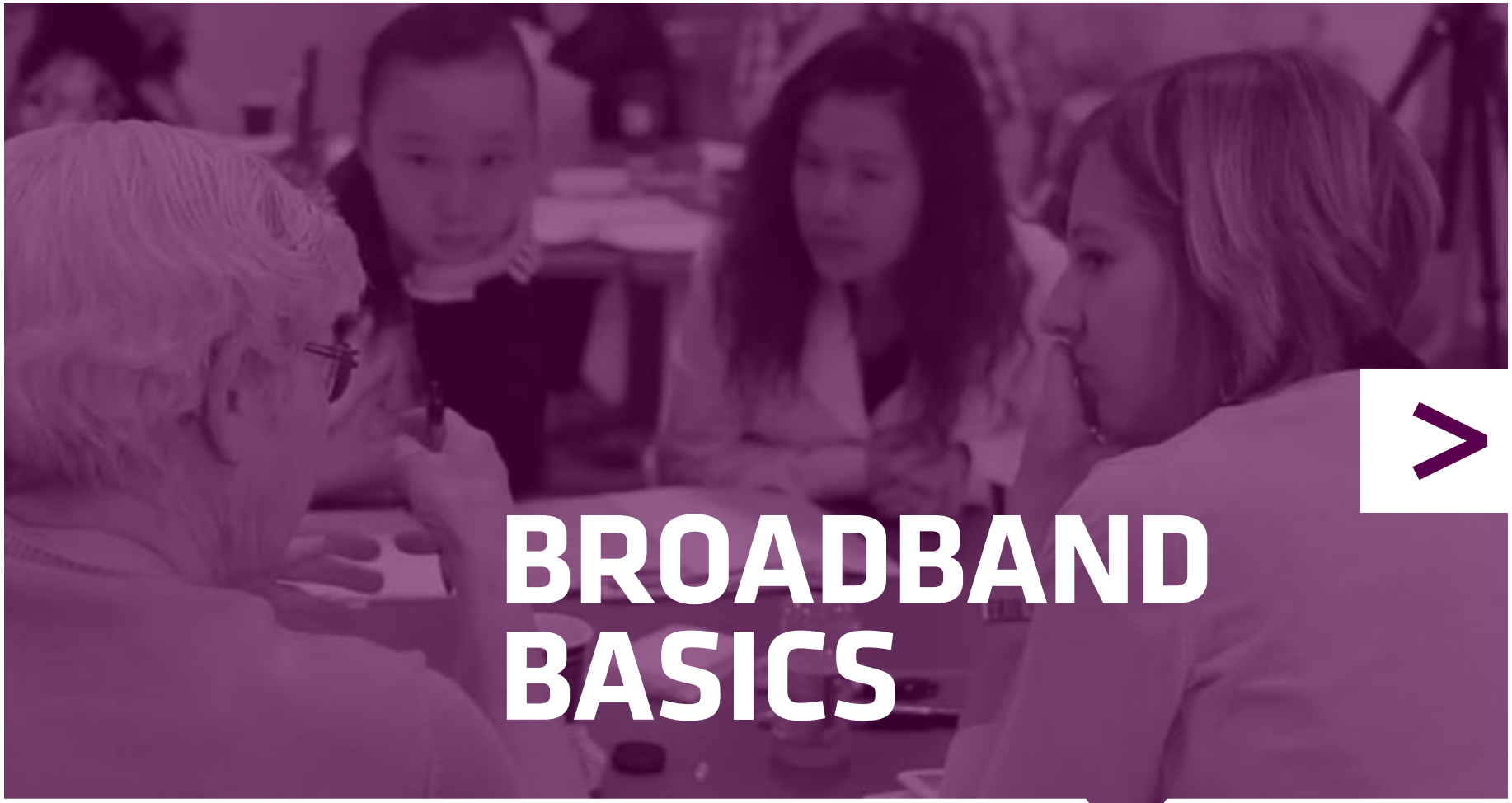

# BROADBAND BASICS

Centre for Public Involvement

Alberta Government

# BROADBAND BASICS

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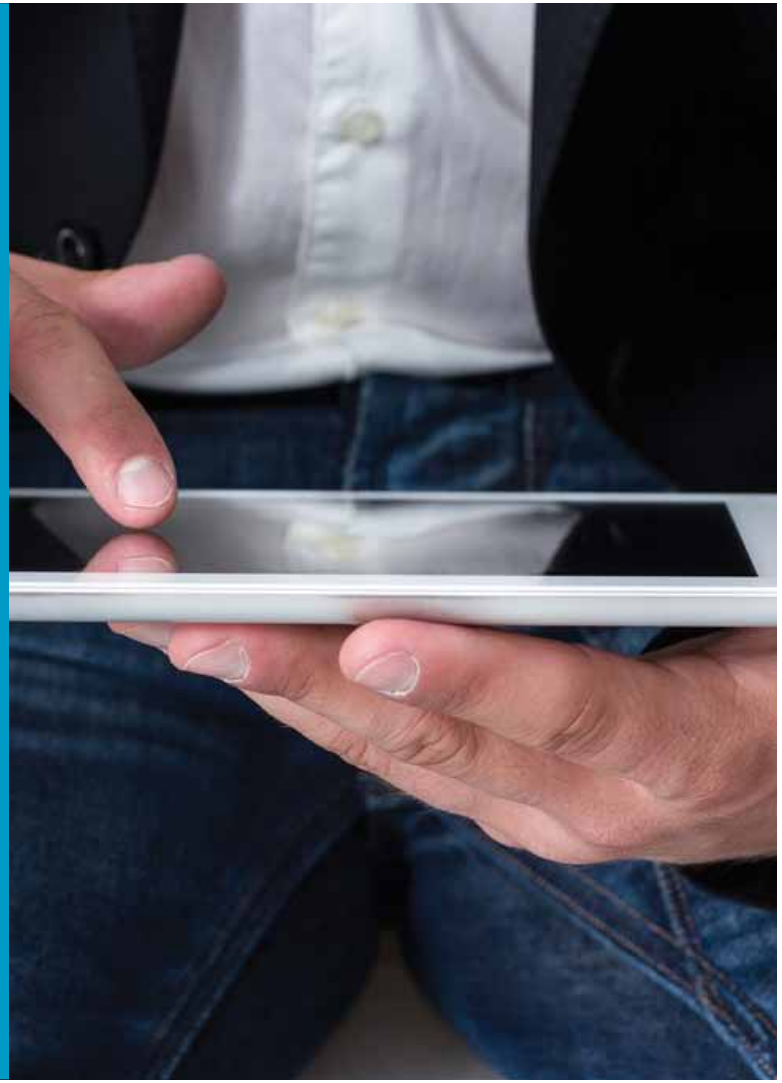


# 1 GLOSSARY

## BANDWIDTH/SPEED:

These two terms are often used interchangeably when discussing internet connections. They refer to the capacity of these connections to carry data, which can be specified in bits per second (bps). Strictly speaking, there is more than bandwidth that determines the speed you experience online (see Latency below), but when downloading large files, the speed at which you finish the download will depend on the number of bits in the file and the bps of your connection. It is common to distinguish between downstream and upstream bandwidth (or speed), as these two are usually not the same (see Symmetric/Asymmetric Bandwidth below). Bandwidth was previously measured in Kilobits per second (Kbps). Each Kilobit is equal to 1,000 bits. Dial-up connections are capable of 56 Kbps.

With faster speeds, it is now common to measure of bandwidth or speed in Megabits per second (Mbps). 1 Mbps = 1,000,000 bps.

The fastest internet connections are measured in Gigabits. 1 Gigabit (Gbps) = 1,000,000,000 bps or 1,000 Mbps.

To put these speeds in perspective, the chart below shows average bandwidth requirements for a number of common online services, as tested by the CRTC.

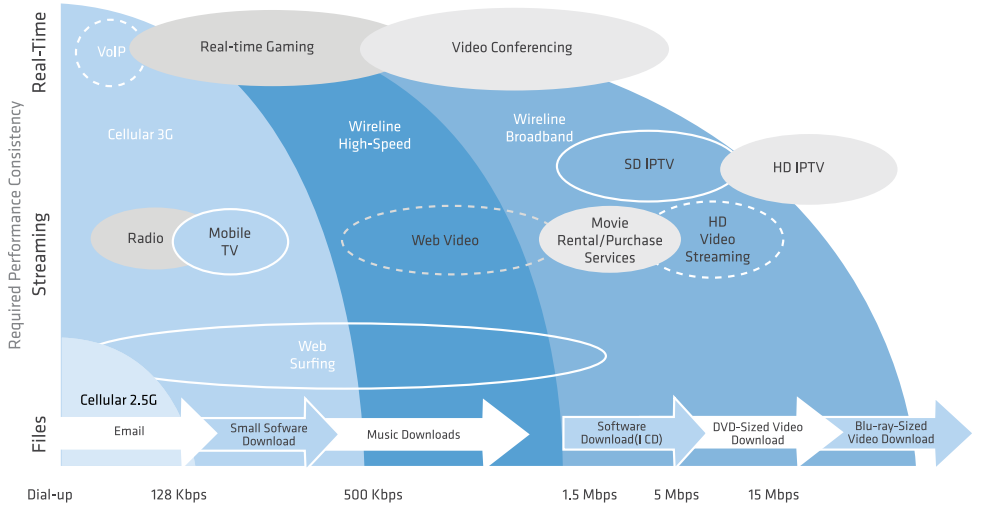



**Table 1. Internet applications - bandwidth requirements[1]**

**BITS AND BYTES (MB, GB, MB, GB):** Bits are the base unit of information in computing, represented as 1s and 0s. The prefixes kilo-, mega-, and giga- refer to to multiples of one thousand (kilo), one million (mega), and one billion (giga) bits.

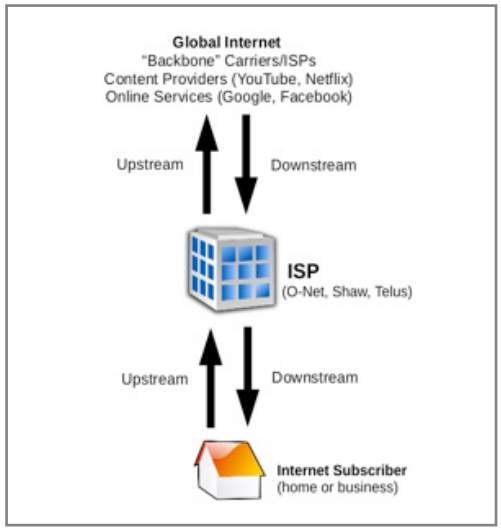
Bytes are units of 8 bits,[2] so that 8 megabits (Mb) = 1 megabyte (MB), and 8 gigabits (Gb) = 1 gigabyte (GB). Bits are normally used to measure bandwidth (bits per second), while bytes are used to measure data storage, file size and data caps.

# GLOSSARY

**BROADBAND:** Broadband refers in general to high-capacity internet connectivity, or high-speed internet. In the past, broadband was used to describe cable and DSL connections to distinguish these from slower dial-up internet. Today, broadband can also refer to high-speed wireless and fibre-optic connections. There is no agreement on what specific speeds qualify as broadband. In Canada the government has long treated 1.5Mbps or higher as broadband, but today this is a relatively slow speed and is not enough to support some broadband applications.

**CLOUD:** Files and services that can be accessed remotely through the internet. Examples include Google Apps, Dropbox, or a hard drive at home that can be remotely accessed over the internet.

**DOWNSTREAM/UPSTREAM, DOWNLOAD/UPLOAD:** If you can imagine the internet as a stream of data flowing towards you from its source, then this is data flowing downstream. The networks and organizations upstream from you, like your internet service provider, can control this flow. When you pull data from the internet, you are downloading. Uploading happens when you take a file from your computer and send it upstream to somewhere on the internet.




Internet "traffic" (content or data) flows downstream to the endpoints – to an individual home, business, or smartphone. When you "stream" a video from the internet, the video's source is upstream from you. Upstream from all of us is an internet service provider (ISPs) to whom we subscribe for internet access. But this ISP must also purchase its own upstream connectivity from "backbone" ISPs or "carriers" that can reach the rest of the world.

What is important from all of this is that local networks connected to the internet, like a home network or a municipal network, are dependent on what happens upstream. Internet speeds at the endpoints depend on what is available upstream from the ISPs providing bandwidth. Small ISPs also depend on the access they receive from larger ISPs upstream. It may be possible to lessen this dependence by connecting to multiple sources upstream, or to connect to an internet exchange where networks are able to exchange traffic directly. These options are not often available in rural Canada.

**INTERNET:** The internet is a network of networks distributed around the globe. It allows different kinds of devices and networks to communicate with one another by speaking a shared language. Ideally, any two endpoints connected to the internet can find each other

and communicate. This keeps the internet quite "flat" - there is no central point of control, and communication happens "horizontally". However, it is important to remember that the internet operates through a physical infrastructure of cables and wireless links. This infrastructure is owned by large companies connecting to one another, and so large volumes of traffic flow along a limited number of paths that connect one ISP to another. This gives broadband a "vertical" dimension (see **Downstream/Upstream**).

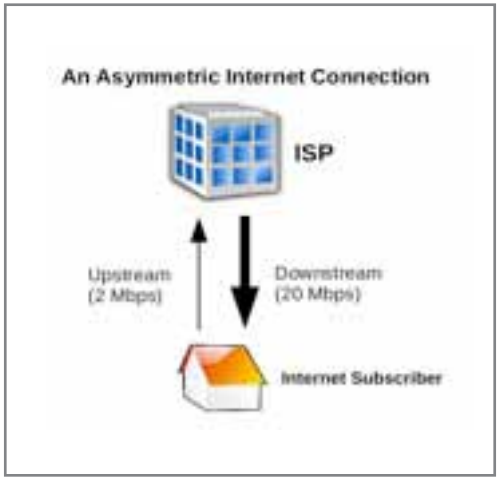
**ISP (INTERNET SERVICE PROVIDER)**: This term is used to refer to companies and organizations that provide access to the internet, typically on a subscription basis. Major Canadian ISPs include Telus, Shaw, Bell, and Rogers.

**LAST MILE:** The part of the broadband network that connects to a subscriber's home or premises. This may be a wire link, copper telephone or cable link, wireless, or fibre-optic.

**LATENCY:** While bandwidth is the most common measure of internet speed, latency can also be important. Latency refers to the time delay between two points on the internet communicating with one another. High latency can be a problem for some applications. Voice conversations become challenging with even a small time delay, and game performance suffers as well. Latency is measured in milliseconds (ms).

**SERVER:** A computer or computer system that you can connect to over the internet. The server answers your "requests", like when you ask to watch a video or download a file that is located on the server.

**SYMMETRIC/ASYMMETRIC (BANDWIDTH):** With symmetric bandwidth, both upstream and downstream bandwidth are about the same. However, most internet connections are asymmetric, meaning that there is more downstream bandwidth available than upstream. For many users this is not a problem, since subscribers typically download much more than they upload. However, businesses in particular need significant upstream bandwidth. Limited upstream bandwidth is a problem when using "cloud" infrastructure, uploading videos, and providing web-based services. Asymmetric connections are common with cable and DSL technologies. Fibre has the advantage of making symmetric bandwidth possible.



# 2 WHY SPEED MATTERS

In the 1990s, a dial-up internet connection was enough to make effective use of the internet. Some subscribers today still use dial-up (particularly in rural areas), but those speeds simply cannot support many internet applications, like video. Files take longer to download and upload on dial-up, and this means more time is spent waiting for web pages to load. As broadband connections became more common, new online services were developed to take advantage of these high-speed capabilities. First, in the early 2000s music services emerged like Napster and iTunes. More recently online video has become possible because of even faster connections. It is difficult to know exactly what uses will be found for the even higher speed connections offered by fibre, but the following table gives an idea of what is possible with greater bandwidth.

**Table 2. Applications for High-speed and Ultra High-speed Broadband[3]**

| | |
|---|---|
| 5 Mbps – 10 Mbps<br>(high-speed broadband) | Telecommuting<br>File Sharing (large)<br>Video Streaming (2-3 channels)<br>HD Video Downloading<br>Low Definition Telepresence<br>Gaming<br>Medical File Sharing (basic)<br>Remote Diagnosis (basic)<br>Remote Education<br>Building Control & Management |
| 10 Mbps – 100 Mbps | Telemedicine<br>Educational Services<br>HD Video Streaming<br>Gaming (complex)<br>Telecommuting (high quality video)<br>High Quality Telepresence<br>HD Surveillance<br>Smart/Intelligent Building Control |
| 100 Mbps – 1 Gbps<br>(ultra high-speed) | HD Telemedicine<br>Multiple Educational Services<br>Gaming (immersion)<br>Remote Server Services for Telecommuting |

# 3 BROADBAND TECHNOLOGIES

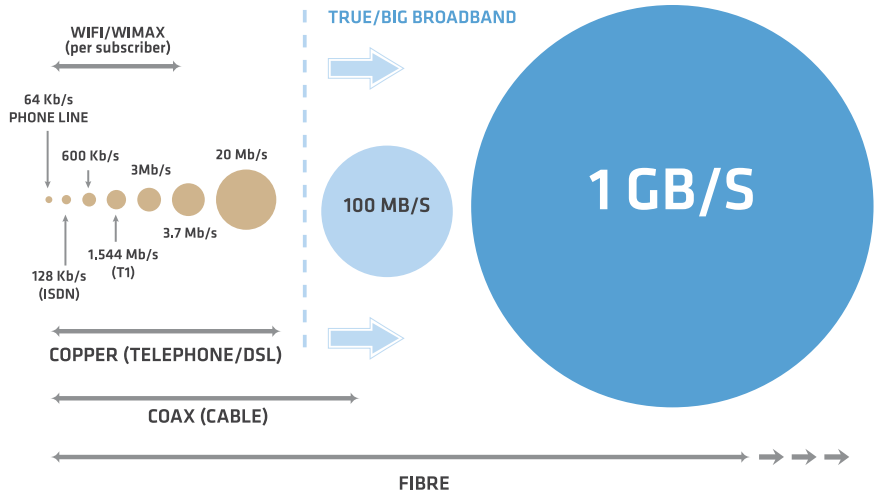
## (CABLE, DSL, FIBRE & FTTH, SATELLITE) AND THE "LAST MILE"

Broadband can be provided through many different kinds of technologies. These include more advanced mobile phone networks, such as LTE or 4G. However, with the exception of satellite and microwave links, all must rely on a wired network to reach into a subscriber's general area. These networks consist of fibre-optic cables. Fibre connects phone towers, cities, towns, and neighborhoods. However, fibre does not usually extend all the way to where a subscriber lives or works. This "last mile" is often covered through a copper infrastructure that was in place before the internet, and can also be bridged wirelessly. "Fixed" or wired broadband subscribers typically connect either through DSL, which uses the local telephone network, or through the local cable network (there is almost never more than one of each in a given area). Across Canada, there are now numerous projects that bring fibre directly, or as close as possible, to subscribers. These technologies are sometimes called Fibre to the Home (FTTH), Fibre to the Premises (FTTP), or Fibre to the Node/ Fibre to the Neighborhood (FTTN).[4] Fibre is promoted as the technology of the future, and one that is "future proof", since it is likely to meet growing bandwidth needs for decades to come.[5] However, running fibre directly to homes or premises is most affordable for neighborhoods and buildings under construction, and the costs involved have so far kept levels of deployment low. Major ISPs have been starting to deploy more fibre closer to subscribers, but the majority of these are FTTN networks which do not extend all the way[6] and are found in urban areas. Many rural parts of Canada will continue to lack access to this resource without alternate ways of funding the infrastructure, as Olds has done.

Because lower population density increases the cost of deploying wired infrastructure, wireless technologies are often assumed to be the preferred solution for rural connectivity.[7]

For especially remote communities, satellite broadband has been promoted as the solution. While the latest Canadian satellite can provide 25 Mbps downstream, it has been criticized for having limited upstream connectivity and high latency.[8] Satellite broadband will still leave rural subscribers at a disadvantage compared to urban areas.[9]

**Relative Bandwidth of Broadband Technologies[10]**



# 4 BROADBAND BY THE NUMBERS

In Canada, broadband service refers to download speeds of 1.5 Mbps or greater. The CRTC has established a universal broadband Internet access target download speed of 5 Mbps,[11] but there is no requirement for universal broadband access in Canada.

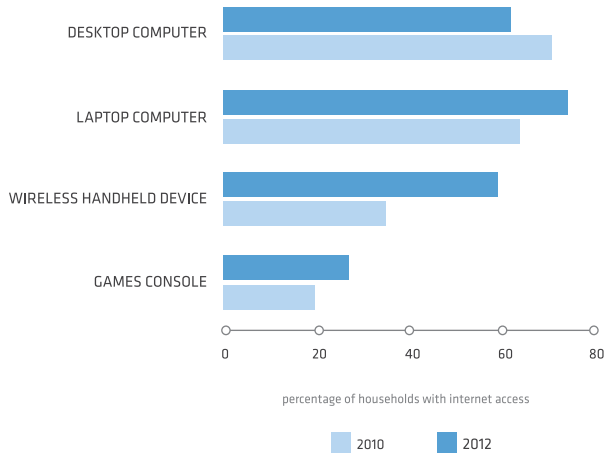
Statistics show that most Canadians have access to high-speed internet, but remote and rural areas face persistent challenges.

On the basis of some statistics, both Canada and Alberta rate highly in terms of broadband availability. According to OECD's international comparisons, Canada ranks favorably with other industrialized nations in terms of numbers of broadband subscriptions, broadband speeds, and broadband usage. Broadband prices in Canada are not remarkably higher or lower than other comparable nations, but Canada does stand out due to the prevalence of data caps[12] which impose fees for exceeding a set amount of data usage.

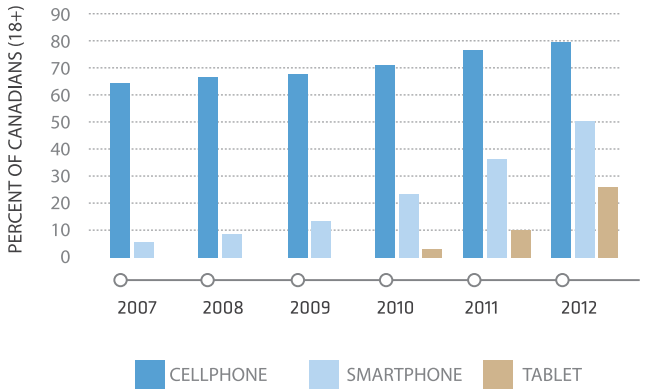
According to data from 2012, 99% of Albertans and Canadians have access to "fixed broadband" – meaning that they can subscribe to wired internet (excluding mobile subscriptions) at 1.5Mbps or higher. 94% of Canadian households have access to Internet download speeds of 5 Mbps or higher. Speeds of 25 to 100 Mbps are available to 80% in Canada and Alberta, and speeds of over 100 Mbps are available to 32% of Canadian households, but only 10% of rural households. While available to nearly everyone at a basic speed, fewer than 80% of Alberta and Canadian households actually subscribed to fixed broadband in 2012.[13] However, 83% of Canadians and 86% of Albertans report having internet access at home,[14] presumably at slower speeds or through a mobile subscription.

Wireless devices and Canadians' use of them have spreading been rapidly. Desktops and laptops remain popular, but the greatest increase has come in adoption of handheld wireless devices. Data to and from wireless (including mobile) devices is predicted to increase over the coming years, exceeding the amount of data to wired devices.[15] In 2012, half of Canadians over 18 had a smartphone, and a rapidly growing number were tablet owners. Alberta stands out as having the highest level of smartphone and tablet penetration in the country.

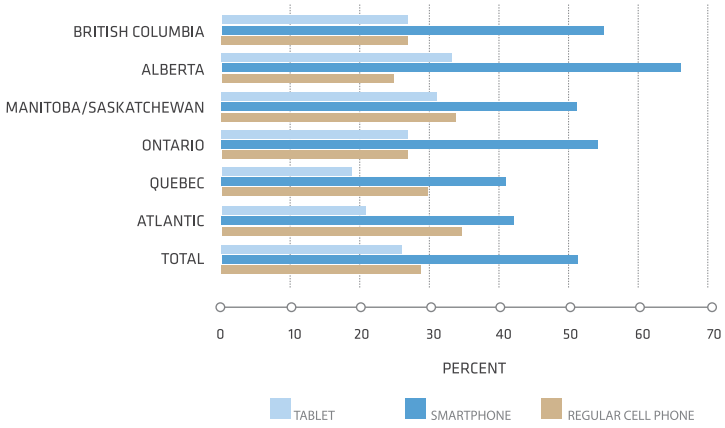
**Devices used to access the Internet[16]**



## Mobile Device Penetration[17]




## Mobile Device Penetration by Region[18]

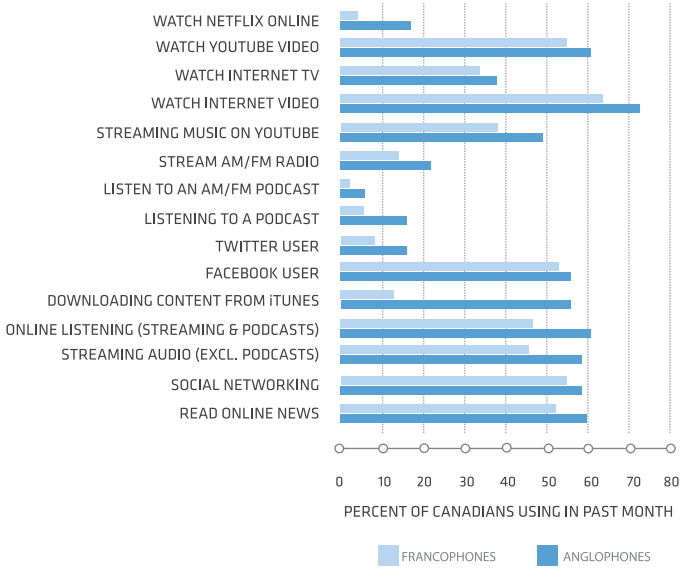



## How Canadians are using the internet

In 2012 the average amount of data downloaded per month by a residential subscriber in Canada was 28.4 GB, an increase of 56% from 2011. The average amount uploaded per residential subscriber was 5.4 GB, a 42.2% increase from 2011.[19] Around the world, video is driving increases in data usage,[20] and Canada is no exception. YouTube and Netflix have been developing higher-quality streams (which require higher bandwidth), and while today only a small percentage of Canadians watch TV entirely online,[21] the numbers are growing.

The tables below show the rates of common uses of the internet in Canada. There is some overlap and some difference between the first two tables, as they rely on different sets of data from 2012.

## Popular Internet Activities for Canadian Internet users[22]



# BROADBAND BY THE NUMBERS

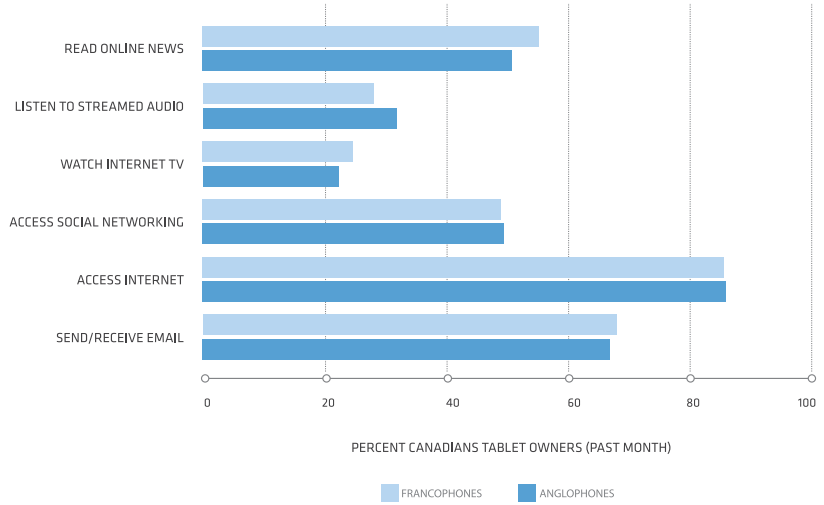
## Additional Popular Internet Activities for Canadian Internet users[23]

| | Internet Users % |
|---|---|
| E-mail | 93 |
| Window shopping or browsing for information on goods or services | 77 |
| Electronic banking (e.g., paying bills, viewing statements, transferring funds between accounts) | 72 |
| Reading or watching the news | 71 |
| Using social networking sites | 67 |
| Searching for medical or health-related information | 67 |
| Travel information or making travel arrangements | 66 |
| Visiting or interacting with government websites | 63 |
| Researching community events | 58 |
| Downloading or watching movies or video clips online | 54 |
| Obtaining or saving music (free or paid downloads) | 50 |
| Making telephone calls online | 43 |
| Using an instant messenger | 40 |
| Downloading or watching TV online | 39 |
| Listening to the radio online | 38 |
| Obtaining or saving software (free or paid downloads) | 38 |
| Formal education, training or school work | 37 |
| Searching for employment | 36 |
| Playing online games | 35 |
| Researching investments | 27 |
| Contributing content or participating in discussion groups (e.g., blogging, message boards, posting images) | 24 |
| Selling goods or services (e.g., through auction sites) | 23 |

As can be seen above, over three quarters of Canadian internet users browsed for goods and services, and nearly a quarter sold goods and services online in 2012. Additionally, it is worth noting that more than half of Canadian internet users (56%) ordered goods and services, with the value of these online purchases reaching $18.9 billion in 2012.[24] Canadians are steadily becoming more comfortable using the internet for banking (72%) and commercial transactions.

Internet use varies depending on the device that is used for access. The following table covers a number of common uses of tablets in Canada. Remember that more than 30% of Albertans have tablets – the highest rate in the country (see **Mobile Device Penetration by Region** above).

**Popular Internet and mobile activities for Canadian tablet owners[25]**




For a number of years statistics have been gathered on the amount of time Canadians spend online. The general trend has been one of greater and greater use the internet, although recently some of these numbers have stabilized.[26] However, these numbers are becoming less meaningful, and more difficult to compare across years as our definition of "online" changes. For many of us, internet-enabled devices are now embedded in our daily lives,[27] and it is becoming difficult to distinguish time spent online from time spent offline.[28]

In the future it is imagined we will carry a number of constantly connected or "always on" internet-enabled devices. Some of us already use our phones in this way. Is it possible to recall and add up the time we spend replying to online messages on our phones if we do it throughout the day? Does time online include cooking a meal while using an internet-enabled baby monitor? There may be reasons to be critical of how deeply embedded the internet is becoming in our daily lives, and in particular the approach of young people to being always connected. However, whether we think of this as use or dependence, the role of internet-connected devices in our lives seems set to continue increasing.

# 5 DIGITAL DIVIDES AND DIGITAL EXCLUSION

Since the early days of personal computers and internet access, an obvious issue has been the fact that some people are better able to take advantage of these digital resources than others. A lot has been written in the past twenty years about the so-called "digital divide" between the digital haves and have-nots. Over time, the cost of computers has decreased, mobile phones have become more powerful, and internet access is now more accessible (including through public sites such as libraries). But despite these lowered barriers, some inequalities have stuck around, and some people still feel excluded.

- Urban areas continue to be better served with more choices and faster speeds for internet access than rural areas.
- Younger individuals are more engaged with new technologies.[29]
- Skilled users of technology continue to have an advantage over those without these same skills.
- Price continues to affect those who cannot afford hardware and fees to access services.

As our society becomes more connected and dependent on electronic communication, the benefits of internet use increase. The internet can help overcome distance, access services and information, and lower everyday costs. These are advantages for internet users, and in comparison, non-users can be at a disadvantage.

When applying for a job, the applicant who carries out internet research in advance will have an advantage over the applicant who does not. A buyer or seller who can check prices online is better off than someone who cannot. This is a relative advantage, but more and more of the services that were once available offline have been moving entirely online. The disadvantage of not being able to effectively use these services can be a serious handicap. Some of us can take advantage of these technological opportunities, but others are excluded.

The lines of who is included and excluded follow already existing inequalities in society. This leads to a "vicious cycle", in which social exclusion creates digital exclusion, which can make social exclusion even worse.[30] The vicious cycle of digital exclusion means that some groups are excluded more than others: those who are poor, elderly, or lacking education. Rural Albertans have also felt that they are the "have nots" in terms of broadband access.[31]

However, we can counteract this cycle by working towards digital inclusion. This means that we don't ignore those who are excluded or unable to "connect" effectively – for whatever reason. Digital inclusion means working to help people and communities overcome these digital inequalities.[32]

# ACKNOWLEDGEMENTS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# ENDNOTES

1 CRTC, 2013, p. 174. http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm

2 Historically, and depending on context, the size of bytes, megabytes and gigabytes has varied. Provided is the most common definition.

3 Adapted from California Broadband Task Force, 2008, p. 12. http://www.cio.ca.gov/broadband/taskforcereport/

4 FTTN brings fibre close, but not all the way to a particular subscriber. This still leaves a "last mile" (or last hundred meters) that must be bridged with another technology.

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6 CRTC, 2013, p. 142. http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm

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8 Solomon, 2011. http://www.itworldcanada.com/article/broadband-satellite-for-rural-canada-launched/44901

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18 Media Technology Monitor [MTM] Fall 2012 survey, cited in CRTC, 2013, p. 197. http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm

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20 Cisco, 2013. http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

21 CRTC, 2013, p. 185. http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm

22 Media Technology Monitor [MTM] Fall 2012 survey, cited in CRTC, 2013, p. 186. http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm

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25 Media Technology Monitor [MTM] Fall 2012 survey, cited in CRTC, 2013, p. 198. http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm

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27 McEwen & Wellman, 2013; Rainie & Wellman, 2012.

28 See Fleming 2012. http://blogs.forrester.com/gina_sverdlov/12-10-17-for_consumers_being_online_is_becoming_a_fluid_concept

29 However, this gap has been shrinking, see CRTC, 2013, p. 186.

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