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WITHIN

THIS ISSUE

FEATURES

Canadians Adopting Mobile as Main Source of Telecom

For the first time, more Canadians subscribe exclusively to mobile wireless services (20%) than to wired telephone services (14%), according to a CRTC report released in October. The transition to the widespread use of mobile wireless services is borne out by the fact that more Canadian households have mobile phones (85%) than landlines (79%). The report contains other interesting stats. Over the past five years, the percentage of Canadians who have access to 5 Mbps download speed has risen from 86% to 96%. 77% of Canadian households subscribe to these services, up 6% from 2013. In 2014, Canadian households spent an average of $203 per month on their communication services, up approximately $12 per month or 6.2% year-over-year. This increase was driven in large part by spending on wireless and Internet services, which rose by 14% and 10%, respectively. The CRTC states that "the decisions Canadians are making as consumers, including choosing the packages that best suit their needs, are contributing to how much they spend on their communication services. In many cases, they are opting for faster and larger Internet packages, as well as using more data on their wireless devices."

GEE, 5G IS GALLOPING ALONG IN GIGABITS AND GIGAHERTZES

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It seems just yesterday that the first 4G LTE systems were installed, and only now are people, in urban areas at least, becoming used to having LTE almost all of the time. But radio researchers get bored easily and they have all moved on, and are focusing on their next bag of tricks, to be known as 5G, or IMT-2020, 2020 being the approximate date of standardization, with implementations to quickly follow.

Wireless operators aren't waiting. They are already talking about taking 5G test drives, but this will be of unstandardized technology, proofs of concept. Don't tell the marketing folks, because as soon as they sense that there is at least one new capability that matches the International Telecommunications Union (ITU) key capabilities on the horizon, 5G will turn into a new marketing buzzword, and the slightest enhancement from 4G will be called 4.5G, or perhaps they will be brazen enough to stick 5G on all their new products.

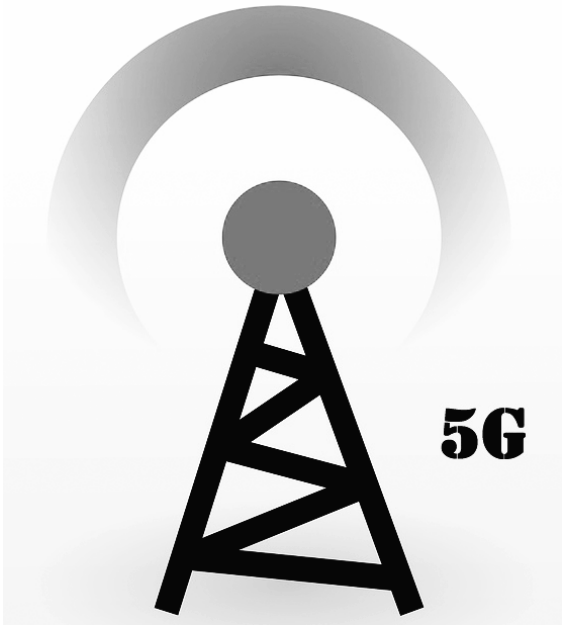
Will 5G bring higher data speeds? Of course. In fact, one might think that the only thing that is important with modern cellular-like radio systems is data speed. Are you excited that 5G will achieve 20 Gigabits per second (20 Gbps)?

Well, hold on a minute, discussions of data speed in wireless are not simple, and the numbers that get thrown around bear no resemblance to your mileage. (What was I saying about marketing promises versus reality?) First of all, the easiest thing to measure with wireless is the aggregate data speed that one chunk of spectrum from one cell can provide, and that has to be shared between many people. And since we don't know exactly how many people will be in each cell, some creativity can be applied to the individual experience, a bit like measuring mileage and emissions in an automobile.

Immediately we have to reduce the best data speed you will experience from 20 Gbps aggregate to 100 Megabits per second (100 Mbps) for an individual. That's a 200 times decline right off the bat. But 100 Mbps is still impressive, and better performance than you probably have at home right now with a wired connection.

And think of another dark side. If carriers did provide you with 1 Gbps data speeds, and you have a 10 GB (a Gigabyte (GB) is 8 Gigabits (Gb)) monthly plan you could burn through it in just over one minute! Even at 100 Mbps you could download a few movies and consume your 10 GB monthly allotment in about 15 minutes. So be careful what you wish for.

I'm still not finished reducing your expectations. It gets worse. Data performance is also affected by the environment (buildings, trees, water molecules, oxygen, etc.), cell size (generally larger in suburban and rural areas), and the speed of the user, particularly with the spectrum being considered for use in 5G. According to ITU estimates (and the technology is not defined yet, so these are just goals that radio experts think are realistic), the data speed available to a single user in a large cell while moving fast might be only 20-50 Mbps. Which means that sitting in a coffee shop so you are stationary and very close to the centre of the cell is not a bad strategy. Luckily, in Canada we don't have high speed trains, so you will have to go to Europe or



Asia to experience the very worst data performance at 500 kilometers per hour.

You might just care about your individual performance, but operators are excited about not just giving more data to each individual but also increasing the number of individuals they can sell service to. One of the ways to increase the amount of data in a given area by a factor of 100 is by increasing the spectral efficiency – that's the amount of data that can be transmitted on the same amount of radio spectrum. But since the ITU only believes that a factor of 3 is achievable, the bulk will have to come from getting more spectrum bands from governments.

And where is this untilled spectrum? Well, the 'G' in 5G not only apparently stands for the Gigabit per second speeds that will be attained, at least in the aggregate, but also for Gigahertz, because attention has moved from cellular spectrum that's measured in Megahertz, far up into the Gigahertz range.

Radio engineers are greedily eyeing the millimeter wave band, which extends from 30 to 100 GHz. These high frequencies can provide extremely high data speeds, but they also cause problems with the area that one cell can cover. Cell sizes with these frequencies are measured in hundreds of meters, not kilometers, which means that 5G may well be restricted to urban areas and in-building deployments.

As a very rough rule of thumb, coverage area decreases as frequency increases. So the very largest cells are currently achieved with the few rural cellular systems that run in the 400 MHz bands. Traditional cellular uses 800-900 MHz, so it does not provide such large cells, but can provide greater capacity. PCS systems use the 1800-1900 MHz bands, and have still smaller cells, but can provide greater capacity in urban areas. Converting to GHz, this means that current systems are in the 0.5-2 GHz range, far below what is being looked at for 5G.

How big will cellsites be in 5G? Not very. Maybe even tiny.

The ITU has looked at coverage for 28 GHz (using a very wide swath of spectrum) and estimates that under the best of conditions (open spaces) they can achieve a data rate of 1 Gbps with a cell radius no bigger than 1 km. They could increase the cell radius to almost 4 km, but only by limiting data speeds to 100 Mbps. In urban areas they can only achieve the Gigabit speeds with cell radiuses of about 50 meters, and even limiting speeds to 100 Mbps only increases the cell radius to a bit over 100 meters.

In higher frequency bands, the achievable data rate goes up over 10 Gbps, but the cell radius shrinks even further. This is great for home and office coverage, but won't be much of a solution for wide area public networks.

Wireless is not just about speed and coverage, there are other facets of wireless communications that also need improvements from 4G. One of these, that is very important for the Internet of Things (IoT), is latency. This is the amount of time that elapses from deciding to transmit until the first bit of data is actually transmitted. Traditional cellular systems, including 4G, were not optimized for this, but for

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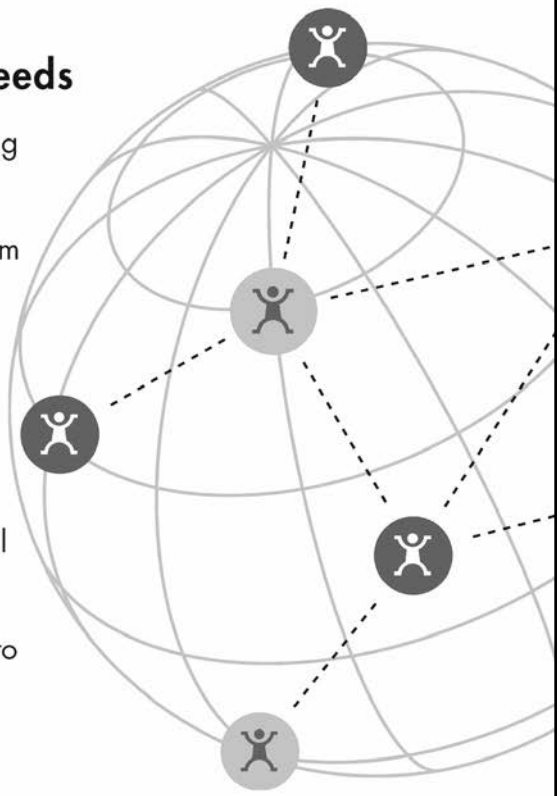

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Calling Apple Watch

According to research firm Canalys, Apple has sold 7 million Apple Watches since the April launch. Apple already leads the smartwatch market, outpacing competitors such as Pepple and Samsung's Gear. But after the initial rush – selling 200,000 units a day in the week of 10 April – research firm Slice Intelligence estimates Apple was then only selling an average of 20,000 watches a day in the U.S. Yet momentum appears to have built and shipments to have steadily increased during the prime end-of-the-year shopping season. Analyst Daniel Ives of FBR & Co. has predicted that Apple Watch sales could reach 6 million in the December quarter, to reach total sales of 12 million units in 2015. Apple revealed in July that the Apple Watch had outsold the first-generation iPad through its first nine weeks. For perspective, Apple sold 3 million iPads in the tablet's first 80 days. Will there be an Apple Watch under your tree these Holidays?

5G they want to get latency down from about 10 milliseconds (10 ms) today to about 1 ms. This is important for critical communications, and for improving the efficiency of a large number of devices transmitting very small packets. Often the amount of data that is transmitted to arrange for a communication is much greater than the information carried within the communication. This makes it difficult for wireless carriers to support millions of connected devices, and makes the service more expensive than it should be.

Another growing problem with wireless systems, that will only get worse with 5G, is energy consumption. When cellular first arose, in the early 1980s, with analog systems, there were only a very small number of base stations. Although each had higher power than today, there are so many times more base stations now (particularly if you include Wi-Fi Access Points) that energy consumption is becoming one of the greatest expenses of running a network.

The ITU has a very aggressive goal of reducing energy consumption of each network component by a factor of 100. But at the same time they expect to increase aggregate data transmissions by the same factor. So energy consumption will not go down overall, even if they achieve their goals. And if they can't achieve their energy efficiency targets, consumption will go up. Look for each communications tower to have a big windmill on top. Or maybe a fuel surcharge on your monthly phone bill.

Energy consumption in phones will similarly have to be optimized, so that if smartphones had the screen size and data speeds of today they would be significantly more efficient. But the problem is that smartphones of tomorrow will have larger screens (or at least more pixels) and much higher data speeds. Even now, many smartphone manufacturers are only able to maintain a decent battery life by putting in a bigger battery. For 5G, they will have achieved a lot just by standing still, by maintaining the same battery life with 5G phones as with 3G or 4G devices.

The demand for wireless data is stretching the ingenuity of engineers and physicists to the breaking point. Ericsson, for example, recently estimated that current North American data usage will rise from just under 4 Gigabytes per user per month to 22 in five years. Consumption increases will be driven by enhancements in video quality, that are already putting a strain on wireless networks. As more people consume HD or ultra HD videos, it will only get worse.

Improvements in wireless data performance are hard won, and with 5G it appears that the world is approaching the limits of physics. 5G may revolutionize the home and office, with Gigabits of data flowing everywhere, and the need for wiring virtually disappearing, but it will probably have less impact out on the range. The digital divide between urban, rural and remote areas may get worse before it gets better. Perhaps 6G should focus on boosting data performance in the more remote and far flung reaches of Canada.

A word of advice for high school students. Studying physics might be a good career move. If you can be involved in the next radio transmission breakthrough, or a dramatic increase in battery performance, you will have the world eating out of your hand, and you will be able to retire to your private tropical island at the age of 30.

From the editors: You can download a well-made infographic (see below) from the European Commission that explains what 5G is, what it will bring and what is new with 5G, and that gives examples of 5G applications at https://ec.europa.eu/digital-agenda/en/news/what-5g-infographic