perceived are not fully known and require further study. Casting the perceived barriers and benefits of broadband use against those of Internet use generally could provide an interesting comparison.

Distinct sectoral patterns of broadband use have also emerged. While there are some explanations underpinning the patterns of broadband use across sectors (for example, the perception that goods in some sectors do not lend themselves to Internet transactions), there are also some complexities that warrant further attention. For example, why have some sectors that are not among the traditional leaders in Internet use embraced broadband technologies? To what extent does awareness of broadband and associated applications vary among business users?

Overall, the findings of this study suggest that Canada has made considerable progress in broadband connectedness. The biggest challenge, however, perhaps remains. Those areas that are most likely to be served by broadband – markets with dense population clusters and access to existing cable infrastructure or located in close proximity to telephone company central offices – are for the most part, already served. Indeed, while the majority of the *population* has access to broadband, measured a different way, only a minority of *communities* is within reach of these services. Canada's unique geography therefore plays an important role in efforts to connect all communities to broadband technologies.

The variety of locations, distances, population densities, existing infrastructure, availability of public support, and specific community needs are all factors to be taken into account when deciding upon broadband deployment in unserved areas. Further examination of the variety of approaches that have been applied – successfully or otherwise – to deploy broadband technologies would be of benefit to those who currently do not have access.

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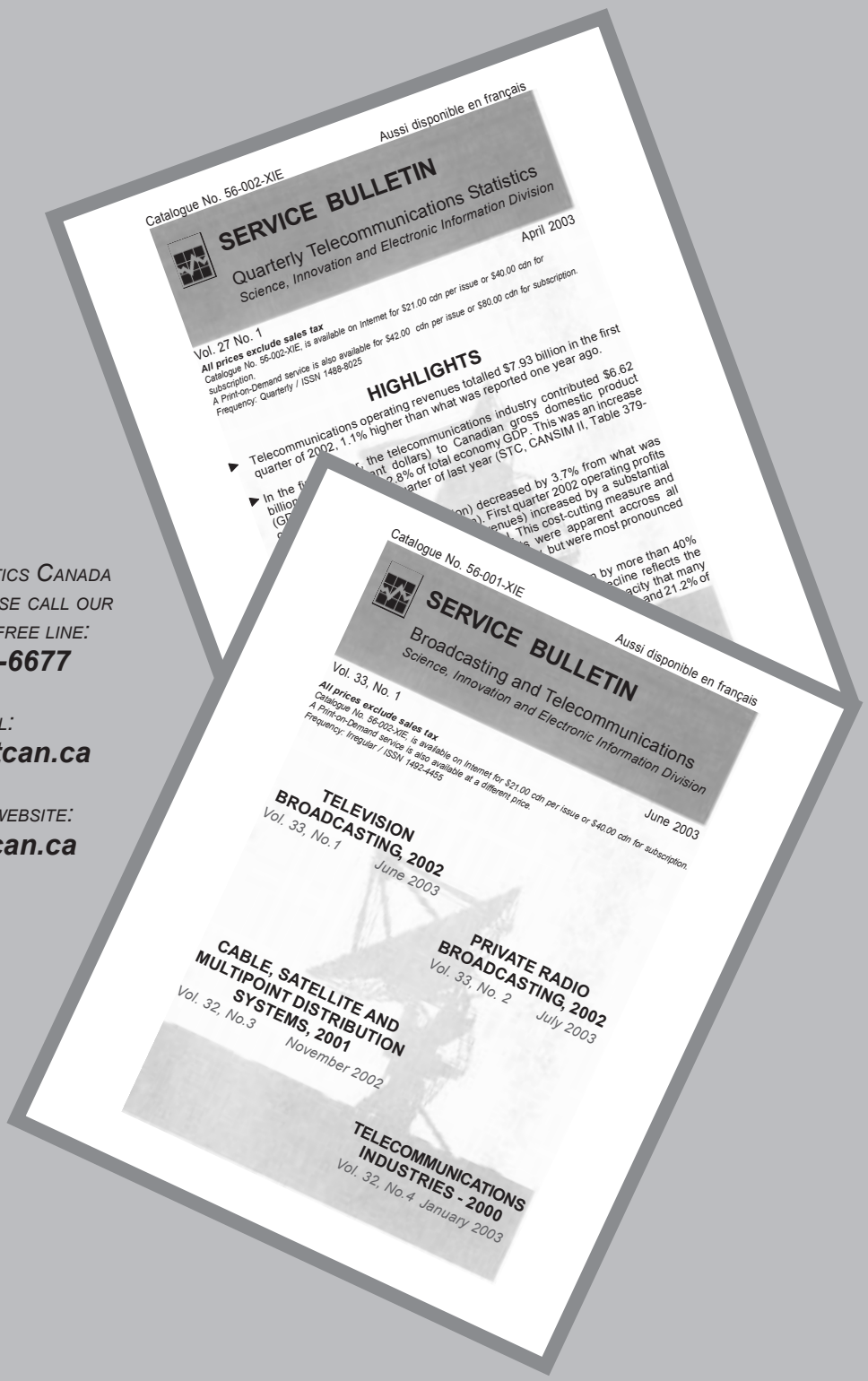

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