

# 5G IN CANADA

*In our modern, data-driven society, demand for mobile connectivity is increasing rapidly. Enter 5G, a new wireless communications technology that will not only make mobile phone communications faster, but promises to transform entire industries, such as healthcare and transportation, and improve the efficiency of businesses, from factories to farms. As this new technology begins to roll out, the policy considerations on a number of topics are receiving increasing public attention.*

## The next generation of wireless

5G stands for fifth generation wireless network technology. The first four generations of wireless networks progressed from analogue voice to digital voice to limited data, and eventually to the current 4G system that allows mobile users to talk, videoconference, browse the Internet, stream video, and use location-based services.

By 2021, there will be on average 3.5 Internet-connected devices per person, and wireless connections will make up 63 per cent of those.<sup>1</sup> 5G is enabling mobile networks that can provide higher speeds and more capacity than current networks.

5G aims to not only keep up with demand for current services, but to support new services and applications aimed at transforming industries such as transportation, health care, manufacturing, and robotics.

Like current mobile network technology, 5G uses radio waves to send digital information. Part of the increase in the speed and capacity of the new network will come from software and equipment that are more efficient at encoding and decoding information. For instance, the amount of time that is required to transfer a packet of information from one device to another has already been cut from an average of 53 milliseconds to 30 milliseconds in one early 5G network, with the potential to eventually reach 10 milliseconds.<sup>2</sup> For many advanced applications, like tele-robotics, this difference is significant.

The new standards will also allow many more devices to be connected at once. While current technology is limited to 2,000 connected devices per square kilometre, 5G will allow a million connections per square kilometre.<sup>3</sup> That means the new networks will have room for all types of devices to communicate, such as roadside sensors, warehouse trackers, industrial machinery controllers, and home thermostats. The technology would help bring about an "Internet of Things" (IoT) in which almost any device could be connected to the network.

To handle the additional data, 5G will use more of the radio spectrum than the current system. One bundle of new frequencies is below 6 GHz, and partially overlaps with frequencies used by current mobile networks. The second bundle includes frequencies between 24.25 GHz and 52.6 GHz, and will soon extend up to 71 GHz. These higher frequencies are often referred to as the "millimetre-wave band" because of the radio wavelength at these frequencies. Higher frequencies can carry more information but increase the chance of blockage by buildings, trees, and even rain. This means more transmitters spaced closely together will be required to provide effective coverage.

## New 5G-enabled technologies

The architects of the 5G system are designing it to be useful in three broad areas: <sup>4</sup>

(1) Enhanced Mobile Broadband (eMBB) will support applications such as ultra-high-definition 3D video streaming, virtual or augmented reality, and mobile cloud gaming. One proposal, for instance, would be to offer an immersive virtual reality *Hockey Night in Canada*.<sup>5</sup>

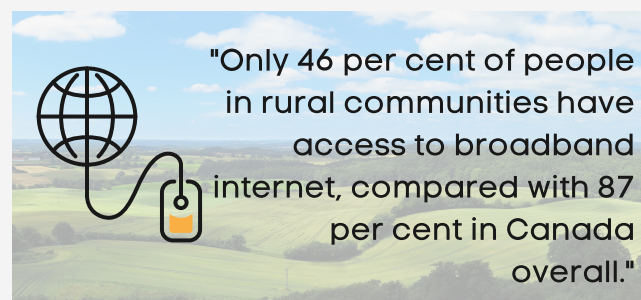
(2) Massive Machine Type Communications (mMTC) will support a huge number of low-cost and low-power devices that send small amounts of delay-tolerant data. This capability would support applications such as smart city grids and precision agriculture. For example, the technology would allow Canadian blueberry farmers to precisely measure and control irrigation, allowing them to reduce water use by 70 per cent.<sup>6</sup>

(3) Ultra-Reliable and Low-Latency Communications (URLLC) will support applications that need instant and dependable connectivity. For instance, industries could use connected devices to monitor and run machinery, allowing them to set up more flexible and efficient factories. Other uses include remote healthcare applications, autonomous driving, real-time robotics – really anything that requires a latency of 10 milliseconds or less and reliability approaching 100%.

## Access for rural and remote areas

Providing broadband Internet access (at speeds of at least 50 Mbps download and 10 Mbps upload) to rural communities is difficult and expensive because of the low population densities and the distances involved. Only 46 per cent of people in rural communities have access to broadband Internet, compared with 87 per cent in Canada overall. <sup>7</sup>

5G could provide a less expensive way to bridge the divide. Using fixed wireless access (FWA), Internet providers would utilize the 5G network to provide high-speed Internet directly over the mobile network. FWA is estimated to have only 40 per cent of the up-front costs of installing fibre-optic cable. <sup>8</sup>



## Current state of the technology

Operational standards for 5G networks are being developed in cooperation between the International Telecommunication Union and an industry group called the Third Generation Partnership Project. The first two sets of standards were released in 2018 and 2020, allowing large-scale 5G deployments to begin globally. As of mid-2020, there were 80 million 5G devices connected to 5G networks worldwide.<sup>9</sup>

In Canada, Bell Mobility, Telus, and Rogers already offer 5G services in some cities, and plan to increase coverage in coming years. Smaller and regional providers are expected to begin offering 5G services in 2021.<sup>10</sup> In total, the industry is expected to invest \$26 billion by 2026 to install 5G networks across the country. <sup>11</sup>

Future standards will address issues such as network efficiency, satellite access to 5G, and aerial networks.



source: Samsung



The staged process means that 5G capabilities will continue to develop throughout the next decade, and eventually evolve into the sixth generation (6G) network.

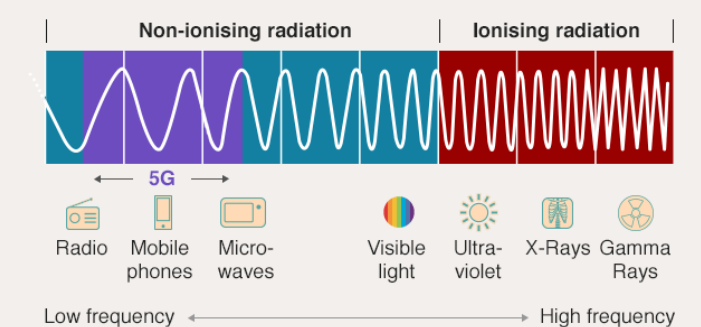
Eventually, the wireless cellular network will become like a large sensor, capable of improving emergency response, tracking unmanned vehicles and robots, supporting autonomous vehicles, and enabling AI to manage increasingly complicated network configurations and service requirements. 6G technology could eventually deliver 3D holographic displays, multisensory extended reality, wireless brain-computer interactions, and connected robotics.

## 5G and health

The move to 5G has raised health concerns among some people. For instance, the belief that 5G somehow caused the COVID-19 outbreak has led to arsons of cell phone towers in the UK,<sup>12</sup> and seems to have been behind a string of arsons in Quebec.<sup>13</sup> (No evidence supports such concerns).<sup>14</sup>

A more common concern is that exposure to 5G radio waves could damage human health. Critics worry that the millimetre-wave frequencies, combined with more antennas placed lower to the ground, could pose risks that are not yet understood. Radio waves from 5G networks are generally considered safe at the levels people are likely to be exposed to. Radio waves, including millimeter-band waves, are forms of non-ionizing radiation, which do not cause damage to DNA. Although the World Health Organization says the issue should continue to be studied, there is no evidence that exposure to 5G or other radio waves at these intensities cause any negative health effects.<sup>15, 16</sup>

### Where 5G fits in the electromagnetic spectrum



source: SCAMP/Imperial College London/EBU via the BBC

Nevertheless, there are continued calls for a moratorium on the deployment of 5G networks amid concerns that exposure to radio frequency electromagnetic fields is more dangerous than regulators and industry recognize.<sup>17,18</sup>

## Environment

The chief environmental concern is that 5G will contribute to climate change by increasing energy use and requiring more devices to be manufactured. Some sources claim that the move to 5G could increase energy used by the mobile network by 150 to 170 per cent by 2026.<sup>19</sup> The number of mobile devices around the world will increase from 8.8 billion in 2018 to 13.1 billion by 2023,<sup>20</sup> with 1.4 billion of them 5G-capable. The network itself will also require new equipment, including millions of base station antennas. A move to an Internet of Things will also require billions of new devices. Overall, mobile communications networks currently contribute about 0.4 per cent of global carbon emissions. For comparison, the aviation industry contributes about 1.5 per cent.<sup>21</sup>

On the other hand, manufacturers have an incentive to make their equipment as energy-efficient as possible. Some devices will go into sleep mode when they do not have data to send or process. Renewable energy sources such as wind or solar, combined with batteries, will provide energy to base stations in some areas. To be affordable, Internet of Things devices will need to be extremely energy efficient with very long battery lives.

There are also concerns about radio frequency effects on birds and insects. Many species use electromagnetic waves to sense their environment and navigate, and previous studies have found that radio waves at existing frequencies, such as in the AM radio band, can interfere. It is not clear if millimetre-wave bands will have any additional effects.<sup>22</sup> A report that 5G towers were responsible for bird deaths was baseless and has already been debunked.<sup>23</sup>

## Policy considerations

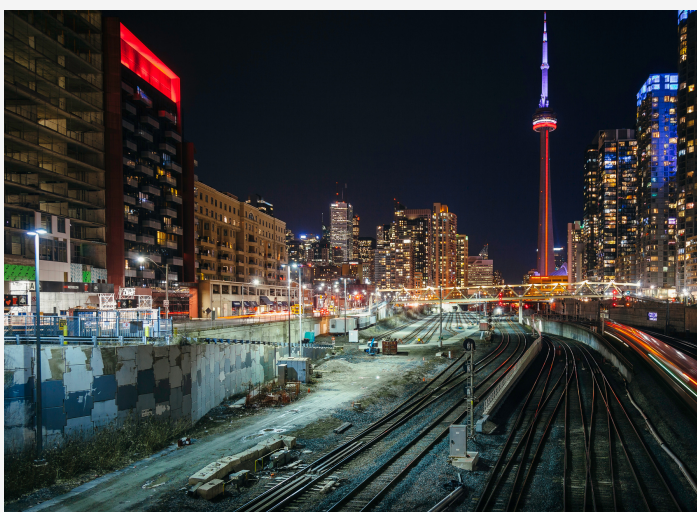
Our society is becoming increasingly data-driven, requiring near instantaneous and unlimited wireless connectivity. In that regard, connectivity has become a right, and the provision of connectivity has become an essential service similar to other utilities. As 5G becomes more widespread, governments will be asked to make decisions about access, security, health and other important issues.

### Radio spectrum

Although the 5G technical standards specify what radio frequencies are to be used, it is up to each country to allocate the spectrum and license it to users, and most countries have already begun the process. In Canada, auctions for spectrum started in 2019 with the 600 MHz band. Auctions for the 3,500 MHz band are planned for 2021, and auctions for 3,800 MHz are planned for 2022.<sup>24, 25</sup> ISSED provides a timeline for the 5G spectrum allocation in Canada.<sup>26</sup>

### Access to infrastructure

Because 5G networks will need hundreds of thousands of new antennas to provide service, telecommunication operators want to attach them to existing infrastructure, such as utility poles and street furniture. They are asking for federal legislation that will overrule local regulations and give them mandatory access and nationally consistent procedures for siting the base stations.



source: Michael Nugent, Flickr, CC BY-SA 2.0 [cropped]

The Federation of Canadian Municipalities, on the other hand, points out that wireless antennas also have to be hooked up to fibre-optic lines and power sources, so access will often require running cables underground and other potentially disruptive construction. They want to maintain current regulations that give municipalities authority to regulate access to infrastructure and rights of way.<sup>27, 28</sup>

### Rural and Remote Communities

Canada has a high number of rural and remote communities compared with many other developed countries. To close the digital divide between rural or remote and urban areas, ensuring everyone has access to affordable connectivity is important. Although 5G wireless will likely play a role in providing these areas with broadband Internet, there are also concerns about the lifetime costs and quality of the coverage. It is likely that some combination of wireless, fibre, and satellite coverage will be required to provide adequate access.<sup>29</sup>

### Security

5G technology poses unprecedented challenges related to security. The first four generations of wireless networks have been almost exclusively implemented on mobile phones. As 5G promises to enable connectivity of virtually any device, assessing potential risks of this technology, such as security breaches, will be necessary. Further research on high speed communication and security is being conducted as part of the National Research Council (NRC) program on high throughput and Secure Networks (HTSN) and a specific assessment on the legal, regulatory, ethical, social and economic (LESP) challenges associated with the deployment and use of HTSN conducted by the Council of Canadian Academies (CCA) is to be released in 2021.

Federally, several departments are involved with the implementation of 5G, including Public Safety Canada, ISSED, the Communications Security Establishment, the Canadian Security Intelligence Service, the Department of National Defence, Global Affairs Canada and the Privy Council Office.

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## Health

There will likely be continuing concerns over health, especially as more antennas are installed. A coalition of citizen groups has already asked the federal government to put a moratorium on 5G technology until more information is available.<sup>30</sup>

In Canada, recommendations for safe human exposure are established in Health Canada's Safety Code 6.<sup>31</sup> Similar to the US, Korea and most of Western Europe, Canada considers short-term exposure and whether the radio waves could do damage by generating heat. Other countries, such as China, Russia, India and some in Eastern Europe, consider non-thermal hazardous effects and the concept of dose, as well as long-term exposure. This latter group of countries uses lower radiation thresholds in their regulations than the former. Finally, countries such as Italy, Switzerland, Belgium, and Croatia<sup>32,33</sup> use the precautionary principle and minimize electromagnetic field exposure and potential unknown risks for fragile populations.

Some municipalities in the US, Canada, and other parts of the world have halted deployment of new antennas near schools, daycares and hospitals<sup>34, 35, 36</sup> until more independent studies are performed. In Wallonia, Belgium, the limits are reduced in schools, day care centers, and hospitals.<sup>37</sup> In Chile, antennas cannot be set at less than 50 metres from the same places mentioned above.<sup>38</sup>

## About SciEng Pages

SciEng Pages is an initiative of the Partnership Group for Science and Engineering. SciEng Pages aims to increase discussion on topical issues that have science and engineering at their core, by summarizing the current state of knowledge and policy landscape. Each issue is prepared and reviewed by a multi-disciplinary team of volunteers, and is published free of charge.



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