

PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

# The Next Gen Future

*Inquiry into the deployment, adoption and application of 5G  
in Australia*

House of Representatives Standing Committee on Communications and the  
Arts

March 2020  
CANBERRA

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# Members

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# Terms of Reference

The House of Representatives Standing Committee on Communications and the Arts will inquire into and report on the deployment, adoption and application of 5G in Australia.

5G refers to the fifth generation of mobile technology, in line with the International Mobile Telecommunications-2020 (IMT-2020) Standard of the International Telecommunications Union and the associated releases of the 3rd Generation Partnership Project (3GPP).

The Committee will:

- 1 Investigate the capability, capacity and deployment of 5G;
- 2 Understand the application of 5G, including use cases for enterprise and government.

Matters relating to national security are out of scope for this Committee.





# List of Recommendations

## **Recommendation 1**

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2.167 The Committee recommends that spectrum allocation be finalised expeditiously and that the Australian Communications and Media Authority, in conjunction with the Department of Communications and Australian Competition and Consumer Commission, investigate how future spectrum auctions can promote improved market competition for the benefit of consumers.

## **Recommendation 2**

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2.168 The Committee recommends that the Australian Government facilitate discussions between carriers, network operators and utility and infrastructure owners for managing redundant and/or ageing telecommunications equipment.

## **Recommendation 3**

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2.169 The Committee recommends that the Australian Government commence a review of the low impact facilities framework to ensure that its powers to encourage co-location of facilities and equipment are fit-for-purpose in a 5G environment. As part of this process, the Australian Government should begin reviewing carrier arrangements for 5G infrastructure sharing.

## **Recommendation 4**

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2.170 The Committee recommends that the Department of Communications and the Arts assess the suitability of current powers and immunities arrangements, especially in relation to the timeframes for raising objections,

noting the likelihood of an increased number of installations for the deployment of 5G.

### **Recommendation 5**

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- 2.171 The Committee recommends that carriers work with state and territory road and transport infrastructure managers to ensure that safety standards are maintained.

### **Recommendation 6**

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- 2.172 The Committee recommends that carriers consider multiuser infrastructure sharing to ensure that rural and regional consumers benefit from 5G services in a timely manner, and ensure adequate coverage across all 5G spectrum bands.

### **Recommendation 7**

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- 2.173 The Committee recommends that carriers ensure rollout trials are conducted in regional and remote areas, and the Committee notes proposals for large scale trial with one of Australia's most innovative farming regions.

### **Recommendation 8**

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- 2.174 The Committee recommends that the Australian Government investigate ways to encourage the manufacture of 5G infrastructure within Australia.
- 2.175 This may be done initially via the Department of Industry, Science and Technology working with Australian telecommunications and related industry partners to examine how Australia could actively participate in the manufacture of components and equipment for use in the rollout of 5G networks - and that manufacturing partnerships be considered with Canada, New Zealand, United Kingdom and United States.
- 2.176 To help enable this, the Australian Government should establish a 5G R&D Innovation Fund to fast track the development and scale-up of alternative manufacturing approaches to reduce the duopoly dependency on 5G related equipment.

### **Recommendation 9**

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- 2.177 The Committee recommends that the Australian Government conduct a review of current legislative arrangements enforcing network and data

security for the supply of 5G equipment. Further, as part of this framework, it must be incumbent on vendors to enforce Cyber Supply Chain Risk Management throughout procurement, roll out and maintenance of the 5G network.

### **Recommendation 10**

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2.178 The Committee recommends that ARPANSA implement a suitable mechanism to consult with members of the community regarding the safe levels of electromagnetic radiation.

### **Recommendation 11**

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2.179 The committee, welcoming the Australian Government's decision to establish a new community information campaign on 5G, recommends that the Government work closely with the ACMA to develop an integrated and comprehensive campaign that can respond to concerns raised about the new network.

### **Recommendation 12**

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2.180 The Committee recommends the Department of Communications and Department of Education and Training, review how current ICT curricula for roles in 5G related industries in TAFE, accredited training providers and tertiary institutions should be modified to ensure graduates are industry-ready.

### **Recommendation 13**

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2.181 The Committee recommends the Australian Government lift apprenticeships in the ICT sector apprenticeships to assist with the rollout of 5G in Australia.

### **Recommendation 14**

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3.99 The Committee recommends that the Australian Government work with carriers to develop campaigns to boost industry awareness about the advantages of 5G to businesses to help realise the benefits of this new network quickly. This campaign should include elements to lift 5G awareness within local government.



# Foreword

The fourth industrial revolution, or ‘Industry 4.0’, is coming. Australians will experience a blurring of the lines between cyber and physical in their workplace, home life, leisure time and travel. The enabling architecture needed to support this revolution in communications technology is fifth-generation mobile network technology, or ‘5G’.

5G builds on current 4G technology, but it is not more of the same. 5G does a number of things differently, from the radio waves to the equipment, handsets, infrastructure and application. 5G will use multiple bands of radio waves (spectrum bands), including bands in a higher frequency to those used for older generations of mobile phone technology. The different way of using spectrum bands means that new equipment and infrastructure are needed in order to transmit information using these radio waves.

Ultralow latency and vastly increased amounts of data that can be carried at any one time are two main features of 5G, and combined, allow a number of use cases to be explored. Automated vehicles, agricultural technology, virtual and augmented reality experiences, remote health and a number of other applications are possible.

The capabilities of 5G are exciting, and offer the opportunity for innovation and connectivity. We are at a point where enough is known about the standards and safety of 5G technology to allow businesses of all sizes, communities, governments and individuals to imagine new use cases and new opportunities and help them come into being.

The Committee heard about Australian-led innovative technology from Cohda Wireless, an Adelaide-based company which is the leader in the emerging vehicle communication market. Cohda Wireless will use 5G to expand its work on

allowing vehicles to communicate with the traffic system and all surrounding vehicles, and use 5G's low latency and high capacity to develop further advances.

WA Farmers told the Committee that agriculture is a digital-reliant industry in need of the next wave of mobile technology in order to continue being productive and competitive in a global market. Combating food fraud, using metadata to lower the impact on the soil when cropping, improving animal welfare and attracting a greater investment in agtech were all noted as opportunities in the near future. The improvements to productivity that could be afforded by 5G were called a 'generational leap'.

Unfortunately, a vast amount of misinformation about the safety and impact of 5G is out there. The Committee received a large amount of information from inquiry participants who were concerned over the deployment of 5G and asserted that 5G would have a detrimental impact on human health. The Committee heard from a number of Australian Government agencies and officials that 5G is safe for humans.

Perhaps some confusion comes from the new spectrum bands 5G will use. The Committee heard that 'higher frequency does not mean higher power', and that, in fact, devices will operate at a lower power due to focussing the 5G signal only to where it is required and the increased number of antennae, which means that users will have less exposure than under previous generations of mobile technology.

The Committee understands that new technology can be complex to understand, and that members of the community may be unsure of its safety. The Committee has been assured that 5G is safe.

Better communication of 5G mobile technology is essential to help dispel some of the myths that exist around 5G. The Australian Government has committed to a public awareness campaign to communicate the safety of 5G. The Committee believes that this needs to continue, and a range of audiences included so that community fear can be addressed.

This 5G inquiry is a Parliament first, and the Committee has heard that the benefits of 5G will be experienced by all Australians if the deployment and adoption can be done successfully. The Committee heard from a number of sectors that 5G is necessary for continuing to be a competitor in the global market. Australia has an opportunity to be a centre of 5G equipment component manufacturing, a place for communication technology startups to develop their ideas and a nation connected.

**Hon Dr David Gillespie MP**

# 1. Introduction

## Background

- 1.1 Australia is set to experience a 'fourth industrial revolution', sometimes called Industry 4.0, in which the lines between cyber and physical are blurred. Fifth-generation mobile network technology, or '5G', will create the architecture which will underpin new uses and services. It will allow innovation by opening up possibilities for businesses, industries, services and leisure through 'intelligent connectivity'.<sup>1</sup>
- 1.2 5G technologies build upon the current 4G technology. Like previous generations of mobile technology, 5G uses radio waves to transmit information, although it 'will offer significantly greater capacity and faster data speeds, significantly lower signal latency or delay, and will support much larger numbers of devices in a given area.'<sup>2</sup>
- 1.3 The capabilities of 5G are derived not only from the higher frequencies used to transmit more data, but from technologies such as 'multiple input, multiple output (MIMO) antennas, beamforming, edge computing and network slicing'.<sup>3</sup> MIMO and beamforming allow radio signals to be sent directly to users; edge computing processes data nearer to where it is generated and network slicing permits services to be segmented, allowing dedicated networks within the same infrastructure.<sup>4</sup>

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<sup>1</sup> Mr Chris Althaus, Chief Executive Officer, Australian Mobile Telecommunications Association (AMTA), *Committee Hansard*, Canberra, 6 December 2019, p. 1.

<sup>2</sup> Department of Communications and the Arts, *Submission 330*, p. 2.

<sup>3</sup> Department of Communications and the Arts, *Submission 330*, p. 3.

<sup>4</sup> Department of Communications and the Arts, *Submission 330*, p. 3.

- 1.4 Australians are using their mobile phones to download data more than ever before. In the four years up to June 2018, the amount of data downloaded on mobile handsets increased six-fold, from 38,000 terabytes (TB) to nearly 250,000 TB.<sup>5</sup> The acceleration in demand is expected to continue, creating unprecedented demand in mobile traffic.
- 1.5 Use of mobile phones surrounds us. With around 34 million mobile voice and data services in operation in Australia, there are 1.4 services for every person.<sup>6</sup> Rising mobile data traffic and an increasing number of mobile connections means there is a need for a generational upgrade of mobile wireless technology.
- 1.6 Fifth-generation mobile network technology, or '5G', is the next step in mobile communications, and is expected to provide 'the underlying architecture that will enable the next wave of productivity and innovation across different sectors of the Australian economy'.<sup>7</sup> The Committee notes, however, that caution has been urged in embracing overly enthusiastic claims about the potential of 5G. In particular, the Australian Communications Consumer Action Network (ACCAN) stated that there will remain bandwidth and technology limitations with 5G:

We are already seeing overzealous pronouncements on the capabilities of 5G before it has been fully deployed in Australia, including insufficient consumer information about the actual capability of 5G networks.<sup>8</sup>
- 1.7 5G will use extremely high frequency (EHF) radio signals to transmit information, which will allow more reliable and faster connections than the current 4G networks. 5G will be able to transmit a high volume of data to mobile and Internet of Things (IoT) devices, and allow a number of new capabilities of mobile communications.
- 1.8 Carriers stated that 5G will require significant investment in telecommunications infrastructure, including physical equipment, devices and spectrum bands used to carry the signals between base stations and devices.

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<sup>5</sup> Australian Communications and Media Authority, *Communications Report 2017-18*, February 2019, p. 10.

<sup>6</sup> ACMA, *Communications Report 2017-18*, February 2019, p. 32.

<sup>7</sup> Department of Communications and the Arts, *5G – Enabling the future economy*, October 2017, p. 1.

<sup>8</sup> Australian Communications Consumer Action Network (ACCAN), *Submission 341*, p. 2.



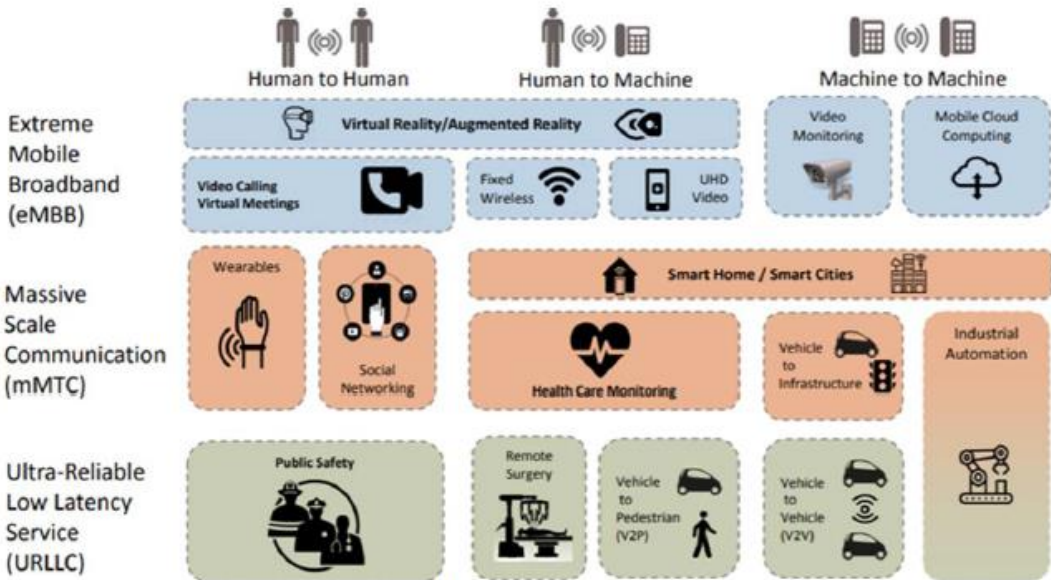
- 1.9 Australia is a strong adopter of mobile technology, and earned the highest mobile connectivity index score conducted by the GSM Association (GSMA). This index considered infrastructure, affordability, consumer readiness and content and services.<sup>9</sup> Australia's early participation in the development of 5G standards means that Australians are well poised to see the early opportunities 5G mobile technology affords.
- 1.10 The communication of the reality of 5G has been neglected, however, allowing fears over health and safety, the technology involved and the application of 5G to take hold. Misinformation has filled the vacuum and public confidence in 5G has been shaken.
- 1.11 Community perception of health risks, privacy loss and negative effects of relying on technology are relatively widespread, with a number of inquiry participants putting their views forward. Inquiry participants advocated for the deployment of 5G to be stopped, and asserted that 5G was not in the interest of the public.
- 1.12 In contrast, representatives of the telecommunications industry stated that 5G was 'not optional', and considered that 5G would allow solutions to 'some of our most compelling challenges at a global and national level'.<sup>10</sup>

**Figure 1.1 Applications enhanced or supported by 5G**

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<sup>9</sup> GSMA, *GSMA Mobile Connectivity Index*, <https://www.mobileconnectivityindex.com/#year=2018> (accessed 18 December 2019).

<sup>10</sup> Mr Althaus, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 1.



Department of Communications and the Arts, Submission 330, p. 6.

## About the Inquiry

### Objectives and Scope

- 1.13 On 13 September 2019, the Minister for Communications, Cyber Safety and the Arts, the Hon Paul Fletcher MP, referred the *Inquiry into the deployment, adoption and application of 5G in Australia* (the inquiry) to the Standing Committee on Communications and the Arts (the Committee).
- 1.14 As part of the inquiry, the Committee looked into:
- what 5G mobile technology is capable of;
  - how it might be deployed; and
  - use cases for enterprise and government.
- 1.15 The terms of reference also stipulated that matters relating to national security were out of scope for the Committee.
- 1.16 The Committee heard that there are strong concerns over the potential health effects of 5G. The Committee appreciates the information provided by inquiry participants raising their concerns, and understands that avenues for raising these concerns have been limited in the past.
- 1.17 The Committee accepted a large number of submissions which solely addressed concerns over how the deployment of 5G may affect human health. As the Committee is not a health committee, it was limited in its

ability to investigate this issue fully. The Committee sought to inform itself about this issue, and refers to it later in the report.

## Inquiry Conduct

- 1.18 A media release announcing the inquiry was issued on 19 September 2019, calling for submissions to be received by 1 November 2019.
- 1.19 The Committee also invited submissions from communications industry bodies, mobile network and virtual network operators, standards setting bodies, component and infrastructure manufacturers, software developers, online service providers, academic researchers and government bodies.
- 1.20 The Committee accepted a large number of submissions after the submissions closing date.
- 1.21 The inquiry received 537 submissions and 50 exhibits, which are listed at Appendix A and B respectively.
- 1.22 The Committee held six public hearings, outlined in the table below. A list of witnesses and organisations is at Appendix C.

**Table 1.1 Public Hearings Held**

Date	Place
19 November 2019	Southport, Queensland
6 December 2019	Canberra, ACT
17 February 2020	Perth, WA
18 February 2020	Adelaide, SA
19 February 2020	Melbourne, Victoria
20 February 2020	Sydney, NSW

## Report Structure

- 1.23 Chapter 2 discusses the rollout of 5G mobile technology in Australia, and examines the challenges raised, the role of governments at all levels and the importance of partnerships. Community concerns over the rollout of 5G are discussed, and include concerns over potential health effects, the impact of the deployment on the environment, and fears of privacy of personal data.

- 1.24 Chapter 3 looks at what 5G can do at a broad level, and highlights the capacity and capability of 5G. The immediate and medium-term use cases of 5G for enterprise and government are also highlighted. The consumer experience of 5G is also discussed.

## **Department of Communications and the Arts**

- 1.25 As a result of the Administrative Arrangement Order introduced on 5 December 2019, the functions that were previously the responsibility of the Department of Communications and the Arts were transferred to the Department of Infrastructure, Transport, Regional Development and Communications as of 1 February 2020. This report uses the name Department of Communications and the Arts.

## 2. The rollout of 5G in Australia

### Overview

- 2.1 5G mobile technology will operate on different bands of radio waves (spectrum bands) in a higher frequency to the bands used for previous mobile technology generations. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) explained that '5G is a brand name. It's not an actual physical quantity, the same with 4G before that. The actual physical quantity is radio waves'.<sup>1</sup>
- 2.2 The higher frequency 'millimetre wave' band (mmWave) will be used as frequencies carry more data the higher in the spectrum they are, however, they are less able to penetrate buildings. New equipment and infrastructure will need to be deployed in order to allow the mmWave to be used for 5G.
- 2.3 Australia's mobile communications infrastructure will require significant investment from carriers like Telstra, Optus and Vodafone Hutchison Australia (VHA) in order to carry 5G mobile technology. Carriers stated that government and industry would need to work together to achieve a successful deployment of 5G, and some policy challenges would need to be addressed.
- 2.4 The design of mobile networks will need to change, and will continue to use towers with transmitters for wide area coverage, but use a greater number of small cells, which are generally mounted on existing infrastructure (e.g. light and power poles) and have lower power output.<sup>2</sup>

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<sup>1</sup> Dr Ken Karipidis, Assistant Director, Assessment and Advice, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), *Committee Hansard*, Canberra, 6 December 2019, p. 18.

<sup>2</sup> Australian Communications and Media Authority (ACMA), *A guide to small cells: fact sheet*, p. 1.

- 2.5 Design and logistical challenges of rolling out such a large scale upgrade were raised by inquiry participants involved in the telecommunications industry. Communications and Information Technology (CITT) stated that 80 per cent of cellular mobile traffic occurs indoors, which may lead to issues given the move to the mmWave.<sup>3</sup>
- 2.6 A significant number of inquiry participants outlined their concerns over the deployment of 5G. These inquiry participants raised concerns over the potential health effects, the impact of 5G on the environment, and fears over privacy and security. Many inquiry participants perceived that radio frequency radiation has toxic effects for living organisms which will be amplified by the use of 5G.<sup>4</sup>
- 2.7 A large body of information was received from inquiry participants which detailed their strong fears that the spectrum bands used for 5G will adversely affect their health, and is, for example ‘as dangerous as chemicals, asbestos and other pollutants’.<sup>5</sup>
- 2.8 In December 2019, the Australian Government announced measures to ‘build public confidence in the safety of telecommunications networks – including new 5G mobile networks’. The measures will also work to ‘address misinformation about electromagnetic energy (EME) emissions which has caused concern in some parts of the community’.<sup>6</sup>
- 2.9 Additional scientific research and further public education will be conducted by ARPANSA as part of the measures.

## 5G Infrastructure

### Spectrum

- 2.10 Radiofrequency spectrum is planned and managed by the Australian Communications and Media Authority (ACMA) in accordance with the

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<sup>3</sup> Communications and Information Technology (CITT), *Submission 344*, p. 16.

<sup>4</sup> See, for example, Oceania Radiofrequency Scientific Advisory Association (ORSAA), *Submission 311*, p. 1.

<sup>5</sup> Mr Peter Dray, *Submission 102*, p. 2.

<sup>6</sup> The Hon Paul Fletcher MP, Minister for Communications, Cyber Safety and the Arts, and Senator the Hon Richard Colbeck, Minister for Aged Care and Senior Australians Minister for Youth and Sport, ‘Building community confidence in 5G safety’, *Joint Media Release*, 16 December 2019.

*Radiocommunications Act 1992*. Spectrum is a finite resource which ‘underpins mobile telecommunications and affects service quality and cost’.<sup>7</sup>

- 2.11 The ACMA stated that 5G ‘emerged as one of the major drivers of change to spectrum demand and existing spectrum arrangements’ and called 5G’s range of bands ‘unprecedentedly wide’.<sup>8</sup> New frequency bands will be supported, and existing spectrum bands optimised for 5G use.<sup>9</sup>
- 2.12 Inquiry participants noted the addition of high and low frequency bands for 5G in order to deliver coverage and support use cases. The Department of Communications and the Arts (the Department) explained that signals can travel a longer distance at a low frequency, but will carry less data. Signals travelling at high frequencies can carry large amounts of data, but over a shorter distance.<sup>10</sup>
- 2.13 The ACMA identified the ranges of spectrum bands as Sub-1 GHz, 1-6 GHz and above 6 GHz. Each of these bands will require a specific approach by the ACMA because each has its own features, including:
- propagation characteristics;
  - international harmonisation and standardisation;
  - domestic policy;
  - legacy planning and allocation arrangements; as well as
  - incumbency factors.<sup>11</sup>

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<sup>7</sup> Vodafone Hutchison Australia (VHA), *Submission 319*, p. 2.

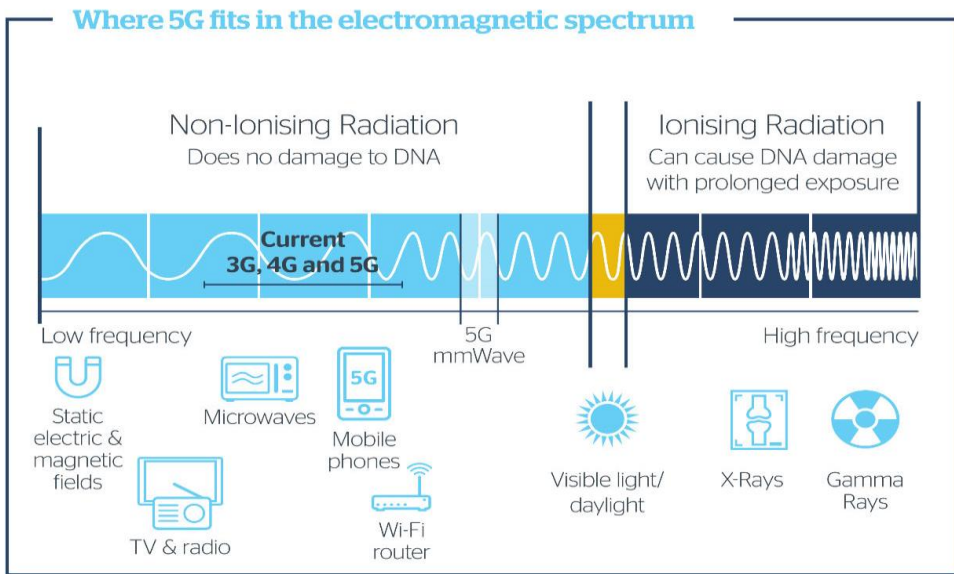
<sup>8</sup> ACMA, *Submission 232*, p. 1.

<sup>9</sup> ACMA, *Submission 232*, p. 1.

<sup>10</sup> Department of Communications and the Arts, *Submission 330*, p. 1.

<sup>11</sup> ACMA, *Submission 232*, p. 5.

**Figure 2.1 Spectrum for 5G mobile technology**



*AMTA and CA, Submission 335, p. 22.*

2.14 Ericsson stated that Australia's 5G deployment would benefit from the amount of spectrum available for 5G:

...from a spectrum point of view Australia is pretty world leading in terms of how much spectrum we've allocated for 5G. Some of that has been because that spectrum was already in market and deployed at a time when it wasn't considered for 5G use.<sup>12</sup>

2.15 The Australian Mobile Telecommunications Association and Communications Alliance (AMTA and CA) estimated that 'each mobile operator will need additional low band spectrum, around 100MHz of mid band spectrum and an initial 1GHz of mmWave spectrum for 5G to reach its full potential and deliver what it is designed to do'.<sup>13</sup>

<sup>12</sup> Mrs Michelle Phillips, Head of Government and Industry Relations, Australia and New Zealand, Ericsson, *Committee Hansard*, Melbourne, 19 February 2020, p. 6.

<sup>13</sup> Australian Mobile Telecommunications Association and Communications Alliance (AMTA and CA), *Submission 335*, p. 5.



- 2.16 AMTA and CA called for a ‘pipeline of new spectrum’ to be made available for 5G, and for reviews of technical frameworks to be progressed ‘so that in-market spectrum is ‘fit for 5G’ and is critical to meet forecast demand’.<sup>14</sup> AMTA and CA suggested that ‘[f]urther work is needed in relation to existing bands to enable the deployment of 5G services, including reallocation of low band spectrum and licence reform in mid band spectrum’, including the 2.1 GHz, 2.3 GHz and 2.6 GHz bands.<sup>15</sup>
- 2.17 Current focus is on the mid-band, between 1 and 6 GHz, and 125 MHz in the 3.6 GHz band has been allocated for regional and metropolitan areas through a spectrum auction conducted by the ACMA.<sup>16</sup> The ACMA has begun a broad review of arrangements in the 3700 to 4200 MHz band, and has completed planning decisions for the 26 and 28 GHz bands.<sup>17</sup> Low band spectrum, below 1 GHz, is being optimised, and additional spectrum will be made available for mobile broadband in the 850 MHz band.<sup>18</sup>
- 2.18 GSMA recommends governments ‘should avoid inflating 5G spectrum prices’ and consult with 5G stakeholders ‘to ensure spectrum awards and licensing approaches consider technical and commercial deployment plans’.<sup>19</sup>
- 2.19 The Australian Government has participated in international discussions on harmonisation of spectrum, including through the World Radiocommunication Conference (WRC), to coordinate the frequency bands used for 5G around the world. The Department, along with the ACMA, attended the WRC in October 2019 to represent Australian interests.
- 2.20 Professor Jock Given stated that ‘one of the issues with the full exploitation of 5G is how rapidly our spectrum regulatory system can really adapt to changes in the way spectrum is used’.<sup>20</sup> Professor Given set out that 5G introduces significant changes to the way that spectrum will be used by

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<sup>14</sup> AMTA and CA, *Submission 335*, p. 9.

<sup>15</sup> AMTA and CA, *Submission 335*, p. 35.

<sup>16</sup> 350 lots were sold in the spectrum auction, realising total revenue of \$853 million. The 3700 to 4200 MHz band is also of interest to Fixed Wireless Access operators. ACMA, *Submission 232*, p. 5.

<sup>17</sup> ACMA, *Submission 232*, p. 5.

<sup>18</sup> ACMA, *Submission 232*, p. 7.

<sup>19</sup> GSMA, *5G Spectrum GSMA Public Policy Position*, <https://www.gsma.com/spectrum/wp-content/uploads/2019/09/5G-Spectrum-Positions.pdf> (accessed 17 December 2019).

<sup>20</sup> Professor Jock Given, *Private capacity, Committee Hansard*, Melbourne, 19 February 2020, p. 9.

handsets by changing the current system of ‘frequency-division duplex’ (using paired channels between a base station and mobile device, with one channel used to take information out and another for the reply coming in) to ‘time-division duplex’ (where one channel is split in time, with one second ‘talking’ to the base and the next second ‘listening’ for the reply):

What's been happening as these technologies have evolved is that the old long-term arrangements that the regulators made and the private sector has bought into have become redundant. They've become suboptimally designed for the new technology. Channels can be too narrow. Geographical areas can be too small. The spectrum could just be in the wrong place.<sup>21</sup>

2.21 Professor Given suggested ways to reform spectrum legislation:

- simplifying the processes for creating spectrum licences;
- giving the ACMA greater flexibility to create and issue new licences;
- empowering the ACMA to offer a different licence rather than re-issue a licence following its expiry;
- reform of the tenure of apparatus licences and reallocation procedures for apparatus licenced spectrum; and
- review the rule for end-of-term arrangements for spectrum licences.<sup>22</sup>

2.22 Carriers considered that the deployment of 5G would require coordination and partnerships between government and industry, as well as significant investment in technology and equipment. VHA stated that the deployment:

...will require a co-ordinated policy approach from all levels of government, working with industry and across key portfolios, to ensure that policy and regulatory settings support the efficient deployment of networks.<sup>23</sup>

2.23 Telstra also made the point that the regulatory framework for 5G needs to be ‘fit for purpose’ and encouraged the ‘required investments in this new technology’.<sup>24</sup> Telstra highlighted its spending on mobile network infrastructure in the last five years, and noted that 5G would require around the same amount again with ‘significant annual investments’ for ‘some years beyond that as we build out 5G across our metropolitan and regional mobile coverage footprint’.<sup>25</sup>

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<sup>21</sup> Professor Given, *Committee Hansard*, Melbourne, 19 February 2020, p. 10.

<sup>22</sup> Professor Jock Given, Dr Giles Tanner, *Submission 181*, pp. 13-14.

<sup>23</sup> VHA, *Submission 319*, p. 1.

<sup>24</sup> Telstra, *Submission 296*, p. 7.

<sup>25</sup> Telstra, *Submission 296*, p. 7.

2.24 VHA, along with AMTA and CA, advocated for ‘timely spectrum allocation’ and broad community support for the economic and social benefits of 5G.<sup>26</sup> Similarly, Optus commented that although 5G deployment has begun, the benefits of 5G are not assured. Optus stated that:

Many of the truly transformative services will depend on the deployment of a radically different network architecture and new spectrum. This will require significant investment in network infrastructure, systems and technology in circumstances where future revenue streams are unclear.<sup>27</sup>

2.25 Further, Optus drew attention to policy challenges, and considered that there may be barriers to achieving the potential promised by 5G, including:

- access to spectrum, including fast-tracking reform of existing bands to enable them to be used for 5G;
- rules for deployment which suited large macro sites but may not work as well for 5G infrastructure;
- the need to address EME safety concerns;
- significant upfront investment requirements, and the need to ensure that the 5G market will be sustainable and competitive;<sup>28</sup>
- allocations should focus on competition and use of spectrum, not on auction revenue raising; and
- licences should be issued with presumption for renewal.<sup>29</sup>

2.26 The Australian Communications Consumer Action Network (ACCAN) also considered that a successful rollout of 5G and Internet of Things (IoT) will require partnerships between government, industry and the community.<sup>30</sup>

2.27 The Internet of Things Alliance Australia (IoTA) echoed calls for close collaboration for the deployment of 5G:

A greater level of involvement and collaboration will be required between network operators with fellow network operators land managers; including federal, state and local jurisdictions – especially in congested urban environments. This is required to underpin practical, well understood, repeatable, guidelines and processes for 5G base-station deployment.<sup>31</sup>

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<sup>26</sup> VHA, *Submission 319*, p. 1; AMTA and CA, *Submission 335*, p. 5.

<sup>27</sup> Optus, *Submission 338*, p. 3.

<sup>28</sup> Optus, *Submission 338*, p. 5.

<sup>29</sup> Optus, *Submission 338*, pp. 20-21.

<sup>30</sup> Australian Communications Consumer Action Network (ACCAN), *Submission 341*, p. 3.

<sup>31</sup> Internet of Things Alliance Australia (IoTAA), *Submission 316*, p. 2.

- 2.28 The Committee also notes that the Chair of the Australian Competition and Consumer Commission, Mr Rod Sims has observed:

High revenues [from spectrum auctions] may be attractive for government, but they can be detrimental to competition in downstream markets if operators overpay at auction. High spectrum costs may impact the financial sustainability of operators...<sup>32</sup>

## Physical Infrastructure, Hardware and Equipment

- 2.29 Developing 5G testing models in Australian cities has highlighted some potential issues with the large-scale deployment of 5G infrastructure.<sup>33</sup> The proposed locations of 5G infrastructure, how to track redundant infrastructure, and the significant capital investment required were raised as potential challenges. Concerns were also raised over whether Australia currently has enough skilled workers to achieve the 5G rollout efficiently and the value of manufacturing 5G equipment within Australia.
- 2.30 The physical infrastructure for 5G will use both small cells and macro cells. Small cells have been widely used since the rollout of 3G, using a ‘smaller and lower-powered base station equipment to either provide localised coverage or supplement the capacity of macro cells’.<sup>34</sup> The number of small cells to deploy 5G will be high, with Optus noting that ‘to offer 1 Gbps [Gigabit per second] speeds, cells would have to be around 200 to 300 metres apart’.<sup>35</sup>
- 2.31 Small cells will provide ‘additional capacity and coverage over a small geographic area, utilising lower power than a traditional mobile phone base station and using smaller equipment’, and will complement the macro network.<sup>36</sup>
- 2.32 Macro cells cover larger areas than small cells, typically reaching ‘from a few kilometres to several tens of kilometres’.<sup>37</sup> Macro cells for 5G will use

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<sup>32</sup> Mr Rod Sims, Chair, Australian Competition and Consumer Commission, *Competition and the 5G spectrum*, Address to the ACMA RadComms 2018 Conference, 30 October 2018, <https://www.accc.gov.au/speech/competition-the-5g-spectrum> (accessed 30 March 2020).

<sup>33</sup> City of Melbourne, *Submission 214*, p. 1.

<sup>34</sup> Telstra, *Submission 296*, p. 6.

<sup>35</sup> Optus, *Submission 338*, p. 9.

<sup>36</sup> AMTA, *Submission 335*, p. 19.

<sup>37</sup> Telstra, *Submission 296*, p. 6.

Massive MIMO (multiple input, multiple output) antennas that will be able 'to send and receive data simultaneously'.<sup>38</sup> CITT stated that macro cells form the core of current Radio Access Network (RAN), and have 'already evolved to support the increasing data transfer demands of the 3G and 4G environments' with the addition of antennas.<sup>39</sup>

- 2.33 AMTA and CA stated that due to the low visual impact of 5G cells, the presence of this infrastructure 'wouldn't be noticed' by 'the majority of the public':

One thing to bear in mind is that small cells are not new. They've been around for decades. We used to call them microcells. They're in the environment now. Most people don't even notice them. The sort of infrastructure we're actually talking about, and that you're talking about the opportunity to co-locate and share, is of the nature where there is very little visual impact in the first place. The compromises you need to make to co-locate or share infrastructure are not necessarily required, simply because the infrastructure itself doesn't warrant you making those compromises, and there are potentially significant compromises in doing it.<sup>40</sup>

- 2.34 The rollout of 5G will involve navigating state and local government planning laws and regulations, arranging site access and the use of relevant utilities.<sup>41</sup>

- 2.35 VHA stated that the implementation of cell deployment is hindered by 'infrastructure deployment rules designed for legacy infrastructure' and that '[r]eforms to deployment rules are needed as a priority to ensure the timely and efficient deployment of network infrastructure with minimal impact on communities'.<sup>42</sup> These concerns were shared by the Queensland Water Directorate, which stated that 'we don't want management of [legacy infrastructure] to get any worse than it is' in the process of new utilities being rolled out due to the adoption of 5G.<sup>43</sup>

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<sup>38</sup> Ericsson, *Submission 339*, p. 6.

<sup>39</sup> CITT, *Submission 344, Attachment 1*, p. 11.

<sup>40</sup> Mr Raymond McKenzie, Manager, Mobile Carriers Forum, Australian Mobile Telecommunications Association (AMTA), *Proof Committee Hansard*, Canberra, 6 December 2019, p. 4.

<sup>41</sup> CITT, *Submission 344*.

<sup>42</sup> VHA, *Submission 319*, p. 2.

<sup>43</sup> Mr David Cameron, Chief Executive Officer, Queensland Water Directorate, *Committee Hansard*, Southport, 19 November 2019, p. 13.

2.36 The IoTAA stated that there would be challenges to deploying the mmWave across busy landscapes:

The 5G millimetre wave radio spectrum is less tolerant of physical encumbrances, compared with lower frequency bands and will as a result require greater 'line-of-sight' placement of base stations and will be more affected by local environment changes e.g. signage, trees and changes in building landscape for example.<sup>44</sup>

2.37 City of Melbourne and City of Sydney raised that trees may have an adverse effect on the performance of 5G by hampering the millimetre wave spectrum, but stated that they 'will not be willing to sacrifice trees in favour of network performance', and that 'sustainable ways to advance the use of technology' must be found.<sup>45</sup>

2.38 CITT explained that the deployment of small cell networks will require equipment to be installed at multiple sites 'from roof tops to power poles, tramways poles and traffic lights.'<sup>46</sup> CITT drew attention to the need for skilled technicians to carry out the work:

While the skill sets required by technicians undertaking small cell roll-outs will not differ widely from those working in the macro cell environment, the logistics of deployment and consequently the overall range of skills involved may differ significantly.<sup>47</sup>

2.39 CITT warned that Australia may be unable to meet demand for the construction, operation and maintenance of 5G networks 'without the development of new training schedules and of mechanisms designed to ensure the quality of training outcomes'.<sup>48</sup>

2.40 Ericsson identified the need for the workforce to continually update training:

...to make sure those attending training have adequate skills to actually move into jobs that are here and now and progress the transition...Ericsson have been heavily engaged in supporting the development and updating of the

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<sup>44</sup> IoTAA, Submission 316, p. z.

<sup>45</sup> City of Sydney, *Submission 310*, p. 1, City of Melbourne, *Submission 214*, p. 1.

<sup>46</sup> CITT, *Submission 344, Attachment 1*, p. 15.

<sup>47</sup> CITT, *Submission 344, Attachment 1*, p. 15.

<sup>48</sup> CITT, *Submission 344*, p. 1.

curriculum for 5G to make sure that TAFE and other training institutions have industry-ready candidates of graduates.<sup>49</sup>

2.41 Ericsson cited a US\$6 million grant by the Government of the United States of America to the Wireless Infrastructure Association to support 5G related apprenticeships.<sup>50</sup>

2.42 Ericsson stated that although they are ‘struggling’ regarding the number of industry-ready job candidates, it has strategies in place to address this:

...we’re working hard to try to ensure that those graduates that are coming through the system are adequately trained. The other part is making sure that our existing workforce has in-house training that is world class, leading and up to speed. It gives an opportunity for those existing Ericsson employees or our suppliers’ employees to be competent in how to deploy 5G networks.<sup>51</sup>

### **Road Safety**

2.43 Main Roads Western Australia raised the possibility of a tension between the ‘commercial drivers of the carriers’ and ‘a safe, reliable and sustainable road based transport system’.<sup>52</sup> Infrastructure maintained by Main Roads WA which may be attractive to carriers for locating 5G equipment on includes:

- bridges;
- traffic signals;
- variable message signs; and
- other road network infrastructure.<sup>53</sup>

2.44 Queensland Transport and Main Roads explained that locating 5G infrastructure on utilities can create challenges and potentially affect safety for the public:

Small cell installations on street lighting, traffic lighting, signs and other road infrastructure assets can impact road safety, the structural integrity of the asset, electrical safety for the public in the event of the installation being

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<sup>49</sup> Mrs Phillips, Ericsson, *Committee Hansard*, Melbourne, 19 February 2020, p. 6

<sup>50</sup> Ericsson, QoN, 5 March 2020, p. 4.

<sup>51</sup> Mrs Phillips, Ericsson, *Committee Hansard*, Melbourne, 19 February 2020, p. 6.

<sup>52</sup> Mr Des Snook, Executive Director Metro and Southern Regions, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 1.

<sup>53</sup> Mr Snook, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 1.

impacted by an errant vehicle and the safety of operational staff undertaking ongoing maintenance.<sup>54</sup>

- 2.45 Queensland Transport and Main Roads further set out that although carriers are required to act in accordance with ‘good engineering practice’ and follow the ACMA industry standards, carriers do not appear to be required to act in accordance with road engineering and electrical safety requirements.

As a result, in some circumstances it can be challenging to help carriers (and their contractors) understand and comply with good engineering requirements for road infrastructure, especially in the short timeframes provided under the Act.<sup>55</sup>

- 2.46 In Queensland, the design, construction, maintenance and operation of relevant assets must be managed by a Registered Professional Engineer of Queensland who has appropriate road safety and electrical engineering experience. Queensland Transport and Main Roads stated that Land Access Notifications for installation and maintenance for 5G small cells ‘rarely have this critical road engineering information’.<sup>56</sup>

- 2.47 Main Roads WA highlighted the significance of maintaining safety of assets such as street light poles if 5G equipment is added:

The issue is that the majority of our poles are slip based and they're designed to act in a certain way in the instance of a crash. There hasn't been the design applied to retrospectively adding equipment onto that, in terms of safety. It's been assessed potentially from a structural loading perspective, but we don't know how that item of infrastructure would react in the instance of a crash: would the pole continue to slip off the way it should do, and what would happen to the equipment under impact— would it leave the pole and would it become a secondary incident of, I guess, launching any communications infrastructure from the pole?<sup>57</sup>

- 2.48 Main Roads WA suggested a collaborative, proactive approach, and stated that it could offer ‘opportunities for a variety of different locations’ which suited the department and carriers:

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<sup>54</sup> Queensland Transport and Main Roads, *Submission 334*, p. 2.

<sup>55</sup> Queensland Transport and Main Roads, *Submission 334*, p. 2.

<sup>56</sup> Queensland Transport and Main Roads, *Submission 334*, p. 2.

<sup>57</sup> Mr James Pinnington, Manager Electrical Asset Management, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 2.



Consultation will allow us to provide advice to carriers about some areas such as whether existing road infrastructure is appropriate for co-location, road safety considerations, avoidance of future asset clashes, issues relating to traffic management, and safe access to the road network.<sup>58</sup>

- 2.49 The existing good working relationship between Main Roads WA and carriers was raised, with a view to continuing to collaborate and find compromises. For example, Main Roads WA is working with carriers to find alternative opportunities to locate equipment on less risky infrastructure.<sup>59</sup>

### *Infrastructure Sharing*

- 2.50 Inquiry participants raised the option of carriers sharing access to utilities. Owners and operators of telecommunications facilities are required to provide other carriers with access to telecommunications transmission towers, sites of towers and eligible underground facilities.<sup>60</sup> This is 'passive' infrastructure sharing. 'Active' sharing involves sharing elements 'such as the radio access network (including the base station, antenna, nodes, feeders), spectrum, transmission and core networks'.<sup>61</sup> Roaming is an example of active sharing.
- 2.51 The Australian Competition and Consumer Commission (ACCC) stated that infrastructure sharing can save money and promote efficiency for operators, but can also raise issues with competition such as 'risk of collusion, and reduced or distorted incentives for investment in shared infrastructure'.<sup>62</sup>
- 2.52 AMTA and CA stated that the Mobile Carriers' Forum is 'the place where carriers principally come together to share all kinds of information to do with co-location, safety management, consultation processes and industry information that's provided to the public'.<sup>63</sup>
- 2.53 Axicom was critical of the way that co-location is handled at the state level:
- ...the state and local governments do not seem to factor in the community benefit provided by the infrastructure as they seek to extract the maximum

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<sup>58</sup> Mr Snook, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 1.

<sup>59</sup> Mr Pinnington, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 2.

<sup>60</sup> ACCC, *Submission 340*, p. 4. The ACCC is currently undertaking a review of the Facilities Access Code, focussing on whether the Code is adequately promoting co-location arrangements.

<sup>61</sup> ACCC, *Submission 340*, p. 5.

<sup>62</sup> ACCC, *Submission 340*, p. 5.

<sup>63</sup> Mr McKenzie, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 3.

amount of revenue from the industry, charging annual rents which exceed the freehold value of the land each year and also extracting a co-user fee from every user of the site.<sup>64</sup>

2.54 Axicom put forward an alternative method of pricing:

In our view, a more appropriate pricing would be a fixed percentage on the unimproved value of the land. The telecommunications industry are the ones who've invested in the infrastructure on that land — they insure it, they maintain it. There is a huge capital investment in that. The state and local governments are leasing a piece of land, so the pricing should reflect that.<sup>65</sup>

2.55 In NSW, an annual rent is charged for communication facilities located on a standard site based on the type of occupation and the location of the facilities. The primary user of a site, who owns and maintains the communication infrastructure, will be charged the rent amount set out by the NSW Government, with a co-user of that site charged at 50 per cent of that rate. Co-users may also have to pay usage fees to the primary user of the site, but that is at the discretion of the parties involved.<sup>66</sup>

2.56 In NSW, the rents charged are higher for the Sydney area than an area of low density. For example, renting a communication licence for a standard site in Sydney is around 4.5 times more expensive per year than for a low density area like any part of NSW not in a city or regional centre.<sup>67</sup>

2.57 Axicom stated that it could be a 'neutral host provider' in rural areas, and help to increase competition for rural consumers:

...if we were to build a site as a neutral host provider, and if we can get more than one carrier on that site at the same time, it should make for a more efficient rollout of the equipment and reduce the costs for everyone. If we can provide fibre, the pole, the power and all those sorts of major costs that go towards building a new site — we've got a model that we've worked on where, if we get more than one carrier, we can reduce the cost per carrier. Then you would get competition in rural areas rather than just a single carrier building a pole for themselves.<sup>68</sup>

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<sup>64</sup> Mrs Jane Pollard, Director, Property and Asset Management, Axicom, *Committee Hansard*, Sydney, 20 February 2020, p. 8.

<sup>65</sup> Mrs Pollard, Axicom, *Committee Hansard*, Sydney, 20 February 2020, p. 8.

<sup>66</sup> NSW Department of Industry, *Communication licence rent Fact Sheet*, June 2019, p. 1.

<sup>67</sup> NSW Department of Industry, *Communication licence rent Fact Sheet*, June 2019, p. 4.

<sup>68</sup> Mrs Pollard, Axicom, *Committee Hansard*, Sydney, 20 February 2020, p. 11.

- 2.58 Main Roads WA currently shares infrastructure with Telstra on an annual rent basis. The structure for providing carriers with access to infrastructure is under review, and may in future allow all carriers to enter into a top level agreement with a 'mechanism to come to an arrangement on where infrastructure would be located'.<sup>69</sup> Proactively suggesting suitable sites may also lead to opportunities for all parties.
- 2.59 Passive and active sharing have been features of the current and previous generations of mobile technology, but may not be feasible in the 5G environment. AMTA and CA outlined a technical challenge which could arise due to the nature of 5G networks and the necessary equipment:
- One example of the type of technical challenge that can arise in active equipment sharing is the ability to build radio transmitters capable of spanning the spectrum holdings of multiple network operators. In the 3.6 GHz band, where operators are using 60-100 MHz, or worse, in the 26 GHz band where operators are likely to be using 800 MHz or more each, it is simply not possible to build a single radio system capable of spanning such a wide frequency range.<sup>70</sup>
- 2.60 Further, AMTA and CA stated that the amount of customers and their geographic locations are unique to each carrier, and explained that:
- As we move to deploying small cells, precise placement is critical for them to be effective. It will be rare that the needs of all carriers align for any small cell to a sufficient extent for sharing the small cell to be viable.<sup>71</sup>
- 2.61 The ACCC is currently undertaking a review of the Facilities Access Code, focussing on whether the Code is adequately promoting co-location arrangements. The ACCC stated that when 5G is deployed in populous areas like cities or built-up areas, carriers will need access to dense fibre networks for 'backhaul'.<sup>72</sup>

### ***Carriers' Powers and Immunities***

- 2.62 Carriers have powers under Schedule 3 of the *Telecommunications Act 1997* which allow them to enter on to land to install and maintain facilities and inspect the land to examine its suitability for a facility. For low impact

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<sup>69</sup> Mr Pinnington, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 4.

<sup>70</sup> AMTA and CA, *Submission 335*, p. 38.

<sup>71</sup> AMTA and CA, *Submission 335*, p. 38.

<sup>72</sup> ACCC, *Submission 340*, p. 4.

facilities, the powers and immunities framework also provides immunities from some state and territory laws such as planning.<sup>73</sup>

2.63 The Department set out that the framework has ‘built in appropriate safeguards to balance the interests of landowners and the community with the need to provide telecommunications services’.<sup>74</sup> These safeguards include, among other things:

- do as little damage as practicable and restore the land;
- act in accordance with good engineering practice, and comply with recognised industry standards;
- make reasonable efforts to reach agreements with public utilities;
- protect the safety of persons, property and the environment;
- ensure the activity interferes as little as practicable with the operations of a public utility, roads and paths, movement of traffic and the use of land;
- notify road authorities, the land owner and land occupier;
- maintain records for overhead cable, underground facilities and towers;
- adopt best practice design to minimise the degradation of the environment and visual amenity and minimise noise; and
- take reasonable steps to co-locate facilities and cooperate with other carriers and public utilities undertaking similar activities.<sup>75</sup>

2.64 City of Melbourne raised concern that the low-impact facilities determination ‘did not foresee this density of cells’ needed for 5G, and suggested that the cumulative effect of an increased number of small cells should be considered.<sup>76</sup>

2.65 Queensland Transport and Main Roads stated that classifying 5G infrastructure as low-impact ‘does not reflect the added risk it has on road safety, planning and operations’ when co-located on road safety

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<sup>73</sup> The *Telecommunications (Low-impact Facilities) Determination 2018* (the Low-impact Determination) provides more information on the application of the powers and immunities framework in the *Telecommunications Act 1997*. Carriers are also required to comply with the *Industry Code for Mobile Phone Base Station Deployment C564:2018* (the Industry Code), which is registered and enforced by ACMA.

<sup>74</sup> Department of Communications and the Arts, *Additional Information*, p. 5.

<sup>75</sup> Department of Communications and the Arts, *Additional Information*, p. 5.

<sup>76</sup> City of Melbourne, *Submission 214*, p. 2.

infrastructure.<sup>77</sup> Queensland Transport and Main Roads highlighted some potential challenges:

Because carriers do not have to get TMR's [Queensland Transport and Main Roads] consent prior to undertaking an installation, the only avenue for TMR to prevent an inappropriate installation on a street or traffic light or other road infrastructure, is to object to it within five business days. If TMR does not object in time, the carrier is entitled to continue with the proposed activity. If Land Activity and Access Notices are to increase twentyfold over two years due to 5G proposals, this timeframe would make the number of applications unmanageable and five-day review/objection turnaround unreasonable.<sup>78</sup>

- 2.66 The Queensland Water Directorate stated that 'water utilities should effectively have first right of refusal about whether [5G] equipment is able to be placed on a tower' on the grounds of possible public health risks which may arise.<sup>79</sup>
- 2.67 More equipment will be needed to make 5G coverage contiguous.<sup>80</sup> Street furniture in cities such as 'lamp posts, park infrastructure and buildings' can be used as an 'opportunity to leverage these existing assets for small cell deployments'.<sup>81</sup> Queensland Transport and Main Roads put forward that in respect of streetlight poles, traffic lights and road signs, 'literally every pole' could accommodate a 5G cell.<sup>82</sup>

### **Box 2.1 Holistic rollout of 5G in Melbourne**

City of Melbourne has led a 5G testbed precinct to model the rollout of 5G in Melbourne. Workshops with users, industry players, carriers and other stakeholders were run in 2019, and although the testbed 'brought to light several issues with the deployment of 5G infrastructure', City of

<sup>77</sup> Queensland Transport and Main Roads, *Submission 334*, p. 3.

<sup>78</sup> Queensland Transport and Main Roads, *Submission 334*, p. 3.

<sup>79</sup> Mr Cameron, Queensland Water Directorate, *Committee Hansard*, Southport, 19 November 2019, p. 12.

<sup>80</sup> Mr Channa Seneviratne, Executive, Network and Infrastructure Engineering, Telstra, *Committee Hansard*, Southport, 19 November 2019 p. 2.

<sup>81</sup> City of Melbourne, *Submission 214*, p. 3.

<sup>82</sup> Mr Tom Orr, Director, Corridor Management and Protection, Department of Transport and Main Roads, *Committee Hansard*, Southport, 19 November 2019, p. 16.

Melbourne was positive about the ‘outstanding opportunities to leverage 5G and other next generation smart technologies’.<sup>83</sup>

City of Melbourne said that their plans were ‘well underway’, and that the testbed would continue to teach ‘much more about the needs of the community, the city and service providers’.<sup>84</sup>

ACCAN supported the initiative, and suggested that ‘this type of multi-stakeholder Testbed initiative could be widely adopted across Australia to ensure that 5G deployment provides equitable advantages throughout every sector of society’.<sup>85</sup>

### *Removal of Redundant Equipment*

2.68 The deployment of 5G is likely to see a significant increase in the amount of equipment located on state-owned and maintained utilities. The Queensland Water Directorate raised concern over ageing and redundant mobile equipment remaining on utilities as 3G and 4G are retired.

2.69 The Queensland Water Directorate explained some of the challenges in co-locating mobile equipment on utilities:

Our primary risks are around safety. There are public health risks associated with the operation of these towers while they have carrier equipment on them. These includes f[a]ecal contamination, which is infiltration through critters defecating on roofs and in holes in roofs; worker safety, which is the EME questions and generally experiences with poorly main[tained] safety diagrams and that kind of stuff; safe access to maintain roofs, which is evidence of cables over hatches and all that kind of stuff; and general asset management questions like whether the roofs have actually been designed for the structural loads that the equipment places on them.<sup>86</sup>

2.70 Seqwater agreed, and added concerns over ‘unknowns’:

It's very hard when we've got a lot of overcrowding on some of these towers and we have a number of unknowns and we cannot locate the owners. In particular, in circumstances where carriers have actually plugged into our

<sup>83</sup> City of Melbourne, *Submission 214*, p. 1.

<sup>84</sup> City of Melbourne, *Submission 214*, p. 1.

<sup>85</sup> ACCAN, *Submission 341*, p. 4.

<sup>86</sup> Mr Cameron, Queensland Water Directorate, *Committee Hansard*, Southport, 19 November 2019, p. 12.

main switchboard and we can't do isolations, it can become problematic in emergencies and things like that.<sup>87</sup>

- 2.71 AMTA maintains the Radio Frequency National Site Archive (RFNSA), which allows users to 'search for Australian Mobile Network base stations to find Electromagnetic Energy (EME) Reports, site locations, carrier contact details for existing sites and community consultation information for new sites'.<sup>88</sup> The RFNSA is used by utility providers, the National Broadband Network (NBN) and the New South Wales Telco Authority, and is publicly available.<sup>89</sup>

### *Manufacturing 5G Equipment within Australia*

- 2.72 The two leading suppliers of 5G equipment to Australian telecommunications companies, Ericsson and Nokia, both manufacture equipment in a number of locations around the globe. Ericsson stated that they have 'a global production footprint' with locations including the United States, Poland and China.<sup>90</sup> Similarly, Nokia Networks manufacture their equipment in Mexico, China, Poland, India and Vietnam.<sup>91</sup>
- 2.73 Neither supplier manufacture in Australia; Ericsson stated that although the company has, in the past, manufactured equipment in Australia, it does not currently do so as it is 'not viable.'

That's a business decision that we make. It's to do with a lot of costs—transport costs, for example, costs associated with labour, which face not just Ericsson as a manufacturer but other manufacturing companies in Australia.<sup>92</sup>

- 2.74 While being open to using equipment manufactured in Australia to increase competition in what is 'effectively a duopoly', VHA stated that the 'difficulty

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<sup>87</sup> Ms Carmel Serratore, Legal Counsel, Seqwater, *Committee Hansard*, Southport, 19 November 2019, p. 13.

<sup>88</sup> RFNSA, *Welcome to the Radio Frequency National Site Archive (RFNSA)*, <https://www.rfnsa.com.au/?first=1> (accessed 6 December 2019).

<sup>89</sup> Mr Althaus, Chief Executive, Australian Mobile Telecommunications Association (AMTA), *Committee Hansard*, Canberra, 6 December 2019, p. 3.

<sup>90</sup> Mrs Phillips, Ericsson, *Proof Committee Hansard*, 19 February 2020, p. 4.

<sup>91</sup> Mr Adam Bryant, Chief Technology Officer, Oceania, Nokia Networks, *Committee Hansard*, Sydney, 20 February 2020, p. 4.

<sup>92</sup> Mrs Phillips, Ericsson, *Proof Committee Hansard*, Melbourne, 19 February 2020, p. 8.

of developing a new vendor...should not be underestimated'.<sup>93</sup> Optus agreed that that exploring options for manufacturing within Australia would be worthwhile, however it is 'more an issue for government'.<sup>94</sup>

## Handsets

2.75 Handsets which will use 5G technology are still under development as the standards are finalised, although some are currently available through Telstra and Optus. Handset manufacturers with 5G smartphones currently available in Australia are;

- Samsung;
- LG;
- Oppo;
- Xiaomi; and
- Alcatel.

2.76 It is expected that Apple will release 5G capable iPhones after the 5G network is deployed.

2.77 ACCAN addressed the reality of consumers purchasing a '5G handset' while the network is still being deployed, and whether there is adequate communication of any increased or ongoing costs:

[We're] watching quite closely the advertising of new handsets, particularly because we want to make sure there's no misleading or deceptive conduct that's going on. There's always a lot of hype around a new technology... However, we have been quite concerned that it's in the fine print that the price is going to go up. And it's not always clear exactly how much it will go up...So we've been quite concerned about what will be the ongoing cost of 5G, and will it end up being a premium service rather than necessarily something that's affordable? Even if there are applications that come forward for people with disabilities, will they actually be able to afford the handsets—or the connected device, because it's not just handsets; it's obviously watches and things like that as well.<sup>95</sup>

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<sup>93</sup> Mr Dan Lloyd, Chief Strategy Officer and Corporate Affairs Director, Vodafone Hutchison Australia, *Committee Hansard*, Sydney, 20 February 2020, p. 38.

<sup>94</sup> Mr Andrew Sheridan, Vice President, Regulatory and Public Affairs, Optus, *Committee Hansard*, Sydney, 20 February 2020, p. 31.

<sup>95</sup> Ms Teresa Corbin, Chief Executive Officer, Australian Communications Consumer Action Network (ACCAN), *Committee Hansard*, Sydney, 20 February 2020, p. 13.



- 2.78 Further, while the network is in its infancy, opportunities to use the 5G capabilities of a 5G-enabled handset may be limited. ACCAN considered that a consumer may purchase a premium handset ‘potentially under the belief they’ll be using 5G all the time...but not necessarily take advantage of that 5G for very much of the time’.<sup>96</sup>

## Costs of services

- 2.79 New pricing models, including latency and location-based charging along with surge pricing, were outlined by Nokia.<sup>97</sup>
- 2.80 Vodafone Australia noted that their expectation was of lower costs for consumers as providers begin to experience a reduction in infrastructure expenditure:

...because you're substantially reducing the cost of deploying the infrastructure and delivering, again, better outputs because you're harnessing economies of scale on spectrum, on backhaul on towers and on antennas. So it should deliver substantially lower costs, and therefore that should absolutely be able to be passed onto regional consumers.<sup>98</sup>

## Network and Data Security

- 2.81 The security of the 5G network was identified by inquiry participants as an important aspect of the deployment, from the design to implementation and maintenance stages. ACCAN cited a recent study which indicated that around 20 per cent of Australians considered 5G to be a ‘potential data security risk’.<sup>99</sup>
- 2.82 Nokia stated that cyber threats are ‘sophisticated and constantly evolving’, and highlighted that the nature of 5G as an end-to-end transformation of the wireless network may allow a greater scale of attacks.<sup>100</sup>
- 2.83 Palo Alto Networks recommended that a priority should be placed on ‘ensuring 5G networks are secure and trusted by design’.<sup>101</sup>

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<sup>96</sup> Ms Corbin, ACCAN, *Committee Hansard*, Sydney, 20 February 2020, p. 13.

<sup>97</sup> Nokia, *Submission 321*, p. 7.

<sup>98</sup> Mr Lloyd, VHA, *Committee Hansard*, Sydney, 20 February 2020, p. 40.

<sup>99</sup> ACCAN, *Submission 341*, p. 3.

<sup>100</sup> Nokia, *Submission 321*, p. 8.

<sup>101</sup> Palo Alto Networks, *Submission 538*, p. 2.

As Australia moves closer to a digitally connected 5G world, there are an increasing array of attack vectors – inside out, outside in, and roaming, to mention just a few. Infected “trusted” end devices become sources of inside out attacks, targeting external web sites, creating signalling storms, wasting bandwidth, and stealing data from users and providers.<sup>102</sup>

2.84 Further, the convergence of mobile and fixed line networks may create cyber security challenges. Palo Alto Networks set out that although there may be additional concerns over security, a broad approach to security should be taken:

...mobile and fixed line networks infrastructures’ convergence can result in unsecure interconnectivity points, which need to be protected. Secure Wi-Fi and LTE access and handover challenges are additional problems...4/5G infrastructure security requires a holistic approach, where detection and prevention is the key ingredient to the infrastructure.<sup>103</sup>

2.85 Palo Alto Networks suggested two important aspects of 5G security:

- constant real-time visibility of traffic passing through the 5G networks of Mobile Network Operators and Internet Service Providers should occur, with cybersecurity threats within that traffic detected and stopped in real time; and
- a high reliance on automation, machine learning, and artificial intelligence (AI) should be designed into 5G networks.<sup>104</sup>

2.86 Nokia stated that new use cases will require in-built security, and will need to use ‘automation, security orchestration, analytics and machine learning to detect and mitigate threats’. Nokia elaborated that:

The new 5G security approach integrates and automates 5G network security by treating the entire network as a sensor - data taken from existing systems is used to provide a much greater level of information.<sup>105</sup>

2.87 The Things Network agreed with the need to have security in mind from the design stage, and explained that LoRaWAN (Long Range Wide-Area Network) technology is built with security in mind:

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<sup>102</sup> Palo Alto Networks, *Submission 538*, p. 2.

<sup>103</sup> Palo Alto Networks, *Submission 538*, p. 2.

<sup>104</sup> Palo Alto Networks, *Submission 538*, pp. 2-4.

<sup>105</sup> Nokia, *Submission 321*, p. 8.

The data is encrypted using AES 256-bit encryption on two layers—both on the transport as well as on the data layer. It is considered a highly secure technology, but as with any technology there is theoretically a risk, largely around denial of service and other things such as metadata, but it is taken very seriously.<sup>106</sup>

2.88 AMTA and CA noted that ‘network slicing’ has potential for services that require ‘guaranteed connectivity, security and reliability’.<sup>107</sup> Network slicing allows networks to be segmented for an industry, business or application:

For example, emergency services could operate on a network ‘slice’ that is independent of other users...thus avoiding congestion and providing dedicated services.<sup>108</sup>

2.89 CITT drew attention to the need for a greater workforce equipped with cyber-security skills in future.<sup>109</sup>

## 5G Safety Standards

2.90 Humans have been exposed to electromagnetic energy (EME) in radiofrequency bands for over 100 years.<sup>110</sup> Safe exposure limits are set by independent, publicly funded organisations; the World Health Organisation (WHO), the International Commission on Non-Ionising Radiation (ICNIRP) and ARPANSA.

2.91 The current 5G network uses a similar frequency to 4G, but will move to use higher frequencies in future as it is expanded. ARPANSA stated that ‘[h]igher frequencies do not mean higher exposure levels’.<sup>111</sup>

2.92 The Australian safety standards for exposure to radiofrequency electromagnetic energy (RF EME) are set by ARPANSA, in line with standards set by the World Health Organisation (WHO) and the International Commission on Non-Ionising Radiation (ICNIRP). ARPANSA

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<sup>106</sup> Mr Leo Gaggl, Managing Director, Opensensing; and Chairperson, Growing Data Foundation Ltd, *Committee Hansard*, Adelaide, 18 February 2020, pp. 11-12.

<sup>107</sup> AMTA and CA, *Submission 335*, p. 20.

<sup>108</sup> AMTA and CA, *Submission 335*, p. 20.

<sup>109</sup> CITT, *Submission 344*, p. 5.

<sup>110</sup> Dr Ken Karipidis, Assistant Director, Assessment and Advice, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), *Committee Hansard*, Canberra, 6 December 2019, p. 18.

<sup>111</sup> ARPANSA, *Submission 317*, p. 3.

published the Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (ARPANSA RF Standard) in 2002, and stated that:

The ARPANSA RF Standard is designed to protect people of all ages and health status against all known adverse health effects from exposure to radio waves... The ARPANSA RF Standard applies a precautionary approach in setting exposure limits. In order to compensate for uncertainties in the scientific knowledge, large safety factors are incorporated into the exposure limits i.e. the limits are set well below the level at which all known adverse health effects occur.<sup>112</sup>

2.93 The standards are used by the ACMA to set exposure limits to EME, which includes radio wave exposure to the public from all wireless telecommunications sources.<sup>113</sup> 5G radio waves will come under these standards by many orders of magnitude.

2.94 Operating frequencies for 5G are included in the limits set by ARPANSA, and are well below the levels at which harm may occur to people. ARPANSA, the WHO and ICNIRP have assessed that there is no established scientific evidence to support any claims of adverse health effects from very low RF EME exposures.

2.95 ARPANSA set out that radio waves are well-researched:

Radio waves are quite well understood. The only established health effect with radio waves are at the very high power levels that can increase body temperature. An example of that is your microwave oven at home. Enclosed within the microwave there are very powerful radio waves that make the water molecules within the food bounce really fast, and that creates friction, which creates heat. However, telecommunications, including mobile telephony, television, radio, wi-fi – anything wireless – operate at extremely low power levels.<sup>114</sup>

2.96 Ionising radiation, such as x-rays and gamma rays, are able 'to cause chemical changes by breaking chemical bonds. This effect can cause damage

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<sup>112</sup> ARPANSA, *Submission 317*, p. 7.

<sup>113</sup> All licence holders must operate within the limits set by the *Radiocommunications (Electromagnetic Radiation-Human Exposure) Standard 2014* and *Radiocommunications Licence Conditions (Apparatus Licence) Determination 2015*.

<sup>114</sup> Dr Karipidis, ARPANSA, *Committee Hansard*, Canberra, 6 December 2019, p. 18.

to living tissue'.<sup>115</sup> ARPANSA stated that the radiation emitted by 5G is 'non-ionising'.<sup>116</sup>

- 2.97 The Australian Centre for Electromagnetic Bioeffects Research (ACEBR) stated that as higher frequencies do not travel as far, 5G will result in 'more superficial exposures which are mostly absorbed by the skin, as opposed to the deeper tissue exposures associated with 3G and 4G technologies'.<sup>117</sup>
- 2.98 Further, an increased number of antennas will mean users are closer to the mobile phone base station, which means their devices can operate at reduced power, reducing users' exposure.<sup>118</sup> Beam forming technology provided by 5G directs the 5G signal directly to each user, which uses 'only enough power required to get to the device'.<sup>119</sup> Telstra reported that millimetre wave indoor small cells were able to provide 'a much faster and a better response over 5G using the same power levels, but the EME levels were lower'.<sup>120</sup>
- 2.99 ACEBR also explained that it is important to distinguish between power and frequency when discussing radiofrequency:

All of our research is based on understanding the effects of power and frequency. And by putting that together, when industry comes up with a new technology, whatever they want to label it, we can then use that knowledge to understand whether it's safe.<sup>121</sup>

- 2.100 AMTA described the need for communication on health, and efforts taken to provide information to the public:

I would say we've done quite a lot. In this space you can almost never do enough. We've taken that very seriously. We understand people's willingness

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<sup>115</sup> Australian Radiation Protection and Nuclear Safety Agency, *What is ionising radiation?*, <https://www.arpana.gov.au/understanding-radiation/what-is-radiation/ionising-radiation>, (accessed 18 December 2019).

<sup>116</sup> Dr Karipidis, ARPANSA, *Committee Hansard*, Canberra, 6 December 2019, p. 18.

<sup>117</sup> Australian Centre for Electromagnetic Bioeffects Research (ACEBR), *5G Wireless Technology – Fact Sheet*, p. 2.

<sup>118</sup> ACEBR, *5G Wireless Technology – Fact Sheet*, p. 2.

<sup>119</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 6.

<sup>120</sup> Mr Mike Wood, Principal, 5G EME Strategy, Telstra, *Committee Hansard*, Southport, 19 November 2019 p. 4.

<sup>121</sup> Dr Rodney Croft, Australian Centre for Electromagnetic Bioeffects Research (ACEBR), *Committee Hansard*, Canberra, 6 December 2019, p. 19.

and interest in this issue. It's highly variable. Roy Morgan did a survey recently where it asked, 'Are you concerned about the health and safety implications of 5G?' Of those who responded, 75 per cent said no and 25 per cent said yes. So there is a chunk of the population that is crying out for information. We are doing our best to service that need.<sup>122</sup>

### *Studies Noted by Inquiry Participants*

- 2.101 Inquiry participants told the committee that they held concerns over exposure to 5G operating frequencies, and what were characterised as unknown risks to human health. Inquiry participants called for independent research to be conducted on the potential health effects of exposure to the frequencies used for the 5G network, and urged caution at the rollout of the network.
- 2.102 A number of inquiry participants noted the *5G Appeal*, *BioInitiative Report* and report of the United States National Toxicology Program (NTP) which looked at the effects of radio frequency radiation on rats and mice.

#### *5G Appeal*

- 2.103 The *5G Appeal* contained four major issues: increased mandatory exposure to wireless radiation; RF-EMF have proven harmful effects; precautions; and safety guidelines protect the industry rather than health.<sup>123</sup>
- 2.104 ARPANSA addressed each of the major topics raised in the *5G Appeal*. On the first of the topics, ARPANSA put forward that '5G will not lead to a "massive increase" of exposure to radio waves in the environment', and continued that:

...although we may be exposed to RF from various sources, it is close proximity to a particular source (e.g. when using a mobile phone) that will typically dominate the exposure. Measurement surveys have shown that exposure to RF radiation in the environment from various sources is very low and typically much lower than the allowable limit for safety in the ARPANSA RF Standard.<sup>124</sup>

- 2.105 The second major point made in the *5G Appeal*, that RF-EMF have proven harmful effects, was also addressed by ARPANSA:

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<sup>122</sup> Mr Althaus, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 3.

<sup>123</sup> *5G Appeal*, *Scientists warn of potential serious health effects of 5G*, <http://www.5gappeal.eu/the-5g-appeal/> (accessed 23 January 2020).

<sup>124</sup> ARPANSA, *Submission 317.1*, p. 2.

Although there have been studies reporting a range of biological effects at low RF levels, there has been no indication that such effects might constitute a human health hazard.<sup>125</sup>

2.106 ARPANSA rejected these allegations or hypotheses, setting out that for scientific evidence to be ‘deemed to be established’ it needs to be consistently and generally accepted by the broader scientific community.<sup>126</sup> Studies must also be replicated, and consideration is given to studies from different disciplines which point to the same conclusion.<sup>127</sup> ARPANSA stated that:

...health authorities around the world, including ARPANSA and the World Health Organization (WHO), have examined the scientific evidence for possible health effects from telecommunications sources. Current research indicates that there is no established evidence for health effects from the low level radio waves used in mobile telecommunications. This includes the upcoming rollout of the 5G network.<sup>128</sup>

2.107 The 5G Appeal’s major issue regarding precautions was also addressed by ARPANSA, which stated that ‘ARPANSA assesses that the ICNIRP guidelines and the ARPANSA RF Standard already have sufficient precaution imbedded in their design’ and that ‘in order to compensate for uncertainties in the scientific knowledge, large safety factors are incorporated into the exposure limits’.<sup>129</sup>

2.108 The 5G Appeal’s claim that safety guidelines protect the industry rather than health was assessed by ARPANSA, which stated that:

...there have been advances in the measurement of radio wave absorption by the human body and ICNIRP is currently revising its guidelines. ARPANSA is planning to revise its RF Standard following the publication of the revised ICNIRP Guidelines. Changes are expected to refine the maximum exposure limits and are not expected to impact exposure from telecommunications (including 5G) which tend to be much lower than the maximum exposure limits.<sup>130</sup>

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<sup>125</sup> ARPANSA, *Submission 317.1*, p. 2.

<sup>126</sup> ARPANSA, *Submission 317.1*, p. 3.

<sup>127</sup> ARPANSA, *Submission 317.1*, pp. 2-3.

<sup>128</sup> ARPANSA, *Submission 317.1*, p. 3.

<sup>129</sup> ARPANSA, *Submission 317.1*, p. 4.

<sup>130</sup> ARPANSA, *Submission 317.1*, p. 4.

*BioInitiative Report*

2.109 The 2012 BioInitiative Report was prepared by a collection of authors about possible risks from wireless technologies and electromagnetic fields. The report stated that:

Bioeffects are clearly established and occur at very low levels of exposure to electromagnetic fields and radiofrequency radiation. Bioeffects can occur in the first few minutes at levels associated with cell and cordless phone use. Bioeffects can also occur from just minutes of exposure to mobile phone masts (cell towers), WI-FI, and wireless utility 'smart' meters that produce whole-body exposure. Chronic base station level exposures can result in illness.<sup>131</sup>

2.110 ARPANSA addressed the BioInitiative Report and stated that it did not follow the health risk assessment approach performed by expert scientific bodies, presents selected research results 'beyond those considered established by the mainstream scientific community', and is not 'an objective or balanced analysis of the scientific body of evidence'.<sup>132</sup>

*United States National Toxicology Program*

2.111 The NTP conducted two-year toxicology studies in rats and mice to help clarify potential health hazards, including cancer risk, from exposure to RFR [Radio Frequency Radiation] like that used in 2G and 3G cell phones. The NTP noted that the types of RFR used for Wi-Fi and 5G networks were not investigated in their studies.<sup>133</sup>

2.112 The exposure levels used throughout the study were equal to or substantially higher to that experienced by humans:

The lowest exposure level used in the studies was equal to the maximum local tissue exposure currently allowed for cell phone users. This power level rarely occurs with typical cell phone use. The highest exposure level in the studies was four times higher than the maximum power level permitted.<sup>134</sup>

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<sup>131</sup> BioInitiative 2012, *BioInitiative 2012 Conclusions*, <https://bioinitiative.org/conclusions/> (accessed 26 February 2020).

<sup>132</sup> ARPANSA, *Submission 317.1*, p. 5.

<sup>133</sup> National Institute for Environmental Health Sciences (NIEHS), 'High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats', *News release*, 1 November 2018, <https://www.niehs.nih.gov/news/newsroom/releases/2018/november1/index.cfm> (accessed 26 February 2020).

<sup>134</sup> NIEHS, 'High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats', *News release*, 1 November 2018,



- 2.113 The NTP conceded that a comparison could not be made between the results found in rodents and humans:

The exposures used in the studies cannot be compared directly to the exposure that humans experience when using a cell phone," said John Bucher, Ph.D., NTP senior scientist. "In our studies, rats and mice received radio frequency radiation across their whole bodies. By contrast, people are mostly exposed in specific local tissues close to where they hold the phone. In addition, the exposure levels and durations in our studies were greater than what people experience.<sup>135</sup>

### *Mobile phone use and incidences of brain tumours*

- 2.114 ARPANSA informed the Committee of a study, published in the British Medical Journal, which looked at the possible correlation of brain tumours with the use of mobile phones.<sup>136</sup>
- 2.115 The study 'examined the incidence time trends of brain tumour in Australia for three distinct time periods to ascertain the influence of improved diagnostic technologies and increase in mobile phone use on the incidence of brain tumours' and found 'no increase in any brain tumour histological type or glioma location that can be attributed to mobile phones.'<sup>137</sup>

## Community Concerns

- 2.116 The Committee notes the significant interest in the inquiry from members of the public, who voiced their strong concerns over 5G deployment.
- 2.117 Some inquiry participants highlighted that concerns over the potential health effects of radio waves were not new. Mr Kody Finlay stated that

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<https://www.niehs.nih.gov/news/newsroom/releases/2018/november1/index.cfm> (accessed 26 February 2020).

<sup>135</sup> NIEHS, 'High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats', *News release*, 1 November 2018,

<https://www.niehs.nih.gov/news/newsroom/releases/2018/november1/index.cfm> (accessed 26 February 2020).

<sup>136</sup> Dr Karipides, ARPANSA, *Committee Hansard*, Canberra, 6 December 2019, p. 22.

<sup>137</sup> Karipides K, Elwood M, Benke G, *et al.* Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: a population-based ecological study. *BMJ Open* 2018;8:e024489. doi:10.1136/bmjopen-2018024489, p. 1.

‘Radio frequency electromagnetic radiation has for quite some years been a point of argument about it's [sic] potential health effects on biological life’.<sup>138</sup>

2.118 Inquiry participants raised concerns over the exposure of young children to 5G. Ms Sarah Arrowsmith wanted assurance that ‘there are no health risks to me and future generations’ and considered that thought should be given to school-aged children:

The government must also seriously consider the health implications of 5G in education while the current situation is that schools already expose children to EMF radiation at rates that far exceed the recommended guidelines for safe use with 4G devices.<sup>139</sup>

2.119 Ms Elena Brennan stated that 5G may add to problems which come from over-use of digital devices, including:

- addiction;
- reduced educational performance;
- problems in interpersonal communications;
- relationship problems;
- behavioural problems; and
- depression, suicide and anxiety.<sup>140</sup>

## 5G and Health

2.120 A number of inquiry participants put forward views that the deployment and use of 5G would have adverse effects on their health, and many submissions noted numerous concerns. Ms Tanja Price linked the following with exposure to wireless telecommunications radio waves:

Electro Sensitivity and Electro Hyper- Sensitivity (or radiation sickness), ADD/ADHD, Behaviour/Learning Problems, Concentration Issues, Memory Problems, Mood Issues, (depression, anxiety, irritability), Early onset dementia, Sleep Disturbances, Headaches, Muscle/Joint Pain, Leg/Foot Pain, Fatigue and Weakness, Numbness and Tingling, Tremors and Muscle Spasms, Dermatological Problems, (itching/burning, facial flushing), Lowering of sperm count and infertility. Mutation of DNA.<sup>141</sup>

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<sup>138</sup> Mr Kody Finlay, *Submission 2*, p. 1

<sup>139</sup> Ms Sarah Arrowsmith, *Submission 6*, p. 1.

<sup>140</sup> Ms Elena Brennan, *Submission 22*, p. 2.

<sup>141</sup> Ms Tanja Price, *Submission 28*, p. 2.

- 2.121 Inquiry participants highlighted articles which associated telecommunications radio waves and adverse health effects. For example, Mrs Angela Kelly and Mr Dean Kelly, Ms Melissa Davey and another inquiry participant drew attention to articles which listed depression as a potential health effect,<sup>142</sup> and Ms Lauren Dry noted an article which listed sleep disturbance, depression, fatigue and heart related problems as risks.<sup>143</sup>
- 2.122 A number of submissions contained personal accounts of symptoms many attributed to exposure to radio waves used in wireless telecommunications. Ms Rosalyn McNulty, for example, stated that:

I suffer on a daily basis with a lack of concentration, tinnitus, vertigo, breathlessness, chronic sleep disorder, asthma, chronic fatigue, nausea, digestive issues, chronic pain, uncontrolled blood pressure and depression and when I turn on my Wi-Fi, which I now only do when I'm only using it, these symptoms are worse.<sup>144</sup>

- 2.123 Ms Elizabeth Pender considered the impact of 5G on people who identify as having Electromagnetic Hypersensitivity (EHS):

Without adequate protection from radiofrequency radiation from a nearby celltower, I have very seriously disturbed sleep. This is currently seriously jeopardising my ability to return to a proper part-time role at work. I would like the committee to consider my experience that EMR impacts my health significantly, including sleep quality.<sup>145</sup>

- 2.124 Electrosensitivity Australia is a community organisation which advocates for EHS to be recognised as a 'functional impairment', and put forward community fears over the scale of the deployment of 5G:

...try to imagine the fear and stress levels of people with EHS right now, at the mere thought of what will happen to them as a result of the deployment of 5G, where they will be unable to escape that which assaults them and makes them incredibly ill.<sup>146</sup>

- 2.125 ARPANSA agreed with Electrosensitivity Australia that EHS is 'not a medically recognised syndrome', and added that:

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<sup>142</sup> Mrs Angela Kelly and Mr Dean Kelly, *Submission 56*, p. 4; Ms Melissa Davey, *Submission 400*, p. 4; Name Withheld, *Submission 9*, p. 5.

<sup>143</sup> Ms Lauren Dry, *Submission 432*, p. 3.

<sup>144</sup> Ms Rosalyn McNulty, *Submission 89*, p. 1.

<sup>145</sup> Ms Elizabeth Pender, *Submission 460*, p. 1.

<sup>146</sup> Electrosensitivity Australia, *Submission 203*, p. 2.

While ARPANSA and the WHO recognise that the symptoms of EHS are real and can have a disabling effect for the affected individual, EHS has no clear diagnostic criteria and the science so far has not provided evidence that RF exposure is the cause. The majority of scientific studies published to date have found that under controlled laboratory conditions, EHS individuals cannot detect the presence of RF sources any more accurately than non-EHS individuals.<sup>147</sup>

2.126 ARPANSA noted that, to date, clinical studies have failed to prove the existence of EHS:

...there has been a range of double-blind placebo-controlled trials that have tested such individuals. What we mean by double-blind is they've exposed the individual to electromagnetic fields in a double-blind scenario. In other words, the person doesn't know when the exposure's on or off and neither does the researcher. In all of those trials, the individual hasn't been able to discern that the exposure has been on or off, even though they might report that they walk into a room and they can feel that the wi-fi is on and that's giving them a range of symptoms.<sup>148</sup>

2.127 ACEBR has conducted studies in the past which failed to prove EHS, and has moved away from conducting testing to focus on research and communication.<sup>149</sup>

## **Environmental Concerns**

2.128 Inquiry participants put forward concerns over the impact of 5G deployment on the environment. Ms Nina Stick commented that:

The earth's living systems and cycles, and all of life that it supports, have evolved in the presence of the earth's much lower electromagnetic environment and are vulnerable to the impacts of artificial EMR which differ in their toxic effects. The earth's natural EMR is relied upon by wildlife for breeding, navigation and flight and survival.<sup>150</sup>

2.129 Concerns over trees were raised by Mrs Martha Bridi Simcox, who stated that articles have shown that trees near cell towers are affected by them.<sup>151</sup>

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<sup>147</sup> ARPANSA, *Submission 317*, p. 4.

<sup>148</sup> Dr Karipidis, *Committee Hansard*, Canberra, 6 December 2019, p. 21.

<sup>149</sup> Dr Croft, *Committee Hansard*, Canberra, 6 December 2019, p. 21.

<sup>150</sup> Ms Nina Stick, *Submission 455*, p. 1.

<sup>151</sup> Mrs Martha Bridi Simcox, *Submission 146*, p. 3.

Stop Smart Meters Australia Inc was concerned that trees may be cut down to improve the signal coverage of 5G, and questioned:

...how will trees, with their proclivity to block signals, be viewed? Will we find ourselves in the situation that trees are being pruned or cut down, not with regard to safety, but in order to facilitate wireless communications?<sup>152</sup>

2.130 Similarly, Dr Don Maisch asked: 'Will residents have to choose whether they prefer tree-lined streets or faster download speeds?'.<sup>153</sup>

2.131 The potential impact of 5G on the bee population was also raised by numerous inquiry participants, with many referring to articles which state that bees are at risk. Ms Jude Nicoll stated that 'the evidence suggests our dying bee population is connected to mobile phone use and the EMR (Electromagnetic Radiation) this produces'.<sup>154</sup>

2.132 In a similar vein, Susannah Jones was concerned that bees may suffer adverse effects:

5G millimeter waves will be approximately the same size as bees and other similar sized insects. The pulses from these millimeter waves will send small shockwaves through the bees and damage their eyes, antennae and wings, as well as cooking them internally before they die. Our food production depends on these bees.<sup>155</sup>

2.133 ARPANSA stated that there is currently limited scientific evidence that showed a direct link between telecommunications radio waves and flora and fauna:

There is limited research on the effects of electromagnetic fields on the diversity or abundance of insects or bees. The few ecological studies that do exist generally report little or no evidence of a significant environmental impact. The studies that do show an effect, such as the ones listed, suffer from poor scientific method and the reported effect of electromagnetic field exposure cannot be separated from other environmental factors.<sup>156</sup>

## Privacy and Security

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<sup>152</sup> Stop Smart Meters Australia Inc, *Submission 357*, p. 4.

<sup>153</sup> Dr Don Maisch, *Submission 42*, p. 4.

<sup>154</sup> Ms Jude Nicoll, *Submission 325*, p. 2.

<sup>155</sup> Susannah Jones, *Submission 274*, p. 1.

<sup>156</sup> ARPANSA, *Submission 317*, p. 6.

- 2.134 A number of inquiry participants listed privacy and security as concerns they hold for the deployment of 5G. Ms Simone Glover put forward concerns over ‘data harvesting and increased potential for cyber hacking due to the interconnectivity and the Internet of things’.<sup>157</sup>
- 2.135 Some inquiry participants were of the view that 5G would pose ‘a breach of privacy’, and may be used ‘as means of surveillance’.<sup>158</sup> One inquiry participant raised concerns over the number of things connected to the internet in the future, such as televisions and refrigerators, and stated that ‘we need to have anti-virus and other security measures for our home computers to reduce our risk of hacking or identity theft, but these new devices have none of that protection’.<sup>159</sup>
- 2.136 Other inquiry participants noted concerns over the following:
- personal privacy;<sup>160</sup>
  - fears over surveillance;<sup>161</sup>
  - data gathering;<sup>162</sup>
  - hacking of household objects;<sup>163</sup> and

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<sup>157</sup> Ms Simone Glover, *Submission 445*, p. 1.

<sup>158</sup> See, for example, Ms Deborah Aldridge, *Submission 403*, p. 6.

<sup>159</sup> Name Withheld, *Submission 131*, p. 1.

<sup>160</sup> Ms Lakshmi Ramanuja, *Submission 467*; Mrs Nicola Bludau, *Submission 36*; Mr Michael Gersch, *Submission 171*; Ms Tanja Price, *Submission 28*; Ms Sophie Knox, *Submission 228*; Ms Rebecca King, *Submission 139*; Ms Melinda Turner, *Submission 405*; Ms Andrea Weber, *Submission 415*; Ms Phillipa Holden, *Submission 156*; Mrs Jennifer Clarke, *Submission 257*; Jeanette Ball, *Submission 276*; EMR Australia, *Submission 166*; Name Withheld, *Submission 178*; Jody Wood, *Submission 279*; Name Withheld, *Submission 265*; Mr Pete Matthews, *Submission 106*; Ms Lisa Serpa, *Submission 333*; Ms Mercy Wolf, *Submission 350*; Ms Samantha Willcocks, *Submission 57*; Ms Enca Crosbie, *Submission 150*; Ms Fiona Ferguson, *Submission 88*; Mrs Linda Moullae, *Submission 87*; Ms Kate Swan, *Submission 349*; Miss Talula Guralnek, *Submission 347*; Mr Karl Wilson, *Submission 14*; We Say No to 5G Australia, *Submission 342*; Mrs Amy Blackmore, *Submission 364*; Name Withheld, *Submission 284*; Mr Damian Donoghue, *Submission 481*; Mrs Louise Nennstiel, *Submission 104*; Mrs Carmen Parra, *Submission 379*; Mrs Jeanette Bullock, *Submission 368*; Name Withheld, *Submission 268*; Ms Kathrin Soroko, *Submission 72*; Ms Zoe Cotterill-Rogers, *Submission 469*; Mrs Elysse Strachan, *Submission 161*; Ms Lesley King, *Submission 45*; Stop Smart Meters Australia, *Submission 357*; Dr Murray May, *Submission 103*.

<sup>161</sup> Ms Julie Barber, *Submission 396*; Ms Danielle Young, *Submission 300*; Renee Jones, *Submission 112*; Name Withheld, *Submission 351*; Mrs Carole Newton, *Submission 137*; Miss Sara Schulz, *Submission 130*.

<sup>162</sup> Mr Brian McLauchlan, *Submission 78*; Ms Elena Dawson, *Submission 373*; Ms Leilani Innis, *Submission 148*; Ms Anat Harari, *Submission 298*; Mr Damien Moses, *Submission 31*.

- personal security.<sup>164</sup>

## Communication of the Deployment of 5G

2.137 The communication of the technology, purpose, safety and utility of 5G has been ad hoc, and much has been left to advertising by the carriers, who may tend to point to faster download speeds and family use to explain the need to move to a new generation of technology.

2.138 Community confidence in 5G has been shaken by extensive misinformation preying on the fears of the public spread via the internet, and presented as facts, particularly through social media.

2.139 AMTA stated there was a need for more information to be provided to the public:

That need has come from, frankly, a high-level misinformation campaign that has been quite fearful in its presentation—particularly on social media, where outrageous things are being said. The government agencies have stepped up, the industry has stepped up and we are all working hard. We plan to carry that on for the foreseeable future.<sup>165</sup>

2.140 ACCAN agreed that there is a need to understand the technology and benefits of 5G, and have engaged with AMTA to work on this. ACCAN highlighted the need for 5G communication to come from the regulators:

...we've been very pleased that the ACMA, the regulator in this space, has actually now also produced information on its website. We think it's much better for it to come from an independent government source. Unfortunately, a lot of people don't know about ARPANSA, even though we've obviously engaged with them for many years. They don't necessarily think, 'I'll go and look up ARPANSA's requirements and standards', so the linkage with the regulator in the communications space directly with the ARPANSA materials is very helpful.<sup>166</sup>

2.141 The Electromagnetic Energy Reference Group (EMERG) was formed in 1997 to provide a forum for ARPANSA to 'engage with a broad range of

<sup>163</sup> Ms Sue-Ellen Middleton, *Submission 416*; Name Withheld, *Submission 213*; Name Withheld, *Submission 346*; Mr Stephen Wells, *Submission 301*; Name Withheld, *Submission 374*; Mrs Fiona Harper-Harwood, *Submission 247*; Ms Sarah Spiller, *Submission 461*.

<sup>164</sup> Ms Susie Figgis, *Submission 239*.

<sup>165</sup> Mr Althaus, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 3.

<sup>166</sup> Ms Corbin, ACCAN, *Committee Hansard*, Sydney, 20 February 2020, p. 13.

stakeholders on EME'. EMERG provided input on a range of information products, including factsheets, revisions to reports and advice on studies aimed addressing public concerns.<sup>167</sup>

- 2.142 Following a review conducted in 2019, ARPANSA found that EMERG 'was no longer an effective means of engagement' and ceased operation of EMERG, with all members advised on 25 November 2019.<sup>168</sup>
- 2.143 In December 2019, the Australian Government announced a \$9 million campaign to build public confidence in 5G, address some of the misinformation about EME and invest in new scientific research and public education. The Hon Paul Fletcher MP, Minister for Communications, Cyber Safety and the Arts, and Senator the Hon Richard Colbeck, Minister for Aged Care and Senior Australians, and Youth and Sport, announced the funding to recognise 'that there is significant community interest in being satisfied that rigorous safety standards are in place as new 5G mobile networks are rolled out around Australia'.<sup>169</sup>
- 2.144 Minister Fletcher said that the current safety standards draw on 'extensive scientific research into EME emissions, globally and in Australia, over many decades'.<sup>170</sup>

## Concluding Comments

- 2.145 The Committee notes the significant undertaking and expenditure required of carriers to deploy 5G mobile technology. 5G will change the nature of mobile network design, placement and integration, and will require collaboration between all levels of government and the telecommunications industry. The Committee heard that for 5G to be successfully deployed and used, partnerships and ongoing discussions will be key to ensuring that the best value is obtained from the next generation of mobile technology.

## Spectrum

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<sup>167</sup> ARPANSA, *Submission 317.2*, p. 1.

<sup>168</sup> ARPANSA, *Submission 317.2*, p. 2.

<sup>169</sup> The Hon Paul Fletcher MP, Minister for Communications, Cyber Safety and the Arts, and Senator the Hon Richard Colbeck, Minister for Aged Care and Senior Australians Minister for Youth and Sport, 'Building community confidence in 5G safety', *Joint Media Release*, 16 December 2019.

<sup>170</sup> The Hon Paul Fletcher MP, Minister for Communications, Cyber Safety and the Arts, and Senator the Hon Richard Colbeck, Minister for Aged Care and Senior Australians Minister for Youth and Sport, 'Building community confidence in 5G safety', *Joint Media Release*, 16 December 2019.



- 2.146 The Committee notes the importance of spectrum allocation in facilitating a competitive telecommunications market. The Committee heard evidence citing concerns about the impact of slow spectrum allocation on the potential rollout of the 5G network.
- 2.147 The Committee acknowledges that spectrum is a finite resource, and that competing interests, industries and priorities will need to be carefully balanced to ensure that needs are met. 5G will use parts of the spectrum which have not traditionally been used for telecommunications, and will fundamentally change the way that information is relayed between the base station and mobile device.
- 2.148 The Committee notes the work of the ACMA to undertake auctions of spectrum, and echoes the views of the telecommunications industry that the allocation of 5G spectrum be timely.

### **Ageing and Redundant Infrastructure**

- 2.149 The Committee heard that as new equipment is installed, ageing and redundant equipment may become an issue. The Committee is concerned that redundant mobile telecommunications equipment from previous generations will be left in place while 5G equipment is installed on state-owned utilities and infrastructure. The Committee heard that there are risks involved in leaving old equipment in place, and that it is difficult to track down some owners to obtain removal permission.
- 2.150 The Committee considers that AMTA, as the operator of the Radio Frequency National Site Archive (RFNSA), may be suitable to take on a greater responsibility for redundant equipment on state-owned utilities. The Committee believes that utility and infrastructure owners who are not able to locate the owner of redundant equipment on their property should be able to apply to AMTA for removal permission.

### **Road Safety**

- 2.151 The nature of 5G necessitates the installation of new equipment in locations that may not have previously hosted telecommunications infrastructure. 5G will require a more dense deployment of equipment such as small cells, and infrastructure sharing between carriers may not be possible, meaning road infrastructure and utilities which run parallel to roads (such as electricity and lighting infrastructure) will be required to host 5G units.
- 2.152 The Committee agrees with Queensland Transport and Main Roads and Main Roads WA that, where co-location of 5G infrastructure and equipment

and road infrastructure is an option, there may be tension between the safety standards required by each party.

- 2.153 The Committee is of the view that the safety of people using the roads should be paramount for every industry involved in the deployment of 5G, and strongly encourages carriers to comply with safety requirements and carry out testing to investigate the reaction of infrastructure in a crash scenario. The structural loading of the pole hosting a small cell should be tested, and whether the cabling added for 5G will comply with safety standards.

### **Infrastructure sharing**

- 2.154 Carriers and industry groups were repeatedly asked through the hearings about the steps being taken to explore and enact greater infrastructure sharing. While they indicated they were considering this, very little evidence was provided to demonstrate that this was the case.
- 2.155 Taking into account the likelihood that carriers will need to roll out a greater amount of small cell technology to ensure the effective operation of their 5G networks, it will be important that, wherever possible, effective infrastructure arrangements are utilised to help minimise the impact on urban environments.

### **Access to 5G in Regional Areas**

- 2.156 The Committee sees great value in the deployment of 5G technology in rural and regional Australia, and is excited by the use cases presented by the agricultural sector. The Committee is concerned, however, that 5G will not be rolled out to regional areas until urban areas have been fully serviced. Other jurisdictions are successfully sharing mobile infrastructure between users to ensure adequate coverage in regional areas, and the Committee would encourage the adoption of this model.<sup>171</sup>

### **Manufacturing of 5G Equipment**

- 2.157 The Committee notes that the equipment required for the deployment of 5G is not manufactured in Australia. The Committee sees great value in encouraging industry to develop facilities within Australia to develop and build the equipment for use in Australia and internationally.

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<sup>171</sup> Crown Infrastructure Partners Ltd, *What is the Mobile Black Spots Fund (MBSF)?*, <https://www.crowninfrastructure.govt.nz/blackspots/what/>, Accessed 11 March 2020.

- 2.158 Australian-based manufacture would provide economic benefits to the nation as well as employment opportunities.

## **Supply Chain Management**

- 2.159 Throughout the inquiry it was evident that 5G networks will have fundamental implications for all Australians, as well as the security of critical infrastructure. Cyber supply chain risks in relation to 5G have the ability to impact upon consumers and national infrastructure in unprecedented ways. It is the Committee's view that it is incumbent upon 5G vendors to actively monitor their supply chain and for the Australian Government to provide strict guidance on this.

## **Community Concerns and Communication of 5G**

- 2.160 The Committee has heard the concerns of inquiry participants, who voiced strong opinions on the deployment of 5G which are not necessarily supported by scientific evidence. The Committee notes that a number of inquiry participants have called for a moratorium on the deployment of 5G through a form letter.
- 2.161 The Committee understands that there are a number of concerns relating to fears over the safety of 5G, particularly relating to health, and that some people have identified as having EHS and are very concerned about the future of telecommunications.
- 2.162 Avenues for raising these concerns may have been limited for members of the public in the past, and the Committee has noted that inquiry participants may feel that they have not been heard previously.
- 2.163 The Committee notes the disbanding of EMERG and believes its continuation was warranted, in a time of heightened interest in EME issues. Given the Government's announcement for an investment into a national community information campaign, the Committee believes this would be a useful component within any such campaigns. The Committee strongly urges that the body be re-constituted immediately or a suitable community consultation mechanism be implemented to take its place.
- 2.164 Better communication of the safety of 5G has been implemented by the Australian Government through the announcement of a campaign to build community confidence in 5G safety.
- 2.165 Current community engagement from the Department about 5G technology, including its rollout and safety, would benefit from additional resources and

efforts, including targeted and evidence-based communications methods for a range of audiences.

- 2.166 ARPANSA and ACMA, responsible for the rollout and monitoring of 5G, have different mechanisms and levels of community engagement. There is an opportunity for these agencies to develop an integrated communication strategy. Better coordination of ARPANSA's Talk to a Scientist engagement program and ACMA's EME hub may lead to enhanced communication on 5G with the community.

### **Recommendation 1**

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- 2.167 The Committee recommends that spectrum allocation be finalised expeditiously and that the Australian Communications and Media Authority, in conjunction with the Department of Communications and Australian Competition and Consumer Commission, investigate how future spectrum auctions can promote improved market competition for the benefit of consumers.**

### **Recommendation 2**

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- 2.168 The Committee recommends that the Australian Government facilitate discussions between carriers, network operators and utility and infrastructure owners for managing redundant and/or ageing telecommunications equipment.**

### **Recommendation 3**

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- 2.169 The Committee recommends that the Australian Government commence a review of the low impact facilities framework to ensure that its powers to encourage co-location of facilities and equipment are fit-for-purpose in a 5G environment. As part of this process, the Australian Government should begin reviewing carrier arrangements for 5G infrastructure sharing.**

### **Recommendation 4**

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- 2.170 The Committee recommends that the Department of Communications and the Arts assess the suitability of current powers and immunities arrangements, especially in relation to the timeframes for raising objections, noting the likelihood of an increased number of installations for the deployment of 5G.**

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## Recommendation 5

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- 2.171 The Committee recommends that carriers work with state and territory road and transport infrastructure managers to ensure that safety standards are maintained.

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## Recommendation 6

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- 2.172 The Committee recommends that carriers consider multiuser infrastructure sharing to ensure that rural and regional consumers benefit from 5G services in a timely manner, and ensure adequate coverage across all 5G spectrum bands.

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## Recommendation 7

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- 2.173 The Committee recommends that carriers ensure rollout trials are conducted in regional and remote areas, and the Committee notes proposals for large scale trial with one of Australia's most innovative farming regions.

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## Recommendation 8

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- 2.174 The Committee recommends that the Australian Government investigate ways to encourage the manufacture of 5G infrastructure within Australia.
- 2.175 This may be done initially via the Department of Industry, Science and Technology working with Australian telecommunications and related industry partners to examine how Australia could actively participate in the manufacture of components and equipment for use in the rollout of 5G networks - and that manufacturing partnerships be considered with Canada, New Zealand, United Kingdom and United States.
- 2.176 To help enable this, the Australian Government should establish a 5G R&D Innovation Fund to fast track the development and scale-up of alternative manufacturing approaches to reduce the duopoly dependency on 5G related equipment.

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## Recommendation 9

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- 2.177 The Committee recommends that the Australian Government conduct a review of current legislative arrangements enforcing network and data security for the supply of 5G equipment. Further, as part of this

framework, it must be incumbent on vendors to enforce Cyber Supply Chain Risk Management throughout procurement, roll out and maintenance of the 5G network.

### **Recommendation 10**

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2.178 The Committee recommends that ARPANSA implement a suitable mechanism to consult with members of the community regarding the safe levels of electromagnetic radiation.

### **Recommendation 11**

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2.179 The committee, welcoming the Australian Government's decision to establish a new community information campaign on 5G, recommends that the Government work closely with the ACMA to develop an integrated and comprehensive campaign that can respond to concerns raised about the new network.

### **Recommendation 12**

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2.180 The Committee recommends the Department of Communications and Department of Education and Training, review how current ICT curricula for roles in 5G related industries in TAFE, accredited training providers and tertiary institutions should be modified to ensure graduates are industry-ready.

### **Recommendation 13**

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2.181 The Committee recommends the Australian Government lift apprenticeships in the ICT sector apprenticeships to assist with the rollout of 5G in Australia.

# 3. Capability and Capacity of 5G

## Overview

- 3.1 The features of 5G technology include ultralow latency and large increases in data transfer speed and volume.
- 3.2 5G promises a number of possibilities, but will rely on the specifications and standards to enable them as well as consumer demand for particular services. The possibilities open up a number of future applications, with some uses in the immediate future and some longer term.
- 3.3 Immediate 5G use cases offer an insight into what is coming later in the decade. It is expected that the practical use cases for the short term future will stimulate consumer demand for the full rollout. In turn, consumer demand will actually shape the applications and use cases of 5G.
- 3.4 Use cases are expected to be in a range of industries, including: agriculture, mining, business, manufacturing, transport, and smart cities and homes. The Department of Communications and the Arts stated that uses cases are likely to be built around the core capabilities of 5G:
  - enhanced mobile broadband (eMBB);
  - ultra-reliable, low-latency communications (URLLC); and
  - massive machine to machine communications (MMMC).<sup>1</sup>
- 3.5 The Australian Mobile Telecommunications Association (AMTA) stated that:

...this next stage of technology evolution will be a solution to some of our most compelling challenges at a global and national level – things like food

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<sup>1</sup> Department of Communications and the Arts, *Submission 330*, p. 5.

supply, water management, climate issues, healthcare delivery, education access, emergency services; and the list goes on.<sup>2</sup>

- 3.6 WAFarmers stated that 5G goes beyond a technology which will enable future benefits. They noted that 5G is essential to take advantage of the benefits of technologies which are rapidly becoming commonplace:

Many of these technologies not only exist today, they will soon be mainstream. All of these technologies rely on the quality of the underlying telecommunication networks that is why 5G is so important to the technology innovation we are seeing today.<sup>3</sup>

- 3.7 Ericsson considered that 5G would be part of a wider suite of innovative technologies:

...5G will provide the glue that will enable all of these other new technologies – artificial intelligence, augmented reality, virtual reality – to actually achieve and do what they're designed to do. It gives that capability.<sup>4</sup>

- 3.8 Nokia stated that 'Industry 4.0 technologies ... are maturing and promise to bring together the physical and digital economies'.<sup>5</sup> Nokia considered that 5G will impact upon many aspects of everyday life and the workforce:

5G will be far more than just a new radio technology...5G mobile communications will cover a wider range of use cases and related applications including video streaming, augmented reality, different ways of data sharing, and various forms of machine type applications.<sup>6</sup>

- 3.9 Inquiry participants considered that 5G would provide major benefit to industry and create opportunities for improved productivity outcomes.<sup>7</sup> Government, especially local government, would also have the chance to leverage 5G networks to create Smart Cities and Smart Regions, applying

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<sup>2</sup> Mr Chris Althaus, Chief Executive Officer, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 1.

<sup>3</sup> WAFarmers, *Submission 61*, p. 1.

<sup>4</sup> Mrs Michelle Phillips, Head of Government and Industry Relations, Australia and New Zealand, Ericsson, *Committee Hansard*, Melbourne, 19 February 2020, p. 6.

<sup>5</sup> Nokia, *Submission 321*, p. 9.

<sup>6</sup> Nokia, *Submission 321*, p. 3.

<sup>7</sup> Mr Althaus, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 1; Mr Trevor Whittington, Chief Executive Officer, WA Farmers, *Committee Hansard*, Perth, 17 February 2020, p. 7;



the Internet of Things (IoT) to help improve the operation of local infrastructure and manage people movement better.<sup>8</sup>

## Consumer Demand for 5G – Enhanced Mobile Broadband

3.10 The application of 5G will rely, in large part, on the demand by consumers for various services. Mobile phones are the most commonly used devices to access the internet in Australia.<sup>9</sup> The Australian Competition and Consumer Commission (ACCC) noted a continued growth in data downloads, ‘likely driven by consumers’ appetite for content streaming services, as well as content and video-rich social media, gaming and other applications’.<sup>10</sup>

3.11 AMTA stated that the demand for mobile data is enormous and increasing:

The average data download per user for the mobile internet using a handset has increased by 1,600 per cent since 2012. This acceleration in demand is set to continue with 5G, with forecasts suggesting that by 2025 at least 20 per cent of users could exceed 160 gigabytes a month on a 5G device. This demand sounds a bit over the top, but mobile growth trends suggest it's not only possible but very likely an underestimate.<sup>11</sup>

3.12 AMTA and Communications Alliance (CA) stated that continued industry investment in 5G networks and spectrum is being driven by consumer demand, and that 5G will deliver improvements needed ‘in order to meet the current and forecast strong and ever-increasing demand for mobile services’.<sup>12</sup>

3.13 Optus stated that use cases will come out of the need for different services and applications, and would be driven by the users of the technology. Optus has formed an advisory group of business clients to co-create 5G solutions

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<sup>8</sup> Mr Adam Bryant, Chief Technology Officer, Oceania, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 1; Mr Geof Heydon, Principal Consultant and Chair of the Platforms and Interoperability Workstream, Internet of Things Alliance, Australia, *Committee Hansard*, Sydney, 20 February 2020, p. 44.

<sup>9</sup> ACCC, *Communications Market Report 2018-19*, p. 43.

<sup>10</sup> ACCC, *Communications Market Report 2018-19*, p. 45.

<sup>11</sup> Mr Althaus, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 3.

<sup>12</sup> AMTA and CA, *Submission 335*, p. 5.

for existing issues.<sup>13</sup> Optus explained that one technology such as virtual reality may have uses for a range of industries:

Virtual reality has applications in industry—for example, when it comes to workplace training. It has applications in health care in terms of remote medicine. I think the opportunity and challenge for us is to get down into the specifics and work with the individual business partners to understand their specific needs and innovate around those in conjunction with those partners.<sup>14</sup>

3.14 The Australian Communications Consumer Action Network (ACCAN) stated that consumers should be able to access trustworthy information on the capabilities of 5G:

We are already seeing overzealous pronouncements on the capabilities of 5G before it has been fully deployed in Australia, including insufficient consumer information about the actual capability of 5G networks.<sup>15</sup>

3.15 The ACCC suggested that there may be some overlap between the National Broadband Network (NBN) and 5G:

...the ability of 5G networks to deliver gigabit wireless broadband speeds, in conjunction with increased capacity, means that they will be able to compete with or by pass the NBN in terms of home broadband. This will also be driven from the demand-side with the performance of NBN services in terms of price and quality having a significant impact on the degree of substitution sought by consumers.<sup>16</sup>

3.16 In contrast, AMTA and CA stated that 5G and NBN could work together, as part of a national network:

As with 4G, 5G mobile networks will complement the NBN, fixed wireless and satellite services, as an essential part of the nation's interconnected system of telecommunications networks. Mobile networks deliver a connectivity capability to consumers and businesses alike, while still relying on interconnection with fixed and microwave networks to provide the requisite backhaul and capacity.<sup>17</sup>

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<sup>13</sup> Mr Harvey Wright, Head of 5G, Optus, *Committee Hansard*, Sydney, 20 February 2020, p. 33.

<sup>14</sup> Mr Wright, Optus, *Committee Hansard*, Sydney, 20 February 2020, p. 33.

<sup>15</sup> ACCAN, *Submission 341*, p. 1.

<sup>16</sup> ACCC, *Submission 340*, p. 3.

<sup>17</sup> AMTA and CA, *Submission 335*, p. 18.

- 3.17 The IoTAA agreed, and stated that 5G will be one part of a larger system, ‘including nbn [sic], satellites and other wireless and fixed infrastructure that will underpin Australia’s connectivity fabric’.<sup>18</sup>
- 3.18 Further, the IoTAA stated that 5G can add value by adding continuity:  
... 5G is unique in that it provides not only high-speed wireless connectivity, but also the ability to federate access types and provide service continuity and sharing across, for example mobile, fixed and Wi-Fi, if carriers choose to implement these capabilities.<sup>19</sup>
- 3.19 The ACCC reported that, while mobile data downloads are increasing, they made up only 12 per cent of the total data downloaded for the quarter ending June 2019, with NBN and non-NBN fixed services making up the remaining 88 per cent.<sup>20</sup>

## Improved Productivity

- 3.20 A number of inquiry participants noted that various industries and businesses expected to benefit from the deployment and adoption of 5G.
- 3.21 Nokia explained that productivity could be enhanced as 5G technologies emerge and evolve:  
The other industry 4.0 technologies—industrial IoT, edge computing, deep analytics based on artificial intelligence and machine learning, ubiquitous networking, augmented and virtual reality—are maturing and promise to bring together the physical and digital economies. As they reach a critical mass of adoption, the opportunity for realising a much bigger productivity boom is before us. However, this is reliant on a communications network beyond what exists today.<sup>21</sup>
- 3.22 The Teletraffic Research Centre agreed that 5G would be significant for improving productivity and follow on from the rapid advances in productivity made by 3G and 4G, and stated that 5G ‘is necessary’ due to the increase in demand for capacity.<sup>22</sup>

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<sup>18</sup> IoTAA, *Submission 316*, p. 2.

<sup>19</sup> IoTAA, *Submission 316*, p. 2.

<sup>20</sup> ACCC, *Communications Market Report 2018-19*, p. 43.

<sup>21</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 1.

<sup>22</sup> Dr Bruce Northcote, Director, Teletraffic Research Centre, The University of Adelaide, *Committee Hansard*, Adelaide, 18 February 2020, p. 1.

3.23 The Department of Agriculture identified the following benefits and uses of the technology:

The deployment of 5G and its capacity to facilitate digital agriculture has the potential to transform the sector with precision agriculture optimising production practices and driving productivity gains. Digital agriculture has been identified as a contributor to achieving the productivity gains required to develop Australian agriculture to a \$100 billion sector by 2030.<sup>23</sup>

3.24 WAFarmers concurred with the Department of Agriculture claiming the following:

Australia needs 5G as it will unlock the potential for farmers and agri-business to stay connected to the latest innovations which will enable a future set of technologies such as autonomous vehicles, virtual and augmented reality, drones, artificial intelligence, machine learning, connected paddock to the plate food safety, and remote surgery and health care.<sup>24</sup>

3.25 WA Farmers noted the potential for large-scale regional trial sites in either Esperance or Margaret River to test and fully unlock the economic potential of 5G in rural and regional Australia:

If we pick an area like Esperance, which is very innovative, they have been able to produce very high-tonnage, highly profitable crops. It is a relatively condensed area. We could trial putting in 5G. I know they are very close together, but you can essentially run it along the high-value strip—120 kilometres by 20 or 30 kilometres wide—and put a whole network there. They are some of the most innovative farmers in the world and they would lead the rest of Australia.<sup>25</sup>

3.26 The Department of Agriculture also looked forward to what 5G may be able to offer in the future:

Eventually, artificial intelligence enabled autonomous vehicles could undertake farming operations 24 hours per day seven days a week, using machine to machine learning, passing data and insights between each other. Operations could be remotely monitored by farmers from the homestead.<sup>26</sup>

## Internet of Things

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<sup>23</sup> Department of Agriculture, *Submission 181*, p. 1.

<sup>24</sup> WAFarmers, *Submission 61*, p. 1.

<sup>25</sup> Mr Whittington, WA Farmers, *Committee Hansard*, Perth, 17 February 2020, p. 9.

<sup>26</sup> Department of Agriculture, *Submission 186*, p. 1.

- 3.27 The Internet of Things (IoT) is a system of interconnected devices, machines and objects which can transfer data without the assistance of a human, enabling ultrarapid analytics. Nokia set out that 5G and IoT are symbiotic, and explained that: 'IoT is a driver for 5G; 5G is an enabler of IoT'.<sup>27</sup>
- 3.28 GSM Association (GSMA) stated that the ability of 5G to offer connectivity on 'a massive scale' is a 'potential game changer' with a number of use cases, including:
- asset tracking and monitoring;
  - waste management;
  - smart parking;
  - water metering; and
  - gas metering.<sup>28</sup>
- 3.29 Further, although some use cases could be met by available technology, 5G could offer efficiencies for the delivery of IoT. GSMA stated that:
- Massive IoT is a good example in which most of the use cases can be served with available technology, such as 2G, NB-IoT, etc. However, these are networks built and operated independently from each other. Serving the IoT use cases over 5G and Network Slicing technology has the potential to greatly reduce operational costs, increase efficiency and leverage additional capabilities an operator can offer.<sup>29</sup>
- 3.30 The Department of Communications and the Arts (the Department) elaborated, and agreed that although IoT is already in operation, pairing it with 5G will allow new IoT applications. The Department stated that 5G can 'significantly enhance the use of IoT', by 'improving the use of networked remote sensors and actuators for data collection, analytics and control'.<sup>30</sup>
- 3.31 IoT which draws on 5G will be able to make use of the ultra-low latency communications, and support more devices per square kilometre. The Department suggested that 'smart factories and warehouses, logistics management and autonomous vehicles' are some potential uses.<sup>31</sup>
- 3.32 The Teletraffic Research Centre elaborated on the importance of 5G to IoT:

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<sup>27</sup> Nokia, *Submission 321*, p. 5.

<sup>28</sup> GSMA, *Submission 255*, p. 5.

<sup>29</sup> GSMA, *Submission 255*, p. 5.

<sup>30</sup> Department of Communications and the Arts, *Submission 330*, p. 5.

<sup>31</sup> Department of Communications and the Arts, *Submission 330*, p. 4.

The promise of 5G is threefold. A massive increase in bandwidth. A massive increase in the number of individual connections that can be supported—up to millions of connections per square kilometre. That's absolutely necessary to be able to support the new things that are emerging in the Internet of Things: the surveillance; the smart devices that we are all carrying—billions of smart devices around the world. Finally, ultralow latency to enable things like autonomous systems to work. These systems need to be able to communicate in very, very near real time. Ultralow latency is what's required. None of these things are achievable in 4G today.<sup>32</sup>

- 3.33 The Department raised that it is exploring whether the 'regulation governing the use of data could unduly inhibit the use of data collected by IoT applications'.<sup>33</sup>

## Smart Cities, Smart Regions, Smart Industries

- 3.34 The use of smart technologies within Australia is already well underway across a number of sectors, particularly for remote monitoring.
- 3.35 Opensensing and the Growing Data Foundation (GDF) highlighted that steps had already been taken to build an open, crowdsourced IoTs data network in Australia – The Things Network.
- 3.36 The Things Network operates on a very low power, long range wireless technology (LRWAN) with about 70 gateways across Adelaide. The technology is designed to send 'data from relatively remote regions into a central server'.<sup>34</sup>
- 3.37 The technology has been taken up by local government in South Australia to monitor sensors:

It's actually local government in South Australia that has taken up the technology. It fits very well with their mission because they can use this technology for their own purposes. They use sensors for people monitoring, park monitoring, water monitoring and irrigation monitoring...<sup>35</sup>

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<sup>32</sup> Dr Northcote, The University of Adelaide, *Committee Hansard*, Adelaide, 18 February 2020, p. 1.

<sup>33</sup> Department of Communications and the Arts, *Submission 330*, p. 12.

<sup>34</sup> Mr Leopold Gaggl, Managing Director, Opensensing and Chairperson, Growing Data Foundation Ltd, *Committee Hansard*, Adelaide, 18 February 2020, p. 7.

<sup>35</sup> Mr Gaggl, Growing Data Foundation Ltd, *Committee Hansard*, Adelaide, 18 February 2020, p. 7.

- 3.38 Opensing and the GDF noted that the network is being adopted more broadly by other individual and organisations for similar ‘low data rate’ monitoring:

...they can then make that network available to other constituents like farmers, viticulturists or businesses in the logistics area that are starting to take up this technology.<sup>36</sup>

## Smart Cities

- 3.39 A number of inquiry participants referred to the interplay between 5G and Smart Cities, where data and communications technology are used to create more efficient and sustainable processes and improve performance and quality of life.
- 3.40 Nokia stated that ‘5G brings the ability to put a massive number of sensors into a square kilometre to tie all of these inputs together and control other systems’.<sup>37</sup> Sensors using 5G are designed to have a ten-year battery life, increasing economic efficiency.<sup>38</sup>
- 3.41 Smart freeways which improve traffic flow were highlighted by Main Roads WA as an example of an existing innovation which could be improved with 5G. Sensors which use existing mobile technology are on freeways and within the asphalt near traffic signals are used to connect traffic signal sets and improve the flow of traffic:

There are effectively two types of sensors that we use: the inductive loop and the Bluetooth sensors that we have on freeways. They communicate with a base station and either communicate centrally via 3G or 4G or connect straight through to a fibre backbone that we have running along our freeways. That technology is available, so 5G would just potentially mean that we could get the information slightly quicker and we could transfer more information.<sup>39</sup>

- 3.42 Using 5G for smart freeways may also provide resilience to infrastructure. Main Roads WA explained that 5G could offer assistance:

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<sup>36</sup> Mr Lepold Gaggl, Growing Data Foundation Ltd, *Committee Hansard*, Adelaide, 18 February 2020, p. 7.

<sup>37</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 2.

<sup>38</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 2.

<sup>39</sup> Mr Simon Beard, Asset Maintenance Manager, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 4.

If we lost our communications network, which can happen from time to time, typically through damage to our infrastructure, then something like 5G would potentially be used to provide an alternative comms path. With that larger bandwidth and lower latency, there is obviously more potential there to look at backup.<sup>40</sup>

- 3.43 Waste management could also benefit from the addition of smart technology such as sensors and communication. Nokia highlighted the use of smart city technology for waste management, and explained how this could be of value:

...garbage collection is a resource of the city, and one of the key things is utilising that to a maximum level through sensors on garbage bins. We've already seen cities like Amsterdam detect when a bin needs to be emptied because it's overfull prior to a scheduled run. So that helps the amenity of the city because you don't have the overflowing bins. At the same time it can detect a bin that is empty and does not need to be serviced. So you can actually adjust the route of a garbage truck to maximize efficiency and save time.<sup>41</sup>

## Smart Regions and Smart Agriculture

- 3.44 The application of technology to farms, supply chains and food production could change the way that agriculture is conducted. Smart agriculture, supported by 5G, would allow a number of efficiencies and gains to be realised. For example, Nokia stated that sensors could be deployed to monitor soil moisture and ensure that the right amount of water is used for irrigation.<sup>42</sup>
- 3.45 WAFarmers commented on how vital the technology would be to the increase productivity in the agricultural sector in Western Australia, increasing the capability for farmers to monitor and environmentally and sustainably manage their arable land:

The next wave of technology that's come is being able to use the megadata that comes from being able to map every square metre—in fact, down to every individual plant that's across the paddock. When you're cropping five million hectares of land in the Wheatbelt of Western Australia you're producing between eight and 18 million tonnes. The lower the impact you have on the

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<sup>40</sup> Mr James Pinnington, Manager Electrical Asset Management, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2020, p. 4.

<sup>41</sup> Mr Bryant, Nokia, *Committee Hansard*, 20 Sydney, February 2020, p. 2.

<sup>42</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 1.



soil, the less carbon you put in the atmosphere, the less chemicals you need to use and the less fertiliser you need to use is all an advantage of the soils. You can't do that in real time with 3G. You can just do it with 4G, but 5G is the next big leap forward. It'll be as great as minimum till has been an impact on agriculture in Australia. It essentially allowed us to double production.<sup>43</sup>

- 3.46 The opportunities to increase animal welfare were also identified as a potential benefit from the increased digital capacity of 5G. WAFarmers observed that the 'immediate response for technology is on electronic eartags, traceability and automatic gates that open and close' adding that an electronic tag that could monitor what they feed the animals, their stress levels, how happy they are, and identify 'which animal is which, can open up an enormous opportunity'.<sup>44</sup>
- 3.47 WAFarmers noted that the Australian Wine Industry hasn't had the technology or spectrum to undertake real time monitoring of their vineyards, but envisioned rapid investment once 5G is rolled out 'in regions like Margaret River, Swan Valley and Great Southern...'.<sup>45</sup>
- 3.48 When asked about how 5G and blockchain technologies might be able to allow for greater scrutiny and produce testing and counter food and wine fraud, WAFarmers pointed out the importance of protecting Australia's produce:

We produce a product that can be easily labelled as coming from another nation around the world, and there's an incentive because we are recognised as a premium producer, but it's pointless being recognised as a premium producer if there is duplication going on at a vast scale. We've seen it in the wine industry. It's actually out there also in the meat industry – wagyu, for instance. You lose your premium edge. You only get one bite of it with customers. So the opportunity not just to protect what we've got but to enhance its value is there, particularly with blockchain.<sup>46</sup>

- 3.49 The Communications Alliance (CA) gave an example of how the Internet of Things can help provide efficiencies and also improve productivity in agricultural settings:

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<sup>43</sup> Mr Trevor Whittington, Chief Executive Officer, WAFarmers, *Proof Committee Hansard*, Perth, 17 February 2020, p. 8.

<sup>44</sup> Mr Trevor Whittington, Chief Executive Officer, WAFarmers, *Proof Committee Hansard*, Perth, 17 February 2020, p. 10.

<sup>45</sup> Mr Whittington, WAFarmers, *Committee Hansard*, Perth, 17 February 2020, p. 10.

<sup>46</sup> Mr Whittington, WAFarmers, *Committee Hansard*, Perth, 17 February 2020, p. 11.

There is a terrific little company based in Southport called Pivotel. At the moment they are doing IoT networks in remote locations to better manage water. A cow can go for a week without food pretty easily, but a couple of hot days without water and then it's in trouble...They calculate 40 million litres of water for every 100 sensors over the lifetime of the sensors, saving each farmer about 650K in transport, logistics and labour.<sup>47</sup>

3.50 Pivotel's sensors use satellite to provide their backhaul at the moment, but are 5G compatible.

3.51 Water systems could also benefit from the application of technology which would allow greater monitoring and control. Nokia set out that 5G could give opportunities to save water for farmers:

Where irrigation systems are not controlled, for example, we lose roughly 50 per cent of water in transit because of pipe breaks and just poor usage of the water. So there's an opportunity there to digitise that system to control that.<sup>48</sup>

3.52 Nokia elaborated that using smart technology could have a range of applications on a farm:

...[loss of cattle] could be noted through the use of digital technology, from the case where a water trough is empty and a pump is turned on to using drones to detect whether there is a fence break or using video in detecting whether a cow has died. If there's a watering trough where there's a dead animal nearby, cattle perceive it as poisoned and will not drink from it, so you have collateral damage from that event; whereas if you had video analysis of that scene you could detect an object there and alert the farmer of the need to check it out.<sup>49</sup>

3.53 AMTA gave another example, called Smart Paddock:

...which is using IoT devices to track the health and whereabouts of cattle. They're estimating that around half a million cattle annually die prematurely, but, if you can identify the location and what's going on, you could basically save those or minimise that loss, which currently stands at around \$700 million in lost revenue for that sector.<sup>50</sup>

3.54 The challenge of mobile phone coverage in regional areas was highlighted by IoTAA, who have a food and agriculture workstream. IoTAA stated that:

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<sup>47</sup> Mr John Stanton, Communications Alliance, *Committee Hansard*, Canberra, 6 December 2019, p. 6.

<sup>48</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 2

<sup>49</sup> Mr Bryant, Nokia, *Committee Hansard*, Sydney, 20 February 2020, p. 2

<sup>50</sup> Mr Althaus, AMTA, *Committee Hansard*, Canberra, 6 December 2019, p. 3.

...farmers are quite disadvantaged for mobile coverage. That's not just for their phones, for collecting data, but, even worse, for receiving back the information—that backward bandwidth problem... It would be a travesty, in my mind, if we ended up having yet another rural divide problem with 5G. Our recommendation was: prioritise areas, not just zones.<sup>51</sup>

- 3.55 The Department of Agriculture highlighted that existing mobile coverage is limited, making it difficult for producers to see the benefits of agricultural technology:

Where deployed into rural and regional areas, 5G mobile technology will provide significant opportunities for agricultural businesses to fully embrace digital agriculture. Mobile networks are important to agriculture and are the main means of connection to the internet. However, mobile network coverage is limited, with 43 per cent of farmers reporting they have little or no coverage in a 2017 survey, and improving this would remain the key focus for agriculture.<sup>52</sup>

- 3.56 The CSIRO's report 'Accelerating Precision Agriculture to Decision Agriculture' noted that poor connectivity to telecommunications infrastructure was inhibiting adoption to technological advancements:

A lack of access to mobile and internet telecommunications infrastructure is a major impediment to the adoption of digital agriculture systems. 55% of producers reported that they relied on the mobile phone network for internet, yet 43% had patchy or no mobile reception across their property.<sup>53</sup>

- 3.57 The CSIRO added that a lack of access to telecommunications infrastructure was 'costing producers, agribusinesses and the Australian economy billions of dollars each year in terms of lost productivity (and profitability)'.<sup>54</sup>

- 3.58 The report highlighted that digital agriculture could increase production values significantly:

Economic modelling has shown that digital agriculture could increase the gross value of Australian agricultural production by \$20.3 billion (25% increase on 2014-15 levels).<sup>55</sup>

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<sup>51</sup> Mr Frank Zeichner, Chief Executive Officer, Internet of Things Alliance, Australia, *Committee Hansard*, Sydney, 20 February 2020, p. 43.

<sup>52</sup> Department of Agriculture, *Submission 186*, p. 1.

<sup>53</sup> CSIRO, Summary Report for Stakeholder Consultation. Accelerating Precision Agriculture To Decision Agriculture: Enabling digital agriculture in Australia, 31 October 2017, p. 19.

<sup>54</sup> CSIRO, Summary Report for Stakeholder Consultation. Accelerating Precision Agriculture To Decision Agriculture: Enabling digital agriculture in Australia, 31 October 2017, p. 22.

## Smart Mining

3.59 Ericsson stated that 5G is already being deployed in the mining industry, albeit not to its full potential. The 'mine of the future' is currently being trialled in Sweden, and explores the role of automation:

Ericsson is working closely with a number of partners to deliver industrialised connectivity and automation mining solutions via 5G. For example: - Boliden is working with a number of partners, including Ericsson, to create the 'mine of the future' at Aitik the largest open pit mine in Europe in the north of Sweden.

3.60 The key outcomes of the trial were:

- Automation to enable the remote operation of diggers;
- Productivity improvements by being able to continue to work on the mine remotely soon after blasts;
- Better safety outcomes with 'smart ventilation' improving air quality;
- The delivery of versatile wireless industrial mining connectivity, enabling greater safety as well as productivity; and
- A 20% increase in drill rig productivity in the Boliden Aitik mine.<sup>56</sup>

3.61 Smart mining is expected to reduce risks and health concerns of workers' well-being and safety while on site through automation of mining facilities. Nokia noted that the technology being developed will allow workers to streamline operations from data collected through robotics, digitally enhanced equipment, sensors, predictive analytics and memory education will:

- Remove workers from the most dangerous parts of the mine
- Monitor worker health and direct them away from exclusion zones
- Optimize resource use and prevent bottlenecks at every step of the mining process
- Gain 360-degree situational awareness in remote operating environments
- Enable predictive maintenance of machines and other important equipment
- Make better decisions from the command centre to the mine face.<sup>57</sup>

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<sup>55</sup> CSIRO, Summary Report for Stakeholder Consultation. Accelerating Precision Agriculture To Decision Agriculture: Enabling digital agriculture in Australia, 31 October 2017, p. 1.

<sup>56</sup> Ericsson, *Submission 339*, p. 20.

<sup>57</sup> Nokia, *Submission 321*, p. 5.

## Automated Vehicles

- 3.62 A major application of 5G infrastructure is the automation of vehicles, including the addition of more advanced driver assist technologies including:
- vehicle-to-vehicle communication: broadcasting position, speed and heading of the vehicles with other road users;
  - vehicle-to-infrastructure communication: vehicles talking to traffic lights for example; and
  - vehicle-to-network communication.<sup>58</sup>
- 3.63 Automated vehicles using the enabling infrastructure of 5G offer the potential to deliver social, economic and environmental benefits to both metropolitan and regional Australians. AMTA and CA stated that:
- ...autonomous vehicles will reduce costs as well as improve safety and accessibility for all road users. The NRMA noted that autonomous vehicles will deliver improved safety, decrease congestion, provide options for young, elderly and disabled people, as well as reduce pollution and emissions.<sup>59</sup>
- 3.64 Telstra also expressed a similar sentiment regarding the benefits of autonomous vehicles:
- Beyond access to information, we will also see emergency responders using 5G enabled autonomous vehicles or driving assistance to increase their safety when driving in disaster areas or in hazardous terrain during rescue missions.<sup>60</sup>
- 3.65 Automated vehicles are also predicted to benefit the environment through both reducing emissions and alleviating traffic congestion. Optus noted the potential of automated vehicles to contribute to emissions reduction:
- 5G technology will power self-driving cars, which in turn may reduce emissions by up to 90 percent and cut travel time by 40 percent.<sup>61</sup>
- 3.66 The Department of Communications and the Arts referred to a report claiming the following:

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<sup>58</sup> Dr Paul Gray, Chief Executive Officer, Cohda Wireless Pty Ltd, *Committee Hansard*, Adelaide, 18 February 2019, p. 13.

<sup>59</sup> AMTA and CA Ltd., *Submission 335*, p. 13.

<sup>60</sup> Telstra, *Submission 296*, p. 21.

<sup>61</sup> Optus, *Submission 338*, p. 15.

Traffic congestion, which is estimated to cost Australia \$53 billion by 2031, could be proactively reduced by smart city traffic management systems that are informed by machine-to-machine communications with autonomous vehicles.<sup>62</sup>

- 3.67 Cohda Wireless highlighted a project that it had employed in Sydney to ensure that heavy freight vehicles kept moving to reduce traffic congestion – the freight signal priority project:

The intention there was to keep the heavy vehicles moving, so we equipped 120 sets of traffic signals along Parramatta Road, Pennant Hills Road and King Georges Road ... and we also equipped 120 heavy vehicles. The idea there was that if it didn't look like a truck was going to make it through before the light turned red you had the option of requesting a greenlight extension to try to keep those heavy vehicles moving. That has flow-on effects for all the rest of the traffic...<sup>63</sup>

- 3.68 The deployment of automated vehicles will require changes to existing road infrastructure. Queensland Transport and Main Roads was keen to ensure that automated vehicle safety features are compatible with existing services due to the progressive rollout of the 5G network and noted the following:

As 5G networks and performance does become available, current and new services will likely rely on the availability of some 5G functions. Connected vehicle safety services must be able to operate when and where 3G/4G/5G services are not available. Due to technology integration, efficiency and consumer needs, the connected vehicle platform uses a mix of WiFi and mobile phone communication and that mix will change depending access to 3G/4G/5G...5G development and services must harmonise with current road transport safety services and initiatives.<sup>64</sup>

- 3.69 State governments are preparing for the deployment of automated vehicles. For example, Queensland Transport and Main Roads is 'developing and deploying connected vehicle services and has strong links with the international deployments'.<sup>65</sup>

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<sup>62</sup> Department of Communications and the Arts, *5G – Enabling the future economy*, October 2017, p. 4.

<sup>63</sup> Dr Gray, Cohda Wireless Pty Ltd, *Committee Hansard*, Adelaide, 18 February 2019, p. 16.

<sup>64</sup> Department of Transport and Main Roads, *Submission 334*, p. 3.

<sup>65</sup> Department of Transport and Main Roads, *Submission 334*, p. 3.

- 3.70 Main Roads Western Australia pointed out that it was ‘involved in a number of working groups with Austroads to investigate the rollout of autonomous vehicles and cooperative ITS’.<sup>66</sup>
- 3.71 They added that ‘obviously 5G is one of the potential enablers for that kind of infrastructure, and that’s one of the reasons why we are very keen to look at opportunities of co-location of our assets for the 5G network.’<sup>67</sup>
- 3.72 Further, Queensland Transport and Main Roads stated that the safety benefits of automated vehicles may not be distributed evenly:

It is...widely acknowledged in the intelligent transport systems community that the scale and coverage of deployment of 5G, over the next decade, is likely to be insufficient to reach key regional and remote areas where the road safety need is greatest.<sup>68</sup>

## Interaction with other vehicles

- 3.73 Automated vehicles will interact with other vehicles, road infrastructure and pedestrians in real time. The way in which the network operates with other elements is shown in the diagram below.

### Figure 3.1 What 5G is about

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<sup>66</sup> Mr Pinnington, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2019, p. 3.

<sup>67</sup> Mr Pinnington, Main Roads Western Australia, *Committee Hansard*, Perth, 17 February 2019, p. 3.

<sup>68</sup> Department of Transport and Main Roads, *Submission 334*, p. 3.



European Commission, *Towards 5G* <https://ec.europa.eu/digital-single-market/en/towards-5g>. (accessed 4 October 2019).

3.74 Network operators and network equipment manufacturers are currently working with vehicle manufacturers to develop autonomous vehicles. Telstra, Ericsson and Lexus have partnered to trial a 'Vehicle-to-Everything (V2X) technology using Telstra's 4G network. A V2X system allows cars to 'talk' to the environment around them using short-range communications and the 4G network. Ericsson explained that:

- The environment around the car could be other cars and trucks, traffic lights, roadworks or even pedestrians and cyclists.
- The use and development of V2X, over 4G and 5G networks will help create clever transport systems to support more efficient use of roads, better traffic management (i.e. reduced congestion) and, in the future, coordinated and safer driverless vehicle operation.<sup>69</sup>

3.75 Cohda Wireless Pty Ltd, an Australian world leading company in V2X vehicular technology systems, provided some insight into how vehicle-to-vehicle communication, using the low latency features of 5G, would benefit drivers and other road users:

It's the vehicles talking to just the vehicles around them. In an open road and out in the country, that might be a two-kilometre range or something like that, but in a city environment that will really compress to maybe 200 or 300 metres.

<sup>69</sup> Ericsson, *Submission 339*, p. 21.



So really it is the short-range communications to just the vehicles and the other road users—not just vehicles; it's pedestrians, cyclists and so on as well—in the immediate vicinity. The information that is shared there is really information such as position, speed and heading of the vehicles. That's broadcast 10 times a second to all the vehicles around them so other vehicles can receive that and be able to extrapolate the position in time and space of the other vehicles around them, assess threats and so on.<sup>70</sup>

- 3.76 5G in conjunction with V2X technology enables users to identify vehicle position with greater accuracy in urban areas where GPS signals are ineffective. Cohda Wireless identified its project with the New York City Department of Transportation to provide greater accuracy on the streets:

They have a big deployment of this V2X technology happening in Manhattan. They're going to equip around 4,000 vehicles, mostly city vehicles and some taxis as well, and about 400 sets of traffic lights. The challenge in New York is the urban canyons, in that GPS systems just don't work very well in urban canyons ... As soon as you get over about five stories you start to have some problems with urban canyons and the poor performance of GPS. In fact, we were the only company which was able to demonstrate using our positioning technology to provide metre-level accuracy on the streets in Manhattan.<sup>71</sup>

- 3.77 Cohda Wireless provided additional evidence of how automated vehicles are providing further benefits such as reducing fuel consumption:

A good example is Peloton, in the US. This is a company doing aftermarket platooning solutions for trucking to allow trucks to platoon together at close-following distances to reduce fuel consumption. This whole platooning idea is probably one of the big leaders in connected autonomous vehicle deployments. We also have a lot of engagements in the mining sector as well.<sup>72</sup>

- 3.78 The complexity of interactions between vehicles and other systems means that the successful deployment of autonomous vehicles will be dependent upon robust regulatory frameworks and collaboration between multiple parties. The Department of Communications and the Arts stated that:

If 5G is to be used to support downstream technologies they also need to have appropriate sectoral frameworks. For example, if 5G is to support autonomous vehicles there needs to be a framework for autonomous vehicles so there is scope for 5G to support them. In the case of autonomous vehicles, Australia is

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<sup>70</sup> Dr Gray, Cohda Wireless Pty Ltd, *Committee Hansard*, Adelaide, 18 February 2019, p. 13.

<sup>71</sup> Dr Gray, Cohda Wireless Pty Ltd, *Committee Hansard*, Adelaide, 18 February 2019, p. 16.

<sup>72</sup> Dr Gray, Cohda Wireless Pty Ltd, *Committee Hansard*, Adelaide, 18 February 2019, p. 14.

well advanced in this regard, in that several jurisdictions have relevant legislation in place, all have trials underway and there are Guidelines for Trial of Autonomous Vehicles in Australia.<sup>73</sup>

## Improved Safety

3.79 A significant benefit of automated vehicles using the low latency of 5G mobile technology is the potential to dramatically improve road safety. The Australian and New Zealand Driverless Vehicle Initiative (ADVI) set out that:

5G will be key in enhancing cellular vehicle-to-everything (C-V2X) communications technology. C-V2X technology allows vehicles to directly communicate with each other, roadside infrastructure, and other road users. This unique sensing allows vehicles to detect and mitigate against potential hazards, traffic and road conditions quicker and from longer distances than other sensors such as cameras, radar and LiDAR. For example, under 4G, the time between a sensor recognising a hazard on the road may be 20 milliseconds whereas under 5G this is reduced to 1 millisecond – a camera flash.<sup>74</sup>

3.80 Echoing this sentiment, the Department of Communications and the Arts stated that:

Improved road safety is also expected to be a key outcome of autonomous vehicles, as the majority of car accidents involve human error. In the 12 months to July 2017, there were 1,235 deaths on Australian roads with road trauma costing the Australian community an estimated \$27 billion annually. Autonomous vehicles can have a valuable role not just in terms of financial savings, but in saving human lives.<sup>75</sup>

3.81 ADVI further noted experts agreed that ‘90 per cent of accidents could be eliminated through advanced driverless vehicle technology’, and that an efficient deployment of 5G would assist with improvements to safety:<sup>76</sup>

...safety is really the fundamental winner out of getting the 5G rollout right and also getting the driverless vehicle implementation in place faster. The

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<sup>73</sup> Department of Communications and the Arts, *Submission 330*, p. 12.

<sup>74</sup> Australian and New Zealand Driverless Vehicle Initiative, *Submission 182*, p. 4.

<sup>75</sup> Department of Communications and the Arts, *5G – Enabling the future economy*, October 2017, p. 1.

<sup>76</sup> Australian and New Zealand Driverless Vehicle Initiative, *Submission 182*, p. 4.

safety benefits are significant, and that really underpins why we're involved in it.<sup>77</sup>

3.82 Cohda Wireless elaborated on how vehicle-to-vehicle communication could help improve road safety by warning drivers:

...exploiting the network effect to have your vehicle talking to all the vehicles around it, including vehicles that may be around a blind corner that the cameras and radar in your vehicle can't even see yet. You can detect that vehicle. For example, if two vehicles are approaching a blind intersection and neither of them are going to stop in time, you can generate a warning in that scenario.<sup>78</sup>

## Social Inclusion

3.83 In addition to delivering productivity gains, automated vehicles also offer to potential to improve the welfare of citizens. Telstra noted the following:

... we see 5G underpinning the transition to automated and connected vehicles, both on the roads and in low altitude airspace (drones). This transition will deliver potential for significant benefits in the areas of social equity, access and inclusion.<sup>79</sup>

3.84 Telstra elaborated that the benefits of autonomous vehicles would aid people who are not able to drive or who lack easy access to public transport, such as 'elderly people, people with disabilities, children, unlicensed [people] or those for whom car ownership and licensing is economically unviable'.<sup>80</sup>

3.85 Automated vehicles are already being deployed in a limited capacity in some industry sectors. There is also a growing number of automated vehicles in non-industrial environments. The AMTA and CA noted that:

Autonomous vehicles are being used now with 4G, particularly in mining and agriculture, but 5G and ultra-reliable low latency communications will greatly enhance the use of autonomous vehicles across industries and the general community.<sup>81</sup>

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<sup>77</sup> Mrs Rita Excell, Executive Director, Australia and New Zealand Driverless Vehicle Initiative (ADVI), *Committee Hansard*, Sydney, 20 February 2020, p. 22.

<sup>78</sup> Dr Gray, Cohda Wireless Pty Ltd, *Committee Hansard*, Adelaide, 18 February 2019, p. 13.

<sup>79</sup> Telstra, *Submission 296*, p. 20.

<sup>80</sup> Telstra, *Submission 296*, p. 20.

<sup>81</sup> AMTA and CA, *Submission 335*, p. 30.

3.86 In addition to providing the actual transport, Telstra also noted the psychological benefits associated with providing new transport options to the communities who lack access to private vehicles and mainstream public transport:

Models such as Mobility-as-a-Service will bring benefits in terms of increased empowerment for these people as they are able to plan and control their transport and journey options and an increased sense of independence that comes from not being reliant on others for transport.<sup>82</sup>

## Entertainment and Leisure

3.87 Although 5G technology is at 'a relatively early stage of development, development, and there is some way to go before its full potential is realised', it is expected that there will be immediate benefits for consumers and, in time, the new use cases for mobile technology will be unlocked.<sup>83</sup> 5G has been suggested to be an alternative to fixed networks, providing 'fibre-like user experiences for the unconnected'.<sup>84</sup>

3.88 VHA confirmed that 5G would provide benefits for consumers:

For most people, for most customers, it's going to be faster throughput, enhanced mobile broadband services. It's going to be HD streaming. It's going to be faster downloads. It's going to be the enhancement of that core mobile broadband experience and then there will be many more exciting niche applications around the edge.<sup>85</sup>

3.89 Telstra has reported that the use of 5G small cells in areas with high-density traffic can support additional capacity and performance.<sup>86</sup> This was demonstrated during the 2019 AFL Grand Final, where '5G users

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<sup>82</sup> Telstra, *Submission 296*, p. 20.

<sup>83</sup> Ms Pauline Sullivan, First Assistant Secretary, Market Reform Division, Department of Communications and the Arts, *Proof Committee Hansard*, 6 December 2019, p. 25.

<sup>84</sup> GMSA, *Submission 255*, p. 4. See also Broadcast Australia, *Submission 314*, p. 2; Huawei, *Submission 270*, p. 5.

<sup>85</sup> Mr Dan Lloyd Chief Strategy Officer and Corporate Affairs Director, Vodafone Hutchison Australia (VHA), *Committee Hansard*, Sydney, 20 February 2020, p.37.

<sup>86</sup> Mr Channa Seneviratne, Executive, Network and Infrastructure Engineering, Telstra, *Committee Hansard*, Southport, 19 November 2019, p. 2.

experienced three to four times the speeds available on 4G, and 4G users also had improved performance due to traffic moving to 5G'.<sup>87</sup>

- 3.90 The lower latency and higher capacity of 5G will improve the experience of gaming competitors and casual gamers, and 'promises to immerse the viewer in a virtual world of high-resolution digital imagery'.<sup>88</sup> Optus reported that the Australian gaming market is worth \$4 billion, of which 25 per cent is mobile gaming, and that '... research shows that one third of gamers would be willing to pay more for 5G gaming services'.<sup>89</sup> It is likely that the gaming industry will be the first to taken advantage of 5G technology, including the use of augmented and virtual reality, and this will help drive the 'acceptance and delivery of 5G networks'.<sup>90</sup>
- 3.91 VHA reported that Vodafone UK had conducted a holographic telephone call.

The low latency and high speeds of 5G made it possible to project a 3D holograph of someone who was more than 330kms away. This technology could transform the way families stay in touch or the remote working experience. It also delivers increased accessibility to education and healthcare for people living in remote areas.<sup>91</sup>

## Concluding Comment

- 3.92 Consumer demand for more mobile data is strong, and will drive carriers to deploy 5G, but significant benefits will be felt broadly in industries like agriculture and mining, transport, local governance and entertainment.
- 3.93 Use cases should be driven from actual need rather than marketing, and the Committee was pleased that carriers like Optus are engaging with business to create 5G use cases that respond to existing issues.
- 3.94 The technologies that 5G enables will have a range of applications across different industries, and the same technology may mean very different things according to the specific encounter a consumer has with it. For example, virtual reality may allow health services to be expanded for consumers who are not able to access a particular specialist, and for a

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<sup>87</sup> Department of Communications and the Arts, *Submission 330*, p. 5.

<sup>88</sup> Nokia, *Submission 321*, p. 6; Dr Don Maisch, *Submission 42*, p. 2.

<sup>89</sup> Optus, *Submission 338*, pp. 13-14.

<sup>90</sup> Optus, *Submission 338*, p. 14.

<sup>91</sup> VHA, *Submission 319*, p. 2.

consumer playing a game, will allow a greater engagement and enjoyment of the game.

- 3.95 The Internet of Things (IoT) will benefit a number of industries and consumers, allowing greater monitoring of supply chains and services and enabling efficiencies and increase productivity. Robotics will be one area in which the data capacity and low latency of 5G will be advantageous.
- 3.96 The promise of automated vehicles is significant, and has implications for accessibility, increased safety for road users and pedestrians, lowering of fuel costs and emissions and increasing the efficiency of traffic flow.
- 3.97 Australian companies like Cohda Wireless are leading the world in the development of technologies which will rely on 5G for greater deployment. The Committee heard that Australia is at the forefront of vehicle communication technology, and commends the work of Cohda Wireless in this space.
- 3.98 Agriculture use cases demand 5G technology, however the Committee is concerned that these areas may not be economically viable for the initial rollout.

## **Recommendation 14**

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- 3.99 The Committee recommends that the Australian Government work with carriers to develop campaigns to boost industry awareness about the advantages of 5G to businesses to help realise the benefits of this new network quickly. This campaign should include elements to lift 5G awareness within local government.**

# A. Submissions

- 1 Mr Gary Fouche
- 2 Mr Kody Finlay
- 3 Soroptimist International of Karratha and Districts Incorporated
- 4 Mr Gary Slee
- 5 Mrs Glenise Slee
- 6 Ms Sarah Arrowsmith
- 7 *Confidential*
- 8 Ms Amanda Fitzgerald
- 9 *Name Withheld*
- 10 Mrs Anita Kilby
- 11 Mr Ed Loffeld
- 12 *Name Withheld*
- 13 *Name Withheld*
- 14 Mr Karl Wilson
- 15 Mrs Mandy Mason
- 16 Ms Judy O'Donnell
- 17 Mrs Candice Bauer
- 18 Mr Robert Heron
- 19 Mrs Sue-Ellen Anastasiadis
- 20 *Name Withheld*

- 21 Mr Zak Muscat-Retsas
- 22 Ms Elena Brennan
- 23 Ms Kaye Handley
- 24 Mrs Di Christiansen
- 25 *Name Withheld*
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- 39 Mrs Linda Moullae
- 40 Ms Michelle Georgiou
- 41 Ms Michelle Card
- 42 Dr Don Maisch
- 43 Mr Michael Harper
- 44 Mr Arthur Moore
- 45 Ms Lesley King
- 46 *Name Withheld*
- 47 A McKendry



- 
- 48 *Name Withheld*
- 49 Ms Danielle Gigante
- 50 *Confidential*
- 51 Ms Bridget Kidcaff
- 52 Ms Ona Henderson
- 53 Mr Marc Cottrell
- 54 Ms Daisy Finn
- 55 Ms Karen Bell
- 56 Mrs Angela Kelly and Mr Dean Kelly
- 57 Ms Samantha Willcocks
- 58 Mr Damien Moffatt
- 59 *Confidential*
- 60 Mrs Anna Wise
- 61 WAFarmers
- 62 Natural Medicine Clinic
- 63 *Name Withheld*
- 64 Mrs Christiena Ennis
- 65 Mr Karl Wise
- 66 Ms Muriele Tesauri
- 67 Mrs Helen Tricarico
- 68 Stop 5G Northern Rivers Group
- 69 Ms Tracey Scott
- 70 Mr Ewen Kloas
- 71 *Name Withheld*
- 72 Ms Kathrin Soroko
- 73 *Name Withheld*
- 74 Ms Diane Martin
- 75 Mr Garry Daud
- 76 *Name Withheld*

- 77 *Name Withheld*
- 78 Mr Brian McLauchlan
- 79 *Name Withheld*
- 80 Mrs Vanessa Comiskey
- 81 Mrs Rinat Strahlhofer
- 82 Mrs Rebecca Phillips
- 83 *Name Withheld*
- 84 Mr David Phare
- 85 Ms Tanya Braithwaite
- 86 *Confidential*
- 87 *Name Withheld*
- 88 Ms Fiona Ferguson
- 89 Ms Rosalyn McNulty
- 90 Mr John Evans
- 91 *Name Withheld*
- 92 Mr George Neofitou
- 93 *Name Withheld*
- 94 Mrs Maria Vulciu
- 95 *Name Withheld*
- 96 Menkit Prince
- 97 Gino Lorenzon
- 98 Mrs Ilse Broekaert
- 99 Ms Maria Arranz
- 100 TasICT
- 101 *Name Withheld*
- 102 Mr Peter Dray
- 103 Dr Murray May
- 103.1 Supplementary to submission 103
- 104 Mrs Louise Nennstiel

- 
- 105 Mrs Jean McQueen  
106 Mr Peter Matthews  
107 *Name Withheld*  
108 Ms Joanne Grant  
109 Mr Daniel Roman  
110 Mr Mark Capp-Perucic  
111 *Confidential*  
112 Ms Renee Jones  
113 Cancer Information & Support Society  
114 Ms Kathryn Beacroft  
115 Dr Richard Cullen  
116 Mrs Linda Wood  
117 Mr Cameron Turner  
118 *Name Withheld*  
119 Mrs Georgina Lock  
120 Ms Moana Reihana  
121 Miss Emma Taylor  
122 Maria Hoffmann  
123 Mrs Denise Oldale  
124 Ms Emma Tobin  
125 Ms Gay Schulz  
126 Mr Mark Reardon  
127 *Confidential*  
128 Caniaba P&C  
129 Ms Naomi Cook  
130 Miss Sara Schulz  
131 *Name Withheld*  
132 Ms Lydia Camilleri  
133 *Name Withheld*

- 134 *Name Withheld*
- 135 Miss Katie Green
- 136 Mrs Lisa Mozes
- 137 Mrs Carole Newton
- 138 Mrs Natasha Hantler
- 139 Ms Rebecca King
- 140 Mrs Michelle De Aguiar
- 141 Ms Sally Green
- 142 Ms Lydia Kirkpatrick
- 143 *Name Withheld*
- 144 *Name Withheld*
- 145 *Name Withheld*
- 146 Mrs Martha Bridi Simcox
- 147 *Name Withheld*
- 148 Ms Leilani Innis
- 149 Mrs Hayley Clarke
- 150 Ms Enca Crosbie
- 151 Ms Sue Marx
- 152 Mr George Carey
- 153 Mr Gwilym Summers
- 154 Ms Lalune Croker
- 155 *Name Withheld*
- 156 Ms Phillipa Holden
- 157 Ms Susan Speirs
- 158 Ms Mary Berry
- 159 Mrs Hilary Thompson
- 160 Marian Porter
- 161 Mrs Elysse Strachan
- 161.1 Confidential

- 
- 162 Mrs Mandy Carman
- 163 *Name Withheld*
- 164 *Name Withheld*
- 165 Mrs Mimi Chiappalone
- 166 EMR Australia
- 167 Australian Centre for Electromagnetic Bioeffects Research
- 168 George Parker
- 169 Ross Pointer
- 170 Kalindra McColl
- 171 Mr Michael Gersch
- 172 *Confidential*
- 173 *Confidential*
- 174 *Confidential*
- 175 Alexandra Ward
- 176 *Name Withheld*
- 177 *Name Withheld*
- 178 *Name Withheld*
- 179 MS Dee (Diane) Barnett
- 180 Professor Katherine Georgouras OAM
- 181 Professor Jock Given
- 182 Australia and New Zealand Driverless Vehicle Initiative
- 183 Anna Plimm
- 184 Miss Katie Fisher
- 185 Anthony Harris
- 186 Department of Agriculture
- 187 *Name Withheld*
- 188 *Name Withheld*
- 189 Mr Leo Leung
- 190 Ms Helen Langlois

- 191 Ms Monika Jakli
- 192 Ms Sarah Davis
- 193 Mr Michael Grant
- 194 Mrs Karen Orlando
- 195 *Name Withheld*
- 196 Ms Rebecca Schutze
- 197 Rose Harvey
- 198 Miss Veronica Clarke
- 199 *Name Withheld*
- 200 Lyn Anderson
- 201 Mrs Amy Westnedge
- 202 Mr Kyle Rogers
- 203 Electrosensitivity Australia
- 204 Mr Christopher Jones
- 205 *Name Withheld*
- 206 *Name Withheld*
- 207 Mrs. Laurie Levine
- 208 Ms Grace Viljoen
- 209 Ms Carmela Leone
- 210 *Name Withheld*
- 211 Elaine Townsend
- 212 Mr Chris Patterson
- 213 *Name Withheld*
- 214 City of Melbourne
- 215 Ms Angela Toohey
- 216 *Name Withheld*
- 217 Mrs Jennifer Robertson
- 218 Ms Susan Howlett
- 219 Ms Anne Dormer

- 
- 220 *Name Withheld*
- 221 Mrs Phoebe Coffey
- 222 Ms Tashi Lhamo
- 223 *Name Withheld*
- 224 Ms Kerry Howell
- 225 *Name Withheld*
- 226 Ms Elisabeth Cummins
- 227 *Name Withheld*
- 228 Ms Sophie Knox
- 229 Environment and Communities Safe from Radiation Inc.
  - 229.1 Supplementary to submission 229
- 230 Mr Garth Atkinson
- 231 Ms Rosa Maria Sierra
- 232 Australian Communications and Media Authority
- 233 *Name Withheld*
- 234 Joanne Carr and Heath Doolette-Cox
- 235 Mrs Julie Madden
- 236 Mr Jason Thomas
- 237 *Name Withheld*
- 238 *Name Withheld*
- 239 Ms Susie Figgis
- 240 Ms Catherine Johnson
- 241 Ms Nichola Atkinson
- 242 Mr Brad Chegwedden
- 243 Mrs Kylie Taylor
- 244 *Name Withheld*
- 245 Greer Chase
- 246 Ms Amie San
- 247 Mrs Fiona Harper-Harwood

- 248 *Name Withheld*
- 249 *Name Withheld*
- 250 Mrs Bronwyn Bennett
- 251 Anna Harpley
- 252 Miss Mikala Dind
- 253 Ms Vanessa Verstappen
- 254 *Name Withheld*
- 255 GSMA
- 255.1 Supplementary to submission 255
- 256 Ms Claire Morrissy
- 257 Mrs Jennifer Clarke
- 258 Lord Rob Ding
- 259 Mrs Jolene Twaddle
- 260 Mr Timothy Sawyer
- 261 *Name Withheld*
- 262 Anita O'Reilly
- 263 Mrs Carrie-Ann Layton-Smith
- 264 Mr Hugh Dickson
- 265 *Name Withheld*
- 266 *Name Withheld*
- 267 Mr Steve Galvin
- 268 *Name Withheld*
- 269 Miss Poppy Edwards
- 270 Huawei Australia
- 271 *Name Withheld*
- 272 *Name Withheld*
- 273 Miss Karen Jennings
- 274 Susannah Jones
- 275 Mrs Sandra Skinner



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- 276 Jeanette Ball
- 277 Miss Christine Pheeneey
- 278 Miss Abeni Elliss
- 279 Jody Wood
- 280 Mr Dave Bourke
- 281 *Name Withheld*
- 282 *Name Withheld*
- 283 Mrs Holly Hunter
- 284 *Name Withheld*
- 285 Ms Louise Dunn
- 286 Ann Page
- 287 *Name Withheld*
- 288 Mrs Jennifer Zurzolo
- 289 *Name Withheld*
- 290 Mrs Suzanne Ryan
- 291 *Name Withheld*
- 292 *Name Withheld*
- 293 *Name Withheld*
- 294 *Name Withheld*
- 295 *Name Withheld*
- 296 Telstra
- 297 Water Services Association of Australia
- 298 Ms Anat Harari
- 299 Lynn Carroll
- 300 Ms Danielle Young
- 301 Mr Stephen Wells
- 302 Ms Beth Marrocco
- 303 *Name Withheld*
- 304 Lynette Doyle

- 305 Dr Marina Zhang
- 306 *Name Withheld*
- 307 *Name Withheld*
- 308 *Name Withheld*
- 309 WALGA
- 310 City of Sydney
- 311 Oceania Radiofrequency Scientific Advisory Association
- 312 Telecommunications Industry Ombudsman
- 313 Commpete Inc
- 314 Broadcast Australia
- 315 Charles Sturt University
- 316 IoTAA
- 317 Australian Radiation Protection and Nuclear Safety Agency
  - 317.1 Supplementary to submission 317
  - 317.2 Supplementary to submission 317
- 318 Ausgrid
- 319 Vodafone Hutchison Australia
- 320 ALGA
- 321 Nokia Networks
- 322 *Name Withheld*
- 323 *Name Withheld*
- 324 *Confidential*
- 325 Ms Jude Nicoll
- 326 *Name Withheld*
- 327 Mrs Lisa Kriewaldt
- 328 Mr Hakan Bayar Kemal
- 329 Carolyn O'Brien
- 330 Department of Communications and the Arts
- 331 *Confidential*

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- 332 *Confidential*
- 333 Ms Lisa Serpa
- 334 Queensland Transport and Main Roads
- 335 Australian Mobile Telecommunications Association and Communications Alliance
- 336 Ashley Cowcill
- 337 Axicom
- 338 Optus
- 339 Ericsson
- 340 Australian Competition and Consumer Commission
- 341 Australian Communications Consumer Action Network
- 341.1 Supplementary to submission 341
- 342 We Say NO to 5G in Australia
- 343 seqwater
- 344 Communications and Information Technology Training Ltd
- 345 *Name Withheld*
- 346 *Name Withheld*
- 347 Miss Talula Guralnek
- 348 *Name Withheld*
- 349 Ms Kate Swan
- 350 Ms Mercy Wolf
- 351 *Name Withheld*
- 352 Mr Daniel Rossi
- 353 Mr benjamin smith
- 354 Department of Corporate and Information Services, Northern Territory Government
- 355 Earthing Oz
- 356 Australian Industry Group
- 357 Stop Smart Meters Australia Inc
- 358 *Confidential*

- 359 *Name Withheld*
- 360 *Name Withheld*
- 361 *Confidential*
- 362 *Name Withheld*
- 363 *Name Withheld*
- 364 Mrs Amy Blackmore
- 365 *Name Withheld*
- 366 Jo McFarlane
- 367 *Name Withheld*
- 368 Mrs Jeanette Bullock
- 369 *Name Withheld*
- 370 *Name Withheld*
- 371 *Name Withheld*
- 372 Leanne O'Donovan
- 373 Elena Dawson
- 374 *Name Withheld*
- 375 Mr Doug Maher
- 376 Mr Marco Sammut
- 377 Ms Deborah Cooper
- 378 Charlene Joy
- 379 Mrs Carmen Parra
- 380 Mrs Natasha Nero
- 381 Jacqueline Perrott
- 382 Anna Clark-Doyle
- 383 N Dawson
- 384 Mrs Michelle Friedman
- 385 Denise Lockett
- 386 Sally Hedderwick
- 387 Julie Stronell

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- 388 Kathryn Milin  
389 EMR Surveys  
390 Miss Loren McMath  
391 *Name Withheld*  
392 *Name Withheld*  
393 Mrs Maureen Kirsch  
394 James Moyle  
395 *Name Withheld*  
396 Ms Julie Barber  
397 *Name Withheld*  
398 Mr Troy Lock  
399 Ms Amanda Doolan-Harris  
400 Ms Melissa Davey  
401 *Name Withheld*  
402 Ms Helen Cahill  
403 Ms Deborah Aldridge  
404 *Name Withheld*  
405 Ms Melinda Turner  
406 *Name Withheld*  
407 Mrs Deanne Hislop  
408 *Name Withheld*  
409 Ms Rebecca De Carlo  
410 Mr Crispin Wellington  
411 Ms Janina Koesling  
412 Ms Jay Ward  
413 Miss Judith Anne Buchan  
414 *Name Withheld*  
415 Ms Andrea Weber  
416 Ms Sue-Ellen Middleton

- 417 Miss Merridee Pilkington
- 418 Mr Michael Goebel
- 419 *Name Withheld*
- 420 Mr Kim Skeltys
- 421 *Name Withheld*
- 422 *Name Withheld*
- 423 Mrs Lauren Newman
- 424 Mr Kevin Schaffer
- 425 Mr Alan Manson
- 426 *Name Withheld*
- 427 *Name Withheld*
- 428 Mr Martin Oliver
- 429 Ms Jacqui Murphy
- 430 Mr Steven Evans
- 431 Ms Una Phelan
- 432 Ms Lauren Dry
- 433 CR Dominic WYKanak
- 434 Mrs Liz Marshall
- 435 *Name Withheld*
- 436 Ms Tess Hansel
- 437 *Name Withheld*
- 438 Main Roads Western Australia
- 439 Ms Annette Chen
- 440 Ms Sheila Masters
- 441 Ms Mel Smith
- 442 Ms Jane Refshauge
- 443 Ms Rebecca Slattery
- 444 Ms Jessica Brosnan
- 445 Ms Simone Glover

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- 446 Ms Renee Gray  
447 Mr Paul Clune  
448 Ms Molly Knight  
449 *Name Withheld*  
450 Dr Yapa Bandara  
451 Ms Kim Thomas  
452 Ms Carmen Amaya  
453 Ms Michelle Kinsella  
454 Ms Barb Kay  
455 Ms Nina Stick  
456 Ms Tracey Kelly  
457 Mr Darren Mercieca  
458 Ms Annette Hill  
459 *Confidential*  
460 Ms Elizabeth Pender  
461 Ms Sarah Spiller  
462 Mr Kevin Arnold  
463 Ms Jaguar Lacroix  
464 Ms Lorna Kaay  
465 Ms Rachael King  
466 Ms Narelle Munro  
467 Ms Lakshmi Ramanuja  
468 Ms Lyn Castrique  
469 Ms Zoe Cotterill-Rogers  
470 Ms Susan Shore  
471 Ms Jodi Donovan  
472 Ms Chandra Easton  
473 Ms Elaine Macdonald  
474 Ms Angelika Ross

- 475 Ms Karen Winter
  - 475.1 Supplementary to submission 475
- 476 Ms Mary Crutcher
- 477 Ms Lorraine Phillip
- 478 Ms Jane Jennings
- 479 Ms Jessica Knight
- 480 Ms Madeleine Burch
- 481 Mr Damian Donoghue
- 482 Ms Juliana Frances
- 483 Ms Shaman Votrubec
- 484 Mr Graeme Keet
- 485 Dr Priyanka Bandara
- 486 Ms Natalie Guralnek
- 487 Mr Mike Dark
- 488 Ms Nicola Dark
- 489 Ms Angela Riley
- 490 Mr Ian Taylor
- 491 *Name Withheld*
- 492 Mr Karl Saxon
- 493 R Davies
- 494 Miss Leah Hudson
- 495 *Name Withheld*
- 496 *Name Withheld*
- 497 Miss Rachel Dove
- 498 *Name Withheld*
- 499 Ms Jenny Guralnek
- 500 Ms Peta Mitchell
- 501 Ms Derran Heney
- 502 *Name Withheld*



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- 503 Mr David Sharpe  
504 *Name Withheld*  
505 *Name Withheld*  
506 Mrs Candice Berghuis  
507 Miss Donna Anderson  
508 Mrs Dina Boljevac  
509 Ms Jodie Delaney  
510 *Name Withheld*  
511 *Name Withheld*  
512 Ms Andra Cordell  
513 *Name Withheld*  
514 Mr Matthew Lee  
515 *Name Withheld*  
516 n/a Phillip Whiteley  
517 Mr Paul Barratt  
518 *Name Withheld*  
519 Ms Tanina Millis  
520 *Name Withheld*  
521 Mrs Claire Martin Reyes  
522 *Name Withheld*  
523 Mrs Laura Agostino  
524 *Name Withheld*  
525 *Name Withheld*  
526 *Name Withheld*  
527 *Name Withheld*  
528 *Confidential*  
529 Alexandra Bock  
530 Steve Weller  
531 National Farmers' Federation

- 532 Australasian Society of Building Biologists
- 533 Anson Friend
- 534 *Name Withheld*
- 535 *Name Withheld*
- 536 *Name Withheld*
- 537 *Name Withheld*
- 538 Paloalto Networks

## B. Exhibits

- 1 *Scientists warn of potential serious health effects of 5G - September 13, 2017, Mr William Benstead*
- 2 *A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation, by Biolnitiative Working Group 2012, Ms Sharnee Lee, Mr Garry Daud, Phillip Whiteley and Alexandra Bock, (25, 75, 516 and 529)*
- 3 *5G: Great risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them, 2018, Ms Sharnee Lee, (25)*
- 4 *Environmental Health Trust links to articles , Mrs Tanja Price , (28)*
- 5 *Letter to the Editor by Ken Karipidis and Rick Tinker, 2018, Mrs Tanja Price, (28)*
- 6 *Health Risks of Wireless Technologies Authors' Response to the Letter to the Editor, 2018, Mrs Tanja Price and Mr Leo Leung, (28 and 189)*
- 7 *Radio Frequency Exposure Risk Assessment and Communication: Critique of ARPANSA Tr-164 Report. Do We Have A Problem? by Victor Leach and Steven Weller, 2017, Mrs Tanja Price, (28)*
- 8 *Biological Effects Of Low-Intensity Radiofrequency Electromagnetic Radiation – Time For A Paradigm Shift In Regulation of Public Exposure by Priyanka Bandara and Steve Weller, 2017, Mrs Tanja Price, (28)*
- 9 *A&E Insurance for Architects and Engineers, Mrs Michelle Georgiou, (40)*
- 10 *Letter to the United Nations Environment Programme Transmitting the International EMF Scientist Appeal, 2019, Mrs Michelle Georgiou, (40)*
- 11 *U.N. Environment Programme Urged to Protect Nature and Humankind from Electromagnetic Feilds (EMF), Mrs Michelle Georgiou, (40)*

- 12 *4G/5G antenna densification is escalating health risks- a global crisis*, Mrs Michelle Georgiou, (40)
- 13 *Key Scientific Evidence and Public Health Policy Recommendations by Cindy Sage, Supplement 2012*, Mrs Michelle Georgiou, (40)
- 14 *Community concerns over 5G: Needless anxiety or wise precaution? by Don Maisch PhD, 2019*, Mrs Michelle Georgiou, (40)
- 15 *Letter From EM Radiation Research Trust to the UK Government. 2019*, Mrs Michelle Georgiou, (40)
- 16 *5G Risk: The Scientific Perspective, by Martin Pall PHD*, Mrs Angela Kelly and Anna Clarke-Doyle, (56 and 382)
- 17 *Eight Repeatedly Documented Findings Each Show the EMF Safety Guidelines Do Not Predict Biological Effects and Are, Therefore Fraudulent: The Consequences for Both Microwave Frequency Exposures and Also 5G, Second Edition by Martin L. Pall, 2019*, Mrs Angela Kelly, (56)
- 18 *Letter from Martin Pall to unknown recipient, 2019*, Mrs Angela Kelly, Mr Leo Leung, Louise Dunn and Phillip Whiteley, (56, 189, 285 and 516)
- 19 *5G Crisis: Awareness and Accountability, 2019*, Mrs Angela Kelly, (56)
- 20 *42 Expressions of High Level Concern Drafted by Scientists and/or Medical Doctors Regarding Health Impacts of Low Level EMF Exposures*, Mrs Angela Kelly, (56)
- 21 *Harmful Effects of 5G Radiations: Review, by Subhash Chander Verma , Mr Garry Daud, (75)*
- 22 *The new ICNIRP radiofrequency guidelines and implications for 5G & Radiofrequency Electromagnetic Fields and Health. Radiation Programme, Department of Public Health, Environmental and Social Determinants of Health, International Commission on Non-Ionizing Radiation Protection & World Health Organization, (Mike Wood, Telstra)*
- 23 *Letter to regulators, July 2019*, Name Withheld
- 24 *Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children, Rinat Strahlhofer, (81)*
- 25 *5G and Health Gaps in The Knowledge Dariusz Leszczynski, 2019*, Dr Murray May, (103)
- 26 *World Health Organization, Radofrequency Radiation and Health - A Hard Nut to Crack, Review by Lennart Hardell, 2017*, Dr Murray May , (103)
- 27 *Letter From Professor Beatrice Golomb, 2017*, Dr Murray May, (103)

- 
- 28 *Stop 5G on Earth and in Space*, Mrs Denise Oldale, (123)
  - 29 *Safety of 5G and Electromagnetic Radiation, an Educational Primer* , Name Withheld, (143)
  - 30 *A Guide to Small Cells*, ACMA, (232)
  - 31 *5G pamphlets*, Name Withheld, (365)
  - 32 *Health Risks to Children from Wireless Radiation*, Mr Hakam Bayar Kemal, (328)
  - 33 *A 5G Wireless Future*, Dr Cindy Russell, Name Withheld, (392)
  - 34 *Planetary electromagnetic pollution: it is time to assess its impact*, *The Lancet*, 2018, Name Withheld, (392)
  - 35 *Carcinogenic effects of NonIonizing Radiation: A Paradigm Shift*, Magda Havas, Name Withheld, (392)
  - 36 *PowerWatch: 1,670 Peer-Reviewed Scientific Papers on Electromagnetic Fields and Biology or Health Electromagnetic Radiation Safety*, 2018, Name Withheld, (392)
  - 37 *EMR and Health*, 2019, Name Withheld, (271)
  - 38 *Radiofrequency/microwave radiation biological effects and safety standards: A review 1988*, Name Withheld and Mr Hakan Bayar Kemal, (272 and 328)
  - 39 *Letter from ARPANSA to Tanja Price*, 2018, Louise Dunn, (285)
  - 40 *Letter from Dr Martin Pall to Governor Jerry Brown, California*, Name Withheld, (419)
  - 41 *Report for the United Nations Educational Scientific and Cultural Organization (UNESCO)*, Ms Jane Jennings, (478)
  - 42 *International EMF Scientist Appeal updated 2019*, Phillip Whiteley, (516)
  - 43 *audio recording from ABC Radio with Dr Ken Karipidis, Assistant Director of ARPANSA speaking on 5G*, Alexandra Bock, (529)
  - 44 *ORSAA submission to ICNIRP*, Steve Weller, (530)
  - 45 *4G/5G Wireless Infrastructure Risks: "Small" Cells*, Mr Hakan Bayar Kemal, (328)
  - 46 *Scientific American*, 17 October 2019, *Inernational EMF Scientistss 5G Appeal and Lloyd's of London decision re insurance of harm from EMF radiation*, Mr Don Benjamin
  - 47 *Collection of documents*, Dr Murray May
  - 48 *NSW Government communication licence rent Fact Sheet*, Axicom

**49** Confidential

**50** *Collection of documents, Professor Jock Given*

# C. Public Hearings and Witnesses

**Tuesday, 19 November 2019**

Southport Community Centre

Southport

## *Telstra*

- Ms Cecelia Burgman, Principal, Government Relations
- Mr Brian Miller, Principal, Network and Technology Regulation
- Mr Channa Seneviratne,, Executive, Network and Infrastructure Engineering
- Mr Mike Wood, Principal, 5G EME Strategy

## *QLD Water*

- Mr David Cameron, Chief Executive Officer

## *Seqwater*

- Ms Carmel Serratore Legal Counsel

## *Department of Transport and Main Roads - QLD Government*

- Mr Tom ORR, Director, Corridor Management and Protection

**Friday, 6 December 2019**

Australian Parliament House – Committee Room 2R2

*Australian Mobile Telecommunications Association*

- Mr Raymond McKenzie, Manager, Mobile Carriers Forum
- Mr Chris Althaus, Chief Executive
- Ms Jane van Beelen, Chair

*Australian Communications and Media Authority*

- Ms Linda Caruso, General Manager, Communications Infrastructure
- Mr Christopher Hose, Executive Manager, Spectrum Planning and Engineering
- Mr Vince Humphries, Executive Manager, Telecommunications and Safeguards
- Mr Allan Major, Executive Manager, Licensing and Infrastructure Safeguards

*Australian Radiation Protection and Nuclear Safety Agency*

- Mr Nathan Wahl, Assistant Director, Government and International Relations
- Dr Ken Karipidis, Assistant Director, Assessment and Advice

*Australian Centre for Electromagnetic Bioeffects Research*

- Dr Rodney Croft, Acting Director, Australian Centre for Electromagnetic Bioeffects Research

*Communications Alliance*

- Mr John Stanton, Chief Executive Officer, Communications Alliance

*Department of Communications and the Arts*

- Mr Richard Windeyer, Deputy Secretary
- Ms Pauline Sullivan, First Assistant Secretary, Market Reforms Division
- Mr Philip Mason, Assistant Secretary, Future Connectivity Branch



- Mr Tristan Kathage, Assistant Secretary, Competition Branch, Market Reforms Division
- Mr Daniel Edmonds, Acting Director, Spectrum Access and Management

### *National Health and Medical Research Council*

- Dr Julie Glover, Executive Director, Research Foundations Branch

## **Monday, 17 February 2020**

Parliament of Western Australia - Committee Room 1

### *Cancer Information & Support Society*

Mr Donald Benjamin, Research Director

### *Environment and Communities Safe from Radiation Inc.*

Mr Stephen Toneguzzo, Chair

### *Main Roads Western Australia*

Mr Des Snook, Executive Director Metro and Southern Regions

Mr Simon Beard, Asset Maintenance Manager

Mr James Pinnington, Manager Electrical Asset Management

### *Private capacity*

Dr Murray May

### *WAFarmers*

- Mr Trevor Whittington, Chief Executive Officer

### *Western Australian Local Government Association*

- Mr Nick Sloan, Chief Executive Officer
- Mr Ian Duncan, Executive Manager, Infrastructure
- Councillor Lynne Craigie, President

## **Tuesday, 18 February 2020**

Parliament of South Australia - Balcony Room

### *Teletraffic Research Centre, University of Adelaide*

- Professor Bruce Northcote, Director

### *Growing Data Foundation (GDF) Ltd and Opensensing (O)*

- Mr Leo Gaggl, Chairperson (GDF) and Managing Director (O)

### *Cohda Wireless*

- Dr Paul Gray, Chief Executive Officer

### *Myriota*

- Mr Paul Sheridan, Director of Strategic Partnerships

## Wednesday, 19 February 2020

Parliament of Victoria

Room G1

East Melbourne

### *Ericsson*

- Mr Mats Norin, Program Manager, 5G for Industries
- Mrs Michelle Phillips, Head of Government and Industry Relations, Australia and New Zealand

### *Oceania Radiofrequency Scientific Advisory Association (ORSAA)*

- Mr Victor Leach, ORSAA Database Administrator
- Dr Julie McCredden, President
- Mr Steven Weller, Treasurer

### *We Say NO to 5G in Australia*

- Ms Louise Dunn
- Ms Deanne Hislop
- Ms Kate Swan

### *Private capacity*

- Professor Jock Given
- Dr Don Maisch
- Mr Giles Tanner

**Thursday, 20 February 2020**

Wesley Conference Centre

Pollard Room

Sydney

***Nokia Networks***

- Mr Adam Bryant, Chief Technology Officer, Oceania

***Axicom***

- Mrs Jane Pollard, Director, Property and Asset Management, Axicom

***Australian Communications Consumer Action Network***

- Ms Teresa Corbin, Chief Executive Officer
- Mr Wayne Hawkins, Director of Inclusions

***Australia and New Zealand Driverless Vehicle Initiative***

- Mrs Rita Excell, Executive Director

***Optus***

- Mr Kent Wu, Head of Network Access Planning and Quality
- Mr Harvey Wright, Head of 5G
- Mr Andrew Sheridan, Vice President, Regulatory and Public Affairs
- Ms Lisa Kelly, National Regulatory & Engagement Manager, Mobile Deployment

***Vodafone Hutchison Australia***

- Mr Tim Mcphail, Head of Public Policy
- Mr Dan Lloyd, Chief Strategy Officer and Corporate Affairs Director

***Internet of Things Alliance Australia***

- Mr Frank Zeichner, Chief Executive Officer
- Mr Geof Heydon, Principal Consultant and Chair of the Platforms and Interoperability Workstream