# The 5G Debate in New Zealand – Government Actions and Public Perception

## Invited Paper

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**Abstract.** The Fifth Generation (5G) of mobile phone technology is gradually witnessing deployment in many parts of the world. New Zealand is also expected to start 5G deployment by the end of 2019. This paper reviews the progress made to date regarding the introduction of 5G specifically in New Zealand. This paper explores several technical and non-technical issues that relate to the 5G debate that is ongoing across the country. Of particular interest are topics that are associated with government's policy and actions towards 5G, and the perception of the general public about this upcoming technology.

**Keywords:** 5G · Spectrum allocation · Security · Health impacts

## 1 Introduction

The Fifth Generation (5G) of mobile phone technology has been introduced in some parts of the world like the US, South Korea, the UK, etc. The early deployment of 5G has mainly been in selected cities in most of the countries. A more ubiquitous and worldwide presence of 5G is anticipated over the next few years. 5G is essentially an improvement on its predecessor 4G. Each 'generation' of mobile phone technology is better than its predecessor at least in terms of network capacity, which may be defined either in terms of the speed each user gets, or in terms of the number of users that can simultaneously connect to the network with a certain Quality of Service. 5G delivers on both definitions of capacity by using the frequency spectra that have never been used for such large scale mobile communication before. The early deployments of 5G are using the 3.5 GHz bands, while the later deployments are expected to use carrier frequencies as high as 28 GHz or 38 GHz. The enormous spectral space that these bands offer enables high speed connections and simultaneous network access to a large user base. Because of this increased capacity, a number of research works are examining the interconnection of devices as diverse as the ground and aerial vehicles [1, 2] with the main 5G network.

In New Zealand, the government has commenced the usual formalities for launching 5G at a national scale. A network service provider called Spark has already launched a 5G lab, which is currently seeking collaborative opportunities with other


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industry and academic units. Spark is expected to start deploying 5G from mid-2020, assuming all government processes get completed. In August 2019, another network service operator Vodafone announced its plans of launching 5G as early as December 2019. This has remarkably changed the 5G landscape in New Zealand, which was originally set to be dominated by only one network operator.

The main purpose of this paper is to provide more detail about the progress that is being made in New Zealand in relation to deploying 5G on a national scale. This paper is motivated by the fact that active researchers, not just in 5G but other areas related to technology, often unintentionally neglect some of the non-technical aspects that may affect the overall deployment of technology. By reviewing aspects such as government policy, public perception of 5G, etc., this paper highlights the technical and non-technical state of 5G in New Zealand. The author understands that the New Zealand government is negotiating with the Maori community about their claims to the wireless spectrum. However, the author is not privy to these discussions and therefore cannot make informed comments on this particular subject.

This paper is organized as follows. The key government actions that are pertinent to 5G deployment are reviewed in Sect. 2. Different aspects that relate to the public perception of 5G are examined in Sect. 3. These issues include health implications of 5G, cybersecurity, etc. This paper is concluded in Sect. 4, which is followed by references.

## 2 Government Actions

### 2.1 Preparing for 5G in New Zealand

In March 2018, the Government of New Zealand issued a discussion document related to the deployment of 5G in the country. The discussion document [3] set out the government plans and also requested feedback on the same from the general public. The Radio Spectrum Management (RSM) division of the Ministry of Business, Innovation and Employment (MBIE) prepared the draft and also collated the general feedback, which was later published online. Most of the feedback received from the public on the deployment of 5G was related to the health implications of this new technology. The following summarizes the initial plans of the government as described in [3]. The health aspects are discussed separately in Sect. 3.1.

The discussion document pointed out that there is enough frequency spectrum available to support the deployment of three separate 5G networks in New Zealand. Having three separate 5G networks is in contrast with the practice adopted in some countries, which are planning on deploying a single national 5G network. Such a national network would then be shared by the network service providers. The discussion document has indicated that there are enough frequency resources to cater for three separate 5G networks in New Zealand. However, it is not incumbent on all service providers to plan and deploy their own 5G networks. There are three network service providers in New Zealand, but given the size of the country, it is not financially feasible to have three separate 5G networks. In the months that followed, one of the network service providers, Spark, took the lead and announced an ambitious target of rolling out 5G by mid-2020. More recently, another network service provider called Vodafone has announced 5G launch in December 2019. It is expected that Vodafone's 5G network will use the devices provided by Nokia. In terms of access to the 5G spectrum, Vodafone is better positioned to launch 5G because it currently holds the licenses of the concerned frequency bands.

The discussion document also pointed out that the network service providers will likely use their 4G infrastructure to help deploy 5G. This would mean that any equipment that has been in use in 4G will potentially become part of the 5G network. Thus the Huawei equipment present in the 4G infrastructure will inherently affect New Zealand's 5G networks, unless all such devices are carefully removed from the existing network. Huawei is still dealing with the cybersecurity concerns that have been raised about their equipment, which is separately discussed in Sect. 3.2.

The discussion document [3] identified the use of 3.5 GHz and 28 GHz bands for potential use in 5G deployment. A few lower frequency bands were also identified. It has been pointed out in the discussion document that New Zealand will start using the 3.5 GHz band in the first instance, which is in line with the 5G deployments around the world. The government has published another discussion document that focuses entirely on spectral issues specifically in the 3.5 GHz band, which is covered in the following section. The government has proposed four different ways of allocating the 3.5 GHz spectrum: first come first serve, lottery, administrative allocation and auction. The government has apparently chosen to 'auction' the 3.5 GHz spectrum.

## 2.2 3.5 GHz Band for 5G Deployment

In June 2019, RSM on behalf of MBIE published another discussion document laying out the arrangements for using and making available the 3.5 GHz band. Citing 'international trends', the discussion document [4] has proposed to use Time Division Duplexing (TDD) in the 3.5 GHz band for 5G deployment.

As far as the range of the band is concerned, the discussion document seeks to make the C-band (3800–4200 MHz) available for 5G deployment. The discussion document [4] recommends the use of 3800 MHz to 4200 MHz for 5G transmissions. On the other hand, the table of radio spectrum usage in New Zealand (more specifically PIB21, issue 10 of May 2019 [5]) maintains that the C-band starts at 3700 MHz. It is unclear what the government's plans are for the spectral space that lies between 3700–3800 MHz.

The discussion document [4] maintains that new licenses in the frequency range 3800–4200 MHz band will only be issued selectively. However, it appears that the first 100 MHz of the existing C-band has somehow been excluded from the discussion. In their response to the discussion document, TVNZ has expressed their concerns that this allocation may potentially impact some of the TV transmissions that are ongoing in New Zealand. In any case, the rights to access the C-band are expiring in 2021 but negotiations are allowed to vacate the spectrum sooner.

The frame structure proposed by [4] has been reproduced in Fig. 1, which allows transmission of data in uplink and downlink directions. It is obvious from the figure that significantly larger time resources have been allocated for downlink transmissions.

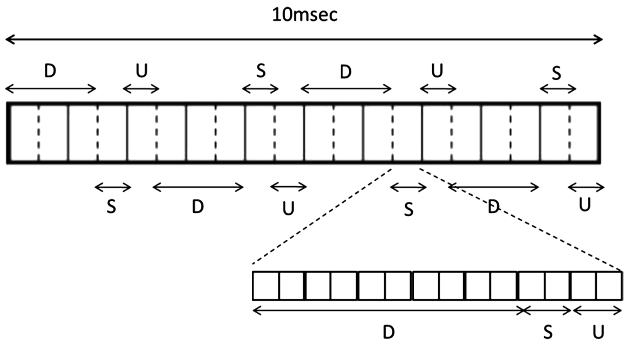


**Fig. 1.** Frame structure for 3.5 GHz band as proposed in [4].

**Table 1.** Selected items listed in category II A by the WHO [12].

| Selected items | Category | Description |
|---|---|---|
| Frying, emissions from high-temperature<br>Red meat (consumption of)<br>Hot beverages about 65 °C (drinking)<br>Indoor emissions from household combustion (wood) | II A | Probably carcinogenic |

Notably, the discussion document [4] has not laid out any plans to introduce the discovery frames, which will allow the 5G enabled devices to "discover" each other even in the absence of network coverage. This new feature of discovering other nearby devices does not exist in 4G and pre-4G systems but is expected to be a key feature in 5G. Network-independent device discovery and communication can potentially provide coverage in far-fetch areas (rural townships, etc.) and in emergency situations.

The structure of these discovery frames has been standardized by the 3rd Generation Partnership Project (3GPP), for example in [6]. A number of other research works have modified the legacy discovery frame structure for improved performance [7–9], etc. It is recommended that the entire 3.5 GHz band should be synchronized to a specific "discovery frame structure", in addition to being synchronized to the frame structure shown in Fig. 1. The discussion document has given careful attention to other parameters like the out-of-band emissions and methods for calculating their strength, which are not separately addressed in this paper and can be seen in [4].

# 3 Public Perception

## 3.1 Health Implications

The first deployment of 5G around the world and in New Zealand is going to use the 3.5 GHz band, as mentioned earlier in Sect. 2.2. The propagation characteristics of wireless signals in this band are similar to the characteristics of wireless signals that are in common use today, in comparison with that of signals in the 28 GHz or higher bands.

The 28 GHz and higher frequency versions of 5G will use the millimeter-waves [10], which have never been used for wireless communication at this scale. One of the consequences of using mm-waves is that the coverage range of a base station will shrink considerably [11]. Therefore, multiple transmitters will be needed to cover a geographical area that is currently being covered by a single transmitter. The increase in transmission frequency (for example from 2.4 or 2.6 GHz to 28 GHz) and the expected increase in the number of transmitters within our ambient environment has led many to believe that 5G will have adverse effects on human wellbeing.

The World Health Organization (WHO) classifies wireless transmissions as "possibly" carcinogenic [12]. Note that all wireless transmissions in general are deemed possibly carcinogenic by the WHO, not just 5G mm-waves. Possibly carcinogenic is the characterization associated with category IIB, which is a level milder than category IIA that has been labelled as "probably" carcinogenic. The items listed in category IIA are more dangerous than those listed in IIB. Interestingly, a number of items that are in common use are listed as probably carcinogenic (category IIA) by the WHO. Table 1 lists some of such items that are potentially more probable to cause cancer than wireless transmissions, according to WHO.

One of the arguments put forward by the opponents of 5G is that there is no escape from it because it will be everywhere. 5G is indeed expected to interconnect a large number of diverse kinds of devices under the frameworks like Internet of Things [13], Machine-to-Machine communications [14], etc. On the other hand, the proponents of 5G technology claim that despite the widespread use of wireless networks, no concrete links have been established between mobile phone use and different medical conditions [15]. Mobile phones came into commercial use in the 1980s and so have subjected the human beings to electromagnetic radiation ever since. A number of other wireless transmissions have also become ubiquitous over the past e.g. TV and radio transmissions, etc., from which, escape is also not possible. Over the years, the research community has reported works that prove harmful effects of 4G/pre-4G transmissions as well as those that have found none. The work in [16] summarizes both sides of the arguments, including the results obtained by both sides and the conditions in which the results were obtained.

More recently, an article in the New York Times [17] claims to have traced down the research paper that linked the mobile phone transmissions with conditions like brain cancer. Citing active researchers in the field, the article [17] suggests that the work reported in [18], which became a widespread caution against wireless transmissions, did not take into account the shielding effect of the skin when subjected to wireless signals. This shielding effect is known to increase with increasing transmission frequencies, and is therefore expected to result in smaller exposure when high frequency signals are used for mobile telephony.

The study by the National Toxicology Program (NTP) [19] has found that there are some medical effects associated with 4G and pre-4G wireless transmissions. This finding is in contrast with the commonly held belief that non-ionizing radiation (which is used for mobile communication) is completely harmless. The NTP study establishes that non-ionizing radiation may also impart undesirable consequences if appropriate thresholds are not put in place.

The thresholds for wireless transmissions in 4G/pre-4G networks are determined and specified using a metric called the Specific Absorption Rate (SAR). As the name suggests, SAR measures the amount of wireless radiation absorbed per unit mass of the human body. Given that the mm-waves of 5G networks do not penetrate into the human body due to the shielding effect of the skin, the metric that determines the extent of electromagnetic exposure is called Power Density (PD). It appears that PD due to 5G will remain within the permissible threshold [20], which is set at 10 $W/m^2$ internationally. The same threshold is also enforced in other applications that use wireless signals such as microwave ovens.

However, some works have suggested that exposure to 5G mm-waves will result in temperature elevation across the human skin [21]. A few recent works have even suggested that the thermal effects associated with 5G transmissions may cause permanent damage [22]. Recognizing the fact that all wireless signals (5G or non-5G) are after all bundles of electromagnetic energy, it is important to ensure that the thresholds set by the national and international organizations do not over-expose human users to wireless transmissions.

### 3.2 Cybersecurity and the Role of Huawei

The public concerns around the security and privacy issues associated with 5G have emerged in the local and international media. While security issues remain linked with all forms of wireless transmissions, 5G poses a new challenge in that it will interconnect not just a users' laptop or a mobile phone, but also appliances that are in everyday use. Therefore, any potential vulnerability in the 5G network may have quite far reaching consequences.

The ban on using Huawei devices, first by the United States and then by other countries, have hinted the existence of security backdoors in the Huawei equipment. A detailed study on the security performance of Huawei devices was conducted in the UK earlier this year. The following briefly reflects on some of the technical aspects of the report published on 28 March 2019 by the Huawei Cyber Security Evaluation Centre (HCSEC) of the UK [23], which covers the assessment of the communication devices that are manufactured by Huawei and deployed in the UK. It must be noted that the technical issues raised by HCSEC will also impact the performance of 4G and 3G networks, and do not specifically relate only to the 5G equipment. Some of the following commentary has come out in a media release [24].

The report published by HCSEC remains largely vague on detail, presumably because publishing too much information about the tests and results may put the Huawei devices at risk. These devices are already in commercial use across the UK and thus must never be comprised. The technical issues that have been highlighted in the report can be broadly classified as software engineering issues and cyber security issues. The issues related to software engineering appear to outnumber those related to cyber security. This may be because many of the cyber security issues stem from the vulnerabilities in the software.

The main issue related to software is concerned with 'binary equivalence' [25], which means that different instances of the same code used in the Huawei devices may build differently. This is problematic because different deployments of the same

Huawei equipment may potentially lead to different performance levels (including the provision of security). Ideally we would want all devices of the same kind to show similar and measurable level of security. Tests performed on four separate Huawei devices have shown that their performance is not repeatable. The report [23] has not identified the devices that have been tested.

On the other hand, one of the main security issues highlighted by HCSEC relates to the cryptographic weaknesses. Cryptography deals with ‘hiding’ the information transmitted wirelessly so that even when the message is stolen its true contents cannot be retrieved and interpreted. A weak cryptographic solution may lead to the message being decoded by persistent eavesdroppers [26]. Cryptographic weaknesses are addressable too, but the scale of solving this problem may be a potential bottleneck for Huawei. HCSEC has not given any hints on the scale of this problem in the report.

A number of other technical issues have also been highlighted in the report. For example, there are issues around integrating Huawei’s operating system with the existing systems. Huawei’s OS apparently comes from a third party and uses an outdated code, which is never desirable. There are a few memory safety concerns as well, which, although not explicitly mentioned in the report, typically relate to pushing more data on a memory location than it can actually handle. Such errors result in ‘overflows’ within the memory units, which may lead to the loss of useful information.

The report did mention that Huawei has offered to invest $2bn over five years to address these issues but HCSEC appears to be looking for a more concrete plan from the company. There are sections within the report that seem to suggest that Huawei has not reasonably addressed the issues raised in the previous audits, which is also a concern for HCSEC. To the best of the author’s knowledge, other device manufacturers (Samsung, Ericsson, etc.) have not gone through this kind of security assessment. It would be interesting to see how other manufacturers are doing in terms of the technical issues raised in the Huawei devices. A number of media releases in New Zealand and elsewhere have reported the possibility of security backdoors [27] in the Huawei equipment, which has been denied by the manufacturer.

Previously in 2018, the Government Communications and Security Bureau (GCSB) of New Zealand had rejected Spark’s application to use Huawei equipment for deploying the country’s 5G network. Spark has not made a resubmission of that application at the time of this writing. Other manufacturers that may provide 5G equipment include Ericsson and Nokia. If Vodafone goes ahead with its plans, the first 5G network of New Zealand will comprise of the devices manufactured by Nokia.

### 3.3 Unclear Expectations

One of the biggest impediments of 5G in New Zealand is that the general public does not know what it will achieve. Of course there are suggestions that 5G will enable quicker download times, but the existing 4G network in New Zealand is reasonably fast already. A number of urban centers within the country have access to fast fiber optic backbone, which further increases the speed that each user gets. It will be difficult to promote 5G without promoting a strong use-case that solves some of the contemporary problems of New Zealand. One of the only few use-cases that are often talked about is the use of 5G in enhancing the viewership experience of the America's cup [28]. The service provider Spark is the main promoter of this particular application of 5G, which will indeed exploit the real potential of 5G. However, this use-case has an expiry date – it will expire at the end of the competition. What New Zealand really needs is an ongoing use-case that can benefit masses in some meaningful way without an imminent expiry date.

Generally speaking, 5G is great for data hungry applications, just one realization of which is virtual reality. Applications such as online gaming have given rise to lucrative industries in countries like South Korea, Japan, etc. However, in New Zealand, virtually real applications that can enable remote medical consultations might be of more value. There is still a long way to go in that direction but the research community needs to try and address some of the contemporary issues of New Zealand with the help of 5G. A smart combination of 5G with artificial intelligence may support 'predictive maintenance' [29], especially in predicting and averting traffic congestion on New Zealand roads and highways. The 5G technology can also help extend New Zealand's fiber infrastructure to remote communities over wireless links. This would not be possible with the existing 4G networks because of considerable capacity imbalance between fiber cables and the existing 4G technology. However, the high-frequency deployments of 5G will have smaller coverage area, which will make it economically difficult to provide coverage in distant regions that typically have low population density.

### 3.4 5G and Weather Predictions

The transmission frequencies in the 23.8 GHz band are heavily used in weather monitoring at present. This band is used by the satellite receivers on Earth to estimate the water content in the atmosphere, which then allows a number of other weather predictions to be made. Because the satellite signals are typically low power, any wireless transmission in the adjacent bands may cause loss of information in the 23.8 GHz band [30]. Therefore, 5G deployment in 28 GHz band (or similar) must not leak into the 23.8 GHz band so that the routine weather predictions are not adversely affected by electromagnetic interference. It must be noted that the initial deployment of 5G in the 3.5 GHz band does not pose any significant risks to the weather related transmissions taking place in the 23.8 GHz band.

## 4 Conclusion

It is an interesting time to be engaged in 5G research and development locally and internationally. In New Zealand, most of the existing issues do not directly relate with the technological foundations of 5G but originate from different concerns, for example security, health and wellbeing, etc. The government and other stakeholders can make a more emphatic case for the deployment of 5G by identifying applications of this new technology that are specific to the New Zealand context. For example, interconnection of health care setups in order to provide medical consultation facilities in areas that typically have few General Practitioners may present a strong use-case of 5G – one that addresses a contemporary problem of New Zealand.

To this end, this paper has provided an updated summary of the state of 5G in New Zealand taking into account a range of technical and non-technical matters.

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