Deloitte.
Access Economics

5G mobile – enabling businesses and economic growth

AMTA

2017

Contents

Glossary

Acronym	Full name
ACMA	The Australian Communications and Media Authority
AMTA	Australian Mobile and Telecommunications Association
Gbps	Gigabytes per second
GHz	Gigahertz
IMT	International Mobile Telecommunications
IoT	Internet of Things
ITU	International Telecommunications Union
LTE	Long Term Evolution
MHz	Megahertz
mmW	Millimetre wave
TIO	Telecommunications Industry Ombudsman

Executive summary

5G is the next generation of mobile networks. More than an upgrade, 5G will complement the broader network ecosystem, working with the latest mobile networks, and broadband infrastructure to create more seamless connectivity.

Every previous generation of mobile telecommunications networks has brought significant gains – from 3G, which enabled faster web browsing on mobile devices to 4G supporting mobile apps and streaming. 5G is set to facilitate the continued growth of the digital economy by supporting better experiences for individuals, businesses and industries, and facilitating advanced use cases.

5G will continue to improve the mobile experience for consumers. However, one of its major benefits will be in how it can be leveraged by industry. It will support commercial use cases in a range of industries: examples include driverless cars in transport, and virtual and augmented reality in education and health care.

Investment in 5G will be of national economic significance:

- It is estimated that **annual network spend by mobile network providers could be worth $5.7 billion in FY 2017-18**, with much of this going towards investment in spectrum, infrastructure deployment and site design. This number is likely to grow further as operators invest in building 5G networks over the next few years.
- 5G will **add to the already significant (and growing) $34 billion long-term productivity benefits** from mobile technology estimated under 4G networks in 2015.

While 5G standards and network specifications are yet to be finalised, it is clear that 5G networks will bring improved network performance standards, **including low latency, faster speeds and seamless connectivity**.

To access these benefits, Australia needs a policy agenda that prioritises 5G. This will be underpinned by a **flexible, forward-looking regulatory framework** which will enable the economic and social benefits of a fully and seamlessly connected society to be realised.

Mobile is an integral part of how Australian businesses and society function. 5G will continue this trajectory and with the digital economy to grow to $139 billion by 2020, it is important to take action to harness the potential of 5G.

1 What is 5G?

5G is an improved mobile network technology that will open up more flexibility and use cases for a broader range of industries.

Australia is a mobile nation. More than 4 in every 5 Australians (84%) now own or have access to a smartphone (Deloitte, 2016), and mobiles are now the most popular way of accessing the internet – 77% of Australians connect using a smartphone, compared to 75% on a laptop and 61% on a desktop (ACMA, 2016c). And demand shows no sign of slowing; the volume of data downloaded on mobile devices has grown over 60% in the last year alone (ABS, 2016).

Clearly, mobile is integral to Australia's digital economy, which currently accounts for around $79 billion of GDP, and is expected to grow to $139 billion by 2020 (Deloitte Access Economics, 2015). This growth will continue to be facilitated by an ecosystem of telecommunications infrastructure – including mobile networks, fixed-line broadband and wireless technology.

Each generation of mobile technologies has increased demand for mobile services and supported new and sometimes unexpected use cases. For example, 3G enabled email and internet use on mobile devices and 4G supported an increase in the use of mobile apps via mobile broadband. Most recently, 4.5G or LTE Advanced has ushered in even faster speeds for streaming on mobile devices, and further enhanced the customer experience during peak periods due to larger network capacity (Optus, 2017a).

The next step for mobile in Australia is 5G – the fifth generation mobile network. Currently being trialled in Australia (Telstra 2016, Vodafone 2016, Optus, 2017b), there will be a gradual roll-out of 5G, starting in major metropolitan areas, which is expected to be commercially deployed from 2020 (ACMA, 2016a).

More than just the next mobile upgrade, 5G will complement the broader network ecosystem, including fixed line networks and working with the latest 4G networks – 4.9G or LTE Advanced Pro. 5G technology is expected to bring considerable benefits. It will facilitate the continued growth of the digital economy beyond 2020, with improvements in network performance to support better experiences for individuals and industries, with the capabilities to facilitate advanced use cases.

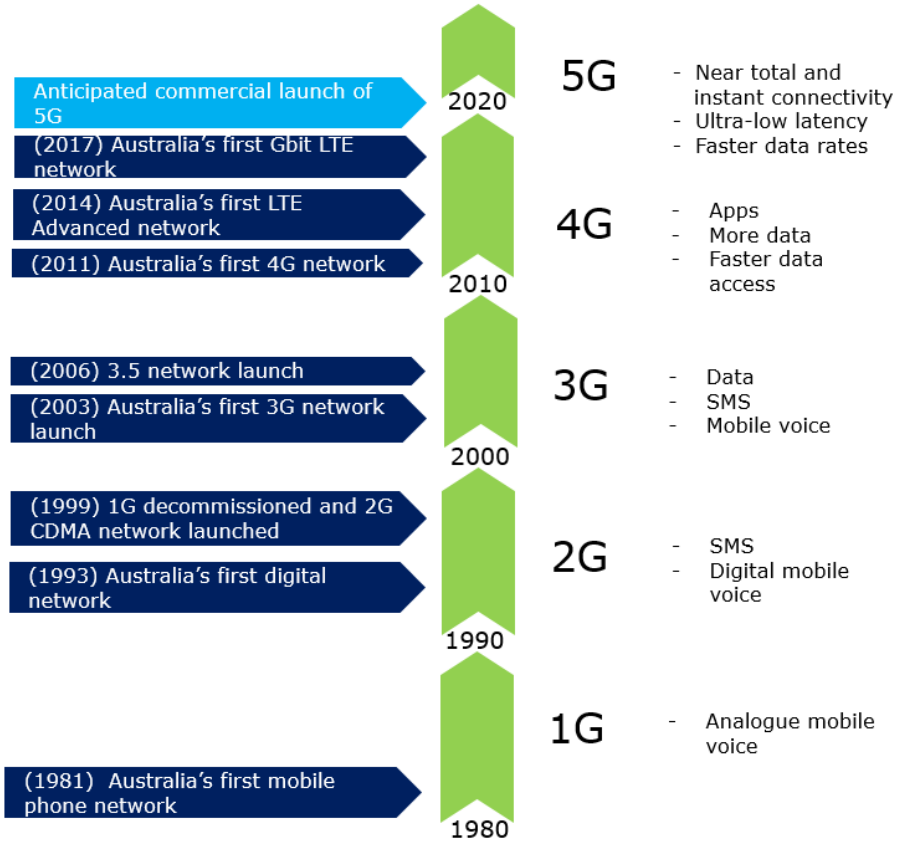
While consumers are set to continue to benefit, much of 5G's value will come from how it can be used by businesses – from automating business processes to enabling seamless connectivity for Internet of Things (IoT) devices. Beyond making current business processes more efficient, it has the potential to improve business productivity by changing or even transforming these activities.

1.1 Evolution of mobile networks

Mobile networks play an important role in driving innovation and social benefit, in addition to increases in productivity and efficiency (ACMA, 2016a).

From the "brick phones" of the 1980s, Figure 1.1 shows how mobile networks and technologies have continued to evolve. Each successive generation of technology has offered new functions and features such as increased quality of services, a higher number of applications and new use cases (Deloitte University Press, 2017).

Figure 1.1: Evolution of mobile networks



Source: Deloitte Access Economics (2017); ACMA (2016a); Ericsson (2013); Ericsson (2017a)

The next generation of mobile network – 5G – is expected to be both an evolution and a revolution. As with previous generations, it will operate in parallel with existing networks to bolster existing capabilities and network performance. At the same time, 5G could offer networks the ability to provide specific services based on the needs of an individual customer, and may be the first mobile network to genuinely compete with fixed-line networks for more data-intensive applications (Deloitte University Press, 2017).

5G is expected to enable a fully mobile and seamlessly connected society (Deloitte Access Economics, 2016). By drawing on the successes of previous generations, it will deliver the necessary environment to support business models and use cases that haven't even been conceived yet (GSMA, 2017).

Although the exact technical parameters and specifications which will formalise the 5G standards are yet to be confirmed, there is broad

consensus about how it will operate and what its capabilities are likely to be at a high level. Development of technical requirements for 5G has been ongoing for several years and standardisation has commenced. As such, this report sets out a working definition of 5G with reference to the benefits that it will unlock.

1.2 5G will improve network performance

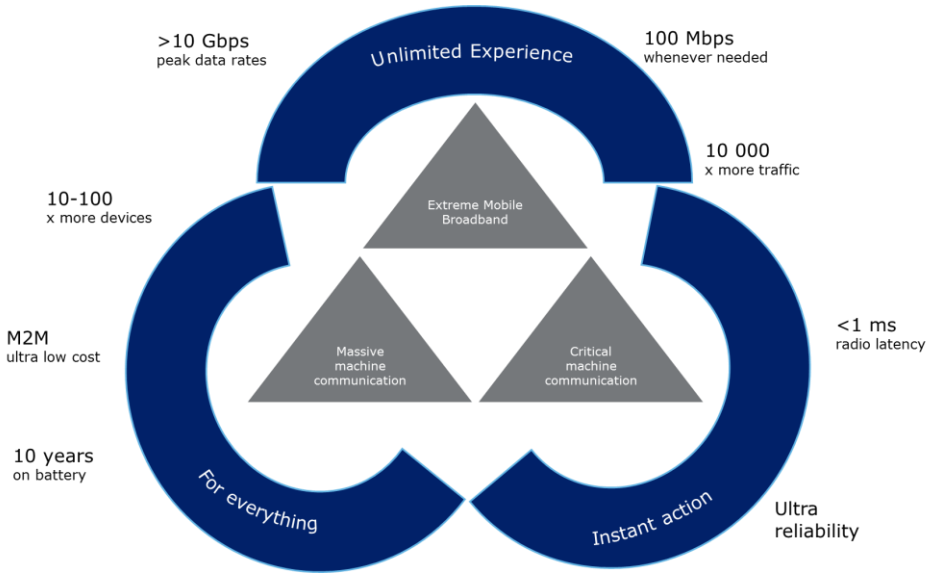
Stakeholders in the mobile industry, are currently working together to define what 5G should be. Globally, 3GPP discussions have focused on formulating the global 5G standard (Qualcomm, 2017). However, most agree that in its final form, 5G will offer:

- latency of less than 1ms;
- ability to deliver speeds of up to 10Gbps and beyond;
- energy efficiency in running 1000s of devices; and
- improved network capacity by enabling millions of low bandwidth devices to connect simultaneously.

Clearly, speed is only one component of what 5G offers. Where 4G focused on providing improved speeds and capacity for individual mobile phone users, 5G will enable more industrial applications, and could be a major technological driver in industrial digitalisation.

An illustration of the types of benefits that 5G will enable is provided in Figure 1.2.

Figure 1.2: Expected performance of 5G networks



Source: Nokia (2017a)

1.2.1 Latency

Latency is a measure of how quickly a packet of data can go from one point to another, back to its point of origination (NGMN, 2015). Lower latency means seamless connectivity without excessive waiting times (ITU-R, 2015).

Improvements in latency are important for technologies which would require very low response times. For example, in remote surgery, a surgeon provides instructions to a robot to perform a surgery in another location. Surgeons need to react very quickly to changes in the operating room; as

such, higher response rates (or latencies) are associated with higher error rates in surgery (Anvari et al., 2005).

Currently, 4.5G networks can deliver a latency of around 10ms (Alleven, 2017). At a minimum, GSMA (2017) suggests that 5G should deliver latencies below 10ms. In fact, many commentators, such as Nokia, Huawei, ACMA and the International Telecommunications Union expect that latency should eventually be less than 1ms (Nokia, 2017a; Huawei, 2015; ACMA, 2016a; ITU-R, 2015).

The significant reduction in latency means less delays in the time it takes for devices to respond to data being received from the network. 5G will enable reliance on mobile networks even in situations where reaction speeds are crucial. The reduction in latency can mean the difference between a driverless car operating on a mobile network avoiding an obstacle in time and having an accident.

1.2.2 Speed

Speed of mobile networks refers to how quickly data can be processed. The higher the speeds, the less waiting time that internet-enabled applications take to process.

5G networks are also expected to improve speeds. They are expected to reach speeds of up to 10 Gbps, providing a more seamless user experience (Nokia, 2017a). This is over 100 times the advertised data rates for 4G networks in Australia of between 2-100Mbps (ACMA, 2016a), and maximum speeds could be similar to those provided by fixed-line broadband networks (Deloitte University Press, 2017).

The significant improvements in speed are likely to provide faster internet download times, supporting a better experience in high-data applications, like streaming, online gaming, and downloading apps, movies and music. This is likely to mean users will experience greater quality of time spent on mobile devices, while providing time savings. In addition, businesses will enjoy greater value-add to their operations from the seamless connectivity of devices.

1.2.3 Energy efficiency

Demand for mobile data has increased with each successive mobile network generation. As the number of mobile-connected devices has increased over time, higher network energy consumption has placed a greater strain on the energy performance of networks. Energy efficiency reduces operational cost by improving network energy performance, amongst other benefits such as better sustainability and resource efficiency (Ericsson, 2015a).

5G is expected to provide energy efficiencies, through support for up to 10 year battery life for low power machine-type devices and 90 per cent reduction in energy usage (ACMA, 2016a). The evolving IoT ecosystem containing billions of wirelessly connected sensors and devices, will require devices with long battery life of several years, without the need for recharging (Ericsson, 2016). By modernising networks and shifting traffic to 5G, network providers could decrease their energy requirements (Nokia, 2016a).

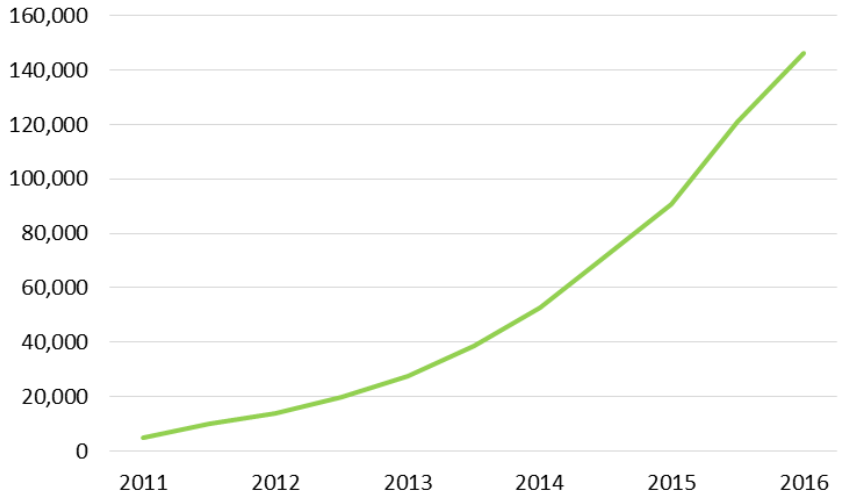
While an increase in demand for data usage will mean more network traffic and costs for network operators, there will be some offset via the energy savings to be provided by 5G.

1.2.4 Capacity

With more and more connected mobile devices, and a continued increase in the volume of data downloaded by mobile handset subscribers, there are continuing concerns about capacity – the ability of the network to simultaneously meet the data demands of all subscribers, especially during peak times and in congested areas.

As more devices demand more data, networks can become congested, leading to slower speeds for end users.

Chart 1.1: Volume of data downloaded by mobile handsets (three months ended) for 2011 to 2016 (Terabytes)



Source: ABS Cat 8153.0

5G networks will have the capacity to facilitate substantial data volumes. A key design principle of 5G will be reliability, which includes the perception of "infinite capacity and coverage that future mobile networks will need to deliver anytime and anywhere" (Nokia, 2017a). An increase in the capacity of the network means that more people and businesses can be connected without experiencing noticeable degradation in performance.

The increase in demand for connected devices will mean more data will be required to flow through a specific connection at one time, and 5G will facilitate this. 5G will utilise several spectrum bands, including higher frequencies which have many bands available to provide increased capacity (Nokia, 2017b).

The resulting faster data rates and increased network capacity will support data intensive applications (ACMA, 2016a). This will also support better network performance in high-density areas, like CBDs, stadiums and transport hubs (GSMA, 2016).

1.3 5G networks

As with previous generations of mobile networks, the new 5G augmented networks will be supported by three network components – core network, radio access network and transmission.

The exact technical specifications of 5G are yet to be finalised, with ongoing discussions through forums such as World Radio Conference (WRC) expected to be finalised and formalised through the International Telecommunications Union for the IMT-2020 standard (ITU, 2017).

Even when the technical specifications are finalised, the exact network configurations and technology used in deployment will vary by network and by area. Indeed, it is likely that 5G will work to complement and supplement existing 4G, 4.5G (4G LTE) and 4.9G networks, rather than replacing them.

As such, what networks will practically look like once 5G has been introduced is still being finalised. However, it is likely that networks will feature:

- a mix of existing and new infrastructure, with improvements in the efficiency and effectiveness of this infrastructure; and
- varying network configurations depending on specific location and need, with a potential trend towards greater network density in high traffic areas.

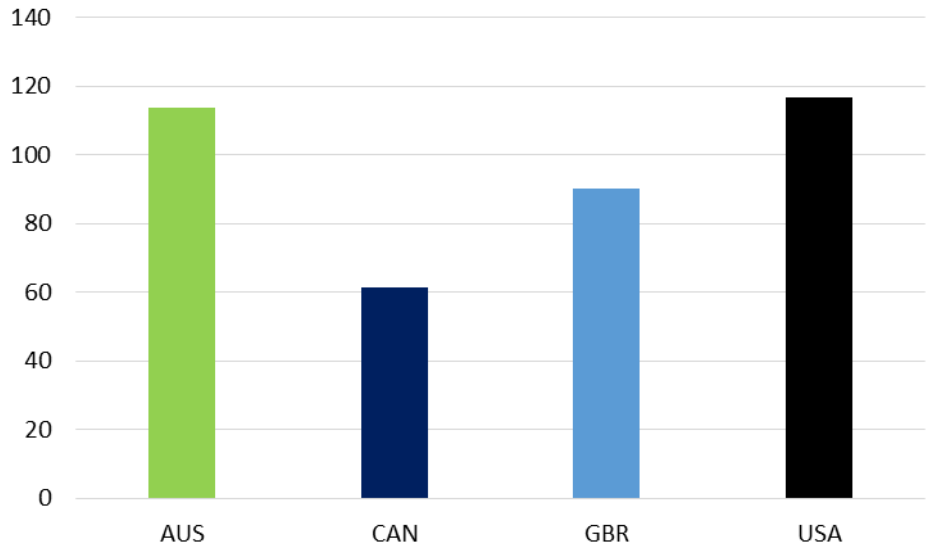
Ultimately, 5G will be a more flexible network, enabled by a flexible cloud-based network infrastructure. It will mean that virtual network configurations (e.g. virtual network slicing to provide fit for purpose virtual networks to multiple customers) can be generated according to the specific needs of certain applications or industries.

5G networks will not operate in isolation. As discussed previously, they will be a part of a broader telecommunications ecosystem, with various opportunities for interoperability, including backhaul to deal with capacity. Indeed, fibre and other fixed infrastructure will be an important complementary component in helping 5G to reach its potential.

2 Economic benefits

Every generation of mobile technology has had a significant impact on our economy and society. Figure 1.1 above highlights how each generation of mobile technology has enabled new uses from SMS to mobile apps. In addition, Australia has one of the highest rates of penetration when it comes to take-up of mobile devices. Chart 2.1 highlights that the number of mobile broadband subscriptions in Australia is relatively high amongst the developed world.

Chart 2.1: Number of wireless mobile broadband subscriptions per 100 inhabitants, which have been used to make a connection in the last 3 months (2015)



Source: OECD (2017)

Past experience highlights that as mobile technologies have evolved, there have been various benefits for individuals, businesses and the broader economy.

5G will continue to support the benefits of mobile technology. For individuals, it will mean better experiences through faster speeds, less congestion experienced due to greater network capacity, and new applications that add value to their lives.

Businesses are likely to benefit from the enablement of new use cases, and new ways of creating and unlocking value. 5G will mean new service and product offerings that will create further value for businesses, while helping them to engage with customers in new ways. New 5G applications will also enable further value through creating new efficiencies in their operations.

Economic growth is underpinned by the three Ps - population, productivity and participation (Commonwealth of Australia, 2010). Improvements in any of the three Ps can be associated with increases in GDP. Mobile will continue to fuel economic growth through boosting two of the three Ps – productivity and participation. For example, mobile technologies can increase the

effectiveness of employees by reducing the down time associated with commuting, and continue to aid workplace flexibility. Previous estimates by Deloitte Access Economics (2016) found that mobile technologies contribute $34 billion to the Australian economy. On the participation side, mobile has been found to contribute to labour force participation by an extra $8.9 billion.

In addition to the economic benefits, there are social ones. For example, in the long-term 5G could help to improve accessibility to healthcare for people living in regional areas through telemedicine diagnosis at more affordable prices. Greater security is also likely to be afforded by more smart installations such as smart lighting in precincts, helping people feel safer.

As discussed below, moving to the next generation of networks will mean more investment by network operators, and in turn, businesses who will invest to take advantage of new use cases. Time savings afforded by an improved mobile network, and the enablement of new products/services will benefit both individuals and business.

While it is difficult to quantify these benefits, the below outlines higher level estimates resulting from investment in 5G networks and benefits arising from 5G time savings and new products/services.

2.1 5G will require significant commercial investment

Major telecommunications network providers have already started to invest more in improving mobile networks. Optus recently announced its plans to invest $1 billion to improve and expand its mobile network in regional Australia by the end of June 2018 (Optus, 2017). Additionally, Telstra recently pledged to spend $3 billion over 3 years, including $1.5 billion on its networks (Coyne, 2016). Meanwhile, Vodafone recently reported a $2 billion spend in 2017 on mobile network and technology, to provide greater value for mobile customers (Vodafone, 2017).

According to Amalgamotion (Amalgamotion, 2017), the annual overall telecommunications network spend for the current financial year across Telstra, Vodafone, Optus and TPG is estimated to be $5.7 billion. This number is likely to grow further as operators invest in building 5G networks. These include significant investment in spectrum, infrastructure deployment and site design.

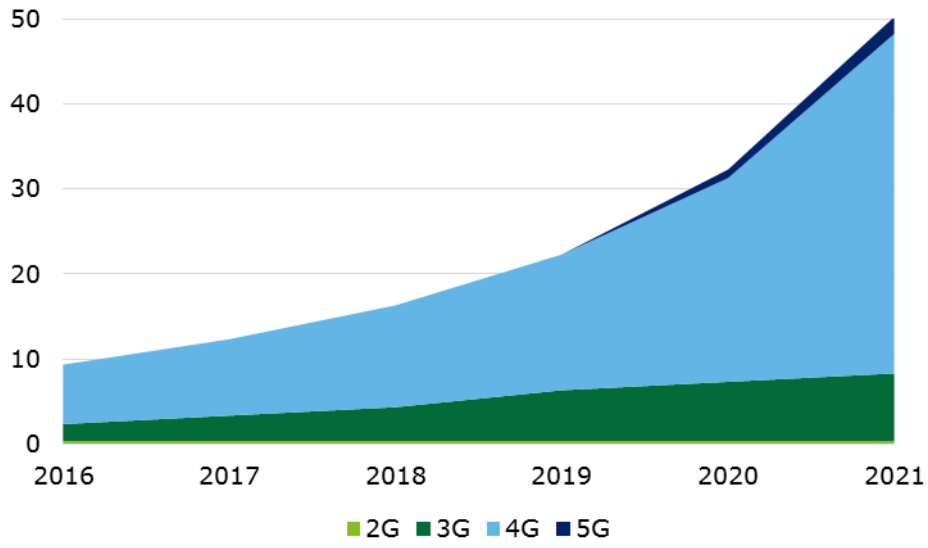
2.2 Time savings

5G is expected to produce speeds of up to 100 times faster than current 4G networks (Dunn, 2017). According to Nokia Bell Labs, the latency and bandwidth benefits that 5G bring will provide new digital experiences that save time and shift the experience towards augmenting our abilities with those of machines (Nokia, 2016b).

Mobile technology under 4G networks contributed $34 billion in long-term productivity benefits in 2015 (Deloitte Access Economics, 2016). And with increasing mobile data traffic, this benefit will only increase as more efficient networks are introduced.

As every successive generation of mobile has been rolled out, there has been a corresponding increase in preference for the new type of mobile data.

Chart 2.2: Global Mobile Traffic by Connection Type (Exabytes per Month)



Source: Cisco (2017)

Chart 2.2 shows over time, 4G traffic is predicted to continue to increase compared to 2G and 3G traffic while 5G traffic will complement and build on 4G from 2019 onwards, as it is commercially deployed.

Part of the increase in data consumed over 4G networks is attributable to the **demand for better quality mobile networks with greater speeds and reliability**. According to Cisco (2017) 4G networks currently generate almost four times more traffic than a 3G connection, partly because higher speeds encourage the adoption and usage of high-bandwidth applications. These include better quality video, driving further demand for high quality video (such as 4K resolution).

In the same way, 5G will deliver new capabilities to address increasing subscriber demands and services trends across mobile, residential and business markets. **5G is expected to deliver faster speeds**, meaning that there will be strong demand for it, as there has been for the benefits that 4G offered over previous generations. This demand is likely to drive further investment in 5G in the longer term.

It is easy to see how faster speeds can drive demand for the corresponding data. Take individuals and the time they spend on their mobile devices as an example.

Research by Nielsen has estimated that the time per person spent on mobile web browsers is about 4 hours per month (Nielsen, 2015). While the improvement in speeds under 5G may not necessarily mean that people spend less time on their phones, the improvement in the quality of the time spent is just as important. **Faster speeds will enable quicker web browsing via mobile devices**, and **quicker downloads**. While 5G is yet to be seen in practice, the potential benefit can be seen in the following.

If we consider that the average load-time for webpages is 4 seconds (Schofield, 2016), even a 1 second faster load-time, will have a substantial cumulative impact when we think about how frequently people use their mobile devices to browse online. Reduced load-times are likely to improve the quality of browsing, and as a result, the leisure time spent on phones.

2.3 New products/services

5G is going to have transformative potential for how businesses conduct their operations. This will particularly be pertinent in industries where the impacts of digital change are taking longer to fully emerge, such as health and education.

According to IHS Economics & IHS Technology (2017), 5G deployments will benefit most sectors, via the enablement of new business models. Particularly, it will enable greater activity in more labour heavy sectors such as manufacturing, which will see almost $US3.4 trillion in global 5G sales enablement or 28% of the total enablement across industries in 2035 (IHS Economics & IHS Technology, 2017b). Therefore, considering Australia's percentage share of global GDP of 1.7% (Austrade, 2017), this would mean **$AUD 73.4 billion** in Australian 5G enabled sales.

While this number provides an indication of 5G benefits, it is merely an indicative forecast based on various assumptions, qualitative data and expert views.

5G will further enable seamless IoT connectivity, driving further products and services. Globally, there will be 20.4 billion connected 'things' by 2021, compared with 8.4 billion in 2017 (Gartner, 2017). A study conducted by Telsyte (2015) forecasted that spending on IoT home products and services in Australia would grow from approximately $AUD 289 million in 2015 to around $AUD 3.2 billion in 2019. As 5G uptake becomes more widespread across industry, these numbers will grow further.

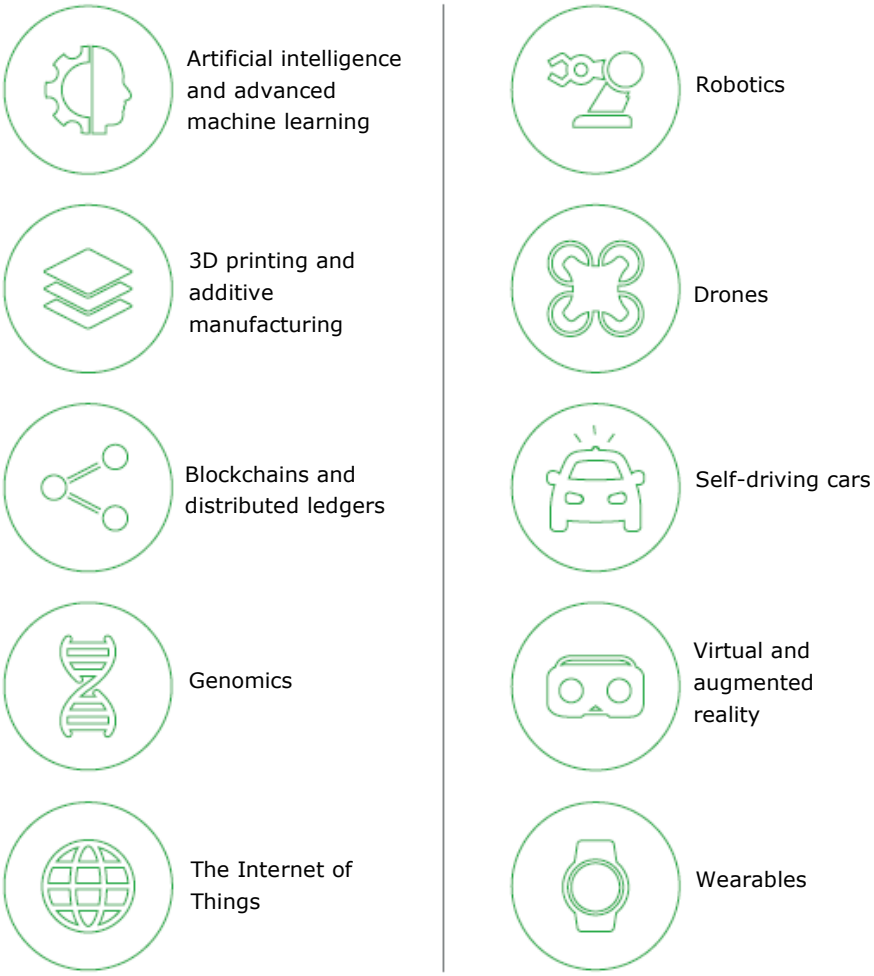
The benefits of increased digitisation in industries could be significant. Ericsson (2017c) identified $US 1.2 trillion of 5G enabled revenue, globally, accruing across a range of industries including manufacturing, public safety, financial services, healthcare, automotive, public transport, media and entertainment and energy and utilities.

3 Applications and expected impacts

5G is likely to create new demand for mobile services, rather than replacing existing usage. With an estimated 84% of Australians now owning or having access to a smartphone (Deloitte, 2016), 5G's innovations will mean that mobile is increasingly used not just by individuals, but by machines, billions of IoT connected devices and other household items.

The proliferation of **new exponential technologies** (Figure 3.1) **-** artificial intelligence, robotics, self-driving cars, wearables and virtual and augmented reality, are already disrupting Australian businesses. Their applications can be further enabled, in part, through the advancement of 5G networks.

Figure 3.1: Exponential technologies disrupting Australian businesses and workers



Source: Deloitte Access Economics (2017)

While industries are already enjoying the benefits of some of these new technologies or have begun testing them, 5G will further enhance their capabilities.

As 5G is yet to be deployed anywhere, we can only speculate about what the applications might be. In some cases 5G may enable a technology which already exists or is being piloted, or improve other use cases; in others it might pioneer completely new applications.

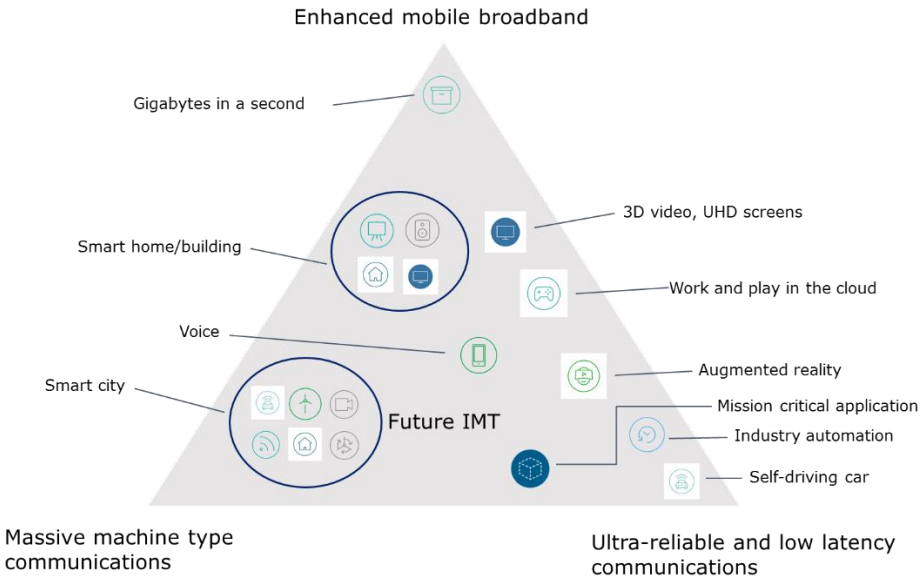
Below sets out just a few examples in terms of how 5G might enable new or more improved use cases.

For example, low latency will enable remote surgery and other sensitive applications requiring seamless connectivity, such as telemedicine, providing significant health benefits for people in remote areas, or people who are too ill to travel. Higher speeds will enable faster downloads which could have a transformative impact on education, especially with the uptake of Massive Online Open Courses in recent times. Additionally, improved Augmented Reality and Virtual Reality applications could significantly improve educational and training experiences, in addition to medical experiences. Other scenarios that require ultra-reliable and resilient network architectures, seamless connectivity, and ultra-low latency include, for example, critical control of industrial manufacturing or production processes and autonomous vehicles.

This section explores the following:

- benefits for smart cities and how 5G will further enhance the role of connected or smart devices;
- benefits for transport via the enablement of driverless cars and the role that 5G could play;
- benefits for healthcare via improved connection reliability for virtual reality and augmented reality applications; and
- benefits for logistics through the improved connectivity of IoT using 5G networks.

Figure 3.2: Potential usage scenarios for International Mobile Telecommunications



Source: Deloitte Access Economics; ITU-R (2015)

3.1 Smart cities

- Smart cities are reliant on IoT connected devices.
- The growth of connected devices requires an increased network capacity that can cope with the resulting connection density.

Governments around the world have been utilising big data and IoT applications to improve aspects of daily life, whether it be in the form of energy saving or crime prevention. Smart cities rely on the connectivity of these devices, and will further benefit from a network that can cope with the increased number of connections at any one time (network density). Telecommunications providers have started offering business solutions utilising IoT technology.

Currently, Optus is providing Wireless Security Monitoring management, enabling security alarms to be transmitted over a wireless network, rather than via a fixed telephone line (Optus, 2016a). The Optus Energy Assist solution utilises IoT through the use of smart wireless sensors to monitor energy usage in real-time, which can also be analysed securely from the internet (Optus, 2016b). The growth of smart cities around the world will continue to be based on these IoT devices and solutions.

Smart cities utilise data sensors that are able to respond in real-time to everyday issues, including congestion and energy supply (Bristol Is Open, 2017). One current example of a smart city is Singapore. Currently, its Smart Nation program collects data in the Virtual Singapore platform, using cameras and sensors throughout the city. This enables the government to prevent crime and understand traffic density in order to send out wide-scale emergency signals (CeBIT Australia, 2016). Its supertrees also provide rain collection and temperature moderation (Hatch, 2013). The reduced need for physical security presence, is likely to result in cost savings.

Figure 3.3: Example of a smart city - Singapore

Source: Hatch (2013)

The benefits of further enabling smart cities will come through cost savings and attraction of more people towards these cities, thus providing an incentive for government to invest more in smart cities.

3.2 Transport and connected vehicles

- The transport industry stands to benefit significantly from connected vehicles.
- Connected vehicles require greater reliability in connections between devices, in order to respond to information and commands in time to navigate safely.

Driverless vehicles and their capabilities will drive benefits for various industries. For example, the Transport industry is likely to benefit from not sending their workers on long deliveries. Driverless vehicles have already been tested in Australia.

Currently, General Motors has announced a partnership with Holden where it will integrate its OnStar vehicle telematics system with Holden cars (Crozier, 2017). In line with this, Telstra has run trials with Cohda Wireless using its 4G network in South Australia. It tested applications including alerting a driver to roadworks ahead, and informing the vehicle of the optimal speed to approach a traffic light, in order to see a green light by the time they arrive.

In Perth, RAC has trialled a driverless Intellibus, which uses ultraviolet light to measure distance and build a map of its surrounding environment (RAC, 2016). Cameras attached are able to detect traffic lights, vehicles and other objects, and it can automatically apply the brakes when it senses an impending collision.

Figure 3.4: RAC Intellibus

Source: RAC (2016)

In mining, driverless trucks have been used by Rio Tinto to move iron ore (Diss, 2015). The entire mine has been mapped and put into a system that is able to work out how to move the trucks through the mine. There have been estimates that each truck can save around 500 work hours per year, with no one required behind the wheel. As they can run 24 hours a day and 365 days a year, there are cost efficiencies to be gained by the industry. It also means more safety for workers who no longer have to undertake dangerous jobs.

Connected vehicles are already being enabled by current networks, and have shown their potential across the transport industry. In particular, driverless vehicles are already promising benefits in terms of cost and time savings. Improvements in networks can only enhance this value.

3.3 Virtual reality and augmented reality in healthcare

- Virtual Reality (VR) and Augmented Reality (AR) experiences are increasingly required to be seamless.
- A seamless connection to networks will mean better quality user experiences.
- The healthcare industry is currently utilising AR and VR applications, and can benefit from improvements in user experience.

VR and AR applications are currently used in healthcare, but there are other health applications that would benefit from a greater reliability in network connections. One application is telehealth.

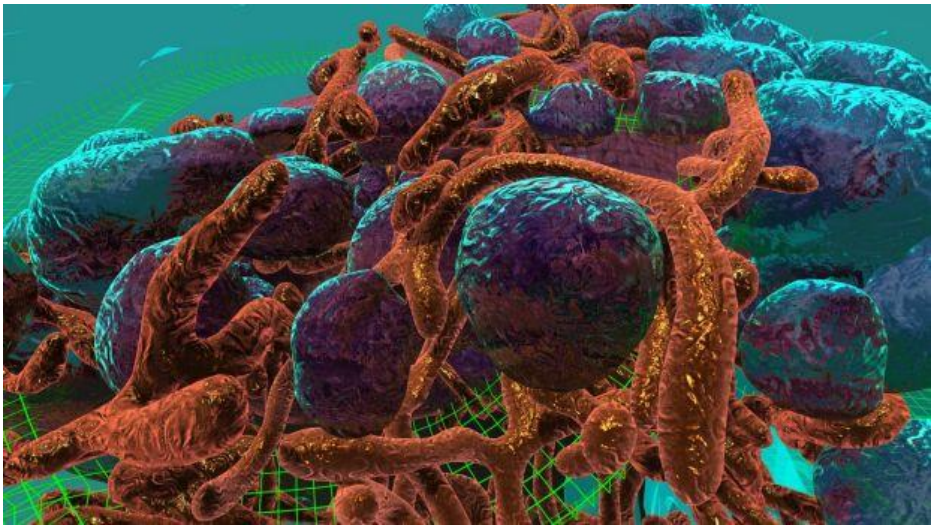
Australia has a geographically disparate population. In some cases, it can be difficult for people living in remote areas to gain access to health services. Mobile networks have enabled telehealth to help address this issue. For example, Telstra's 'Anywhere Healthcare' provides virtual clinics, so that people living in regional areas can talk to a specialist, using specialised equipment at their local GP (Telstra, 2017b). This significantly reduces week or month long waiting times to see specialists.

Telehealth in regional areas can often suffer from a lack of reliability in connections, where audio and picture can lag significantly, and in some cases experience connection dropouts. Hence, a more reliable connection is needed.

Improvements in connection reliablity, will act further to enable VR and AR experiences. While these technologies and use cases are becoming more prevalent, improvements in their operation are likely to have significant benefits for industries, such as healthcare, education and training. For example, firefighters can be trained to fight fires without being in real danger (360immersive, 2016).

VR is valued for its ability to simulate real-life situations. In Australia, the National Institute for Experimental Arts at the University of New South Wales has used VR to allow cancer researchers to see a scan of a breast cancer cell in a virtual world, where they can see how drugs can enter cells, to help design appropriate chemotherapy drugs.

Figure 3.5: Virtual breast cancer cell



Source: Strom (2016)

Another significant technological advancement in health has been telesurgery. The da Vinci Robot, allows surgeons to do their work remotely and at a distance away from the actual patient (UnityPoint Health, 2017). The surgeon sits at a special console and via 3D cameras inserted into patient, the surgeon is given a magnified 360 degree view of the area required to be operated. Using controls, they manipulate robotic arms with surgical instruments to perform the operation. In the future, greater connection reliability will enable telesurgery to be done at greater distances.

One current issue with VR and AR is the motion sickness associated with lags between the user moving their head and image reflecting that movement (Barras, 2014). Improvements in the reliability of the connection to reduce latency would lessen this effect.

3.4 Logistics and the Internet of Things

- IoT is currently being utilised by the logistics industry to keep a track of goods and secure them.
- IoT depends on the capacity of networks to handle the necessary signalling between devices.

IoT has brought more solutions to businesses and industries across the world. The Logistics industry is always looking for opportunities to reduce costs and improve efficiencies in transporting goods. It has already started relying on IoT for asset tracking.

Currently, Vodafone's Mobile Asset Tracking solution allows businesses to keep a track of critical mobile assets (Vodafone, 2016). Tracking assets enables businesses to prevent theft, gain insight into their operations to guide efficiency improvements, and monitor the usage and performance of assets for preventative maintenance. Vodafone has a global IoT network that allows businesses to keep track of their assets wherever they are in the world using a single, secure, web-based portal.

For service providers in the logistics industry, utilising IoT is a way of providing further value for customers across the value chain. Providers such as DHL also provide solutions that heavily rely upon mobile connectivity. For example, the SmartSensor by DHL is an intelligent sensor that can monitor temperature and humidity, while also indicating shock and light events that helps ensure goods are kept intact during transportation (DHL & Cisco, 2015).

This has also been combined with newer developments such as blockchain, where IBM has launched a platform for companies to track high-value items through complex supply chains (Nash, 2016).

These examples highlight the efficiency improvements for businesses, increased security and potential cost savings for them. The more businesses that utilise this technology, the more signalling capacity is needed to handle the increasing number of connected devices at any one time.

4 Accessing the benefits of 5G

Technology trials of 5G technology have already started in Australia, and international processes to define the technical specifications are well underway. Already, trials of 5G enabling and candidate technologies are in progress by 81 operators in 42 countries (GSA, 2017).

With continued growth in mobile data requirements, it's important to note that data access is an ecosystem, rather than a single network. The roll-out of 5G will mean more seamless connectivity with fewer discrepancies in performance. 5G networks will be tailored to use, working in conjunction with complementary networks, such as Wi-Fi enabled broadband, hotspots and previous generations of mobile networks.

5G will unlock new value for consumers, businesses and industry – from faster downloads to more responsive and interactive advanced services and applications, through to enabling new products and services, like a full commercial deployment of drones for logistics and IoT.

Governments around the world have prioritised the development of holistic strategies, underpinned by clear, predicatble and forward-looking regulatory frameworks, to support digital innovation and to facilitate 5G.

One example of this is in Europe, where a ministerial directive aimed at adopting 5G is already in play to help facilitate investment (Estonian Presidency of the Council of the European Union, 2017).

> *"We share a common vision … for 5G … to establish the necessary policy and regulatory framework conditions at regional, national, and European level that are clear, predictable, future-looking and facilitate investment within a competitive market.*
>
> *5G is a critical element in order to be able to leverage digitalisation and ensure that consumers and businesses can benefit across all industry sectors in Europe, which is at the same time essential for maintaining and enhancing Europe's competitiveness."*

Similarly, in March of 2017, the UK Government released a comprehensive 5G strategy to "outline the steps the UK needs to take in order to be at the forefront of the development and deployment of 5G" (Future Communications Challenge Group, 2017).

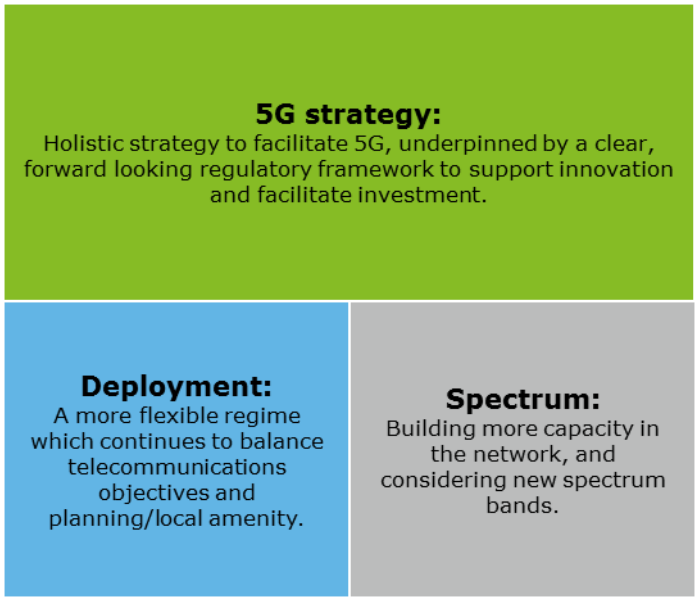
Holistic strategies of this nature enable the economic and social benefits of a fully and seamlessly connected society to be realised. Core principles of timely allocations of spectrum and a broader strategic dialogue amongst other things are important for all aspects of government planning and industry – ranging from health to transport.

Government will need to get the balance right between industry needs and community responses. The government has previously established this balance, but again will require further balancing with new technologies.

Two immediate priorities for 5G policy are network deployment and spectrum considerations, in the context of a broader strategic dialogue about how best to access the benefits of 5G.

A whole of government approach to 5G should target the removal of barriers to investment and enables an efficient commercial deployment of 5G in Australia. In a positive recent development the Australian Government has announced its intention regarding a strategic policy framework to support 5G in Australia. Importantly, the Government's approach will be a collaborative and ongoing dialogue with industry with immediate priorities identified as; making spectrum available in a timely manner, active engagement in the international standardisation process, streamlining mobile network deployment arrangements and reviewing existing regulatory arrangements to ensure they are fit-for-purpose.

Figure 4.1: Considerations for 5G policy



Source: Deloitte Access Economics

Barriers to efficient deployment and spectrum allocation are among the key aspects that need to be addressed by government.

4.1 Deployment

Deployment issues in mobile technology have always sought to find a balance between telecommunications objectives and planning or local amenity issues.

Existing legislation and processes govern this balance and set out rules for deployment, to ensure that it meets community requirements. For example:

- federal law, in particular the *Telecommunications (Low-impact Facilities) Determination 1997 (the Determination)*, sets out rules about where how, and under what circumstances 'low impact' (broadly, mobile infrastructure which is attached to other facilities) can be deployed;
- the Communications Alliance's *Industry Code: Mobile Phone Base Station Deployment* provides more detailed discussion of deployment processes; and
- various jurisdictional-based regulations set out rules regarding the deployment of free-standing mobile towers, and the requirements for requesting approval of these developments.

However, to access the benefits of 5G, more deployment will be required, and in some cases infrastructure will be in more dense configurations. In order to facilitate a timely roll-out to allow Australians to access the social and productivity benefits of 5G in a timely manner, we need to continue to refine the system, whilst keeping the balance between amenity and infrastructure in mind.

1. **A consistent framework**

   Currently, states have their own laws, rules and regulations governing the deployment of certain free-standing mobile infrastructure, which is not covered by the Determination. Complying with regulations that are inconsistent with each other, can impose an additional regulatory burden on carriers, create uncertainty and slow the pace of deployment.

   The government should consider making planning rules and requirements more consistent. This could be achieved through two mechanisms:
   - broadening the coverage of the Determination, so that more or all mobile infrastructure can be deployed under the existing federal regulations; or
   - introducing model regulation or similar, that is endorsed by states, so that there is a more consistent regulatory framework at a state level.

2. **More technology-agnostic regulation**.

   The existing federal regulatory framework sets out the rules which govern the deployment of a prescriptive list of specified infrastructure types and technologies, which have a minimal impact on amenity (i.e. 'low impact'). This technology-specific model of regulation cannot keep up with the rapid evolution of modern mobile networks, meaning the prescriptive list continually becomes outdated.

The government should consider updating the Determination to account for deployment of new technology solutions. This could be done by broadly defining what 'low impact' installations are in terms of their amenity impact, as opposed to their name/form.

3. The future of low-impact facilities in residential zones

Currently, there are stronger restrictions around building infrastructure, even where it is low-impact, in residentially zoned land. This is to minimise amenity concerns in residential areas.

However, given increasing demand for mobile services and capacity constraints, as well as the potential need for network densification, the government could re-consider whether the stronger regulation reflects community views and preferences.

Given increasing demand for mobile services, constraints in capacity and the potential for network densification, the stricter regulations around deploying low-impact facilities in residential zones could be reconsidered.

4.2 Spectrum

Radiocommunications spectrum underpins mobile networks. There are many competing demands for spectrum – from television and radio astronomy to mobile.

Successive generations of mobile networks have required increasing amounts of spectrum to meet the rising demand for mobile services. But spectrum is limited – a finite resource – with competing demands for usage. 5G will mean a broader range of frequencies will be used than previously, which will place further strain on this resource.

Given competing demands for spectrum, Australia currently has an auction system to allocate mobile spectrum. The stated goal of this system is to "allocate spectrum to the highest value use or uses" (ACMA, 2016c).

In practice, it is difficult to design the most effective system for allocating mobile spectrum. Amongst other things, the system should balance the need for investment certainty with the flexibility to react quickly to new developments in technology.

With technology testing of 5G already underway in Australia, reforms currently being considered should have a view to **improving flexibility** and reaction times. Identifying and allocating priority bands as early as possible will allow Australia to access the full benefits of 5G more quickly.

It is likely that international standards will specify new spectrum bands to be used globally for 5G (ITU-R, 2015). Globally, regulators are already identifying new spectrum for 5G. For example:

- the UK communications regulator, Ofcom, is working with other European spectrum regulators to identify spectrum bands for enabling 5G in Europe;
- the Federal Communications Commission in the United States has similarly been exploring spectrum options; and

- recently, the ACMA proposed to repurpose the 3.6GHz radio frequency spectrum range for use with 5G wireless data services, as a result of strong interest from industry (IT News, 2017), and has announced that it is accelerating planning processes for mmWave spectrum for 5G (ACMA, 2017).

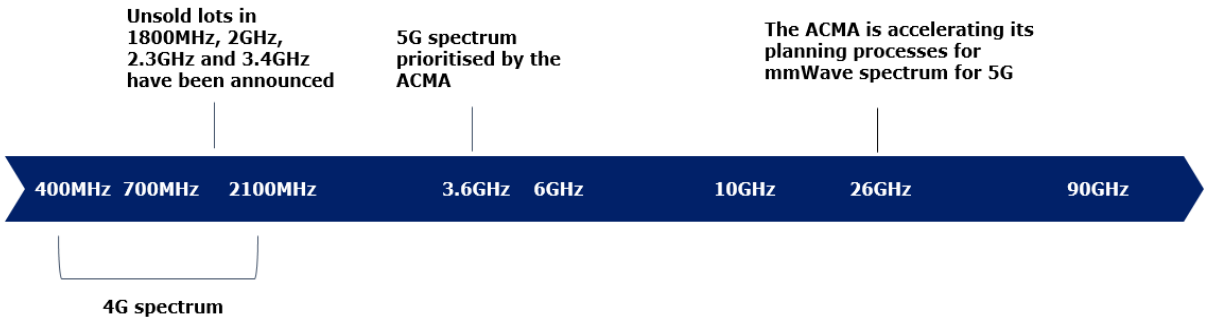
As the manager of spectrum in Australia, the ACMA is already considering spectrum arrangements to facilitate 5G roll-out, which will remain important when international standards are agreed.

Earlier this year, the Government released an Exposure Draft of the Radiocommunications Bill which aims to redraft the *Radiocommunications Act 1992* to facilitate more timely allocations of spectrum and greater flexibility in the use of spectrum. Generally, the proposed *Radiocommunications Bill 2017*, seeks to improve general inefficiencies in the telecommunications marketplace, while providing faster adaptation and addressing the fact that the 1992 legislation was a creature of its time. The Bill has already gone through its first round of consultations, with a second round expected to commence at the end of 2017.

Amongst other things, the Bill introduces a single licensing framework designed to improve flexibility, combining spectrum, apparatus and class licenses. The single licensing framework aims to provide licensees with better clarity regarding the use and terms of the licence, ultimately enabling licences to adapt to technological change (Department of Communications and the Arts, 2017a).

This reform has been widely supported (AMTA & Communications Alliance, 2016b). It reduces the need for the Minister to be actively involved on a day to day basis (Department of Communications and the Arts, 2017a). A revised Bill will be a part of the second consultation stage, which is also anticipated to include the *Transitional and Consequential Amendments Bill* and the *Radiocommunications Licence Tax Bill* (Department of Communication and the Arts, 2017b).

Figure 4.2: Mobile spectrum in Australia



Source: Deloitte Access Economics (2017)

There are also more specific issues around accessing spectrum for testing purposes. With 5G trials underway, it is still not clear exactly what spectrum will be required, and what infrastructure and technologies will be best placed to support this. However, there is growing agreement between industry and policymakers that advancing the spectrum planning agenda is important for 5G deployment.

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