Prepared on behalf of: Telstra Corporation Ltd

Australian Competition & Consumer Commission
Domestic mobile roaming declaration inquiry 2016

Statement of Michael James Wright

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Address: Level 14 275 George Street Brisbane
Occupation: Group Managing Director Networks at Telstra Corporation Ltd
Date: 1 December 2016

[**CIC begins**] = information not to be released without a confidentiality undertaking

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I, Michael James Wright, Group Managing Director Networks, at Telstra Corporation Limited (**Telstra**), of L14 275 George Street Brisbane, in the State of Queensland, say as follows:

1 I am the Group Managing Director Networks within the Operations business division at Telstra.

2 I make this statement from my own knowledge as Group Managing Director Networks, from my experience accrued as an employee of Telstra across 35 years, and from having consulted and made enquiries of relevant staff and the records of Telstra.

1 BACKGROUND

3 I have been employed by Telstra since starting as a graduate Engineer on 6 January 1981.

4 In my current role as Group Managing Director Networks I am responsible for:

(a) the planning, design and construction of Telstra's networks and products across fixed, wireless and media;

(b) ensuring we continue to deliver new and innovative products to our customers in order to maintain our position as Australia's leading telecommunications provider; and

(c) working closely with product development and operational teams to design and integrate new products into our networks.

5 In my role as Group Managing Director Networks, I report to the Chief Operations Officer and work closely with the Board, including participating in decision making.

6 Prior to my role as Group Managing Director Networks (2013 – present) I held the following positions at Telstra: Engineer Fixed & Mobile Systems (1981-1985); Senior Engineer Transmission & Mobile Systems (1985-1989); Manager Network Development Mobile Networks Queensland (1989-2001); National Manager Network Deployment OnAir Networks (2001-2002); National Manager Infrastructure Standards & Services Mobile Network Engineering (2002-2003); General Manager Product Infrastructure - Mobile Voice (2003-2004); General Manager 3GSM Development (2004-2006); Executive Director Wireless Engineering & Operations (2006-2010) and Executive Director Networks (2010-2013).

7 I hold a Bachelor of Engineering (Hons) from Queensland University of Technology awarded on 19 March 1981. I am a Registered Professional Engineer Queensland.

8 My most recent curriculum vitae is attached as annexed and marked "**MJW-1**".

2 HISTORY OF TELSTRA'S MOBILE NETWORK

9 I have been personally involved in building each generation of Telstra's cellular mobile networks. I was also involved in building the public automatic mobile telephone system

(**PAMTS**) mobile network, which predated the first cellular networks. Fundamentally, each generation of network is based on a different set of cellular communications standards.

10 The network architecture of each of the Next G and later networks I describe below has been built for one provider (Telstra) and, in relation to the Telstra Mobile Core & Radio Access Network, typically by a single vendor (Ericsson). This allows Telstra to make changes easily and efficiently to both elements of the network, enabling regular upgrades and early end to end integration testing of new devices for guaranteed handset capability.

11 In building each of these networks, the key focus for Telstra has been meeting the rapidly growing demands of customers for mobile services in Australia. Underpinning the adoption of each wave of new technology and investment has been a desire to provide wider and deeper coverage to Telstra customers across Australia.

12 When I refer to "wider coverage", I am referring to "coverage breadth". Coverage breadth is essentially the range of geographical land mass and relative population, over which the mobile network extends. This encompasses the highly populated metropolitan areas, to less densely populated regional areas, to even less densely populated rural areas and town centres, through to remote Australia which is very sparsely populated across a vast area of land. Coverage breadth essentially refers to the "footprint" of the network.

13 When I refer to "deeper coverage", I am referring to "coverage depth". Coverage depth refers to the quality or level of services that are provided within the coverage area. It refers to the quality of "in-building" coverage and data speeds, which improve internet and video downloading speeds.

14 Set out below is a brief history of each network build, my involvement and my understanding of the key technical motivations for each network.

2.1 Previous mobile networks

AMPS Network

15 In the mid-1980s I assisted in developing and building 1G Advanced Mobile Phone Service (**AMPS**), Australia's first cellular network, which was launched in 1987 by Telstra (then trading as Telecom Australia). At the time, Telstra was operating the NEC supplied PAMTS from the early 1980s until 1993 which was fully automatic but not cellular. Ahead of the roll out of the AMPS network Telstra also built an Interim Manual Mobile Telephone Service (**IMMTS**) into some regional centres not covered by PAMTS. My role was to plan, design and build out the IMMTS, AMPS and Paging networks and related product platforms for Queensland.

16 The introduction of AMPS delivered the first cellular network with a range of phone types, including handheld, portable and in-car units. The AMPS network was based on the analogue

telecommunications standards operating on the 850 MHz cellular band offering voice calls and limited data connectivity. It operated on the same technology as a regular FM radio transmission via Frequency Division Multiple Access (**FDMA**) which used separate frequencies for each conversation.

17 I recall that this dedication of channel frequencies to individual conversations using FM radio and relying on physical separation of users to avoid interference between calls on the same channel meant that it was a relatively inefficient use of spectrum as it required increased use of bandwidth as users increased. Given this, the overall capacity of the network was limited and, once the physical and spectrum limits of a base station were reached, could only be improved by cell splitting through the construction of additional cell sites and the re-use of the same spectrum across those sites. As users of the network grew, congestion therefore became an issue if new sites could not be built in time.

18 Of further concern was that the FM signal transmitted could be easily intercepted such that eavesdropping was possible. The benefit of the low 850 MHz frequency however was that it had a longer range of signal propagation, which meant coverage for voice calls was relatively high. In addition, the Telstra Engineering teams worked to build higher powered sites in regional areas which, combined with the higher powered (3Watt) car and bag phones, gave rural users better coverage.

2G GSM Network

19 In 1991, AUSTEL, the then telecommunications industry regulator, introduced a proposed competition regime in respect of mobiles and mandated the use of a new 2G Global System for Mobile (**GSM**) communication standard being used throughout Europe. The competitive regime was created via a near equal 3-way split of 900 MHz spectrum held under license from the government in exchange for an annual fee.

20 I remember when the government licensed both Singtel Optus Pty Ltd (**Optus**) and Vodafone Group Plc. (**Vodafone**) in around 1992 and 1993 respectively. I recall that both Optus and Vodafone were given the right to wholesale access to resell Telstra's AMPS network at regulated prices while they established their own infrastructure. Whilst Optus took up the access offer, Vodafone did not.

21 Under this regime, the three carriers were required to establish 2G GSM digital networks that were expected over time to attract customers from, and to replace, Telstra's existing AMPS network which was to be closed.

22 I remember that at about this time Telstra introduced the first digital 2G GSM network. My role was to manage the network utilisation and test program for the technology introduction of this network using the newly appointed 2G network vendors. I recall that it was launched by Telstra

in April in 1993. I recall that Ericsson (for Victoria, Tasmania, South Australia and Western Australia) and Alcatel (for Queensland and New South Wales) were the initial network equipment and software suppliers for Telstra.

23 The 2G GSM network operated on the 900 MHz cellular band licensed by the government. I recall that later in the decade Telstra, Optus, Hutchison and a new entrant called One.Tel Limited (**One.Tel**) all additionally purchased 2G GSM spectrum in the 1800 MHz band (also widely used in 2G GSM systems) in the first mobile spectrum auction held in April 1998. At the same time, I recall that Telstra, Hutchison and AAPT additionally purchased spectrum in the 850 MHz band that was being freed up by the closure of AMPS. The Hutchison and AAPT 850 MHz spectrum was ultimately rolled into Vodafone at a later date.

24 The 2G GSM network was based on Time Division Multiple Access (**TDMA**) technology which built on the FDMA technology of the AMPS network. TDMA meant that each frequency could now be split by time, with each timeslot (up to 8 per frequency) able to carry data for an individual voice call. This allowed more users per cell site and greatly increased the capacity of the network. In addition, TDMA technology gradually introduced many new features to customers including SMS text messaging, caller ID and circuit switched data.

25 I recall however that despite the capacity improvements achieved under the 2G digital network the rapid take-up in 2G smart phones put pressure on the limited 900 MHz spectrum. Given the lower power of 2G GSM mobiles, inferior signal link budget to AMPS and the initially limited 35km range of the 2G GSM technology, significant coverage issues emerged in matching the broad coverage optimised AMPS network ahead of its scheduled closure.

26 Telstra undertook a range of activities to improve 2G GSM performance in regional areas however despite these efforts, the limited range of the 2G GSM network meant that it was simply not economic to extend it into more remote areas with broad coverage requirements and lower population densities.

27 The 2G GSM network was effectively a network covering metropolitan and more populated regional areas given these coverage issues. Telstra's 2G GSM network reached approximately 600,000 km² but it still fell short of AMPS. As such, despite Government expectations, the 2G GSM network had not supported coverage and competition into the rural and regional areas where the Telstra AMPS network was still being used.

28 I recall that at about this time One.Tel purchased 1800 MHz spectrum and licenced Lucent Technologies to build out a metropolitan based 2G GSM network. The use of the higher 1800 MHz band and the poorer choice of sites left the One.Tel network with limited coverage. One.Tel's business subsequently collapsed.

CDMA Network

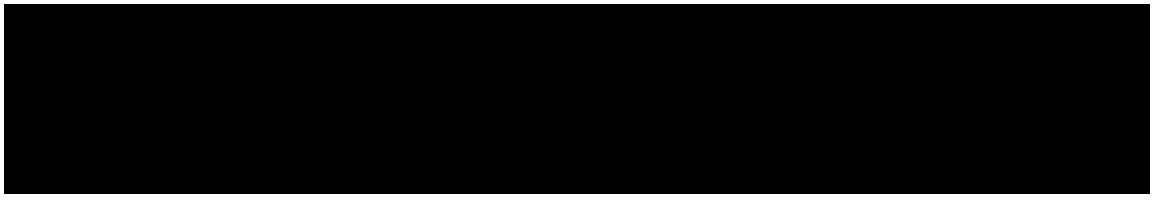
29 I recall that as part of the Government's introduction of telecommunications competition, the AMPS network was mandated to be closed by 2000. However, I also recall that due to the slow take up of the 2G network and its limited coverage in regional Australia, it was recognised that the closure of the AMPS network would mean customers in rural and regional Australia may lose their mobile coverage.

30 I recall that as a result of this "coverage gap", Telstra (still partially government owned) was effectively required by the Government to design and build a new digital network capable of matching AMPS. In my view, this decision was politically driven because of the dissatisfaction of rural and regional communities with the coverage of the 2G GSM network. Telstra chose to develop the newly emerging Code-Division Multiple Access (**CDMA**) technology network to essentially replace the coverage of the AMPS network. CDMA was also referred to as a 2G network technology. I was the National Network deployment Manager for the CDMA network.

31 The CDMA network was launched in September 1999 and was designed and modified to match the coverage of the AMPS network by using the same 850 MHz spectrum being used by the AMPS network. Telstra had purchased the spectrum through spectrum auctions.

32 CDMA technology was not inherently optimised for rural coverage equivalent to AMPS and Telstra was required to undertake significant engineering design and optimisation changes in partnership with the vendor, Nortel. This included software changes to increase the inherent timing limits of the CDMA coverage range, development of high powered boomer cells and work on optimising the channel performance.

33 Despite this work, the availability of device types and handsets to match the higher powered AMPS devices and the complexity in enhancing the new CDMA technology made the closure of AMPS and matching of CDMA a complex and politically charged time for regional Australia. It took some time and a phased set of AMPS closures beyond 2000 until the CDMA coverage was optimised. CDMA technology did not use a SIM card so individual handsets had to be programmed for the user's number.

34 

35 I recall that at about this time, each of the three carriers added to their 1800 MHz spectrum for 2G and secured 2100 MHz spectrum for the emerging 3G standard in auction purchases in 2000 and 2001. Whilst Vodafone and Optus focused their 1800 MHz spectrum purchases on the capital cities, Telstra purposefully bought additional spectrum to cover Cairns, regional

South Australia and other regional areas. Telstra purchased more than double the spectrum purchased by Vodafone. All three carriers bought 2100 MHz spectrum as did others such as Hutchison and Qualcomm.

36 With continuing rapid growth in customer numbers and call traffic with early data usage, Telstra knew additional spectrum would soon be required – and indeed the 2100 MHz band was later used for the 3G build in 2004.

3G Network

37 The 3G network standard evolved from the European GSM standards and was developed under a standards body known as 3GPP. The 3G network standards were developed in or about the year 2000 and networks and devices began to be built in the early 2000s. Like many new technologies, this standard took some time to mature and become stable. The 3G standard was designed to deliver both voice and data (initially up to 384 kbps). It was variously named 3G, UMTS or WCDMA.

38 The initial frequency standard assigned to 3G was the 2100 MHz band. This spectrum band had larger amounts of spectrum allocated per channel to support more users and higher speeds. However, as it was a higher spectrum band it was not optimised for coverage and, even in metropolitan areas, many more sites were needed to prevent users 'dropping back' to 2G on 900 MHz indoors.

39 The high cost of building out 3G at 2100 MHz and the emerging and uncertain nature of whether users would take up a network for data usage left many operators uncertain of the business case for developing the 3G network further. This resulted in sharing discussions between Telstra's Wholesale business unit and Hutchison who had built an early 3G network in major capital cities.

40 In August 2004, Telstra (still partially Government owned) and Hutchison signed a Heads of Agreement to establish a 50:50 joint venture enterprise to own and operate Hutchison's existing 3G radio access network (known as "RAN") and jointly fund future network development. Hutchison's existing 3G network was launched in 2003 and operated on 2100 MHz spectrum licensed by Hutchison in the 2001 spectrum auction. Telstra also contributed its 2100 MHz spectrum to the joint venture. My role as the newly appointed General Manager 3GSM Development was to develop Telstra's 3G network. With the signing of the Heads of Agreement, I became the Lead Engineer on developing the detailed joint venture contracts associated with the planning, design, operation and development of the joint venture network.

[redacted]

41 This shared network was known as the 3GIS network and was launched in about September 2005. It connected the 3GIS Base Station Controllers (**BSC**) to Telstra's existing core network using a new standard known as Multi Operator Core Network (**MOCN**), which allowed both Telstra and Hutchison customers to use the 3G network layer. A "shared network" arrangement is quite different from a "roaming arrangement" given the deeper integration of the two networks. Further details on this shared network arrangement with Hutchison is set out below in paragraphs 159 to 162.

42 [redacted]

43 [redacted]

2.2 Next G Network

44 I recall that in November 2005, following a strategic review under the leadership of Telstra's then CEO, Sol Trujillo, Telstra (to be fully privatised the following year) announced plans to build a new Next G 3G network. I was involved in the strategic review in conjunction with John Gonner (who had come to Australia from the United States to advise Telstra) and consultants Bain & Company. I led the planning for Next G, the technology specification and contract negotiations, the selection of the vendor, and the design and rollout program for the Next G network build whilst working through the plans to match the coverage and later closure of the CDMA network.

45 This network was intended to use the 850 MHz band to extend 3G coverage across the entire Telstra footprint. The 850 MHz spectrum had wider and deeper coverage than the existing 3G networks operating on the 2100 MHz band and expanded 3G coverage from around 10,000 km² to more than 1.6 million km². The use of the lower frequency bands was intended to make Next G particularly suitable to deployment in rural and regional areas. I recall at the time that Telstra had enough 850 MHz spectrum to turn on Next G and was subsequently able to re-farm the 850 MHz spectrum freed up by the closure of the CDMA network.

Telstra's investment in the Next G network

46 In my view, the extent and scale of the Next G infrastructure, including new towers and broadband, that Telstra built in the course of the Next G rollout was significantly above and beyond any remaining infrastructure advantage Telstra may have held in inheriting the CDMA and 2G networks. This investment was made at a cost of $1 billion (including the wireless rollout) under contract to Ericsson. I recall that under the roll out, Telstra had to effectively plan and build a new network from top to bottom with the help of Ericsson architecture. This resulted in Telstra installing Next G 3G on the 850 MHz band into 5112 towers (which was the sum of the existing GSM and CDMA sites) across 10 months as well as designing a range of new features such a high powered boomer cells to provide more coverage, together with introducing 3G coverage and new High Speed Packet Access (**HSPA**) speeds for the first time to vast areas of the country.

47 Telstra was able to re-use some existing sites from its previous 2G and CDMA networks but not without significant modification and upgrades of those sites. The installation of Telstra's Next G network required an entirely new set of radio equipment because of the change in technology and the standards that underpinned the network. This meant that any existing sites needed to be strengthened, upgraded or re-built to support this new technology, including turning repeaters into base stations, installing Ericsson 3G hardware inside equipment shelters, new low noise amplifiers at the rural tower tops, often new or changed antennas and feeders into each tower, and upgrading the power, air conditioning, rectifiers and batteries in each.

48 A major portion of Telstra's $1 billion spend was in the rollout of the required backhaul for the Next G network. Telstra was unable to re-use much of the backhaul from its previous CDMA network because it could not support the bandwidths required for Next G services. This was an extremely extensive task given the reach of the network into remote areas. As a result of the backhaul rollout, Telstra's base station capabilities went from typically 2Mbps to at least upwards of 4Mbps in all regional sites, and in some cases 8Mbps. This involved investing in backhaul from the cities to each of the Next G sites, widening and thickening the routers and expanding the radio system or multiplex system to add more cells. Later, it also involved adding fibre optic Ethernet enabled backhaul to cover 93% of the population.

49 Telstra's 3G 850 boomer cell upgrades resulted in cell coverage in the 850 MHz band increasing from up to a 50km to up to a 200km radius depending on the site's location and terrain. The lower frequency along with a significant increase in towers equipped with 3G 850 MHz technology across all GSM and CDMA sites extended the geographic reach of Telstra's 3G services from around 10,000km² to more than 1.6 million km² in 10 months.

Telstra's role in influencing the Next G technology and standards

50 I was also engaged with the Global System for Mobile Communications Association (**GSMA**) which had supported Telstra's choice of building out the Next G network and closing CDMA (which was a controversial decision in Australia and abroad at the time). The GSMA is an industry body that represents the interests of mobile operators worldwide and has had a strong influence on the development of technology standards. I personally travelled to Barcelona in 2006 and subsequently to attend the GSMA's Mobile World Conference (**MWC**).

51 I recall that there were only three handsets at the time which had the required spectrum band and HSPA technology for use on Telstra's Next G Network. I worked with the GSMA to set up a user group of operators with similar spectrum holdings to influence device manufacturers to incorporate 850 MHz as an included additional band for 3G (WCDMA) handsets. This would ensure that the HSPA technology had critical scale and availability of compatible handsets to connect to the Next G network – without this scale manufacturers would not have developed enough handsets to supply the Australian market at a reasonable price. I continued to be involved with GSMA meetings and subsequently participated in technology meetings and specific technology programs, including the original embedded module and Machine to Machine (**M2M**) program.

52 Telstra pursued the development of Next G technology very aggressively internationally. This investment in promoting the global uptake of new technology was critical to Next G's subsequent success in Australia.

53 My experience throughout my time at Telstra is that it has always involved itself heavily in global industry participation to promote technology and standards in a way that benefits its customers and the Australian conditions.

54 In my view, if Telstra had not invested in the Next G network and promoted the technology globally, regional and rural Australia would not have access to the same technologies or handset types nor the same coverage, or quality of coverage and data performance, they have received to date. In fact it is unclear to me how rural Australia's CDMA network technology would have evolved in the absence of Telstra's Next G network strategy.

Closure of the CDMA and 3GIS networks

55 In order for Telstra to be allowed to close the CDMA network it was required to demonstrate to the government that the Next G network had coverage equivalence. The Government, through the Australian Communications and Media Authority (**ACMA**), engaged independent consultants to test this coverage equivalence.

56 To gain coverage equivalence to CDMA and to migrate these customers onto the Next G network Telstra had to develop extensive communications and customer solutions for users. In particular I was involved with the design of antenna attachments and a specific 'Country Phone' developed with ZTE. I also proposed the 'Blue Tick' standard and labelling system which to this day informs customers about phones with superior antenna and coverage performance.

57 Following confirmation of coverage equivalence, the CDMA network was closed on 28 April 2008.

58 In August 2010, following the successful launch of the Next G network, Telstra announced that the 3GIS network would be closed by 2012 and all 3G spectrum assets in the 850 MHz and 2100 MHz bands would be dedicated to the Next G network.

2.3 4G Network

59 The technology standard known as Long Term Evolution (**LTE**) is now referred to as 4G. LTE uses another form of radio signal modulation known as Orthogonal Frequency Division Multiplexing (**OFDM**) to deliver higher bandwidth and greater efficiency from the spectrum. There was early competition between vendors and industry bodies and a lack of clarity around the definition of 4G, with another standard known as WiMax also being seen as an early candidate. Once the industry settled on the LTE standards, the network equipment and chipset ecosystem rapidly evolved.

60 I recall that the increasing pressure of data traffic on the Next G network (which had been doubling every year) motivated Telstra to introduce the 4G network four years earlier than expected. The original 4G network was a data network. Voice calls continued to be made via the existing Next G network under 3G technology until the recent launch of Voice over LTE (**VoLTE**) technology. Telstra launched 4G in September 2011 covering Australian capital cities, airports and 30 regional centres.

61 My role was at the time as Executive Director of Mobile Networks involved the planning, design, deployment and optimisation of all of Telstra's mobile networks and associated product platforms.

Telstra's role in influencing the 4G technology and standards

62 Telstra was also instrumental to the early development of the 4G Network technology adoption. The 1800 MHz spectrum provided a useful springboard for early 4G deployment focused on capacity and demand management in cities and urbanised areas. However, in order to efficiently bring 4G to more lightly populated regional, rural and remote areas, Telstra needed a viable low-band spectrum to be adopted.

63 The technology that underpins Telstra's 4G network is the LTE standard. The original spectrum band standardised for LTE and expected to be used in Australia was the 2600 MHz band. There were also longer term plans for the closure of Analogue TV to free up coverage friendly 700 MHz 'digital dividend' spectrum. These were expected in the 2014 - 2015 timeframe.

64 Through ongoing engagement in international forums, Telstra recognised the emerging potential to use the 2G 1800 MHz spectrum band to be re-farmed as an LTE band. Discussions with the vendor, chipset maker Qualcomm and handset manufacturers (in particular HTC) showed that an LTE network rollout in 1800 MHz would be viable. At the time, the 1800 MHz band was not recognised as a potential LTE band. I worked with the Global Suppliers Association (**GSA**) and lobbied internationally with a range of device vendors and at various industry events (such as the MWC) to have the band accepted and supported. From that beginning, 1800 MHz has become the most used band for LTE worldwide.

65 During the development of the spectrum planning for the Analogue television spectrum digital dividend Telstra became extensively involved with the industry regulator, Telecom New Zealand and the International Telecoms Union (**ITU**) around the planning and design of the new 700 MHz spectrum band channel configuration. This included evaluating adjacent band sharing with television broadcasting, the performance of miniature ceramic handset filters, and the harmonic implications for GPS receivers in handsets, and formally presenting the results to a regional treaty forum of peers and the ITU. This band plan for 700 MHz became known at the Asia Pacific Telecommunity APT700 band. It is now being implemented in the majority of countries outside the United States and Canada (who have their own more complex arrangements).

Telstra's investment in the 4G network

66 In 2013 the Government auctioned the APT700 spectrum band and the 2600 MHz band. Telstra spent a total of $1.3 billion at this auction, acquiring the largest 2x20 MHz block of the 700 MHz rural coverage friendly spectrum band. Telstra recognised the need to secure low-band spectrum suitable for LTE to address the needs of regional and rural Australia. It considered that acquiring this spectrum was necessary to continue to deliver the future capacity, best performance and broadest coverage 4G network. At the same auction, I noted that Optus acquired 2x10 MHz of this spectrum and Vodafone chose not to acquire any.

67 Telstra made the world's first data call on a commercial LTE network using the APT700 spectrum band. It is important to get scale in new spectrum bands such as the then new APT700 band so I once again worked with the GSA and GSMA as well as attended conferences in May to promote this new band. Most devices today now support the APT700 band, and it has been adopted by Latin America and partially adopted by Europe.

68 It has been my experience that in order to provide more certainty in the longer term and to better manage increasing customer demand for data with greater capacity, Telstra has also ensured that it has invested heavily in its spectrum holdings across both the coverage friendly low bands (eg. 700 MHz and 850 MHz) and the capacity optimised high bands (1800 MHz, 2100 MHz and 2600 MHz). These investments have been made to ensure Telstra can continue to offer the best possible range of Next Generation mobile services. Telstra has also taken an aggressive technology roadmap approach with many early and world leading adoptions of Next Generation technologies across HSPA+, LTE-Advanced, MIMO and more to deliver more capacity and greater performance in the available spectrum.

69 In total, over the last six financial years, Telstra invested over $8 billion in its mobile network on a fully allocated basis, including spectrum purchases and renewals.

70 In 2014, Telstra announced a new 4G service called 4GX, bringing higher speeds and extra 4G coverage to a range of communities across Australia in cities as well as rural and regional areas. The new 4GX service operated on new 700 MHz spectrum combined with the 1800 MHz band using an evolution of LTE known as LTE Advance Carrier Aggregation. 4GX services were initially switched on in all capital cities and surrounding suburbs and 50 regional locations. This has since rapidly grown to include coverage to regional towns across Australia.

71 Telstra has continued to evolve the speed and network efficiency of LTE through the world's first evolution of peak network speeds to 450Mbps and 600Mbps during 2015 and to 1Gbps during 2016.

72 In 2015, Telstra first introduced Australia's first 4G Calling, or Voice over LTE (**VoLTE**), allowing users to stay on the 4G network during voice calls (rather than switching back to 3G for the duration of the call). This rollout has allowed customers to progressively move to VoLTE as their handsets and settings have allowed throughout 2016.

73 In February 2016 Telstra invested a further $190 million to acquire additional 1800 MHz spectrum for mobile use in 12 regional areas across the country, including major regional cities like Albury, Cairns, Grafton, Mackay and Darwin and their surrounding areas. This was to ensure Telstra could deliver a similar level of capacity and performance for regional Australia as we could for metropolitan areas.

3 TELSTRA'S FOCUS ON COVERAGE DIFFERENTIATION

3.1 The reasons behind the early network builds

74 While coverage has always been commercially important to Telstra, early network builds (particularly AMPS) into regional and rural areas were strongly influenced by government policy about addressing coverage concerns from people in rural areas. As Telstra was still

Government owned (at least in part) across this period, it had to balance this stakeholder interest when making any decisions to build.

75 I recall that in the early 1990s, when the Government offered access to the existing AMPS Network following the part-privatisation of Telstra, there was an expectation that the 2G network coverage and quality would be so good that they could turn simply turn off the old analogue network. However, given the coverage issues with the 2G network, it did not deliver the nationwide competition envisaged by the Government despite its best intentions.

76 It was because of these coverage issues, and the Government's promise to switch off the AMPS network in 2000, that the Government of the day essentially required that Telstra build an alternative digital network which became the CDMA network. To build that network, Telstra had to invest in significant spectrum, as well as design an array of new features across its network to ensure the range would carry effectively into rural Australia. At this time, Telstra was building two networks, the 2G network and the CDMA network, under two different standards. This was an inefficient and costly exercise, and tended to cause confusion for end users. Furthermore, there were no handsets that could work simultaneously on both networks which led to some customers purchasing two handsets – one for use in regional areas on the CDMA network, and the other for use in GSM regional towns and metropolitan areas.

77 I recall that at the time Telstra elected to proceed with the 3GIS partnership with Hutchison, there was not a strong business case for the 3G network given it was to be such a high frequency network without the coverage benefits of a lower frequency network. I remember that it was actually because of how poor that business case was that Telstra ultimately partnered with Hutchison, which made the roll out more economic. However, ultimately, given the high frequency of the 3GIS Network, it was only ever able to be a city or metropolitan based network.

78 As such, whilst 3G technology was able to deliver new features and speeds for customers, it was a city based service with regional and rural Australia limited to GSM or CDMA 2G technology.

3.2 The decision to build the Next G "city to country" Network

79 Telstra's decision to invest in Next G was a turning point in Australia's telecommunications history and, in my view, marked the beginning of a strong focus within Telstra on coverage as a means of competitive advantage across both metropolitan and rural customers. At this time, Telstra made a clear decision to differentiate itself based on coverage. Next G was the new "city to country" network, which from day one had wider and deeper coverage and greater speeds.

80 I recall that following the arrival of the new CEO Sol Trujillo and the full privatisation of Telstra in 2006, a strategic review was undertaken across all Telstra networks and IT. I recall that under

this review, management stood back and realised that Telstra had been building three separate mobile networks across GSM, CDMA and the 3GIS 3G network. It was considered to be very inefficient and confusing for customers. Following the review, the decision was made to invest in the Next G Network which would extend the new 3G technology across Telstra's entire network footprint. Telstra made the decision to make this investment on the basis that it could be used as a point of competitive differentiation between it and its competitors.

81 At this time, the other carriers, Optus, Vodafone and Hutchison were building their 3G networks in pockets to cover the main metropolitan population centres. Telstra's business case for the Next G "city to country" Network was built on differentiating itself from its competitors by offering a better quality network with better coverage overall in terms of breadth and depth into buildings, and particularly for rural and regional Australia.

82 Given the relatively high cost of building a network across rural and remote sites, the business case for building the Next G network in those locations in isolation was considered poor. Put simply, the forecast direct revenues achievable in rural Australia would not provide an adequate return to cover the capital and operating costs of those network sites.

83 I recall that at the time people were questioning why Telstra would build a 3G network over its entire footprint, given other carriers were limiting themselves to just building islands of 3G in selected rural areas and how uneconomic it was. However, I understood that Telstra's thinking at the time was that it would put Telstra in a position to sell a "bigger footprint". Telstra's firm belief was that customers are prepared to pay for coverage and mobility in their services, not just in rural Australia, but across Telstra's entire customer base. It is my view that Hutchison had the resources to follow a similar strategy at the time yet did not pursue this.

84 Telstra understood fundamentally that customers value good and reliable coverage in mobile services, so with coverage in more places, fewer dead spots, fewer drop outs and faster data speeds they would be willing to pay for that quality of service.

85 Documents showing Telstra's business strategy with respect to the Next G network include:

(a) Telstra's media release unveiling its city-to-country mobile 3G broadband vision, dated 15 November 2005. A copy of this release is annexed and marked "**MJW-2**";

(b) Telstra's Technology Strategy Briefing of 16 November 2005 (see pages 16-19 where I describe the upgrade to the mobile network for Next G). A copy of this document is annexed and marked "**MJW-3**"; and

(c) Telstra's public media release regarding the Next G network 'going live' dated 5 October 2006. A copy of this document is annexed and marked "**MJW-4**".

3.3 The "race for coverage"

86 With Next G marking a clear shift in strategy for Telstra towards a focus on coverage, speed and quality of customer experience as a competitive differentiator, it is my experience that Telstra very much views its infrastructure investment pathway in the 10 years since 2006 as demonstrating the ongoing "race for coverage" between the carriers.

87 Over time Optus and Vodafone have responded to the competitive coverage pressure placed on them by Telstra's Next G coverage advantage, by rolling out 3G in the 850 MHz band (held by Vodafone) and by re-farming parts of the 900 MHz 3G bands (held by each of them).

88 Telstra has since sought to build and maintain coverage, with the other carriers, most notably Optus, continuing to invest persistently in an attempt to erode this coverage advantage. It is my view that the "race for coverage" is still very much occurring in the Australian telecommunications industry.

4 TELSTRA'S CURRENT MOBILE NETWORK

4.1 Current network coverage

89 Telstra's 2G GSM Network is closing on 1 December 2016 (it announced the closure back in July 2014) due to the bulk of its customers having naturally moved to 3G and 4G enabled networks which offer faster speeds and better user experience.

90 Telstra's 3G and 4G are not marketed as separate networks, but are viewed as a single fully integrated mobile network enabled with 3G and 4G coverage comprising 'The Telstra Mobile Network'. [redacted]

91 The Telstra Mobile Network is the largest mobile network in Australia covering more than 2.4 million km². Its 3G network coverage reaches 99.3% of the population and its 4G network coverage reaches 98% of population.

92 Telstra has invested in more than 8,500 coverage sites across city and country, providing the nation's lowest mobile call drop-out rates. More than 6,300 of these sites are 4G enabled sites, offering 4G speeds in all the capital cities, many suburban areas and regional towns across Australia.

93 Telstra currently plans to continue to extend its already expansive 4G coverage footprint in regional Australia from current 98% population coverage to reach 99% population coverage by the end of June 2017. This planned continued investment in 4G is based on the current

regulatory environment remaining unaltered. This increase amounts to an expansion in Telstra's total 4G coverage footprint of several hundred thousand square kilometres.

94 Telstra has also invested heavily in its fibre optic Ethernet enabled backhaul which connects sites covering more than 93% of the Australian population. This high-capacity backhaul ensures a faster and more reliable mobile experience.

95 Annexed and marked "**MJW-5**" is a coverage map which illustrates Telstra's current coverage of its 3G and 4G networks.

4.2 Current network capacity

96 The Telstra Mobile Network is currently enabled with the following network technologies and spectrum frequency bands, depending on location and the customer's handset capability:

(a) **4GX (LTE + LTE-A)** is provided by the base 700 MHz frequency across Telstra's 4GX coverage footprint supplemented with LTE-A capability in aggregation with existing 4G on 1800 MHz and new 4G on 2600 MHz in selected areas. This process of 'gluing' two or more bands of spectrum together is referred to as carrier aggregation. Carrier aggregation creates a broader channel to allow more data, meaning customers have access to faster more reliable speeds.

(b) **4G (LTE)** is our original 4G service on the 1800 MHz frequency band. It is now largely provided in conjunction with, and exceeded in some areas by, our 4GX coverage.

(c) **3G (HSPA)** is provided in the 850 MHz frequency band across Telstra's entire coverage footprint, supported by 3G in the 2100 MHz band to provide additional capacity in selected high traffic areas.

(d) **2G (GPRS/EDGE)** is provided in the 900 MHz frequency band across Telstra's entire 2G coverage footprint (to be closed on 1 December 2016).

4.3 Current network speeds and latency

97 The following table provides a more detailed breakdown of the Telstra Mobile Network data speeds and latency (a measure of the time it takes a data packet to get from one point in the network to another), noting that:

(a) the network technology speeds quoted are those for which the technology is rated and actual customers speeds are always lower;

(b) typical user speeds are the range of speeds a customer might experience whilst using their connection in typical coverage locations based on extensive testing;

(c) latency figures quoted relate to that component of user-experienced latency that relate to the Telstra network; and

(d) % population coverage is the percentage of the population where customers are able to experience the quoted typical user speeds at their place of residence.

Table 1: Network speeds and latency

Network Technology	Typical Download Speeds	Typical Upload Speed	Latency	% Population
2GSM GPRS	30-40kbps	10kbps	~500ms	All coverage areas
2G EDGE	75-90kbps	30-40kbps	~500ms	All coverage areas
3G HSPA 14.4Mbps	550kbps – 3Mbps 550kbps – 6Mbps	300kbps-1Mbps 300kbps-3Mbps#	~100ms ~100ms	99.3%. (Entire coverage) 97%#
3G HSPA+ 21Mbps	550kbps – 8Mbps	300kbps-3Mbps#	~100ms	97%
3G HSPA+ [Dual Channel] 42Mbps	1.1Mbps – 20Mbps	300kbps-3Mbps#	~100ms	85%
4G LTE (1800 MHz)* **4G (LTE) rated devices** **Will seamlessly switch over to our fastest available 3G speeds outside 4G coverage areas.*	2Mbps – 50Mbps	1Mbps – 10Mbps	~30ms	98% (combined 4G and 4GX coverage)
4GX (700 MHz)~ **4GX rated devices** *~Devices will seamlessly switch over to our fastest available 4G or 3G speeds outside 4GX coverage areas.*	Cat 4^: 2Mbps-75Mbps Cat 6^: 2Mbps – 100Mbps Cat 9^: 5Mbps-150Mbps Cat 11^: 5Mbps – 200Mbps	1Mbps-10Mbps		

 # 300kbps-3Mbps upload speeds are available to 93% of the population

^ Depending on the Category (or 'Cat') of a device/handset, the speed a customer experiences on the 4G network will differ. The higher the category number, the faster the speeds. For example, Category 6 devices can achieve speeds up to 300Mbps, while Category 4 devices get 150Mbps.

4.4 Current network capabilities and services

Key capabilities

98 In my view, it is Telstra's focus on investment for the future and collaboration with worldwide strategic vendors to develop plans for future technology which has meant that its capabilities

and services are truly world leading. Telstra's investment in rural Australia in circumstances which, viewed in isolation may not necessarily be economic, has led not only to coverage breakthroughs but also to the development of temporary coverage capabilities which are now deployed for commercial use.

99 Some of the key capabilities of the Telstra Mobile Network are set out below:

(a) simultaneous voice and data functionality;

(b) 3G and 4G network interaction: customers will seamlessly switch between the 3G network from the 4G network as they move in and out of coverage. Currently, Telstra's 4G network is not designed to exactly replicate 3G, and 3G is inevitably relied upon at the edges of coverage and importantly to manage load / traffic congestion where necessary. This is designed for load management reasons (ie. to manage traffic congestion). As referred to above Telstra's 3G and 4G are not marketed as separate networks, but are viewed as a single fully integrated mobile network enabled with 3G and 4G coverage comprising 'The Telstra Mobile Network'. Importantly, Telstra's coverage claims in respect of its network rely on both 3G and 4G coverage, with 3G providing the "fall-back" to Telstra's 4G coverage to improve reliability of service;

(c) wireless priority functionality for voice: the Telstra Mobile Network prioritises voice traffic over data such that in heavy demand times data capacity could be reduced to ensure voice calls can proceed. The priority system also allows Telstra to prioritise certain customers' voice calls, however only in situations where network demand is high and the capacity of the cell is at its limit;

(d) High Definition: Telstra introduced high definition (HD) voice technology in June 2011 across its entire network. HD voice technology delivers clearer voice quality as well as providing noise suppression. To enjoy the benefits of HD technology, both the caller and receiver need to be using a compatible handset on the Telstra Mobile Network;

(e) Voice over LTE: the introduction of VoLTE in September 2015 (an Australian first) expanded upon Telstra's HD voice technology using the Wideband Adaptive Multi-rate (WAMR) codec to increase the proportion of mobile calls that are HD quality and extend HD calling from mobile to Next G and compatible fixed phone services. Previously, when customers made a voice call on their 4G device, their device switched back to 3G for the duration of the call;

(f) Video over LTE (ViLTE): ViLTE video calling has been progressively released during 2016. ViLTE enables users to make high quality video calls to ViLTE compatible devices just like they make a regular voice call;

(g) Voice over WiFi (VoWiFi): to help address the difficulty in getting strong coverage in every corner of the house, Telstra launched VoWiFi in 2016. VoWiFi uses a wireless broadband network standard for the purpose of voice conversation;

(h) Out to Sea and In-flight coverage: the Telstra Mobile Network covers more than 1 million km² out to sea, which is not included in its coverage map. Projects are currently underway with the aim to provide in-flight WiFi service for aircraft passengers;

(i) network security: all entry points into the Telstra Mobile Network are firewalled and certified according to ISO27001:2005 standards. Surveillance audits are completed every 6 months; and

(j) law enforcement requests: for example, device location.

Support for emergency services

100 Telstra's investment in emergency services capabilities is driven by its ability to differentiate itself from its competitors. In my experience, Telstra's ability to provide coverage in emergency situations, as well as being the only operator able to respond to these situations in the time frame, sets Telstra apart from others and contributes to its brand image.

101 Telstra deploys temporary mobile coverage and/or capacity to support emergency services and local communities during emergency situations (ie. fire, flood, accidents). The provision of these services is undertaken on a case by case basis in areas where there is existing coverage and backhaul available.

102 To support emergency services, Telstra has also invested in developing a LTE Advanced Network for Emergency / Enterprise Services (**LANES**) strategy. LANES is a concept developed by Telstra that will provide a dedicated service and preferential data treatment on the Telstra Mobile Network where LTE is enabled.

103 In December 2013, Telstra conducted the first live demo of LANES to a number of emergency services organisations and enterprise customers in the mining and resource industry. From December 2016, in a world first, Telstra's LANES emergency service will be available to Emergency Services Organisations (**ESOs**). This will provide ESOs with the opportunity to increase their network capability, coverage and reach, without having to build their own private network. Telstra's expansive core network and investment in spectrum, as well as its ability to provide the best coverage (or the only coverage) in rural and remote areas has enabled it to provide these services where others cannot.

Special event services

104 Telstra also seeks to differentiate itself from other carriers by making investments in special event coverage. It is my view that, by providing better coverage, fewer drop outs, network consistency, and reliability at times when capacity would otherwise be under tremendous stress, Telstra avoids negative publicity and word of mouth, contributing to its superior marketing message.

105 Where temporary coverage or capacity is sought for non-emergency conditions and the relevant resources are available, Telstra can deploy temporary mobile coverage and / or capacity for special events or even seasonal requirements at key holiday destinations. The requestor may be required to pay for part or all costs of the deployment, however costs vary on a case by case basis. This dedicated program deploys additional mobile resources at well over [redacted] locations across Australia each year.

106 Telstra plans for this temporary coverage using information from the previous year, with a focus on ensuring its customers have access to a quality and reliable network in all situations. Special events are tracked and customers similarly provide feedback or place a request to Telstra on a needs basis.

107 An example of Telstra's capability in responding to temporary coverage requests for commercial opportunities is annexed and marked "**MJW-6**".

Other temporary coverage capabilities

108 In my view, what truly differentiates Telstra is its investment in rural and remote Australia as part of its drive to provide the best coverage in Australia. The product of this investment is Telstra's unique and considerable capabilities in providing temporary coverage in remote areas.

109 Telstra offers commercial temporary coverage capabilities to meet the needs of paying customers in a range of industries that operate in remote or other areas with no or limited access to mobile services. Typical scenarios include temporary coverage whilst a permanent solution is being constructed (ie. new mine sites), Defence exercises in remote areas, large remote infrastructure projects and remote workforce accommodation camps.

110 Among other solutions, Telstra has developed (in response to the Black Saturday bushfires in 2009) modular portable satellite backhauled cells (known as **Sat COWs**) that are light and compact enough to be "choppered" in, and new portable cell on wheels (**COWs**) for fast deployment by road. The Sat COW capability required a network modification with the Ericsson software and was developed for this purpose. The addition of generators and extendable masts to Telstra's portable COWs have also allowed deployment in locations where no power or tower infrastructure exists.

5 MOBILE TECHNOLOGY AND INNOVATION

111 It has been my experience that Telstra has invested, and continues to invest significantly in mobile technology and innovation in order to differentiate its services from those of its competitors. The investment in new mobile technology, particularly technology upgrades for rural and regional Australia, is not always economically rational or profit generating when viewed in isolation. The more remote and less populated the area, the more economically challenging it becomes.

112 Given the obvious economic challenges, it is important to understand that Telstra does not view its business as one of simply building static infrastructure in remote areas in an attempt to bridge the coverage gap. Telstra makes this investment in order to differentiate itself from its competitors by ensuring that it not only has a presence in rural and remote Australia, but that it delivers a quality service at the same time.

113 This means more than just building a tower – this includes boosting capacity through the use of small cells or 'boomer' cells, working with vendors to ensure handsets are consistently compatible with advancements in technology and have sensitivity suitable for rural usage (ie. Blue Tick devices), and developing antennas for cars and homes to ensure the best possible tower signal can be accessed. More often than not, this also involves engaging with overseas industry participants and generating a conversation around worldwide industry innovation.

114 Set out above in paragraphs 50 to 58 and 62 to 65 are the details of Telstra's involvement in the development of 3G and 4G technology which demonstrate Telstra's track-record of innovation and being "first to market". I have further set out in the paragraphs below some of the additional technology developments in which Telstra has invested, followed by an explanation of the current and future technology that Telstra is currently trialling to ensure it continues to differentiate its network from its competitors.

5.1 Telstra's previous technology investments

115 It is my experience that Telstra has been a world leader in telecommunications innovation and, through close collaboration and co-operation with world leading technology companies such as Ericsson, Qualcomm and others, has brought to the industry a raft of 'world firsts' along the path to 5G and beyond.

116 In order to achieve these timelines and leadership positions, I have used my responsibility for network planning and investment and worked closely with executives from partner companies to develop longer term network forecasts to plan for future technologies well before they become available. This approach has allowed the network to be configured early and be compatible with the future technology (ie. early optical high speed Ethernet for both HSPA+ and early LTE).

These steps lowered the cost and time to introduce each of the technology evolutions. To name a few, Telstra:

(a) launched the world's first 200km cell range with maximum network download speeds of 14.4Mbps (2007);

(b) became the first operator in the world to activate HSPA+ technology on a live network (2008);

(c) launched 21Mbps peak-rated mobile broadband modem making Next G the fastest mobile broadband network in the world, recognised by the Guinness World Records (2009);

(d) together with Nokia Siemens, announced LTE world-first trial achieving 100Mbps at 75km using 2.6GHz (2010);

(e) together with Huawei Technologies, announced Australian first in successfully demonstrating LTE technology operating on 1800 MHz spectrum (2011);

(f) performed the first live demonstrations of LANES (2013);

(g) completed a live test of LTE Advanced (**LTE-A**) Carrier Aggregation, combining three data channels to achieve speeds of 450Mbps, a world first (2014); and

(h) launched world first 600Mbps device (2015).

117 Telstra has also invested in creating or trialling products and services which enhance the customer experience and the capacity and coverage of its network, many of which are specifically driven towards providing better coverage across rural and regional Australia to ensure quality and reliability of service. For example:

(a) Satellite has now been proved a viable albeit expensive means for back-hauling Telstra Mobile Network Coverage such that coverage can now be deployed in remote areas with no or limited power and transmission. Our development of Sat COWs takes advantage of this and provide permanent remote coverage at iconic remote locations such as Birdsville.

(b) I proposed and promoted the testing and labelling of Telstra's 'Blue-Tick' Rated Device. These are devices that have been tested to provide customers with optimal device performance particularly in rural and remote coverage areas.

(c) I pursued a then new mobile signal repeating device and arranged for it to support our 850 MHz band. Repeater technology is used to regenerate or replicate a signal. This

became the Telstra Mobile Smart Antenna which has been designed to extend indoor coverage over 3G and 4G for Telstra handsets or mobile broadband devices, provided there is at least partial coverage somewhere in the customer's office or home.

(d) LTE-Broadcast (**LTE-B**) aims to introduce a multicast capability to the network in order to alleviate congestion. When Telstra's operational division and the network detects multiple users attempting to access the same content, it will shift to broadcasting within the local cell, rather than having every user continue to access the content directly from the network. This is particularly useful in managing capacity in areas of intense traffic such as sporting stadiums and other special events. There is also ongoing testing of opportunities for LTE-B in video broadcast, signage, mass M2M updates, software / OS updates, application updates and emergency alerts. Like many emerging technologies this needs the support and scale of many operators, and for this reason I worked with UK-based EE, Verizon and South Korea's KT to establish the LTE-B alliance this year.

(e) in regional Australia, Telstra's Small Cell technology is being used as a cost effective means to deliver 4G coverage to areas where existing coverage is minimal or non-existent. I asked my team to explore this option based on my experience with the use of early low cost repeater technology to improve in-building coverage in small towns.

(f) Telstra recently supplied access to space on its radio spectrum and base stations to communicate with hydrogen balloons for Google's Project Loon – a plan to provide internet to remote regions via helium balloons that circle the globe.

118 Annexed and marked "**MJW-7**" is a series of media releases and articles from Telstra and various other partners in relation to the above achievements.

5.2 Telstra's future planned network innovations

119 I am aware that Telstra is currently actively engaged in network innovation through numerous trials and collaborations as part of its business plan and budgeting. Some of these include:

(a) On 13 September 2016, Telstra completed live network tests achieving speeds of 1 Gbps on the downlink (from the base station to the device) and 150Mbps on the uplink (from device to the base station) using a commercial grade chip set. A commercial product launch of a Netgear 1Gbps WiFi router is now imminent.

(b) On 20 September 2016, in collaboration with Ericsson, Telstra conducted the first live 5G trial in Australia for the public at the 5G Test Bed located at its Global Operations Centre. Telstra has also worked with Intel and Qualcomm on early prototype 5G enabled devices. Telstra is also actively involved with the 3GPP on 5G standards inputs and has already

gained support for feature proposals that will make 5G more suited to Australian conditions, in particular changes that will support longer cell ranges.

(c) Telstra's involvement with The Boeing Company & Queensland Government's Advance Queensland Platform Technology Program is helping the development of new situational awareness drone technology to ultimately enable safer drone operation and enhanced data analytics. Telstra will be providing 3G / 4G dongles to Boeing to allow the use of its mobile network to provide data connections between sensors located on Telstra radio towers and a ground station located in the trial area.

120 Whilst the above developments are exciting, the true future of mobile services, and an innovation which I believe Telstra is in the process of bringing to the forefront in Australia, is the ability to service the wide area network M2M and Internet of Things (**IoT**) markets. [redacted]

121 IoT development has been driven by an increased demand to connect all types of things to the internet in order to track, monitor and control our world – from water meters to environmental sensors. There are a range of "categories" designed to support different usage types.

122 IoT technology is inextricably linked to 4G technology. The various capabilities for IoT are formally included in the 3GPP standards that define LTE (4G) technology. The key capabilities for regional application of 4G IoT are that:

(a) the technology can utilise the already extensive regional 4G coverage footprint for coverage; and

(b) specific capabilities of IoT allow low data rate IoT devices (such as sensors) to operate well beyond the edge of coverage of standard 4G devices. The fringe of coverage can therefore be extended by IoT technology as the resistance of the data transfer to packet loss is increased by repetition, made possible by the low IoT data rates. Hence, the extension of 4G out to 99% (assuming the current regulatory environment remains unaltered) will ensure that IoT is available across rural and regional Australia for application in the transport, agriculture and health industries.

123 I am aware that Telstra has been involved in shaping the industry standards to ensure IoT evolves in the same direction. It is continuing to work with the industry to drive the scale and standardisation of these solutions.

124 In February 2016, Telstra announced that it had enabled support for Category 1 (**CAT-1**) devices and is in the process of building a new foundation for IoT. CAT-1 represents the next

development in IoT LTE devices that are lower cost and offer longer battery life but are still required to carry reasonable data rates. CAT-1 will be closely followed by the introduction of both Category M (**CAT-M**) which will increase coverage and reduce device cost, and ultimately Narrow Band-IoT (**NB-IoT**).

125 My view is that NB-IoT will be the next big breakthrough in that it will provide deeper coverage into buildings and extend existing remote and rural penetration beyond our current geographical coverage. Telstra has partnered with Ericsson and its device partners to bring this technology to Australia for network trials and demonstrations to the industry.

126 In an Australian first, Telstra has also partnered with LTE for IoT chipmaker, Sequans Communications, to test their Calliope CAT-1 chipset on Telstra's production network.

127 With the IoT's ability to use a huge network at very low cost, I believe that this technology has the potential to drastically change the productivity of industries such as the agricultural sector. Yet this will require significant investment and development, and it still has a long way to go.

6 MANAGEMENT OF TELSTRA MOBILE NETWORK

6.1 Network Performance Targets

128 To ensure the network is performing to meet customer needs, Telstra has a set of internal Key Performance Indicators (**KPIs**) which it targets and which reflect what Telstra strives to achieve in terms of performance in the network. These KPIs are used internally to manage the capacity of the network and they are constantly evolving and improving as technology advances and as customer expectations and data usage increases.

129 These KPIs are intrinsically linked to customer demand and the value that customers place on coverage and innovation. It is my experience that having clear KPI targets is critical to ensuring superior and reliable network performance to support Telstra's desire to differentiate itself on a quality and coverage basis.

130 To ensure that Telstra had a leading ability to manage and monitor the complex traffic engineering, capacity headroom statistics and parameters associated with 3G and 4G, Telstra developed an innovative tool in conjunction with the University of South Australia originally known as 'Devil'. Telstra owns the intellectual property of this tool and licenced it to a company called Ascom for worldwide sale as a product known as TEMS Capacity Manager. In addition to a set of other KPI monitoring tools Telstra uses this tool extensively to manage the planning for cell capacity and performance across the network.

131 [redacted]

132 In addition to the above core KPIs, Telstra uses a wide range of internal and external tools, metric and robots to understand and manage the customer experience delivered by the network.

133 Setting and meeting these KPIs is undertaken as part of the annual planning cycle. KPIs play an important role in determining where and when Telstra invests. Further details on Telstra's investment decisions are set out below in section 9.

6.2 Network Management

Congestion impacts on voice and data

134 It is our intention that Telstra's network is effectively designed and managed to prevent congestion including by appropriately forecasting traffic growth and ensuring the network is upgraded on an 'as needs' basis (see section 6.3 below which refers to the capacity management of Telstra's network).

135 Despite this, there are times when congestion may occur and planning in order to prevent congestion is not always possible. Congestion may occur where the number of users greatly exceeds the normal traffic use at a particular location (for example, during emergencies and special events, and even on highways when there has been an accident and there is a build-up of vehicle traffic). Some special events can generate mobile traffic equivalent to the traffic generated at a medium sized city that is usually serviced by multiple base stations. During periods of extreme customer demand, customers may experience difficulty in accessing the mobile network.

136 If congestion does occur the network will take the followings steps in line with a continual increase in congestion:

(a) data sessions will firstly be managed to even out data throughput to all users on the cell;

(b) the throughput will then be reduced to allow voice calls to be made; and

(c) lastly, all data throughput will be reduced to zero to allow voice calls to be made.

Network priority to services

137 Services are grouped into two categories which determine the priority of the service. The first category, known as 'Guaranteed', is that of voice. The second category, known as 'Non-guaranteed', includes High Speed Downlink Packet Access (**HSDPA**) connections. HSDPA is an enhanced 3G mobile communications protocol which allows networks based on Universal Mobile Telecommunications System (**UMTS**) to have higher data speeds and capacity. The LTE network standards allow for prioritisation of voice (ie. VoLTE) and data services using a set of Quality of Service (**QoS**) levels.

Network Redundancy and Availability

138 The Telstra Mobile Network is designed and maintained to specified network standards which are in line with world best practices and adhere to all Australian standards. Telstra's core mobile network systems for both voice and data are designed with redundant systems to mitigate the possibility of a single point of failure causing an outage.

139 The Telstra wireless core network (switches, routers and transmission) is designed for very high availability and robustness. Physical redundancy and, wherever feasible, geographical diversity are provided for each of the core network elements. In case of failure of one network element, automatic switchover to a working element takes place. With respect to the radio network best efforts are made to rectify faults in the shortest possible time.

6.3 Network Planning

140 Telstra regularly monitors and forecasts the growth of traffic on its network through use of the 'Devil' tool (described at 130 above) in order to manage the growing capacity usage of its network. With its existing customer base doubling its data usage each year, Telstra is constantly innovating to provide solutions for capacity stress. Some of these innovations to boost capacity have already been detailed in section 5 above.

141 When headroom KPI figures have been reached and congestion is forecast to become a chronic issue at a particular location, there are various solutions which Telstra can use to

expand network capacity to accommodate this growth. These options are tiered, and increase in both complexity and cost as you work through the options.

142 Where spectrum is available, the first step would be to add additional spectrum to the cell, to boost the power of the cell and improve its capacity.

143 Where no more spectrum can be enabled on the cell, the next step would be to assess whether any software optimisations may be an option, however these are usually only suitable for increasing coverage for a short period of time until a more permanent solution can be found.

144 Following the deployment of additional spectrum, or where additional spectrum may not be available, the next step would be to increase capacity by splitting the cell. Under cell splitting, a multi-directional cell will be 'split' into multiple cells (most commonly three) to improve coverage depth and to increase capacity. However, cell splitting is usually only effective where the cell is right on top of the traffic (ie. in the middle of a town), and so primarily only works best for more highly populated areas. It does not work as well for those cells that may be outside of a town, where the coverage required is only in one direction.

145 Beyond the above options, the next step would be to install new sites.

7 TELSTRA'S WHOLESALE ARRANGEMENTS

146 In my experience, the telecommunications industry has been characterised by various commercial arrangements and agreements that have effectively enabled enhanced coverage across the separate networks.

147 Telstra proactively sells wholesale access to parts of its network at negotiated prices via various arrangements. There are also separate co-build arrangements allowing competitors to build radio transmitters on Telstra's towers (known as 'co-location' or 'tower sharing'). Although I have not been intimately involved with the terms of these arrangements, I have spoken to those who are, and set out below is my understanding of various resale agreements or roaming "style" agreements that Telstra has previously participated in. I understand that co-location and co-building arrangements between the carriers is being described in the witness statement of Mr Robert Joice, and as such, I have not described these below.

148 In my view, the agreements described below demonstrate that commercial roaming agreements have historically operated effectively to provide the negotiated roaming services to other carriers, subject to the commercial limitations and technical restrictions of those agreements. Importantly, the terms of the roaming agreements meant that Telstra was able to limit the geographic coverage of the roaming services, and preserve its coverage advantage. The resulting limited coverage overlap also mitigated technical issues.

7.1 International roaming arrangements

149 Telstra offers international roaming to international visitors who roam domestically according to preferred roaming agreements Telstra holds with overseas carriers. Relative to domestic traffic levels, international roaming user numbers and related traffic levels are very low and do not materially add to or impact network load or performance.

150 In order to do so, Telstra sets up its network to recognise visitor mobiles. This will trigger two processes:

(i) interaction with the roamer's home network to register the visitor mobile onto Telstra's network; and

(ii) interaction with the back-end of Telstra's own network to allow that customer to make calls.

151 There will then be a set of billing processes agreed between the operators which involve the periodic settlement of costs relating to visiting customers who have roamed onto their respective networks.

152 International roaming is covered in a very robust way between all three Australian carriers due to the difference in coverage across networks. That is, if the Vodafone network is the preferred roaming network of a visitor, but that visitor travels to an area where there is no Vodafone coverage, the handset will automatically start searching for the next preferred operator, which may be Telstra or Optus.

153 Furthermore, handsets are programmed so that where there is no 3G coverage, the handset or device will connect to the 2G network (where available). Similarly, where there is no 4G coverage, the device can connect to 3G or 2G as applicable.

154 There are limitations to international roaming which detract from the user experience, such as no in call-handover, switching delays, and fewer features than what is available to Telstra customers. These are discussed in more detail in section 8 below.

7.2 Domestic arrangements

155 Telstra has previously entered into a number of commercial arrangements. In my view, these agreements demonstrate that, collectively, commercial agreements have historically effectively provided services to other carriers, subject to the technical limitations and restrictions of those agreements, as negotiated and discussed further below in section 8. Importantly though, at least over the last 10 years these agreements have been subject to geographic limitations which have sought to preserve Telstra's coverage advantage.

Arrangements across the 2G GSM and CDMA networks

156 [redacted]

157 [redacted]

158 [redacted]

[redacted]

159 [redacted]

160 [redacted]

161 [redacted]

[redacted]

162 [redacted]

7.3 MVNO arrangements

163 Telstra offers a wholesale product called “resale”, where wholesale customers use a Telstra-provided SIM card to sell services under their own brand on the Telstra Mobile Network. Telstra began supplying wholesale 4G data mobile services for both pre-paid and post-paid mobile solutions to its mobile virtual network operator (**MVNO**) resale customers in April 2016, with speeds capped below those available to Telstra’s retail customers.

164 This offering includes access to Telstra’s 1800 MHz and 700 MHz coverage areas, with 2600 MHz spectrum coverage in selected areas, providing access to 4G coverage reaching 95% of the Australian population across 4800 base stations. Peak download speeds for 4G MVNO customers are capped at 100Mbps (an offering that Telstra views as competitive in the wholesale market place). VoLTE services are not currently part of the offering.

165 Outside of Telstra wholesale 4G coverage areas, wholesale customers can continue to access Telstra’s 3G wholesale coverage reaching 98.8% of the Australian population across more than 1.59 million km² of land and 7,800 base stations.

166 The majority of the base stations built under the government’s Mobile Black Spot Programme will automatically be added to the wholesale footprint, which is expected to change over the life of the 4 year program. Of the 58 base stations that have been built under the Mobile Black Spots Programme prior to 30 June 2016, 51 were automatically added to the Telstra wholesale footprint.

167 These wholesale MVNO arrangements are commercially very different to providing wholesale roaming to mobile carriers as MVNOs have not typically invested in building their own core or radio network. [redacted]

8 TECHNICAL IMPLICATIONS OF OFFERING DOMESTIC ROAMING SERVICE

8.1 Potential approaches to domestic roaming services

168 In my view, any domestic roaming solution would necessarily pose technical challenges to Telstra's network, as Telstra's network was not designed to accommodate a large scale national roaming service. As set out above, Telstra currently offers international roaming, and has previously entered into limited domestic roaming arrangements. On that basis, some form of domestic roaming is technically possible.

169 Whilst possible, there are various technical complexities which are likely to be created or which become more pronounced as a result of any mandated domestic roaming arrangement. This is due to the fact that mandated roaming has not been done before in the Australian telecommunications ecosystem – the scale of such an arrangement would be much larger than any previous arrangement entered into with Telstra (with several parties, significantly more end users and larger geographic scope). There is also the added complexity of how mandated roaming would impact on the evolution of new technology, and its impact on Telstra's investment incentives.

170 Under mandated roaming, I consider that the technical issues likely to arise would be most pronounced in areas where there is a substantial overlap in operator coverage, particularly where other carriers have "islands of coverage" over town centres but require roaming in the areas between these "islands" resulting in numerous, fragmented and moveable roaming boundary areas. In my view, the precise type and extent of these technical complications will also largely depend on the type of roaming service declared.

171 In this section of my statement, I have considered these issues by setting out three options for domestic roaming, and what I believe would be the technical implications that are likely to arise under these options.

172 I consider there to be three main technical solutions that could enable domestic roaming:

(a) A shared network approach using a MOCN (**shared network**). This model was used for the 3GIS joint venture with Hutchison where both parties shared the cost and responsibilities for managing and investing in the network. Whilst a shared network approach provides the outcome of roaming, it does so under a much more complex arrangement. It would involve a dedicated structure to manage the customer relationship and a deep integration of the access provider / seeker networks. By definition, it would be a national or network wide approach. This approach poses significant technical network integration issues and would be very costly. These technical challenges are discussed further below; or

(b) An international roaming approach (**standard roaming**). Under this approach the host network would effectively provide continuous coverage to customers of the roaming carrier in all areas where their own networks did not have coverage. In effect, it would be a roaming arrangement technically similar to international roaming. It would therefore be a national and continuous approach to roaming. Whilst it would not require any significant network integration, it would be subject to many of the same constraints as the current international roaming arrangements and give rise to additional technical challenges which are discussed further below; or

(c) A sub-national roaming approach (**sub-national roaming**). Under this approach the roaming would be limited to specific geographic areas, most likely those areas where there is only one carrier operating (predominantly in rural and remote Australia) and between the higher density regional areas where other carriers may only have "islands of coverage". Whilst it would not require significant network integration, similar to the standard roaming approach, it would face the same constraints as international roaming, with additional complications around how to define the geographic boundaries of the service.

173 In my view, each of the above approaches to domestic roaming involves a trade-off between what features can be supported, the complexity of the network, disruption risks, granularity of roaming areas and the time and cost of implementation.

174 These trade-offs can be broadly categorised as relating to:

(a) customer experience; and

(b) network management and operation.

175 My views on each of these categories is set out below. Whilst I have a good understanding of these issues, I have also sought the opinion of various technical experts within Telstra for the purposes of this statement.

8.2 Customer experience

176 The technical implications of standard and sub-national domestic roaming would impact the customer experience. In particular, whilst the customer would experience improved overall coverage, there is likely to be a degradation in quality in boundary areas (areas where the roaming and non-roaming coverage overlap) and reduced access to premium features in roaming areas. I describe these in more detail below.

In-call handover challenges

177 For both the standard and sub-national approaches to roaming, a customer roaming on to (or out of) Telstra's network will experience in-call dropouts. That is, there is no in-call handover between the networks which means that when a customer reaches the boundary of its network's coverage, the call will drop out, and the customer will be required to re-initiate the call once the handset has successfully switched to the new network. For the customer, this lack of in-call handover between the networks will mean their conversation is interrupted, or their data session terminates or becomes frozen, while their device searches for a new host network.

178 A seamless in-call handover solution does not currently exist for standard and sub-national roaming, and I do not consider it would be feasible to achieve this technically without engaging in an entire network re-configuration, involving a shared network solution. In particular, these issues would be more pronounced in areas where the access seeker has "islands of coverage" within the declared roaming footprint.

Switching delays

179 For both the standard and sub-national approaches to roaming, a customer roaming on to (or out of) Telstra's network will inevitably experience 'switching' delays caused by the customer's handset disconnecting and re-connecting to an alternate network. Depending on the particular device and signal strength of the alternate network, this process could take anywhere from between a few seconds and up to several minutes. For the customer, this would have various impacts, including a delay in being able to re-initiate the relevant call, or a delay in data downloads.

Handset management issues

180 For both the standard and sub-national approaches to roaming, given the above in-call handover challenges and switching delays, there is also the potential for this to result in handset management issues. For example, the handset may automatically "ping pong" between networks in low coverage areas in an attempt to repeatedly handover and reconnect between the two networks, which could lead to excessive volumes of charge records. Similarly, I understand that searching for a new network uses significant battery power of a handset. As such, reduced battery longevity may also degrade the customer user experience.

181 In the reverse scenario, even where the access seeker is able to easily switch to Telstra's network without experiencing "ping-ponging", there is a tendency for the call to remain on Telstra's network even when it is back in the coverage area of the access seeker. This not only raises customer service and billing issues, but would further add to congestion in overlapping areas which are not designated for the purposes of roaming.

Unavailability of network features

182 The telecommunications industry has evolved into an extremely technically sophisticated environment in that the features and functions on new generations of technology renders a customer's previous hardware incompatible. In comparison to previous and current roaming arrangements, this adds considerably more complexity to the implementation of domestic roaming and is likely to mean that, whilst roaming, customers will be unable to access innovative new products due to the sheer complexity and technological challenges of providing them.

183 In the case of international roaming, for example, Telstra currently does not provide products such as VoLTE, ViLTE and QoS to international roaming partners. This is due to the complexity of these Next Generation products – requiring an entirely new process to be set up with the overseas carrier, as well as customer handset compatibility and feature enablement on each device. For instance, VoLTE roaming is difficult because 4G is a data network and there is no ability to tag a voice call. These same issues would arise under a standard or sub-national approach to roaming.

184 Similarly, there are several 3G features which are currently not available to international roaming customers, despite the introduction of the Customized Applications for Mobile network Enhanced Logic (**CAMEL**) application.

185 Historically, a shared network approach has only ever been adopted for joint venture network arrangements (such as the 3GIS joint venture between Telstra and Hutchison) not simply for the provision of roaming to another carrier, and even then only supported basic features, not the complex suite of products and features that have arisen with 4G networks. Telstra would need to investigate precisely what level of network integration was necessary to enable all of the network features under a shared network approach to roaming. However, in my view, the integration cost of a shared network approach to try and resolve these issues makes it completely unfeasible and the cost implications would far outweigh any benefit to customers of the roaming arrangement.

Customer care

186 Ancillary to the issue of customer service is the management of network usage and self-care notifications. Telstra supplies billing information to its customers based on their customer profile and usage. However, customers roaming onto its network under standard or sub-national roaming would not have the benefit of this support or consumer profiling.

8.3 Network Management and Operation

Setting the geographic boundaries of roaming

187 For the reasons set out above, coverage overlaps and "islands of coverage" create significant issues as, in my view, one of the key technical implications of a sub-national approach to roaming is the complexity involved in attempting to set the geographic boundaries of that roaming in a way which avoids significant overlap. This is because, due to Telstra's signalling configuration (which is not unusual in a global context), it is not possible to simply "switch on" roaming at an individual cell level. For network management purposes, cell sites are necessarily 'grouped' together to form 3G Location Area Codes (**LACs**), which contain 100 cell sites, or 4G Tracking Area Codes (**TACs**), which contain 10 cells sites. I understand that for sub-national roaming to be "switched on", it would need to be done at the LAC / TAC level.

188 Under a sub-national roaming approach, there would be initial difficulty in defining exactly where one carrier's footprint starts and ends, especially in the "islands of coverage" roaming scenario. The complexity in doing so is demonstrated when you consider a regional highway or a remote town. These areas can often sit in between two carrier's base stations or are only partially covered by different carriers at any point in time. Given this, and Telstra management of its cell sites on a LAC/TAC basis, defining the areas to which sub-national roaming would apply would be particularly imprecise.

189 If the access seeker continues to build its network, it is even more difficult to manage overlap on a dynamic basis in an attempt to carve out "islands of coverage" where the access seeker builds a small number of base stations in areas where it has previously had no existing coverage, such as in a rural town.

190 My understanding is that it is also not easy to change the size, location and number of Telstra's LACs/TACs, and technical implications would flow from this.

191 In addition, Telstra uses the LAC/TAC boundaries for other purposes apart from roaming, such as paging and automated location based services such that the boundaries are relatively inflexible or, if forced to align with new roaming boundaries, would have a detrimental impact on network performance and customer experience around the boundaries. Where roaming is intended to fill the gaps between the different carriers' "islands of coverage" within the geographic boundaries of the area in which roaming is available, these issues become further exacerbated. This is particularly complicated in a shared network scenario.

Managing capacity and signalling constraints

192 In the context of either standard or sub-national roaming, where there is increased traffic around the boundaries of these LACs/TACs, it will be necessary to expand signalling and data links to ensure the additional signalling traffic does not cause congestion issues.

193 Signalling is where all of the transitions around an interaction with the network occur (ie. starting and finishing calls, and locating devices). There is only a limited amount of capacity in the network for signalling and the more time roaming customers spend around the boundary of a LAC/TAC, and the higher the number of customers in or crossing such boundary areas, the more pronounced congestion issues become. This is particularly an issue in a sub-national roaming scenario.

194 The use of non-Telstra devices roaming onto the Telstra network would result in increased signalling (to establish identity and network and feature compatibility). Such devices may also, depending on the headroom of the cell site, reduce the cell size and/or capacity by requiring more power than Telstra approved devices.

195 Significant numbers of users roaming from other networks could also trigger capacity expansions earlier than normally required that cannot be managed through additional 4G spectrum activation or cell splitting. That would potentially necessitate significant expenditure in infrastructure that was either not planned, or would be required to be brought forward. With the loss of Telstra's coverage advantage under mandated roaming, it is also the case that not all of these upgrades would continue to make economic sense.

196 The only way Telstra could manage these issues would be by trying to forecast likely increases in traffic and to expand the capacity in its network to accommodate these forecasts. To do this, it would require forecast data from other carriers of the likely traffic that would be using its network. In areas where the other carriers do not have a presence, such traffic forecasts will inevitably be unreliable. The actions of access seekers may also have an impact on forecast traffic. For example, if an access seeker increases its data cap or offers unlimited data usage to attract new customers, this will clearly increase usage.

197 Given the difficulties with forecasting, and the fact that Telstra would be relying on third party information that it has not yet tested, I do not consider that even a robust customer management platform or complex traffic forecasting analysis provided by all carriers would solve the potential for congestion and the creation of poor user experiences (for both Telstra customers and roaming customers). This is particularly the case for a standard approach to roaming, but would also be of concern for a sub-national approach to roaming.

198 I am not aware of any network operator that has been able to safeguard its customers by de-prioritising roaming traffic in the event that actual traffic is in excess of forecasts. This is much

more complicated than simply disconnecting users from the network, particularly since the signalling traffic congestion still remains an issue whether traffic forecasts are exceeded or not. Further, even if possible, it would result in a degraded customer experience for customers of other networks, compared with the customers on the Telstra network.

Potential for network avalanching and overload

199 In addition to simply managing everyday signalling constraints, under a standard roaming approach, and to a lesser extent even a sub-national roaming approach where there was some duplicate coverage areas, the failure of the access seeker's network could be catastrophic. If a large failure of this nature occurred on the access seeker's network in areas of significant coverage overlap, all users on that network would simultaneously start signalling in an attempt to roam onto Telstra's network, which could cause major voice and data traffic congestion and even failures in Telstra's network leading to an outage for some or all customers.

200 This outcome is not desirable for those trying to roam onto the Telstra network, and would have a significant impact on Telstra customers who would be unable to access the network. Failures of this nature are not only very damaging for Telstra's customers, but would be very damaging for Telstra's commercial and operational reputation. Under configurations where the roaming overlap or magnitude of potential roaming customers is a lower percentage of the Telstra network traffic this risk would be lower. As the overlap areas and number of potential customers from other networks roaming increases, the level of risk would increase significantly.

Other operational impacts

201 The network operational impacts caused by the technical implications of roaming are varied and very hard to predict. This includes complications related to:

(a) increased network support – under any roaming scenario, network support for the more complex customer usage scenarios and / or product features will require extensive IT and network development;

(b) handset compatibility – a lack of ability to test and verify the different devices that are accessing the Telstra network will also make it almost impossible to tell whether a network issue is caused by the incompatibility of a device or some other fault in Telstra's core infrastructure. In these instances, if carriers are required to share information and make joint decisions in order to resolve an issue, this will lead to prolonged delays; and

(c) network design and data integrity – additional roaming configurations over and above the current wholesale offering, whether they be national or sub-national, would also add significant overhead to network design and data integrity. On a sub-national approach to

roaming, where multiple roaming areas exist, there would also be additional overhead to ensure coverage mapping meets the roaming requirements.

202 Whilst a shared network approach might mean that some of the above additional complications eventually operate more smoothly, this would be at the cost of a very significant and large upfront investment in integrating the relevant networks. This would also raise significant information sharing arrangements and obligations, and a level of intimacy between competitors which would not be commercially acceptable.

203 I am not aware of a network sharing arrangement that has existed between more than two networks at any time.

8.4 Scope of costs involved to upgrade network and solve technical issues to facilitate roaming

204 Given the limitations of previous commercial roaming arrangements, Telstra has not had to implement a technical solution for the issues set out sections 8.2 and 8.3. To try and resolve these issues, whether it be for any future commercial roaming arrangement, or if required under mandated roaming, a technical solution and the cost of that would need to be investigated.

205 Depending on the type of roaming arrangement that is declared, the costs and processes involved in upgrading Telstra's network to facilitate roaming could be extremely expensive and time consuming. Trying to solve for the technical issues set out above would require complex testing, and attract a huge cost to implement the relevant upgrades, where it is even possible to do so.

206 The scale of analysis that would be required to look at these solutions, and cost them, would be an extremely significant and laborious task. Set out below are just some of the considerations that would need to be considered, and costed, even if the most simple roaming configuration was implemented:

(a) any necessary changes to the architecture of the network and interfacing with other networks;

(b) the development, building and testing product and service solutions associated with features that may be required but are not currently developed in standards or in vendor solutions;

(c) any necessary changes to vendor equipment;

(d) whether any capacity upgrades are required, for example, cost of installation of transceivers, software deployment; and

(e) any necessary changes to customer management systems and service 'ticketing'.

207 Given the type of roaming that might be declared is unclear, and given the above solutions have not yet been investigated, it is not possible to estimate how large these costs might be. The ability to recover and adequately compensate Telstra for those costs is also uncertain.

8.5 Future network developments and innovation

208 Telstra's innovation and differentiation is largely made possible because of a single vendor model. Everything is typically designed and tested by one vendor – Ericsson. This allows Telstra to make changes easily and efficiently to both sides of the network, enabling regular upgrades and guaranteed handset capability.

209 The shared network option raises particularly concerning issues for the roll out of future network developments and innovation. To enable the integrated network for these new features would require extensive interaction between vendors and networks leading to significant delays in software and feature rollout. This is entirely contrary to Telstra's strategy which is built on the rapid deployment of technology.

210 In effect, Telstra would lose control of its radio network and its ability to provide a quality and innovative service to its customers. In particular, Telstra would have an inability to control QoS on its radio network such that its LANES program would be negatively impacted.

211 Even with sub-national and standard approaches to roaming, whilst there would be fewer technical complications to Telstra making technological changes and updates to its network, there are likely to be constraints placed on Telstra under the contractual agreements with the access seekers. For example, if there was a contractual obligation that required Telstra to give notice to other operators of power outages or changes to the network, Telstra would be required to engage in additional management and rolling out changes could be delayed.

212 Additionally, in my view Telstra would have much less flexibility in dealing with small delays where notice obligations required a set period of notice. For example, if circumstances meant there was a delay to a power outage, rather than simply being able to push the work back a couple of days, Telstra may be required to serve out another notice period under its contractual obligations.

9 THE INCENTIVES THAT UNDERPIN TELSTRA'S MOBILE NETWORK INVESTMENT PROGRAMS

9.1 Telstra's investment programs

213 My team and I play an integral role in Telstra's annual investment planning programs. We receive various inputs from the business, usually from the product side, including the type and numbers of customers that Telstra intends to connect and what type of services those

customers are likely to consume. We then convert these inputs into an annual investment program.

214 Within the annual investment program, Telstra makes various types of investments.

215 There is a basic capacity "BAU" program, which this aims to ensure Telstra is continuing to meet its KPIs for existing and new users to support Telstra's superior network market position. It is the sum of investment required to carry Telstra's forecasted traffic and to maintain network quality, and will usually involve plans to increase capacity where required through upgrades to existing infrastructure or new tower builds as appropriate.

216 Telstra also makes strategic coverage investments. Given Telstra is, like most businesses, capital constrained, this program is targeted at making investments that best support Telstra's key coverage and quality claims in the market. As such, even if an investment is likely to yield a negative net present value, the fact that it will yield a positive coverage story or meet customer demand for more data / features etc, will attract its own value (or strategic market share) and be just as important as meeting Telstra's KPIs. As part of this, we look at Telstra's differentiation and competitive position and put forward an argument as to how and why the investment will ensure our network superiority is maintained and how this will either protect or enhance our mobile market share.

217 In addition, Telstra invests significantly in innovation and technology to maintain its hard won perception as being a "first to market" with new technology. This includes Telstra's investment in spectrum and the development of new features.

218 Fundamentally, Telstra's investment programs focus on what minimum spend is required to meet its existing customer needs and maintain its coverage and network superiority claims. However, Telstra's capital expenditure programs are also focussed on strategic coverage investments that can extend and deepen the capabilities of our mobile coverage.

219 Spending on strategic coverage investments usually takes place within the annual planning cycle, but there are occasions when I ask for additional funds, or a re-prioritisation of funds, which I think are particularly important to meet competitor activity or support new inter-generational features. When these arise, they are referred to the Telstra Board for information or approval, where appropriate and if required. Requests for additional funds outside of the annual planning cycle are not always approved. Set out below in paragraphs 229, 234, 235, 244 and 246 are some examples of business cases for additional capital expenditure, not all of which were approved, and some of which were only approved in part.

9.2 Key drivers of Telstra's investment programs

220 As set out above, Telstra's investments programs support Telstra's ability to differentiate itself from its competitors. In my experience, Telstra strives to differentiate itself on three key grounds, being:

(a) providing a premium customer experience;

(b) providing superior network coverage; and

(c) providing technology and innovation leadership.

221 Given the relatively similar nature of mobile services, differentiation as between your competitors is critical in competing for, and retaining, market share. I have described each of these grounds below.

Premium customer experience

222 Telstra seeks to concentrate on what matters most to customers by delivering a high quality customer experience based on key performance indicators which include speed, reliability, fewer drops-outs and customer service. A description of these KPIs is set out above at paragraphs 128 to 133.

223 Telstra uses these points of differentiation to market itself and build market share. Marketing claims that Telstra is able to make because of this include:

(a) faster speeds and greater reliability: "Australia's fastest mobile network" and "greater reliability and faster speeds in more places"; and

(b) fewer drop-outs: "the Telstra Mobile Network has fewer drop-outs and works better in more places – such as in buildings – than any other Australian mobile network."

224 To ensure this premium customer experience, Telstra makes investments under its basic capacity investment program which ensure, to the extent possible, there is enough capacity in the network for existing and forecasted new users to continue to experience reliable services and faster speeds. These investment decisions are made based on projected growth in network traffic as part of the annual planning cycle.

225 Ideally, these investments are made with enough lead time to ensure that Telstra can continue to deliver services to its customers in accordance with its KPIs. These investments are proactively made to occur on a "just in time" basis.

Superior network coverage

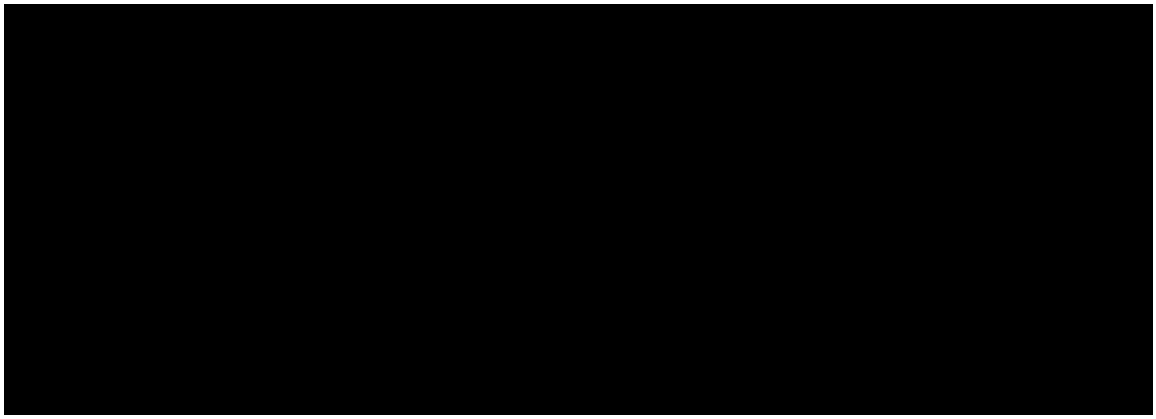
226 As I have discussed above, Telstra focuses on providing superior network coverage nationwide as a key point of differentiation from its competitors.

227 Telstra actively markets its superior network coverage and most of its customers recognise that it is one of Telstra's key strengths. Marketing claims that Telstra is able to make because of this include:

(a) largest coverage: "Australia's largest mobile network covering more than 2.4 million square kilometres, so you can do more on the go"; and

(b) fewer dead spots: "With more than 8,500 mobile coverage sites nationwide, the Telstra Mobile Network has fewer dead spots than any other Australian mobile network".

228 To ensure it can continue to market these claims, and given Telstra is capital constrained, Telstra makes strategically focused investments aimed at supporting these points of differentiation. These investments effectively build out the network in terms of extending the existing footprint, improving the existing coverage, as well as rolling out new technology across the existing footprint. The ultimate aim of these investments is achieving differentiation in respect of both coverage breadth and depth against Telstra's competitors. Given they are coverage related, Telstra's investments tend to focus on infrastructure investment in rural and regional Australia.

229 

230 I recall that this investment was made on the basis that it would ensure Telstra could continue to materially differentiate itself in the marketplace in breadth of coverage, stay ahead in depth of coverage, and position its network for video traffic by accelerating the network technology advancement.

231 Included in these strategic investments is Telstra's involvement in several government assisted coverage programs to increase regional and remote coverage, as well as quality of customer experience. In FY06-FY15, government funding accounted for less than 1% of Telstra's mobile

investment spend on a fully allocated basis excluding spectrum purchases and renewals. Examples of coverage programs include:

(a) Telstra has committed $165m to the Federal Government Mobile Black Spots Programme Round 1. Under this program, in December 2015, Telstra activated the first of the new mobile sites which will see Telstra build 429 new 3G/4G towers across regional and rural Australia as well as up to 250 small cells in small country towns. Although the nominated Black Spot sites under this program are generally not commercially viable, investment in these sites supports Telstra's strategic coverage strategy by providing Telstra with continued marketing opportunities to assert regional coverage superiority as well as demonstrating Telstra's commitment to the Australian community.

(b) The Western Australian Government funded Regional Communications Project, which was a four year project across FY12-FY15 targeted to improve the mobile coverage at small communities and strategic sites in regional Western Australia, which again, although not generally commercially viable, supports Telstra's coverage advantage.

Technology and innovation leadership

232 My experience is that Telstra has consistently invested in being a technology and innovation leader in mobile services. This is because providing new and better technology earlier than the rest of the market operates hand in hand with the premium service, quality and coverage brand that Telstra has built. Marketing claims that Telstra is able to make because of this include:

(a) continued investment: "Telstra has a clear technology and capacity management roadmap that will ensure Telstra and its customers remain at the forefront of mobile connectivity".

(b) Australia's fastest mobile network: while this also rests heavily on Telstra's capacity and spectrum investment, it is Telstra's world leading innovation with LTE-A speed technology that helps Telstra to make best use of that capacity and keep Telstra faster than its competitors.

233 Telstra's investment in developing new features like LANES, LTE-B and Narrowband IoT is aimed at maintaining this point of differentiation in the market, and Telstra works hard to ensure it can translate these new technologies into usable services quicker than its competitors.

234 [redacted]

[redacted]

235 [redacted]

236 Additional spectrum is clearly a key strategic asset for Telstra. Telstra is incentivised to continue to invest in spectrum because it enables Telstra to increase its existing bandwidth which translated to increased capacity and faster more reliable speeds for our customers. Newly acquired and future spectrum acquisitions will also prepare the way for growth in new products such as IoT, M2M, LTE-B and Enterprise LANES.

10 THE IMPORTANCE OF COVERAGE SUPERIORITY TO RURAL AND REGIONAL INVESTMENT DECISIONS

237 As set out above in section 2, the history of Telstra's network demonstrates that seeking to differentiate its services through coverage superiority is built into the DNA of the Telstra network. Telstra's decision to invest $1 billion in 2006 to completely transform its network by building the Next G Network covering 98% and expanding to 99.3% of the Australian population, and its continued expansion of the 4G Network, have been fundamentally driven by its pursuit of coverage differentiation compared to its competitors. This pursuit of the coverage advantage has delivered significant benefits to rural and regional Australians.

10.1 The business case for infrastructure investment in rural and regional Australia

238 The business case for many infrastructure investments in the more highly populated metropolitan areas can be justified by examining the expected NPV of the individual sites based on expected direct revenue.

239 However, for many of Telstra's investments decisions in sites across rural and regional Australia, the expected NPV of the sites based on expected direct revenue makes the investment simply uneconomic. This is because the cost of building and maintaining individual sites in rural areas is much greater than in metropolitan areas, however these areas are much less densely populated resulting in far less direct revenue potential. The more rural and remote the network extends, the less populated and challenging the terrain becomes, and the less economic these investments become on a direct revenue basis.

240 Whilst investments in rural and regional Australia do not provide adequate returns in themselves, they are able to be justified by Telstra on the basis of the potential market share gain Telstra is able to secure by using coverage and quality claims to signal to the broader market, including in metropolitan areas, Telstra's network superiority.

241 In my view, there is a clear and established marketing benefit in having this coverage and quality superiority, and the competitive advantage it has generated for Telstra across the broader market place is what has incentivised Telstra to invest so significantly in rural and regional Australia.

242 

10.2 The importance of coverage to Telstra's competitors

243 Optus also clearly recognises the coverage benefit. In recent years, Optus has strategically built in selected rural areas to obtain a localised coverage advantage in order to shift community perceptions about Telstra's coverage superiority. In a deliberate way, Optus has located base stations in outer metropolitan and regional areas where it can achieve this localised advantage in an attempt to cast doubt on Telstra's coverage superiority and reduce Telstra's market share. For example, in 2012, Optus installed a base station directly in the small South Australian town of Corny Point where, to date, Telstra has only supplied limited coverage in the area from a number of surrounding base stations.

244 [redacted]

10.3 The focus on coverage does not result in inefficient investment

245 Whilst Telstra's strategies are influenced by competitor activity in rural markets, it does not seek to invest in any location in order to simply 'match' the infrastructure of a competitor. This approach is not only necessitated by capital constraints, but is also more consistent with Telstra's longer term strategic coverage investment program which is designed to provide more value to its brand and service than simply matching the infrastructure of a competitor. In this way, Telstra largely focuses on innovative solutions for rural Australia, rather than necessitating a capex spend that is always in line with, or in excess of, its competitors.

246 [redacted]

10.4 The benefits to rural and regional Australia

247 On average, approximately 15% of Telstra's mobile capital expenditure over the previous 12 years has been directed at the last 2% of the population in remote Australia. This includes investments in new sites as well as technology investments.

248 Many of the technology benefits that have accrued to rural and regional customers through Telstra's focus on coverage differentiation have been set out above in section 4.1.

249 In addition to the technology investments mentioned in section 4.1, and as mentioned in section 4.4, Telstra also heavily invests in special event and seasonal capacity requirements for rural Australia, servicing around 200 events / destinations per year and in some cases absorbing a

temporary capacity uplift of up to 300%. This capacity uplift is achieved through software licence upgrades, or building a temporary cell, or it may require re-building new hardware and upgrading backhaul. Examples of these special events include Splendour In the Grass in Byron Bay, Alice Springs Show Day, Birdsville Races, Tour Down Under in Willunga Hill, Rip Curl Pro at Bells Beach and the AgFest Field Days in Carrick (TAS).

250 A selection of media releases and articles relating to Telstra's particular focus on regional / rural Australia in recent years is set out at Annexure "**MJW-12**".

11 THE IMPACT OF ROAMING ON TELSTRA'S INCENTIVES TO INVEST

251 It is my view that if roaming is mandated it will essentially neutralise the strategic benefits of the current investment in 4G beyond the Optus 4G footprint, undermine the coverage differentiation Telstra has historically invested to obtain across both its 4G and 3G networks, and stifle investment in the development of new innovative technologies (such as the current 5G trials) and features.

252 This is because where roaming provides our competitors with the same coverage footprint as Telstra, Telstra will be unable to market itself on the superior coverage basis which has to date incentivised so much of its investment decision making.

253 Under roaming, Telstra will have no incentive to expand 4G beyond its competitors' footprints, and similarly, Optus and Vodafone, assuming they act in an economically rational way, would be unlikely to invest in building new sites where they can service their customers via roaming.

254 I firmly believe that the inability to differentiate itself on this basis would impact Telstra's ability commercially to justify a range of future planned and potential investments in regional and rural Australia, and would also provide disincentives to Optus and Vodafone to continue to invest substantially in infrastructure in these areas. In my view, it would effectively "freeze" any further investments in coverage.

11.1 There is still more infrastructure investment to come

255 Despite the significant amount of investment that has already been made in the Telstra network over the preceding 10 years, there is still significant investment to be made in order to unpack the full capacity and capabilities of the 4G network. This is the case even once the 4G network reaches 99% of the population which, based on current investment plans, will be by the end of June 2017.

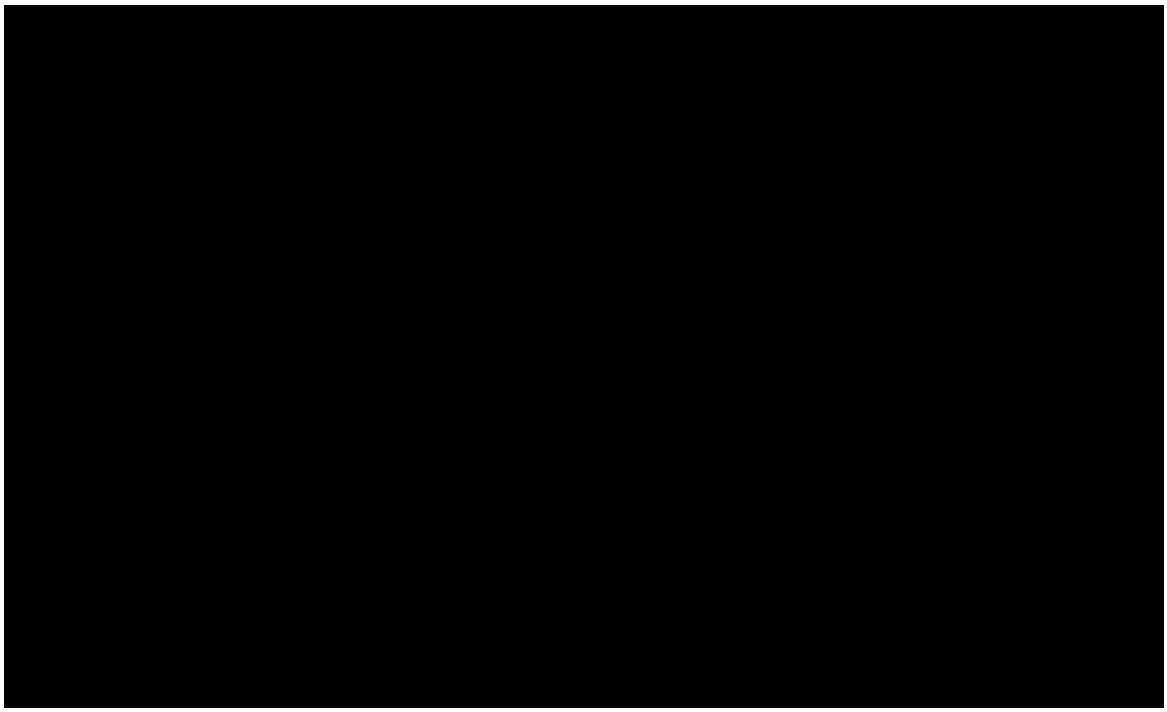
Capital expenditure in regional and rural Australia

256 If roaming is mandated it has the potential to impact Telstra's ability to commercially justify a range of future planned and potential investments. Our current plans are to continue to invest

strongly in regional and rural Australia. Over the next five years we expect to spend a further $350 million, which will include expanding coverage and capacity beyond our competitor's footprints, and improving in-building coverage and speed performance of our network.

Co-funded programs in regional and rural Australia

257 In addition to the above planned capital expenditure into regional and rural Australia, over the next 5 years Telstra also expects to invest in co-funded programs, including:



258 Telstra also expects to invest in programs which it has not yet made a financial commitment to, and which will be particularly susceptible to any decision as to mandated roaming. These include continued co-investment into coverage in remote towns, such as the recent fibre roll-out in Queensland to Birdsville and Bourketown.

259 Taking into account the expected external government funds on the above co-funded programs, amounting to approximately $415 million, the total future planned capital investment program into regional and rural Australia equals over $1 billion. This is significant additional investment that is being made into the future of telecommunications in Australia – any decision to mandate roaming I believe will inevitably impact this significant investment.

260 Whilst not quantified, any decision to declare roaming would also limit the future roll out of new technologies such as IoT, LTE-B and 5G.

11.2 3G-only roaming

261 Essentially, Telstra's network is made up of the combination and interaction of its 3G and 4G networks. It is my view that, if only 3G was to be regulated (ie. 3G-only roaming), this would create a disincentive to invest in upgrading to 4G technology and to continuously improve existing 3G services which usually occurs with 4G upgrade and will create network management issues between the two technologies where deployed by Telstra at the same cell site.

262 From a network management perspective, 3G acts as a 'fall-back' for the 4G network. Telstra currently uses 3G in sites where 4G is deployed to provide services where the 4G signal is not available, for example if 4G coverage in the basement of a building is limited or the 4G signal is limited at the edges of coverage in the cell. The technical compatibility of 3G and 4G means that both the network and the customer's handset can work to move the customer between 3G and 4G to maintain a high coverage quality without the customer needing to intervene or even necessarily knowing this is occurring. Customers therefore regularly move between the two networks as a means of capacity and coverage management. In these circumstances, it is difficult to envision a solution which would effectively enable 3G-only roaming without causing problems for the management of Telstra's network.

263 Telstra's contribution to the Mobile Black Spots Program and other co-investments require both 3G and 4G enablement. Telstra also continues to invest in ensuring its 3G software is kept up to date so that it remains compatible with 4G technology. When upgrading sites to 4G, Telstra also will undertake work in the course of upgrading a 3G cell site to 4G which has the effect of improving the quality of 3G coverage within the cell, such as speed and depth of coverage: for example, by upgrading the backhaul to bandwidth levels which support higher speeds on both 4G and 3G. This assists in ensuring that 3G and 4G can work in a complimentary way in a cell site to provide a consistent level of customer service.

264 As 4G is the primary technology where 3G and 4G are deployed together and 3G is the 'fall back', 3G traffic is relatively flat or declining, whilst 4G traffic is currently growing. Telstra ultimately expects to close its 3G network as we continue to improve the quality and depth of 4G coverage so that it can provide consistently high levels of service without the need for a 3G fall back. I am aware that our current plans have 3G closure becoming increasingly likely from 2022, with a 50% chance of 3G still being available at 2025, and more than likely closed by 2028.

265 Although it does not currently have a solution for those 3G-only areas, Telstra is working towards improving those sites by upgrading them with 4G technology, even if customers are unable to obtain 4G speeds because of other site-specific constraints, such as limited backhaul capacity.

266 It is my view that mandated roaming on the 3G network will mean that there will be no incentive for greater investment in current 4G sites in regional and rural Australia, resulting in a lack of innovation and introduction of new features/functions. I also think it is very possible that as previously un-economic sites steadily depreciate and their operating costs outweigh any generated revenue, de-commissioning of towers may result in an actual reduction of the coverage footprint across Australia.

11.3 The implications of roaming on investment in rural and remote Australia

267 Generally, an investment is only made where it can be linked back to the recovery of its expenditure via direct or indirect revenue. As described above, there are many rural and regional sites that are not stand-alone economically viable due to low usage or low population density. Many of these sites were invested in either as strategic investments to provide competitive differentiation or as part of a partially Government funded program.

268 Without the competitive advantage obtained through Telstra's ability to make coverage claims from these investments, the business case for these investments simply falls away. Not only could this mean that the continued expansion of the 4G network to 99% may need to be reviewed, but it will also mean that entire rural communities will simply miss out on services or experience a degradation in coverage which is essential to the broader economic prosperity of those communities and regions.

269 It is my view that any decision to declare roaming would also limit the future rollout of new technologies such as IoT, LTE-B and 5G. Telstra currently has an incentive to, and does, invest in 5G trials with Ericsson, Intel and Qualcomm to prototype 5G enabled devices and test the technology. It is also actively involved with the 3GPP on 5G standards to gain support for features and longer cell ranges. A very different set of factors and economic analysis would be involved in decisions to invest in and optimise these technologies throughout rural Australia in the context of mandated roaming.

270 It is therefore my view that under roaming new features and new technology rollouts in rural Australia would inevitably be curtailed. Without a developed 4G foundation and continued investment, the introduction of any new 5G technology will not be economic.

271 Essentially underpinning all of this is my view that the introduction of declared roaming will result in a disincentive across all carriers for future infrastructure investment, particularly in rural Australia.

272 The current competitive and political state of telecommunications in Australia has resulted in its position as one of the top ranking telecommunications industries in the world, largely as a result of strong infrastructure competition. In my view, declared roaming will mean the end to the coverage race in Australia and ultimately a degradation of the industry and the valuable

services it provides to consumers and the broader Australian economy, with the greatest impact on rural and regional Australia.

Signature

Michael James Wright, Group Managing Director
Networks, Telstra Corporation Ltd

Date: 1 December 2016