# Vodafone New Zealand

## Preparing for 5G in New Zealand

Response to Radio Spectrum Management

Discussion Document

May 2018

# Executive Summary

(i) Vodafone welcomes the opportunity to comment on MBIE's discussion document "Preparing for 5G in New Zealand". 5G technology offers a step change in the speed, data capacity and capability of mobile networks.

(ii) Vodafone New Zealand is proud to have recently demonstrated 5G in Auckland, where we showcased exciting future applications such as low-latency robots, live virtual reality performances, and the world's first gaming tournament over 5G. 5G has the capability to increase New Zealand's productivity, collaboration and economic opportunities. Ensuring that spectrum policy supports widespread competitive 5G deployment is vital.

(iii) This paper sets out Vodafone's responses to MBIE's questions on the design, roll-out and spectrum considerations for the 5G network.

***Infrastructure competition is crucial for delivering 5G mobile networks that offer Kiwis real choice***

(iv) New Zealanders are well served by three competing networks; Vodafone, Spark and 2Degrees. The Commerce Commission's Annual Telecommunications Monitoring Report for 2017 notes that mobile pricing is between 27% - 47% below OECD averages.[1] New Zealand continues to benefit from leading mobile technologies, including 95%+ 4G coverage.

(v) With a history of bringing innovation to New Zealand, Vodafone is committed to delivering a 5G network as an evolution of our existing mobile network.

(vi) The Government must not be distracted by unrealistic claims regarding supposed efficiencies of a single-provider 5G network. The time and costs involved in creating such a regime would ultimately jeopardise the benefits New Zealand stands to gain by keeping pace with global deployments through network competition.

(vii) MNOs cooperate today where there are efficiencies for coverage and network. The Rural Connectivity Group (RCG), for example, is a multi-operator core network where

[1] Commerce Commission, Telecommunications Monitoring Report 2017 infographic

Vodafone, Spark and 2Degrees are sharing resources to expand mobile and broadband coverage to remote rural New Zealand.

***Early access to 3.5 GHz is critical to meet large commercial opportunities.***

(viii) For the successful commercial launch of 5G, it is crucial that mobile network operators (MNOs) to have early access to spectrum in the 3.5 GHz band. Current management rights do not expire until 2022 and if MNOs are not able to get early access to this expanded and re-planned spectrum band, it will result in considerable delays in 5G deployment, with MNOs limited in our ability to rapidly plan for, test, and deploy networks.

***Access to 600 MHz is vital for 5G deployment across rural New Zealand***

(ix) 3.5 GHz is the preferred spectrum band for deploying 5G in urban centres with high population density. However, this band is not the most suitable for rural New Zealand. Instead, the propagation characteristics of the 600 MHz band are best for areas with lower population density.

(x) Without allocation of this band for 5G/IMT, New Zealand risks creating a future urban/rural digital divide where MNOs cannot economically deploy 5G outside of main cities. That would be inconsistent with the government's aim to reduce the digital divide.

(xi) Vodafone recommends that the 600 MHz band be quickly allocated following 3.5 GHz. We consider it is a higher priority than allocation of the 26 GHz band.

***The 26 GHz band will play an important role in 5G networks***

(xii) The 26 GHz or mmWave band will also play an important role in providing capacity for 5G networks. While this will not be an issue at 5G launch, it will become important in the medium term. There is still significant uncertainty as to which parts of this band will become mainstream, due to developments in the American market. For this reason, we recommend the decision and allocation of this band be delayed until after the World Radio Conference in 2019.

***5G technology requires sufficient spectrum bandwidth to realise its full potential***

(xiii) For New Zealanders to experience the best possible 5G network experience, national MNOs will require sufficient bandwidth, especially in the 3.5 GHz and mmWave bands.

(xiv) New Zealand is fortunate to have significant available spectrum when compared to larger countries with larger populations. Vodafone strongly recommends that 3410 – 3800 MHz be fully allocated for 5G/IMT use. This will provide sufficient bandwidth to accommodate both national and regional operators within this band.

(xv) Without the full allocation of this band, we are concerned that accommodating regional providers within a limited allocations would result in much reduced available bandwidth to all parties, which would inhibit MNOs from delivering high quality 5G networks. Such a constraint is unnecessary.

***Implementation requirements may be imposed***

(xvi) Vodafone accepts that certain implementation requirements may be imposed on 5G spectrum allocations to ensure that spectrum is used to deliver real service to New Zealanders, rather than speculatively land-banking. Depending on the band, we recommend that any obligation relates to population coverage or cellsite numbers, rather than specific technologies.

# 1 Introduction

## 1.1 What is 5G?

1. As outlined in MBIE's discussion document, 5G is the next generation of international mobile telecommunications system (IMT). While 5G technology is not yet finalised, early trials indicate that 5G networks will provide considerably greater speeds, greater connection reliability, lower latency and increased spectrum efficiency compared to 4G.

## 1.2 What will 5G be used for?

2. These characteristics allow for the development of new applications (or the enhancement of existing applications) that can provide transformative change in New Zealand. With benefits in healthcare, education, increased security, positive social impact, positive impact on the environment and increased employment, 5G networks provide the platform for harnessing new technology to solve current challenges.

*Q1. What are the likely uses for 5G in New Zealand initially and in the longer term?*

3. We agree with RSM's view that when 5G is initially launched, it will be mainly used as an enhancement of existing mobile or fixed wireless broadband services. This will provide significantly increased network capacity and user data throughput along with much lower end to end latency, providing an improved experience for both mobile and fixed wireless users.

4. With its much improved data speed, reliability and scalability, 5G may also make wireless broadband a viable alternative to shared fibre (e.g. GPON) for many consumers and businesses. Additionally, it may replace 802.11xx Wi-Fi as the preferred wireless LAN technology in many environment and user cases, such as offices and some commercial applications that currently rely on 802.11xx Wi-Fi connections.

5. In the medium term, 5G networks will be increasingly used for machine to machine (M2M) or Internet of Things (IoT) connectivity. As one example, our energy sector has deployed smart meter technology at a retail level for many years, with customers enjoying the benefits of greater transparency regarding peak usage and pricing and the control to adjust their power consumption habits. One example of truly transformative change however, will be the future ability of energy companies to deploy such technology into their own grids and respond instantly to changes in supply and demand. Smart energy networks will no longer need to estimate usages and build in buffers for any shortfalls.

Instant information and the ability to respond will create much more efficient networks, ultimately translating to better consumer pricing and environmental outcomes.

6. Similarly, the nascent development of smart technology in healthcare such as remote patient diagnosis, online/central patient record management and in-home patient rehabilitation will continue to grow and being embedded. Gamers will enjoy a mobile network that allows them to compete on the international stage without suffering latency or congestion issues. At home, Kiwis will increasingly be able to control their appliances remotely – turning the air conditioning on just before getting home (or even better, automatically according to real-time weather information from meteorological sources) or being able to switch the forgotten hallway light off after you've already left for work.[1]

7. Farming and agricultural applications relying on wide-area wireless connectivity is also being actively developed in New Zealand. Given its importance to the New Zealand economy, 5G coverage in rural areas will become critical for the future of dairy, meat, wool and forestry in New Zealand.

8. New Zealand will likely adopt the trends of other global leaders in technology development – the deployment of driverless cars, the development of smart cities using smart transport technology (such as intelligent parking, real-time traffic solutions, smart waste management), and increased opportunities for our most remote learners to participate in global education platforms. Augmented reality is likely to become a feature of everyday life, with enhanced imagery overlaid onto real world scenes providing end users with greater information regarding what they are seeing or experiencing.[2]

[1] Arthur D. Little, "Creating a Gigabit Society – the role of 5G", https://www.vodafone.com/content/dam/vodafone-images/public-policy/reports/pdf/gigabit-society-5g-14032017.pdf
[2] Ibid

# 2 Regulatory considerations for 5G in New Zealand

## 2.1 Network competition

*Q 2. Do you consider competition should be encouraged at the infrastructure level or purely at the retail level for 5G? Why?*

9. Vodafone strongly supports infrastructure competition for mobile networks – a model that continues to deliver significant benefits to New Zealanders including the choice to select a provider on things that matter to them.

10. New Zealand's mobile market is characterised by:

- **Fast mobile data speeds** –New Zealand is consistently ranked within the top 20 nations for mobile data speeds;[3]
- **Growing mobile data use** - consumers now average 1.2 G of mobile data per month;[4]
- **Growing mobile subscriptions** – in 2017 New Zealand reached 134 active mobile connections per 100 people;[5]
- **Good mobile pricing** – in 2017 the Commerce Commission reported Kiwis enjoy mobile pricing from 27% - 47% below OECD averages;[6]
- **Good coverage** – Vodafone's mobile coverage now reaches more than 98.5% of where New Zealanders live and work;[7] and

[3] Speedtest Global Index, http://www.speedtest.net/global-index
[4] Commerce Commission, Annual Telecommunications Monitoring Report 2017, file:///C:/Users/soperc/Downloads/2017-Annual-Telecommunications-Monitoring-Report-20-December-2017.PDF
[5] Ibid
[6] Ibid
[7] Vodafone, https://www.vodafone.co.nz/network/coverage/. In those rural and remote areas of New Zealand where it has not been economic to roll out mobile infrastructure, MNOs have partnered with Government through the Mobile Blackspot Fund to cover over 1,000 kilometres of state highways and 100 tourism locations without previous coverage.

- **Fast access to new technology** – following Vodafone's introduction of 4G in 2013, all three MNOs now offer this technology nationwide. Similarly, all three MNOs have publicly confirmed their intention to upgrade networks to 5G[8].

11. Mobile networks in New Zealand have largely been built without government intervention or investment; the nature of our industry and the pressure of competition ensures MNOs continuously invest in network technology. The incremental upgrade from 4G to 5G is no different.

12. Chorus, a fixed broadband network provider, has recently suggested that New Zealand's 5G mobile network should no longer utilise this model and instead be built on a shared, regulated, government-backed basis. Vodafone believes that a competitive 5G deployment will be faster, lower cost in the long run, all the while delivering a range of other benefits.

13. As intended by the 3GPP standard, 5G is an extension and evolution of existing LTE technology. It is designed to utilise existing LTE network infrastructure and supporting systems as much as possible. All major cellular network vendors have also made their latest LTE mobile network equipment (e.g. BTS/eNodeB RF Module, Baseband Unit and Core Network elements) compatible and upgradable to 5G.

14. Additionally, development in radio technology and antenna design make 5G coverage from higher frequencies (like 3.5 GHz), similar to that provided by lower frequencies (e.g. 1800/2100 MHz) using 4G/3G technologies. This allows existing MNOs to deliver 5G quickly and cost-effectively by simply upgrading their existing cellsites as soon as the technology, spectrum and market is ready.

15. Furthermore, New Zealand's existing MNOs are experienced in managing technical and operational issues related to the design and build of cell towers, inter-operator coordination, radio interference, and EMF related public concerns, among others. A wholesale provider new to the mobile industry will take considerable time to become familiar with these issues.

16. New Zealand's competitive mobile market will ensure that MNOs deliver fast and efficient deployment of 5G technology – or risk losing customers. Competitive pricing pressure

[8] Chris Keall, National Business Review, https://www.nbr.co.nz/article/spark-vodafone-2degrees-scorn-self-serving-5g-build-proposal-chorus-b-210963

also delivers lower costs to consumers without the need for on-going regulation characterised by a single wholesale 5G network.

17. Multiple networks also provide greater network resilience than a single model, important for our small and distant country beset by earthquakes and storms. Recent outages have shown the importance of multiple networks when single providers' sites have gone down following bad weather.

18. All three MNOs have publicly signalling their commitment to investing in 5G network technology. This efficient use of corporate investment is one of the key benefits to New Zealand of our competitive mobile environment – we enjoy continuously upgraded networks without government intervention, taxpayer subsidies or regulation.

### 2.2 Other regulatory issues

*Q3. What regulatory issues need to be considered from a 5G perspective in New Zealand?*

19. Vodafone supports removing any unnecessary impediments to the rapid and widespread deployment of 5G networks. There are two main areas that we believe need attention; Land Access and the National Environmental Standard for Telecommunication Facilities (NESTF).

20. First, where previous reforms to the Land Access regime focused on fibre installs, Vodafone would like to highlight the importance of land access for new site deployments of mobile networks. Easing access will help improve the speed of network delivery, ensuring Kiwis enjoy 5G technology without delay.[9]

21. Second, Vodafone supports a review of the NESTF, to ensure that 5G antenna parameters are included within this framework. We recommend that this review take place nearer to the commercial deployment of 5G technology, at a time when we will have a clear understanding of the technical designs.

22. Recent legislative processes, media attention and 5G trials have seen concerns raised by a small number of people in respect of electromagnetic fields (EMF). Vodafone is committed to ensuring that our network meet all local and international regulations, standards and best practices. We do not believe that the deployment of 5G technologies is

[9] We submitted a similar concern during the recent Select Committee proceedings of the Overseas Investment Amendment Bill whereby any new or renewed leases for cellsites captured as rezoned 'special' land would be subject to formal OIO review, a timely and expensive process that we estimated may occur 200 times per year.

cause for regulatory review within New Zealand in this area, as discussed in more detail below.

*Q4. What aspects of these regulatory issues are most significant for 5G?*

23. As mentioned above, EMF levels have had greater prominence in media coverage and public interest as MNOs begin 5G technology trials. It is important that New Zealanders understand and are reassured that 5G technologies conform to stringent standards, based on the best independent scientific knowledge globally.

24. All mobile devices and base stations in New Zealand meet national and international standards, based on guidelines set by the International Commission for Non-Ionising Radiation Protection, the World Health Organisation (WHO),[10] and the Ministry of Health's Interagency Committee[11].

25. For almost 70 years, scientists have examined non-ionising radio frequencies for any indication of risks to human health, and leading independent scientific bodies continue to review all of the available evidence. The majority of scientific opinion, supported by the WHO, is that there is no clear evidence that mobile phones or base stations present risks to human health. In 2014 the European Commission's Scientific Committee agreed with the WHO findings.[12]

26. In 2017, the GSMA published a report identifying that while there may be a small localised increase of electromagnetic energy when 5G is added to an existing site, or when coverage is provided in a new area, advances in base station design and new mobile communication technologies provide higher capacity with greater efficiency.[13] All mobile technologies, including 5G, are designed to minimise power to reduce system interference.

[10] Internationally, the World Health Organisation reviews and monitors EMFs http://www.who.int/peh-emf/en/
[11] The Committee assesses and makes recommendations whether any changes are required to operational and safety rules around EMF emissions based on local and international evidence. See: https://www.health.govt.nz/our-work/radiation-safety/non-ionising-radiation/research-non-ionising-radiation
[12] European Commission, Scientific Committees, "Final opinion on EMF" https://ec.europa.eu/health/scientific_committees/consultations/public_consultations/scenihr_consultation_19_en
[13] GSMA, "5G, the Internet of Things and Wearable Devices" 2017 https://www.gsma.com/publicpolicy/5g-internet-things-iot-wearable-devices

27. In summary, Vodafone notes that even allowing for additional 5G transmitters over time, total exposure to EMFs will remain very low relative to both national and international exposure limits.

# 3 Possible frequency bands for 5G

## 3.1 3.5 GHz band

*Q5. Do you agree that the 3.5 GHz band is the top priority for allocation for 5G?*

28. Vodafone agrees that the 3.5 GHz band is the top priority for 5G allocation.

29. Internationally, 3.4 to 3.8 GHz has been identified as the primary band below 6GHz for 5G rollout. Depending on allocation limits, this band will offer sufficient bandwidth to support key 5G features and use cases. The propagation characteristics at this frequency provide satisfactory coverage for deployment 5G on existing cellular networks.

30. Vodafone plans to use this band for the initial 5G rollout when the technology and market is ready. This will be dependent upon sufficient bandwidth being made available.

*Q6. Do you have any comments on reallocating 3587 to 3690 MHz for 5G?*

31. Vodafone considers reallocating 3587 – 3690 MHz is critical for 5G.

32. As acknowledged and recommended by 5G standards and the network equipment vendors, it is important that 5G runs on sufficient bandwidth, ideally with 100 MHz if using the 3.4 - 3.8 GHz band.

33. 5G is considered an evolution of 4G technology. It does not provide revolutionary new capability that offers a breakthrough in spectral efficiency. Instead it relies on the use of wider frequency bandwidth and aggregation of frequency bands, as well as other improvement of existing LTE technologies, like Massive MIMO, to provide increased user throughput and other features. Hence wide bandwidth is key to differentiate 5G from LTE+ both technically and commercially. This is the reason why it is important that mobile network operators obtain 100 MHz in this band.

34. Given the current state of the mobile industry and potential interests from regional operators and/or new entrants, it is critical that sufficient bandwidth in the 3.5 GHz band is

made available for IMT use, to provide opportunities for all existing MNOs to obtain up to 100 MHz while accommodating the regional operators in the same band, if that is required.

35. In addition to 3587 – 3690 MHz, it is critical that 3690 – 3800 MHz is also allocated for 5G use. There are a number of reasons for this:

    i. First, if only 3410 – 3690 MHz is allocated for 5G, just 280 MHz becomes available. This does not allow for all existing MNOs to obtain 100MHz as recommended by developing standards and equipment providers. If regional operators are also accommodated in this band, even less bandwidth is available for each MNO;

    ii. Second, in the above scenario, there is no room for any guard band between MNO's and regional operators. This will create difficulties in preventing interference should regional operators use non-3GPP compliant technologies, or use 3GPP technologies and do not synchronise with other MNOs. Should a guard band be reserved to prevent interference, it further reduces the available bandwidth to all operators; and

    iii. Third, and practically, in New Zealand 3690 – 3800 MHz is not heavily used, making it relatively easy to reassign for IMT use.

36. Allocating 3690 – 3800 MHz for 5G/IMT use would ensure sufficient spectrum across the 3.5 GHz band for both national MNOs and regional operators, whilst retaining the possibility of reserving a guard band between the two uses. This solution allows for the most cost efficient 5G network rollout while ensuring the best performance and service levels from each provider.

37. If the above recommendation is accepted, Vodafone proposes reserving 3410 – 3710 MHz for nationwide 5G use, with 3720 – 3800 MHz for regional use. Guard bands could be reserved between the two parts if required.

### 3.2 26 GHz band

*Q7. Do you agree that the 26 GHz band is a high priority for allocation to 5G in New Zealand?*

38. Vodafone believes that the 26 GHz, or mmWave band (here discussed as 24.25 - 29.5 GHz) is also an important band for 5G technology.

39. The available bandwidth would allow a spectrum allocation of up to 1 GHz to each MNO, providing greater user throughput and cellsite capacity. The short wavelength at this frequency enables the building of massive MIMO antennas at a practical size and reasonable cost. Such efficiencies are critical to realising the full benefits of 5G technology and meeting the projected increases of demand from existing and new 5G use cases.

40. Vodafone hopes to deploy 5G nationwide as soon as practically possible. With the availability of 3.5 GHz and a low-range frequency band (e.g. 600 MHz) also available for 5G use, the logical deployment strategy is to first implement 5G at 3.5 GHz on existing cellsites in urban areas and hot spots to provide a basic coverage layer to high density, high usage areas, and then deploy 5G on low frequency band in rural areas on existing rural cellsites, making use of our past investment in RBI projects. The lower band can also be implemented in higher density areas to improve deep in-building coverage.

41. Deploying 5G on the mmWave bands is likely to occur sometime after deployment on 3.5 GHz and the low frequency band. It will be deployed, on a case by case base, at locations where usage is high or where use cases require higher data throughput. With this in mind, we believe allocation of the 26 GHz band is less urgent than the 3.5 GHz and 600 MHz bands.

42. 24.25 - 27.5 GHz (Band n258) was identified for IMT/5G in WRC-15. However, recent developments in a number of countries appear to have pushed focus towards 26.5 - 29.5 GHz (Band n257). While we believe that both Bands n257 and n258 will eventually be supported by equipment and user device vendors, it is unclear at this stage which band will be supported earlier, in what timeframe, and how the device ecosystem for each of these bands (in combination with other bands) will shape up.

43. As New Zealand is a small market, it is important that we align our spectrum allocation with overseas regional markets so we can benefit from economies of scale as well as avoiding conflicting spectrum allocations/combinations that causes interference.

44. If MBIE decides to allocate only 24.25 - 27.5 GHz but not 26.5 - 29.6 GHz, there is a risk of misalignment with other markets if the industry decided to focus on band n257 instead of n258 later.

45. We recommend that the allocation of 24.25 - 29.5 GHz be made after WRC-19, when we have more clarity on global trends in this band. We do not believe that this delay will materially impact the 5G rollout in New Zealand.

*Q8. Would this band be of interest to your organization for trials for 5G services in New Zealand?*

46. Yes. Vodafone suggests delaying formal allocation of this band for 5G. However it is important that this band be made available for technical trials and other temporary usage. Vodafone recently partnered with Nokia to conduct some 5G trials and we expect further tests using the 24.25 - 29.5 GHz band in the coming years.

### 3.3 Other extremely high frequency bands

*Q9. Do you agree that the 31.8 to 33.4 GHz, 40.5 to 42.5 GHz and 42.5 to 43.5 GHz bands are a lower priority for allocation to 5G in New Zealand?*

47. Vodafone agrees that the 31.8 to 33.4 GHz, 40.5 to 42.5 GHz and 42.5 to 43.5 GHz bands are a low priority for allocation to 5G in New Zealand at present. The planning and allocation of these bands can be considered later.

*Q10. When do you think equipment is likely to become available in the bands identified in Q9?*

48. Vodafone is not aware of when equipment in these bands will become commercially available.

*Q11. Do you have any comment on the possible allocation of 27.5 to 29.5 GHz to IMT?*

49. Please refer to our comments for Q7 and Q8.

### 3.4 Possible ultra high frequency bands

#### 3.4.1 1400 MHz band

*Q12. Is there demand for alternative uses other than IMT of the 1400 MHz band? If so, what uses?*

50. Vodafone is not aware of any demand for alternative use other than IMT of this band in New Zealand.

*Q13. When is the demand likely to require consideration of reallocation of the 1400 MHz band for IMT, if at all?*

51. Vodafone notes that this band was identified for IMT in WRC-15. However agreement is yet to be reached regarding usage of this band, either internationally or locally. For example,

there is not yet consensus whether this band should be allocated as FDD, TDD or Supplement Downlink (SDL).

52. Current industry thinking indicates this band is likely to be used initially to provide extra LTE capacity. However, with many markets still deploying 4G on other similar bands (e.g. 1800/2100/2600 MHz and 700/800/900 MHz) the requirement for 1400 MHz is not urgent. The situation in New Zealand is similar to that internationally.

53. Given the lack of consensus in band planning and the lack of urgent demand for 1400 MHz spectrum, Vodafone recommends that MBIE delay decisions on allocating this band for a further two to three years.

54. Vodafone believes this band will be required at some stage in the future for 5G as 1400 MHz is a frequency band that potentially offer a good coverage range that will be very valuable for providing more 5G capacity in low population density areas.

### 3.4.2 600 MHz

*Q14. Is there a need for more sub 1 GHz spectrum for IMT/5G?*

55. Vodafone believes that the success of 5G in New Zealand is critically dependent on more sub 1GHz spectrum being made available.

56. With our low population density, especially outside of the few main centres, it can be challenging to build economically viable mobile networks in New Zealand. Critical to this is ensuring that coverage from each cell site reaches a sufficient number of users. For low density areas, this is only possible by using sub 1 GHz frequencies with its favourable propagation properties.

57. Delivering 5G to low density residential areas and rural New Zealand is not economic if MNOs must rely only on 3.5 GHz and higher frequencies. The deployment of 2G, 3G and 4G technologies has proven this.

58. MNOs in New Zealand currently use 700, 850 and 900 MHz bands for 2G, 3G and/or 4G technology. It is not possible to repurpose these bands for 5G use in the foreseeable future as all MNOs need to ensure long term continuity of these existing services. For this reason, more sub 1 GHz spectrum must be made available for 5G.

59. The 600 MHz band has been identified for IMT/5G at WRC-15. In the United States, 600 MHz has already been allocated and deployments have started in this band, creating a growing ecosystem of equipment and device support. A number of network equipment manufacturers (including our vendor Nokia) already supply equipment in this band, which both supports 4G technology and is upgradable to support 5G.

60. 600 MHz is lightly used in New Zealand. The declining over-the-air TV market means future digital TV use is unlikely in this band, making it relatively easy to allocate it for IMT/5G use.

61. Vodafone believes that for New Zealand to fully realise the benefits of 5G (and avoid creating any further digital divides) all areas where people live, work and play must eventually be covered. Increased availability of sub 1 GHz spectrum is critical to this.

*Q15. If so, how should we deal with radio microphones in the 600 MHz band?*

62. Vodafone considers it is fair that the government offer a full or partial subsidy to radio microphone users who recently migrated to this band and have devices that cannot be re-tuned to frequencies below 600 MHz. The cost could be factored into the allocation price of this band.

63. A two-year grace period could be offered to radio microphone users which would provide sufficient time to re-tune or replace their equipment.

*Q16. When is the demand likely to require reallocation of the 600 MHz band to IMT, if at all?*

64. Vodafone plan to initially deploy 5G on 3.5 GHz, starting in urban and other high density areas. Following this and subject to availability, we will deploy 5G in other parts of New Zealand on 600 MHz. We anticipate this deployment will take place two to three years after the initial 3.5 GHz rollout. Our third phase will be to deploy 5G on mmWave bands.

65. To allow for appropriate planning and purchasing, Vodafone recommends that the 600 MHz band be allocated after the 3.5 GHz allocation but before that of the mmWave band.

# 4 Spectrum Allocation

## 4.1 Allocation methodology

*Q17. Which allocation methodology should be used for allocating spectrum bands identified for use with 5G? Why?*

66. Vodafone recommends that for allocation of "new" IMT bands, including 600 MHz, 1.4 GHz, mmWave and higher, the government use auctions.

67. For 3.5 GHz, we consider there is merit in using a mix of renewals and auction. A mixed approach will reduce uncertainty of outcomes while avoiding any artificial price inflation. Any cost savings for MNOs will increase funds available for the actual implementation of 5G.

*Q18. Should different allocation mechanisms be used for rights for regional providers and national providers? Why?*

68. Vodafone believe different allocation mechanisms should be used for regional operators and national operators.

69. To successfully deploy 5G networks across New Zealand, national providers require nationwide Management Rights with long terms. This can be achieved through the allocation methods recommended in Q17.

70. We believe regional operators face different challenges. They are smaller, often have less access to funding, and higher fluidity. With this in mind, we think it is likely they would benefit from greater flexibility and lower initial costs. This can be achieved through short-term regional Management Rights, or by licencing only (similar to the current practice).

71. It is important that long-term, nationwide Management Rights and any short-term, regional Management Rights/Licences are in different parts of the spectrum and do not overlap. This is critical in managing interference and ensuring optimal use of all frequency bands.

## 4.2 Implementation requirements

*Q19. Should deployment of 5G technology be specified for some or all bands? If not, why not?*

72. Vodafone does not believe that detailed requirements should be imposed for any of the bands discussed in this submission.

73. It is best to let industry decide the exact technology and services to be implemented on each frequency band allocated.

74. Specifying exact technology to be used as part of any allocation risks inflexibility in the face of potential technology and market change. Such changes are not always foreseeable. The implementation conditions for the 2.6 GHz band is one such example.

75. We do accept however, that some general conditions be specified for each of the frequency bands. This can be in the form of broad service types, e.g. for IMT use, or as a requirement to be aligned with prevailing international best practice as recommended by 3GPP/ITU.

*Q20. What implementation requirements should be specified and how should these be expressed? Time, extent, etc.*

76. Any implementation requirements could be similar to those imposed on the 700 MHz band, and tuned to the specific characteristics of each band.

77. For the 3.5 GHz band, Vodafone recommends a percentage population coverage requirement over 5 years. We believe this will provide the right incentives for spectrum owners to roll out services and prevent "land banking" of spectrum. Qualification SLAs can be imposed to ensure the services offered are of sufficient quality in line with those intended by 5G standards.

78. For 600 MHz, Vodafone recommends a percentage population coverage requirement for rural or lower density suburban areas. Again qualification SLAs should be used to ensure the quality of service offered.

79. Because 24.25 - 29.5 GHz is likely to be used for capacity purposes, it is more difficult to use coverage as an implementation requirement. A better requirement could be the number of cell sites (small cells) to be built.

*Q21. What should be the consequence of non-implementation – lose spectrum, additional payment, other*

80. Management Right owners should be given an opportunity to extend their implementation deadlines by a set time period, provided that the delay is caused by

factors not under their control. Such factors include technical reasons like delays in finalisation of industry standards, availability of network equipment supply etc., or unforeseen reasons such as a large scale nature event like an earthquake.

81. Should owners still fail to meet their requirements after the extension, they should ultimately lose their spectrum allocation.

82. The assessment criteria for meeting requirements should be clear, precise and transparent, to avoid manipulation by any party.

*Q22. Should the implementation requirements be different for regional and national providers? What should these be and why?*

83. Vodafone believe implementation requirements should be different for regional and national providers.

84. Regional providers and national providers have different business models, targeting different marketing segments, and possibly using different technologies. These differences allow New Zealanders greater choice when selecting a provider to meet their needs, in their location. This variety and choice is indicative of a healthy, competitive market.

85. We propose that implementation requirements for regional providers are similar in form to those for national providers, but with different numbers and timeframes depending on the region in which they operate. For example, a percentage population coverage within a defined region, or number of sites with a defined SLA. To ensure spectrum is utilised, we propose that regional providers are also subject to similar non-implementation processes and consequences as national providers.

### 4.3 Acquisition limits

*Q23. Should acquisition limits be imposed on 5G bands? If so, what should these be and why?*

86. We believe an acquisition limit within a finite time can be imposed on 5G bands. This would ensure all MNOs get their fair share of spectrum. The actual limit however, needs to allow MNOs to acquire sufficient bandwidth for the full potential of 5G technology to be realised.

87. Current developments in 5G technology enable network equipment to utilise up to 200 MHz bandwidth in the 3.5 GHz band, providing 10+ Gbps throughput. However, given the

total amount of spectrum available in this band, we recommend an initial spectrum cap of 100 MHz over the first 3-5 years for nationwide Management Rights in this band. This is in line with the industry standard and vendor recommendations that allow MNOs to provide customers with a good 5G experience.

88. We believe that allocation of spectrum in the 3.5 GHz band to regional providers should be dependent upon the total amount of spectrum made available. We see two distinct scenarios:

    a. If 3410 – 3800 MHz is made available, regional providers may have an initial limit of 40 MHz within a limited region over 2-3 years.

    b. If, however, only 280MHz is allocated in the 3.5GHz band, regional providers should not be offered any frequency in this band in any region. To do so would reduce the amount available to national operators, severely limiting the end user's experience.

89. For the 600 MHz band, we suggest acquisition limits be set at 2x20 MHz due to the limited total amount of spectrum available.

90. In the 24 - 29 GHz band, there are relatively large amounts of spectrum available. Recent technology developments in this band already make it possible to use up to 1 GHz bandwidth to offer more than 40 Gbps data speed. The technology is likely to be further refined in the future, allowing even wider bandwidth to be used. To make sure New Zealanders can enjoy the full benefit of the technology, an acquisition limit of 1GHz should be allowed in this band.

*Q24. Should acquisition limits be imposed for regional providers? If so, what should these be and why?*

91. See comments for Q23

### 4.4 Duration of allocated rights

*Q25. What term should be used for management rights suitable for 5G? Why?*

92. Management Rights for nationwide 5G spectrum should be for a term of 20 years. This will provide sufficient long-term certainty and encourage investment while providing enough time for operators to recover their initial costs.

93. It is also important that renewal dates across different spectrum bands are staggered. This prevents Management Rights for different frequencies expiring at the same time, reduces the impact to a business in the case of non-renewal, and smooths CAPEX requirements.

94. It may be more appropriate for Management Rights for regional providers to be for a shorter term. This would better accommodate their smaller investments, on a shorter investment life cycle and may also provide more flexibility for re-assigning spectrum should they be impacted by significant technology or market changes. A term of 5-10 years may be more suitable in such cases.

# 5 Management rights for 5G

## 5.1 Band planning

*Q26. Should the 5G bands be re-planned as TDD bands or some bands or parts of bands be retained as FDD? Why?*

95. 5G spectrum band plans should follow prevailing industry standards, best practice and recommendations from international standard bodies. This is crucial for New Zealand given our small market.

96. Vodafone recommends the following arrangements:

- 3.5 GHz: TDD
- 600 MHz: FDD, as per Band 71
- 1.4 GHz: Supplement Downlink (SDL)
- 24.25 - 29.5 GHz: TDD

## 5.2 Bandwidth

*Q27. What bandwidth should be used as the basis for allocation? Why?*

97. Vodafone recommends the following bandwidths be used for allocation:

- 3.5 GHz: 20 MHz
- 600 MHz: 5 MHz paired (2x5 MHz)
- 1.4 GHz: 10 MHz
- 24.25 - 29.5 GHz: 200 MHz

## 5.3 Out of band emissions

*Q28. What out of band emission limits should apply to management rights when first created for allocation? Why?*

*Q29. Should out of band emission limits be different if the band is technology neutral? If so, what out of band emission limits should be applied?*

98. The out of band emission issue related with 5G standards is still being discussed hence no confirmed solution or recommendation is available from the industry standard bodies or

equipment vendors. We suggest that this issue be further discussed as part of the technical workshop related to interference issues that RSM is leading in parallel with this consultation.

99. In general, the emission limits should consider AAS deployment (active antennas), Massive MIMO, and TDD deployment and should address both synchronised and non-synchronised deployment with carrier bandwidths up to 100 MHz for 3.5 GHz band and up to 1 GHz for mmWave band. Emission limits should be technology agnostic if technically possible.

*Q30. How should interference between adjacent frequency 5G TDD networks be managed? Should this be the same for all frequency bands?*

100. Industry research and development continues on this issue.

101. If TDD 5G is used on all adjacent frequencies, synchronisation between networks provides the most efficient use of spectrum. Dependent on the government's configuration decisions, we expect all MNOs will use TDD 5G, allowing for this coordination. This is the ideal situation that provides the most benefit to New Zealand.

102. If different technology is used on adjacent frequencies, it becomes much more difficult to manage interference without a sufficient guardband. This scenario is highly likely if part of the band is allocated for regional providers on a technology neutral base.

103. To avoid these difficulties, Vodafone strongly recommends that the 3410 – 3800MHz band be fully allocated for IMT/5G use. The upper part of the band may be allocated for regional providers with a guard band between nationwide MNOs and regional providers. This provides the easiest solution for preventing interference between operators.

104. If only 3410 – 3690MHz is allocated for 5G use, then regional providers should not be allocated any frequencies in this band. They should instead be accommodated in other frequencies.

*Q31. How should interference between different technologies within the same band be managed, if bands are technology neutral?*

105. The only effective method to prevent interference between TDD 5G and other non-3GPP technologies on adjacent frequencies is to reserve sufficient guard bands between them.

106. We believe that national MNOs, in the rare case they decide to use different technologies, should be responsible for working together to manage interference. Such interference will affect both parties equally, and is therefore it is in both parties' interest to find a solution. National MNOs also tend to have sufficient expertise and support from their vendors as well as funding to implement agreed solutions.

107. This may be different for regional providers, who are likely to be smaller businesses with limited resources and access to technical support. If they choose to use different technologies, it may prove more difficult to implement solutions to prevent interference. We recommend that the frequency bands for regional providers be isolated from national Management Rights holders with a guard band, or that regional providers are allocated frequencies in different bands.

# 6 Access to Spectrum for Regional Providers

*Q32. Should regional uses be provided for in the 3.5 GHz band plan? Why?*

108. As indicated in our comments for previous questions, it is important that sufficient bandwidth is allocated to national MNOs. Otherwise the full features and benefit of 5G technology cannot be realised.

109. Accommodating regional providers in the 3.5GHz band plan is dependent upon the amount of spectrum available. We see two scenarios:

    a. If only 3410 – 3690MHz is allocated for 5G/IMT use, it provides just 280 MHz of usable bandwidth. This is less than 100 MHz for each of New Zealand's MNOs. In this case, we believe no spectrum in this band should be allocated to regional providers. Instead, they should be accommodated in other frequency bands, including 2GHz, 2.3GHz, and possibly the mmWave band.

    b. If 3410 – 3800MHz is allocated for 5G/IMT use, then sufficient spectrum is available for MNOs to obtain 100 MHz each, and provide 80MHz for regional providers. This would also provide an optional 10MHz guardband between the band for MNOs and that for regional operators, delivering an easier solution for potential interference issues.

110. Should this second scenario be agreed by RSM, we recommend reserving 3410-3710MHz for national allocation, 3720–3800MHz for regional allocation, and using 3710 – 3720MHz as the guardband.

*Q33. If allowed in the 3.5GHz band, how could this be managed or facilitated?*

111. Please refer to our comments for Q32.

*Q34. Which alternative bands may be suitable for regional allocation? Why?*

112. If insufficient bandwidth is allocated in the 3.5GHz band, regional providers may be accommodated in the following bands (assuming no renewal is offered to existing Management Rights holders):

- 2053 – 2110MHz
- 2236.5 – 2300MHz
- 2370 – 2395MHz
- Part of 24.25 - 29.5GHz (as part of the mmWave allocation)

113. These bands provide sufficient bandwidth for regional operators.

# 7 Timing

## 7.1 3.5 GHz band

*Q35. Is early access to the 3.5GHz band required for roll out of 5G networks prior to the expiry of existing rights in 2022? If so, why?*

114. Yes. Information from the mobile industry indicates that 5G technology standards, equipment and devices will be ready and commercially available around 2019. We expect that MNOs would be in a position to start deploying 5G on the 3.5GHz band in 2020 with an early launch around 2021.

115. Ahead of a full commercial launch, MNOs also need time and spectrum for trials and tests. The current Management Rights likely prevent this.

116. For these reasons, Vodafone believes early access (ideally before 2020) to the 3.5GHz band is critical to the successful deployment of 5G in New Zealand.

*Q36. How could early access to the 3.5GHz band be achieved?*

117. To provide Management Rights holders with the certainty required to develop 5G blueprints and provide adequate time to rollout networks, we propose the following method to achieve this :

    i. Government offer existing Management Rights holders early renewal equivalent to existing holdings. The remaining spectrum in the 3410 – 3800 MHz band could then be auctioned off. Any renewals would count towards each provider's total spectrum cap. The renewal cost could be set based on the auction reserve price.

    ii. For those Management Rights holders who do not wish to take up the renewal offer and/or do not wish to participate in the subsequent auction, Government to pay the difference between the new expiry date and the remaining term. The cost can be set based on the auction reserve price.

    iii. A protection mechanism, such as limited-time spectrum licences, could be offered to existing Management Rights holders for current usage until October 2022. With the majority of current usage in rural areas, this would only have limited impact on the rollout of 5G before October 2022, which will likely to be focused in urban areas.

*Q37. Should the government be involved in early access arrangements for the 3.5GHz band?*

118. As we proposed in comments for Q36, the early re-plan process becomes part of the allocation process, which means the government needs to take a leading role to make it happen.

### 7.2 26GHz band

*Q38. Is early access to the 26GHz band required for roll out of 5G networks prior to the expiry of existing rights in 2022? If so, why?*

119. As discussed in Q7 and Q8, Vodafone recommends that decisions regarding allocation for this band are postponed until after WRC-19. We do not think it is necessary to have full access to this band before the expiry of existing rights in 2022. However, limited and temporary access for testing and trial are likely to be required. This can be accommodated using temporary licences either from the government, or from existing Management Rights holders.

*Q39. How could early access to the 26 GHz band be achieved?*

120. As suggested in our responses for Q7, Q8 and Q38, we do not think early access to this band is required.

### 7.3 Other bands

*Q40. When is demand for the bands above 30 GHz likely to eventuate?*

121. We do not have sufficient information or knowledge to determine when these bands will be required for 5G/IMT use.

*Q41. When is demand for the 600 and 1400 MHz band likely to eventuate, if at all?*

122. Per our responses in Q14, Q15 and Q16, 600MHz is needed after 3.5GHz. We suggest that the 600MHz band be allocated after the 3.5GHz band, but before mmWave bands.

123. The requirement for 1400 MHz is still uncertain, with unresolved issues regarding the band plan. Demand for this band may arise at a later stage, possibly 2-4 years after the first launch of 5G services in New Zealand.

# Conclusion

124. 5G technology is poised to deliver real benefits to New Zealand. This upgraded network technology will allow for the realisation of many technology advances, from driverless cars and machine learning through to advanced robotics. These benefits will help improve education, healthcare, security, social and environmental outcomes, while increasing employment.

125. Realising these benefits is dependent upon strong mobile market competition, providing Kiwis with real choice. It is dependent upon early and sufficient access to spectrum to allow for appropriate planning, testing and purchasing equipment for rollout. It is dependent upon national and regional providers meeting reasonable implementation obligations while delivering networks free from interference.

126. The government has a role to play in facilitating all of these conditions for a world-class 5G network. We thank the Ministry for the opportunity to contribute to this discussion and look forward to continuing our engagement in this area.