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WHITEPAPER

5G TO DELIVER RESULTS IN ASIA-PACIFIC NEEDS ALL STAKEHOLDERS TO COLLABORATE

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Foreword

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Modern society increasingly depends upon our ability to connect seamlessly to others. New advances by one person or group are available to others even though we do not know each other personally nor anticipate the new advance. These new advances depend upon our ability to deliver video content and interaction anywhere in the world. In turn, the supporting communications infrastructure requires greater agility and scale than present 4G networks provide. New advances in cloud computing make it possible for all businesses to undertake a digital transformation, enabling them to support vast numbers of new users with greater personal control than ever.

5G networks will underpin digital transformation in South Asia-Pacific. They will enable faster data transmission, but they will also provide a flexible and resilient way of delivering communications and will extend cloud computing closer to where users operate. To achieve the benefits of digital transformation however, industry stakeholders – operators, vendors, policymakers, will all need to closely work together to create the right conditions for the development of a strong supply ecosystem and encourage widespread adoption of solutions enabled by 5G.

With sponsorship from Huawei, Analysys Mason has developed the following white paper to highlight the benefits of 5G and the key steps that the industry ecosystem must take to achieve these benefits. It includes recommendations to operators and policymakers to address these challenges. The paper is editorially independent, and views expressed and analysis included are those of Analysys Mason's key 5G experts.

Lim Chee Siong
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5G technology is potentially expected to extend and accelerate the benefits of ICT to people, enterprises and industries alike, yet there are more questions today, than answers to what lies ahead. Future ICT infrastructure development needs to essentially target solving realistic problems, thus enabling network build-up outside-in. Right timing is of extreme essence where each nation, society, economy and industry need to identify specific respective areas where embracing digital and intelligence can make a sustainable difference. Understanding the realistic demands need to be the starting point for governments, regulators, service providers, innovators and equipment manufactures to integrate their focus and efforts to ensure necessary readiness in time. Innovation in technology and how it is put to use is going to lead the way, thus collaboration across industry and larger ecosystem is fundamental to identify, build, deliver and sustain the expected 5G benefits in South Asia–Pacific region.

With this objective, Huawei is pleased to be a part of this research that approaches 5G with demand vs supply aspects. Key insights from the South Asia–Pacific region, substantiated with global leaders' references, consulting experts and industry thought leadership inputs will certainly enable guidance in the right direction. Collective output would be definite leverage for informed decisions towards sustainable goals, robust infrastructure, holistic business models and above all better digital services to the end user. We humbly invite you to explore with us "5G to deliver results in Asia–Pacific needs all stakeholders to collaborate" a paper developed by Analysys Mason for 5G in South Asia–Pacific region.

1. Executive summary

Digitalisation is transforming economies, enterprises and societies in the Asia–Pacific region. Enterprises in the region have been leading the adoption (and sometimes the development) of next-generation technologies (such as artificial intelligence, IoT, big data, cloud), enabling new business opportunities, increased efficiency and solving unique regional challenges.

The international vision for the development of 5G is that it will lie at the heart of the future digital economy and society. The deployment of ultra-fast, highly reliable, scalable and very low-latency networks will facilitate and accelerate the digital transformation of enterprises and support the broader digitalisation of economies and society by enhancing existing services.

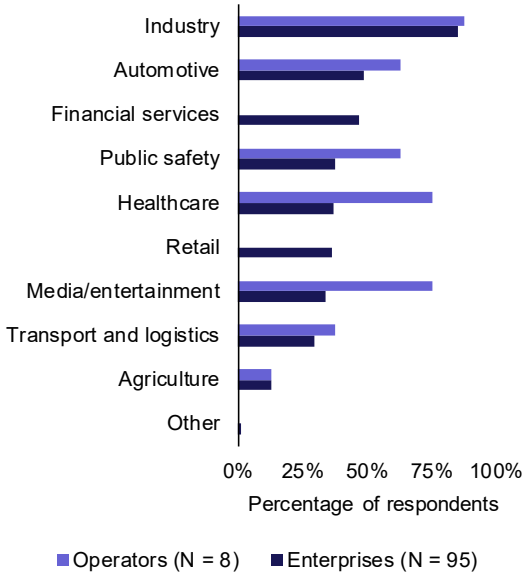
5G generates interest from operators, enterprises and consumers in Asia–Pacific. Operators are keen to use 5G to enable adjacent or new revenue opportunities, while enterprises from a variety of sectors (such as industry, automotive, financial services, public sector) see 5G-enabled solutions as an opportunity to accelerate their digital transformation efforts. Consumers are relatively unaware of 5G, but some individuals are aware of 5G for some of the early use cases (such as enhanced mobile broadband, fixed–wireless access, connected cars, augmented/virtual reality). Solving unique challenges would result in realistic demand generation for 5G and the supply side development will largely depend on the acceleration and depth the telecoms operators aim to cover, scale up and sustain.

Like any transformation process, less than 2 years before the first commercial deployments of 5G services, a range of business barriers have yet to be removed by telecoms operators to drive 5G adoption in the region.

- **Operators' vertical priorities are misaligned with actual demand today, which could limit operators' business success.** An operator survey conducted by Analysys Mason in Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines[1] and an enterprise survey conducted by the MIT Technology Review Insights across 191 senior executives in organisations operating in these countries suggest that some of the vertical sectors identified by operators as the most interesting to them (such as healthcare, media & entertainment, public safety) generate limited interest from enterprises, and vice versa (for example, the financial services and retail sectors are generally perceived by enterprises as being key beneficiaries of 5G capabilities, while no operator has considered any as part of their target sectors for 5G services launch) (see Figure 1.1 and Figure 1.2 below). Operators could miss out on early revenue streams if they fail to identify which sectors are likely to generate demand for 5G services.

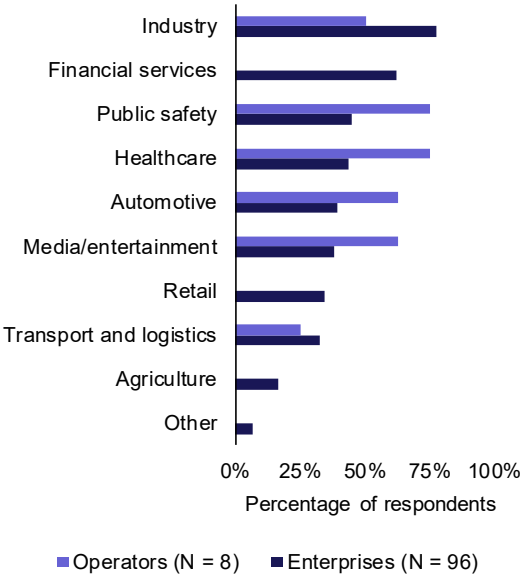
[1] The findings presented in this report, unless stated otherwise, cover the following six countries: Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines.

Figure 1.1: Share of enterprises in developed countries placing each sector among top 5 benefiting the most from 5G and share of operators placing each sector among top 4 priorities for 5G commercial deployment



Source: Analysys Mason

Figure 1.2: Share of enterprises in emerging countries placing each sector among top 5 benefiting the most from 5G and share of operators placing each sector among top 4 priorities for 5G commercial deployment



Source: Analysys Mason

- **Operators do not align their 5G roll-out plans with business needs, which could put the digital transformation plans of enterprises at risk.** Our surveys suggest that 65% of enterprises in Asia–Pacific expect 5G to be available in 2020, while only 10% of operators expect a full launch by the end of that year. This could lead to some industries being left disappointed in 5G or moving to competing technologies.

- **Large-scale commercial trials have yet to be conducted, which is limiting the development of a strong ecosystem of suppliers.** Most operators in the six countries reviewed in this paper have conducted 5G technology demonstrations, but none appears to have a rolled out commercial trials (currently limited to technology capability testing). Equally concerning is the lack of trials aimed at testing the real-life benefits (and therefore business potential) of specific 5G use cases for verticals other than automotive and healthcare, preventing the development of a strong supply ecosystem to offer these services.

- **Device availability and affordability does not appear to be a key concern**. Major device makers (e.g. Samsung, Huawei) and chip suppliers (e.g. Qualcomm) have announced first 5G customer premises equipments and have firm roadmaps to release 5G smartphones by the end of 2019. While the timescale and cost for non-smartphone devices (e.g. industrial modules, in-car systems, VR headsets) remains unclear at the moment, the use cases supported are likely to be introduced only later by most operators (i.e. after 2021), by when the supply ecosystem is likely to be more matured.

In addition, local policymakers have yet to provide a strong and favourable environment for 5G.

- **Visibility over spectrum release remains poor in most markets, which may delay 5G availability.** Australia has recently (November 2018) allocated some 5G spectrum in the 3.6GHz band, but national regulatory authorities in the other countries in our study have not released details about the timings of 5G spectrum auctions or the rules that will apply to the spectrum, or the likely cost.

- **Limited regulatory guidelines have been issued to facilitate indoor small-cell deployments, which could prevent operators from supporting key industry use cases.** Extensive indoor coverage will be required for a range of enterprise use cases (for example, retail, industrial). As a result, small cells will be necessary to offer coverage and additional capacity within buildings. However, regulations regarding installation of wireless equipment inside commercial buildings remain fragmented or unclear. In this report, we focus on indoor small cells, but outdoor, pole-mounted small cells will also be important to 5G and will require new regulations too. Only two of the countries reviewed in this paper (Australia and Singapore) have issued initial guidelines to streamline 5G infrastructure deployment, indoors and outdoors.

- **Government policies for cross-industry collaboration around 5G remain scarce.** Governments can lift barriers to cross-industry collaboration on 5G tests and use cases – for example, by setting up and co-ordinating taskforces or innovation centres to drive co-operation between different stakeholders. Apart from Australia – which has an active programme of working with industry stakeholders to accelerate 5G – governments in other countries that we reviewed have yet to develop detailed policies for cross-industry collaboration or to encourage vertical market use cases.

- **Limited emphasis on the importance of 5G in vertical policies could slow down enterprise adoption.** Except in Australia, reference to specific 5G use cases in roadmaps for non-telecoms verticals is scarce or non-existent in multi-annual vertical policy strategies. This may result in a range of industries not understanding the potential benefits of 5G or making plans around alternative technologies. An implication could be that operators miss valuable business opportunities, while enterprises may settle for sub-optimal connectivity solutions for their needs.

To address these issues, we have identified a number of key remedies for operators and policymakers.

Figure 1.3: Key recommendations for operators

Recommendation	Details
Set out clear commercial and deployment priorities by vertical sector and use case	• Conduct large-scale enterprise surveys to prioritise vertical sectors and use cases. • Use vertical and use-case prioritisation to plan the timescales and geographical coverage of 5G roll-out and the launch of commercial services. • Some use cases will be impossible to predict at launch – maintain the engagement with enterprises to make sure that you quickly notice new requirements that may emerge in the future.
Accelerate commercial trials of specific 5G use cases with industry partners to determine use case benefits and foster adoption	• Set up test beds and conduct trials with enterprises across high-demand vertical sectors to evaluate/validate the real-world benefits of key 5G use cases. • Seek active participation in cross-industry initiatives to start building an ecosystem of partners to co-operate around innovative 5G use cases and trial solutions.
Ensure good communication with enterprise sectors to align network deployment efforts with enterprise objectives and manage expectations	• Engage with vertical sectors that have limited interest in 5G to increase awareness and communicate the benefits of 5G use cases. • Communicate 5G geographical coverage timescales clearly so enterprises can plan/adjust their digital transformation efforts accordingly. • Work with companies located outside of initial areas of 5G roll-out to evaluate whether their requirements could be met with 4G or to assess options to co-invest in network deployment to accelerate availability.

Recommendation	Details
Engage with an ecosystem of manufacturers to ensure device availability and affordability	• Work with multiple partners to ensure the availability of a range of devices at different price points. • Explore ways to make handsets more affordable (e.g. financing schemes), especially in emerging markets, to accelerate customer migration to 5G.
Evaluate network co-investment options to reduce the cost of 5G indoor deployments and plan for high-quality indoor coverage	• Options to consider could include infrastructure sharing with other operators, integration with neutral-host wholesalers, co-investment with enterprises from relevant sectors (e.g. manufacturing, retail). • Actively lobby national regulatory authorities to publish policies to encourage infrastructure sharing and facilitate indoor small-cell deployments.

Figure 1.4: Key recommendations for policymakers

Recommendation	Details
Consider earmarking spectrum in the 3.5GHz and mmWave spectrum bands in priority	• Focus on 5G bands with a high chance of being adopted as global allocations at WRC-19 (3.4-3.8GHz, 24.25-29.5GHz) • If spectrum fragmentation or difficulties in obtaining satellite clearance for 5G C-band or mmWave spectrum, conduct spectrum feasibility study on using under-utilised 2.3GHz and 2.6GHz bands for coverage
Produce a formal national 5G roadmap document setting out a clear national 5G vision and outlining the path to introduction	• Publish a document outlining the country's ambitions for 5G and a description of the role played by the government to support the successful introduction of 5G. • Key areas for government intervention and typically discussed in 5G roadmaps include: expected schedule for spectrum release, initial thinking about the evolution of regulatory frameworks, programmes for 5G testbeds and trials, conditions for network deployments, development of technology and standards.
Issue national-level planning guidelines to facilitate indoor small-cell deployments	• Produce guidelines to facilitate the acquisition of new sites to accelerate indoor small-cell deployments (e.g. greater transparency on available assets, streamlined processes to avoid lengthy deployment delays, pro-infrastructure siting and sharing policies to ensure the wider deployment of small cells). • Encourage co-investment and integration between national fibre wholesalers and operators to ensure that 5G/fibre reaches the rural population in a cost-effective manner.
Develop policies and allocate funding to facilitate cross-industry tests and trials between operators, enterprises and suppliers	• Facilitate collaborative tests and trials between operators, enterprises and suppliers (e.g. vendors, chipset providers), for example via subsidies, funding, test beds, workshops, to create an ecosystem of local suppliers across the value chain and encourage the development of innovative 5G-enabled solutions. • Allocate direct funds to accelerate research and 5G projects, for example for technology development, vertical use-case trials, test beds (e.g. V2X, smart manufacturing), that are expected to help to stimulate demand for services and promote industry collaboration (e.g. some countries have already committed significant funding towards these types of 5G).
Give a more prominent role to 5G as a key enabler of digital transformation in vertical	• Develop national strategies with clear objectives and roadmaps in relation to the development of key vertical sectors of the economy.

Recommendation	Details
sectors (e.g. smart cities, healthcare, utilities)	• Provide a clear description of the role played by the ICT industry in achieving these objectives and the extent to which technology-enabled initiatives are already implemented today, and place 5G at the heart of future industry policies.

2. Introduction

Digitalisation is transforming economies, enterprises and societies in Asia–Pacific. Enterprises in the region have been leading the adoption (and sometimes the development) of next-generation technologies (such as artificial intelligence, IoT, big data, cloud), enabling new business opportunities, increased efficiency and solving unique regional challenges. In Singapore and Malaysia for example, digitalisation and automation are re-shaping the biomanufacturing and electronics industries, while in Indonesia and the Philippines, the fusion of digital and physical technologies is having an effect on the app economy, in segments like on-demand services. Consumers are able to access and consume a large range of 'digital economy' services, offering increased choice of information and entertainment, and generating significant time savings for consumers.

The international vision for the development of 5G is that it will lie at the heart of the future digital economy and society. The deployment of ultra-fast, highly reliable, scalable and very low-latency networks is to further facilitate and accelerate the digital transformation of enterprises and support the broader digitalisation of economies and society by enhancing existing services (such as mobile broadband, fixed–wireless access) and enabling a range of new services (such as augmented/virtual reality, analytics supported by artificial intelligence). The potential socioeconomic benefits of 5G are substantial. A study conducted by the GSMA in 2018 estimated that 5G services would generate a cumulative contribution of USD2.2 trillion to world GDP over 2024-2034.[2] In particular, the Asia-Pacific region is expected to account for over 675 million 5G connections by 2025, more than half of worldwide 5G connections by then[3].

Operators and enterprises in Asia–Pacific are interested in 5G. Some operators have started conducting advanced testing of 5G connectivity, and a few are making plans to launch commercial services as soon as 2019. Enterprises expect that 5G-enabled solutions will be an opportunity to accelerate their digital transformation efforts and generate additional business benefits.

However, less than 2 years before the first commercial deployments of 5G services, a range of business and regulatory barriers remain to be addressed by the industry ecosystem to create the right conditions for 5G to deliver on this vision. This white paper aims to provide fresh insights into some of the barriers to 5G adoption and offers a set of remedies to operators and governments to remove these. The findings presented in this report, unless stated otherwise, cover the following six countries: Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines.

This white paper is based on the results of an operator survey conducted by Analysys Mason across 39 operators in Asia–Pacific and interviews with 16 senior executives in Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines. It also refers to MIT Technology Review Insights report "From follower to

2 https://www.gsma.com/spectrum/wp-content/uploads/2018/12/5G-mmWave-benefits.pdf

3 https://www.gsma.com/newsroom/press-release/gsma-asia-set-to-become-worlds-largest-5g-region-by-2025/

leader: Digital Transformation and the road to 5G in southern Asia-Pacific which included enterprise survey of senior executives in organisations operating in these six countries. Additional information on 5G regulatory and government activities has been collected through extensive desk research.

3. 5G is critical for operators, enterprises and consumers in Asia–Pacific

3.1 Operators are keen to use 5G to enable adjacent or new revenue opportunities

Operator revenue growth from mobile connectivity services has been stagnating over the past few years in the Asia–Pacific region, prompting some operators to assess new services for growth opportunities, for example by offering a more advanced set of ICT services to enterprises (for example, cloud, co-location and hosting, security, IoT). In terms of IoT, expanding service offerings beyond connectivity in other parts of the value chain can provide new revenue opportunities, but this opens up new competition and carries risk and only a few, large operators have been willing to experiment in this direction so far. On the cost side, the demand for high-bandwidth services (such as video streaming in high-definition) has driven operators to upgrade capacity across their networks with limited or no additional revenue gain.

Operators regard 5G as an opportunity to address some of these issues and to establish renewed revenue growth. In a survey of operators conducted by Analysys Mason in 2018 in Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines, a significant proportion of operator respondents emphasised the role that they expect 5G to play to support their efforts in the enterprise segment, with 63% of operators in developed economies[4] (Australia, New Zealand, Singapore) expecting 5G to enhance their role in the enterprise value chain, and 63% of operators in emerging markets[5] (Indonesia, Malaysia, the Philippines) expect 5G to drive an increase in their revenue from new enterprise use cases (see Figure 3.1). The consumer segment appears of lower priority among operators in developed economies, most likely as a result of the market saturation and competition.

The need of operators to reduce the cost of delivering connectivity services appears far more urgent in emerging markets (selected by 63% of operators) – where operators experience massive demand for high speeds but low ARPU levels – than in developed countries (no operator selected this response), where operators are more concerned about the total cost of ownership (38% of operators).

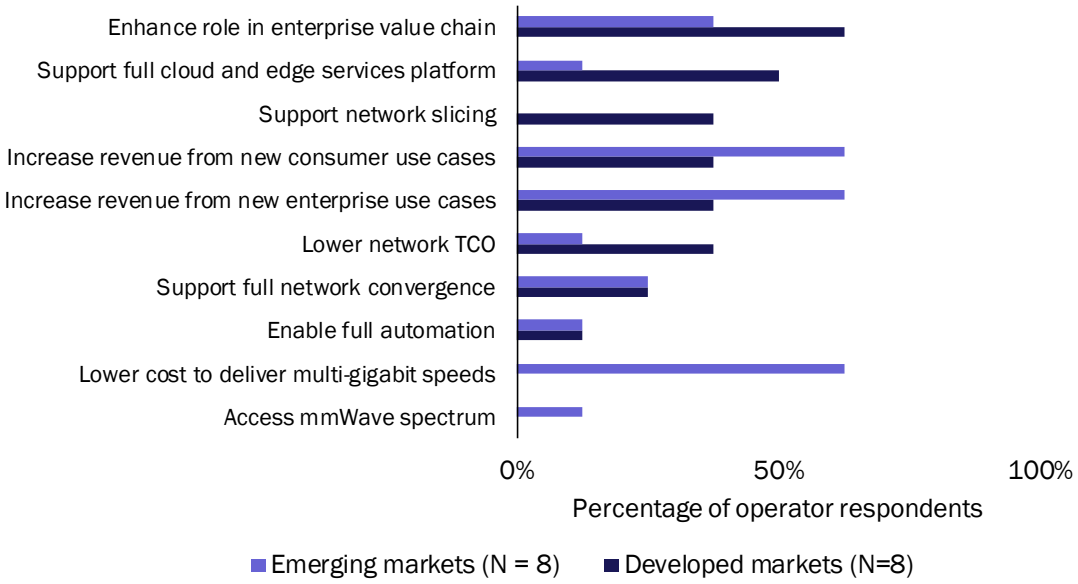
5G can also help operators to increase connectivity revenue. For example, 5G will enable operators to offer higher service-level agreements to certain vertical sectors with stringent availability or latency requirements (for example, emergency services, vehicle-to-vehicle communications), for which operators will be able to charge a premium. Fixed–wireless services will also benefit from higher speeds, providing upselling opportunities for operators. In addition, some applications will only be able to work (or will see a significant improvement of performance) with 5G, typically because they require very low latency or high reliability. Examples include

4 In the rest of the paper, the use of ‘developed economies’, ‘developed markets’ or ‘developed countries’ refers to Australia, Singapore, and New Zealand

5 In the rest of the paper, the use of ‘emerging economies’, ‘emerging markets’ or ‘emerging countries’ refers to Malaysia, Indonesia, and the Philippines

applications that use augmented/virtual reality technologies (for example, gaming) or cellular-based remote control of drones, offering operators an opportunity to generate additional connectivity revenue.

Figure 3.1: Share of operators placing each factor among top-three drivers for the long-term deployment of 5G by type of region



Source: Analysys Mason

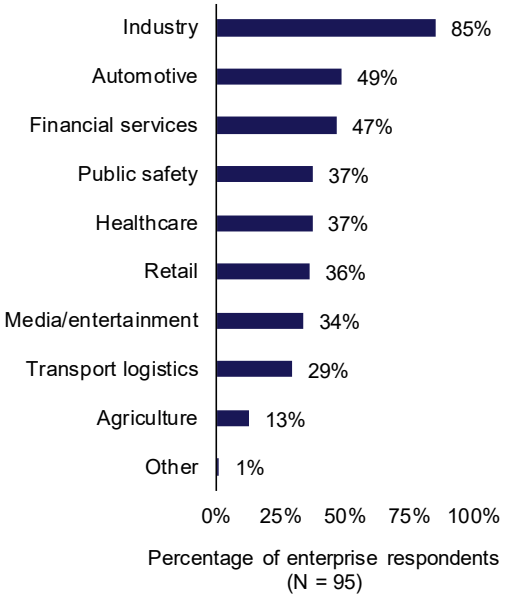
3.2 5G-enabled solutions are an opportunity for enterprises to accelerate their digital transformation efforts across a variety of vertical sectors

Enterprises in Asia–Pacific have made significant progress in adopting next-generation technologies, driven by business imperatives to improve customer experience, decision-making and operational efficiency. According to a survey conducted by the MIT across 191 enterprises in Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines, cloud and IoT services have seen the strongest adoption, being respectively deployed for more than a year by 29% and 34% enterprise respondents. Artificial intelligence, automation and big data services are expected to account for most new deployments in the coming 12 months, while blockchain and virtual/augmented reality are expected to become more widespread in the longer term (to be deployed within the next 2 years by respectively 48% and 41% respondents). Improved customer experience, decision-making and operational efficiency are the commonly cited drivers for the deployment of next-generation technologies.

5G is expected to improve the benefits generated by the adoption of these technologies. On one side, it will improve the performance of existing applications, for example solutions leveraging IoT and cloud technologies: in the public sector for example, the high availability and device density capabilities will enhance the delivery of broadcasting video of city-wide surveillance cameras over wireless networks and enable the use of advanced technologies such as facial recognition. On the other side, combined with the use of nascent technologies such as artificial intelligence, robotics or virtual/augmented reality, it will enable a variety of new solutions across different sectors (e.g. remote control of industrial robots in the manufacturing industry, video conferencing between patients and doctors leveraging virtual reality technologies to improve patient–doctor interactivity in the healthcare sector).

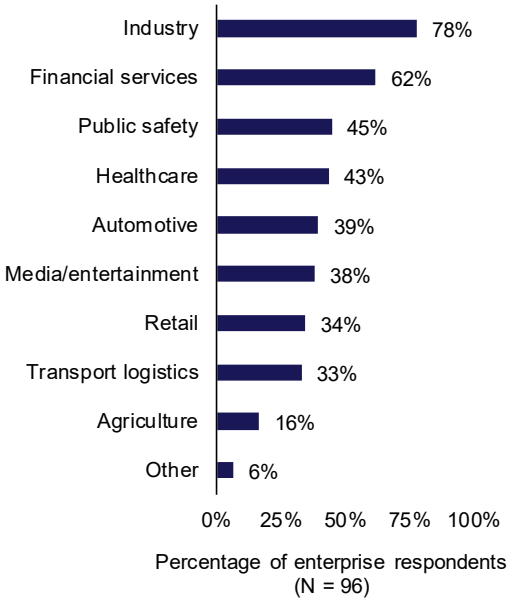
The enterprise survey suggests that the industry, automotive, financial services and public sectors are expected to benefit the most from 5G and are therefore likely to be some of the earliest adopters of 5G-enabled solutions. The distribution of responses by vertical sector is broadly similar across enterprises based in developed or in emerging countries, although the automotive industry is perceived to benefit more significantly from 5G in developed economies – probably as a result of the greater awareness and availability of connected vehicles in advanced economies – while public safety applications are expected to generate more interest in emerging countries.

Figure 3.2: Share of enterprises in developed markets placing each sector among top 5 benefiting the most from 5G



Source: Analysys Mason

Figure 3.3: Share of enterprises in emerging markets each sector among top 5 benefiting the most from 5G



Source: Analysys Mason

3.3 Consumers are aware of 5G for some early use cases

The digitalisation of the economy has already transformed the way individuals access and consume a large range of 'digital economy' services, offering increased access to choice (for example, e-commerce), information (for example, travel fare aggregators), entertainment (for example, online gaming, video streaming) and generating significant time savings (for example, e-government platforms, smart parking apps).

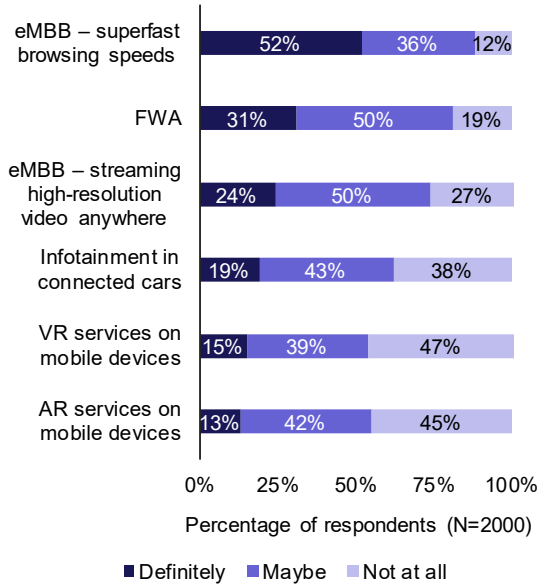
5G will improve consumers' experience of digital services (for example, reduced buffer and improved resolution for mobile video streaming services, higher dates rates for fixed–wireless services in areas underserved by fixed-line infrastructure), and its unique capabilities will also enable consumers to access a range of new services. Emerging applications with very low latency and very high-speed requirements such as mobile cloud gaming, mobile gaming based on augmented reality, video on demand or live streaming services using virtual reality technology to offer a more immersive experience, are expected to be more widely adopted with 5G.

Analysys Mason's Connected Consumer Survey conducted in 2018 across consumers in Australia, New Zealand, Malaysia, Indonesia, and the Philippines suggests that consumers are interested in such services. Most

respondents were interested in eMBB and FWA use cases, with a greater proportion in Malaysia, Indonesia, and the Philippines than in Australia and New Zealand (probably because good-quality fixed broadband services are less prevalent in emerging markets): on average, 75% respondents in developing markets stated that they would "definitely" be interested in superfast browsing speeds, compared with 52% in developed countries; similarly, 61% of respondents in developing countries would be "definitely" interested in FWA services, compared with only 31% in developed economies. More advanced use cases such as connected cars and services leveraging augmented and virtual reality are likely to be perceived as more aspirational in emerging markets and therefore generate more interest in Malaysia, Indonesia, and the Philippines than in Australia or New Zealand.

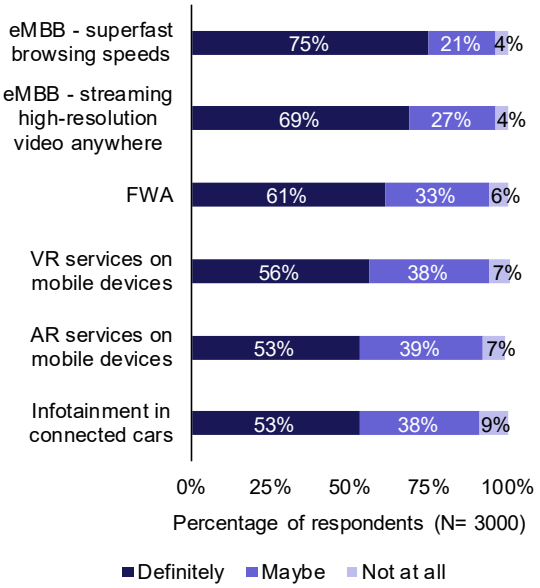
The picture seems to be positive, but caution needs to be exercised because these results consider only the share of respondents with basic awareness of 5G, which is still relatively low (on average 20% over the five countries surveyed). In addition, the survey does not capture consumers' willingness to pay for such services. For example, while a large proportion of respondents in emerging countries are "definitely" interested in the high speeds delivered by 5G for browsing (75%) or HD video streaming (69%), only a small share of these respondents is likely to be prepared to pay a premium on top of an existing mobile data plan to have access to such speeds (in particular in emerging markets where consumers' disposable income is lower than in developed economies).

Figure 3.4: Share of consumers in developed countries with interest in 5G-enabled mobile services



Source: Analysys Mason

Figure 3.5: Share of consumers in emerging countries with interest in 5G-enabled mobile services



Source: Analysys Mason

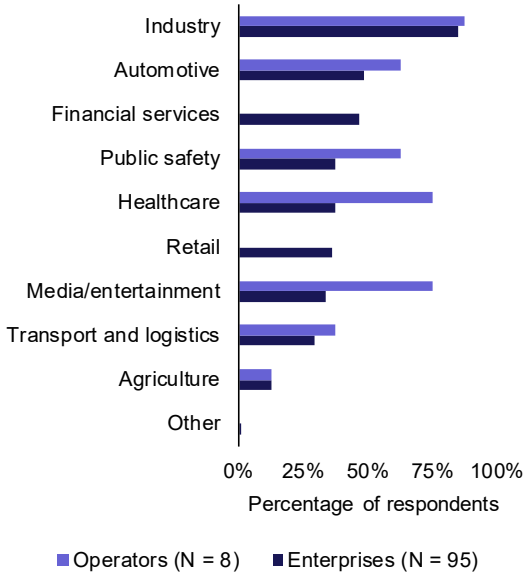
4. Some significant business barriers need to be removed to drive 5G adoption in the region

We have established that operators, industries and consumers in Asia–Pacific are interested in 5G services. However, for this interest to translate into short-term 5G success and sustained development in the future, the objectives of all sectors need to be aligned, and a clear roadmap set out to deliver them.

4.1 Misalignment between operator vertical priorities and actual demand could limit operators' business success

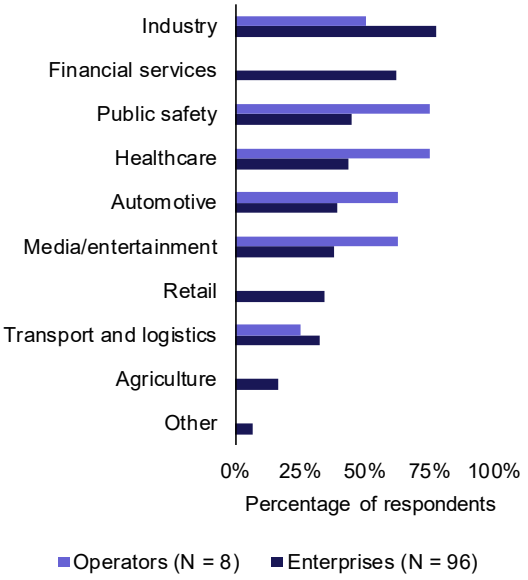
A key success factor for operators is the ability to concentrate their development, deployment, ecosystem and marketing resources on industries where demand is relatively high, at least in the early years. Failure to identify which sectors are likely to generate demand for 5G services may result in operators missing out on early revenue streams, and in some industries being left disappointed in 5G. This is highlighted by the contrast between results of the demand-side and supply-side surveys, as shown in Figure 4.1 and Figure 4.2.

Figure 4.1: Share of enterprises in developed countries placing each sector among top 5 benefitting the most from 5G and share of operators placing each sector among top 4 priorities for 5G commercial deployment



Source: Analysys Mason

Figure 4.2: Share of enterprises in emerging countries placing each sector among top 5 benefitting the most from 5G and share of operators placing each sector among top 4 priorities for 5G commercial deployment



Source: Analysys Mason

Some sectors attract less interest from operators than enterprises (e.g. financial services, retail). A non-negligible 35% of enterprises in have placed the retail sector among the top 5 sectors likely to benefit from 5G. The financial sector attracts even more interest, with 47% and 62% of enterprises in developed and emerging countries believing it would benefit greatly from 5G. By contrast, no operators in emerging or developed markets placed either of these two sectors in their top-four industries to prioritise for 5G services, probably as a result of the perceived lack of relevant use cases and limited knowledge of the structure of partnerships and profit models to address these sectors.

Other sectors attract more interest from operators than enterprises (e.g. healthcare, media and entertainment, public safety). For instance, 75% of operators in developed markets placed media and entertainment in their top-four sectors to target with 5G, but only 34% of enterprises selected this industry as one that might benefit most from the new networks and services. Both sectors are well known to operators, driving operator incentive to place them among their top priorities.

On a more positive note, some sectors attract a similar level of interest from both operators and enterprises, such as transport and logistics, and automotive, because operators are familiar with both verticals and it is widely expected that these sectors will generate early demand for a number of 5G use cases that have been already identified (e.g. vehicle-to-to-vehicle communications, in-car entertainment, location-based services). As a result, these are likely to be the low-hanging fruit for early 5G services in the region.

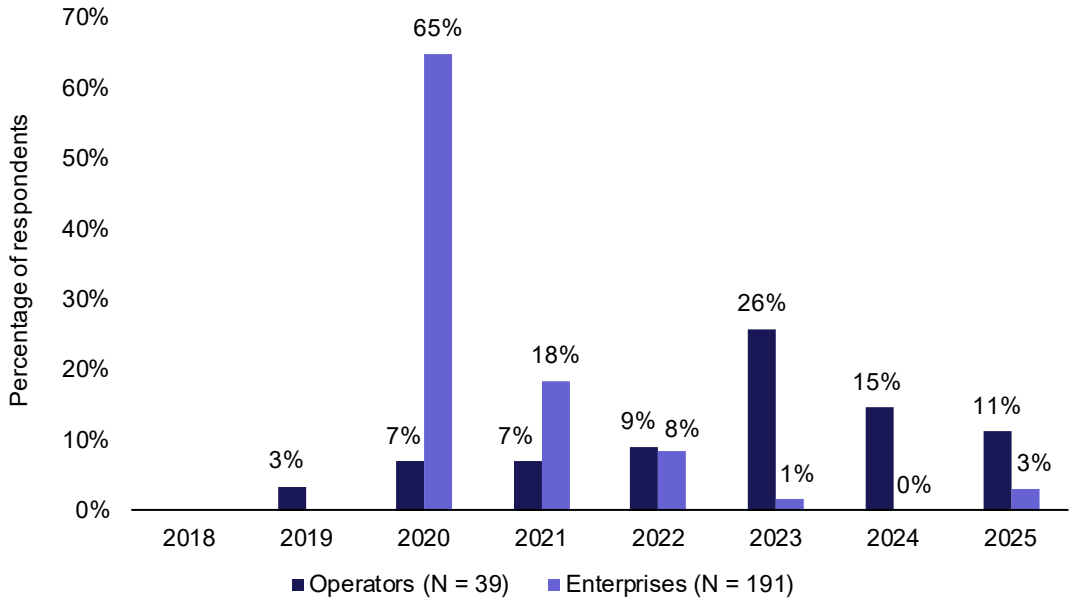
4.2 Delayed operator 5G deployment could put enterprise digital transformation plans at risk

Another success factor for operators is the ability to connect enterprises to their new networks at the right time for their business plans and digital transformation agenda. While a high-capacity network with broad coverage

will suit an operator that is primarily focused on enhanced mobile broadband (e.g. for consumers, connected vehicles), some of the sectors with the most interest in 5G will require a deployment that prioritises industrial or urban areas, strong in-building penetration, or high availability/low latency.

Each operator will decide on a 5G roll-out timescale and geographical pattern depending on the use cases and sectors that it prioritises. A consequence of poor vertical prioritisation by operators (as described in sub-section 4.1) is the risk that they will not align their roll-out plans to the needs of leading industries, and that they are not managing expectations about timescales for full coverage. This is highlighted in Figure 4.3, with 65% of enterprises expected 5G to be available to them in 2020, but only 10% of operators anticipate a full launch by the end of that year. In fact, the timescales for launch in the Asia–Pacific region (excluding the Indian sub-continent and Central Asia) are far more conservative than the enterprises expect. After 2020, 16% of operators expect to launch mainstream 5G services in 2021 or 2022, while over half (52%) plan to launch in 2023-2025, and 22% later than 2025. By contrast, 91% of enterprises expect 5G to have been deployed at scale by the end of 2022, representing a significant gap in expectations.

Figure 4.3: Share of operators with large-scale 5G deployments in Asia-Pacific[6] and share of enterprises that expect 5G to be available in their country[7]



Source: Analysys Mason

4.3 The lack of extensive commercial trials could hinder the development of a strong ecosystem of suppliers

Conducting large-scale commercial trials are essential for operators for several reasons – to test the technology and assess the spectrum requirement in a real-world scenario, to validate the user experience for different use cases, to involve diverse stakeholders in active co-operation to build an ecosystem of suppliers, developers and partners around a particular sector or workable 5G use case, and to build confidence in the business case, among operators and enterprises.

6 Refers to the entire Asia-Pacific region excluding Central Asia and India.

7 Refers to Australia, Singapore, New Zealand, Malaysia Indonesia, and the Philippines

In some parts of the world, the government has taken a lead in co-ordinating a significant number of initiatives that focus on specific segments and involve a wide diversity of stakeholders (e.g. 5G Testbeds and Trials Programme in the UK, 5G Field Trials programme driven by the government in Japan). However, countries in Asia–Pacific have made more modest progress, with only 38% operators in the region (excluding Central Asia and India) reporting to be in the process of conducting 5G laboratory tests or trials as of the end of 2018. In the six countries, no operator appears to have a rolled out any commercial trial, and while most have already conducted technology demonstrations, their number varies significantly by country – 11 trials have been publicly reported in Australia and Singapore but operators in other countries such as Indonesia, Malaysia and the Philippines have made much less progress (see Figure 4.4).

Figure 4.4: Operator trials and 5G technology demonstrations

Country	Number of operators that conducted publicly reported trials	Number of trials publicly reported	Use cases trialled
Australia	3	11	eMBB/FWA, connected cars, gaming, 5G data calls, VR, URLLC, IoT and 8K video streaming
Singapore	3	11	eMBB/FWA, AR/VR, gaming, IoT and healthcare
New Zealand	2	5	Robotics, live VR, gaming, IoT and healthcare
Malaysia	1	1	Robotic control, connected environment, IoT, VR and 4K video streaming
Indonesia	3	3	eMBB, mMTC and URLLC
The Philippines	2	2	eMBB and VR broadcast

In addition, while most of these trials covered a large range of consumer applications (such as mobile broadband, video streaming, gaming, augmented/virtual reality), very few have been aimed at testing use cases for enterprise verticals other than automotive and healthcare, therefore limiting the understanding of both enterprises and the broader industry ecosystem of the benefits of specific 5G use cases to address particular business problems, and delaying the development of a strong ecosystem of suppliers to offer these services. In the long term, this may reduce interest in 5G from both the supply side (business potential remains theoretical with limited 'real-life' confirmation) and enterprises (limited understanding of the benefits of use cases, lack of strong supply ecosystem to offer services).

5. Local policymakers have yet to provide a favourable environment for 5G

In addition to common objectives, shared by operators and industries, and a clear roadmap providing operators with the confidence in the business case and to proceed quickly with deployment, 5G success depends also on the ability of governments to develop and share an ambitious 5G vision and build business confidence around the technology, which in turn is driven by the governments' ability to create a regulatory environment that is conducive to 5G investment and the level of government involvement in facilitating and coordinating cross-industry activities. These factors, and the progress made by the six countries in addressing these so far, are discussed in the following sub-sections.

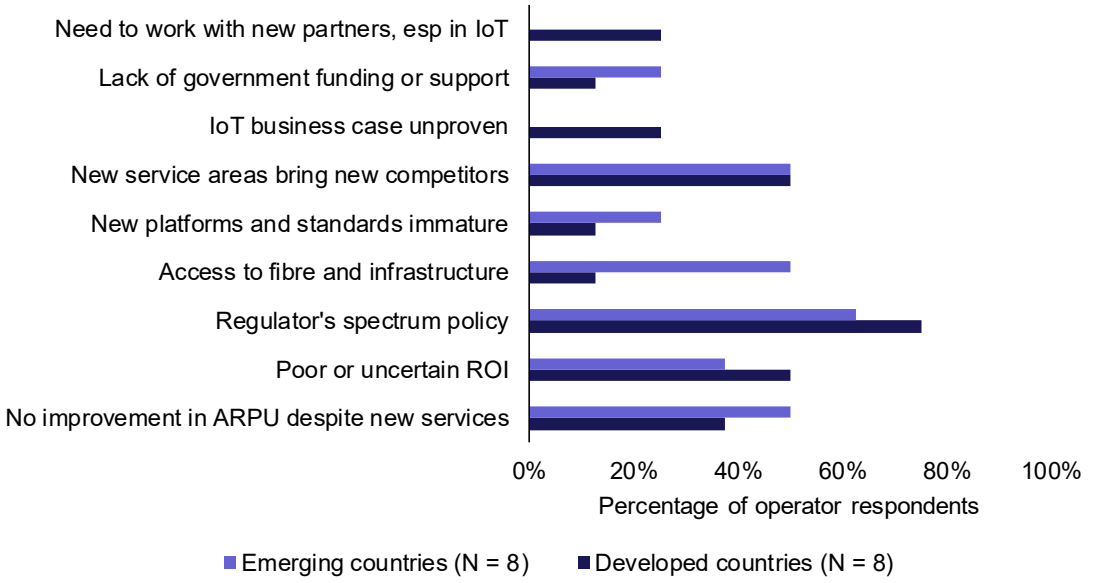
5.1 Poor visibility of spectrum release plans in emerging markets may delay the availability of 5G

One of the most fundamental activities on the regulatory front is for national regulatory authorities to allocate spectrum and decide on policies for its use. Operators and enterprises need to know which frequencies will be available (e.g. 3.5GHz, mmWave, and possibly 2.3GHz and 2.6GHz bands in cases of spectrum fragmentation or difficulties in obtaining satellite clearance for C-band or mmWave spectrum), under which timeframe, and what conditions will apply to make a firm business case for 5G, because the quantity and cost of spectrum underpins all other calculations of return on investment or total cost of ownership.

Countries that are often regarded as 5G leaders (for example, China, Japan, South Korea, USA) have all either awarded 5G spectrum or have clear, near-term timelines to do so. They have allocated spectrum (or plan to) in sufficient quantities, across the best mixture of frequency bands, to support a diversity of 5G use cases. By contrast, in the six countries included in this study, only one (Australia) has allocated some 5G spectrum, in an auction of 3.6GHz frequencies that concluded at the end of 2018. In the other countries, regulators have given little clarity on the timings of 5G auctions or the rules that will apply to the spectrum, or the expected cost.

The importance of clarity over spectrum availability was highlighted by the operator survey, with 75% of operators based in developed economies citing the regulator's spectrum policy among their top-three barriers to 5G deployment, and 63% of operators in emerging markets (see Figure 5.1).

Figure 5.1: Share of operators placing each factor among top 3 barriers to long-term 5G deployment



Source: Analysys Mason

5.2 The lack of regulatory guidelines to facilitate indoor small-cell deployment could make it impossible to support key industry 5G use cases

As discussed in previous sections, 5G is expected to benefit a range of verticals sectors outside the telecoms industry itself, and an increasing number of base stations will need to be installed on poles close to street level, or indoors, to achieve the coverage and quality of service required for many of the target use cases. Indoor coverage in particular will be crucial to many enterprise and consumer use cases. Of the industries that were

identified as benefiting the most from 5G, five out of seven (retail, healthcare, industrial, financial services, and media/entertainment) believe that at least 80% of the data traffic generated by 5G solutions will be indoors (see Figure 5.2). To support indoor traffic, small cells will be important to provide full coverage and a strong, reliable signal within buildings, in particular because core 5G spectrum bands such as 3.5GHz have limited propagation through walls. Some enterprises will also want indoor cells to control security or support edge computing. Because operators have often found it difficult to make a strong business case for indoor deployment (partly because of the need to work with commercial landlords, enterprise integrators, and other stakeholders from outside their usual ecosystem), clear guidelines on aspects such as power output limitations, rapid site permit processes and streamlined equipment approvals are necessary to facilitate indoor 5G deployment.

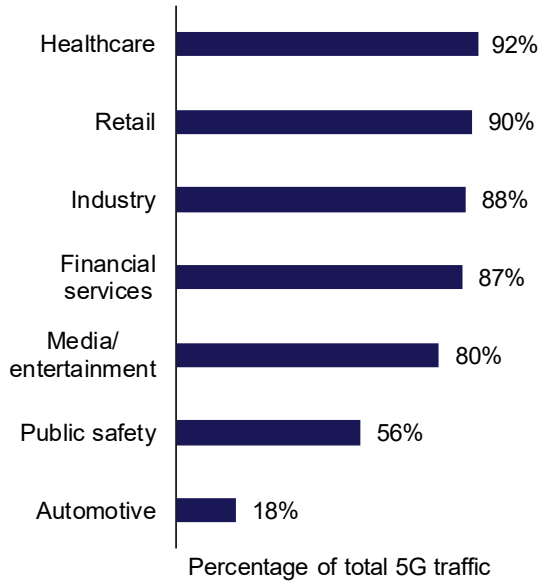
However, regulations regarding installation of wireless equipment inside commercial buildings remain fragmented or unclear. In this report, we focus on indoor small cells, but outdoor, pole-mounted small cells will also be important to 5G and will require new regulations too. Only two of the countries reviewed in this paper (Australia and Singapore) have issued initial guidelines to streamline 5G infrastructure deployment, indoors and outdoors.

In the absence of more widespread frameworks, operators remain cautious about small-cell deployment. By the end of 2023, operators are expected to deploy an estimated total of 500 000 small cells across the six countries, with 75% of these being deployed indoors (equating to over 360 000 indoor small cells – see Figure 5.3). However, effective indoor coverage in areas of dense usage requires 150 or more small cells per square kilometre[8], which is likely to translate into a far higher number of indoor small cells than planned by operators.[9] This in turn may risk leaving many buildings with poor-quality mobile coverage, and unable to support key 5G use cases effectively.

8 Small Cell Forum/Sprint.

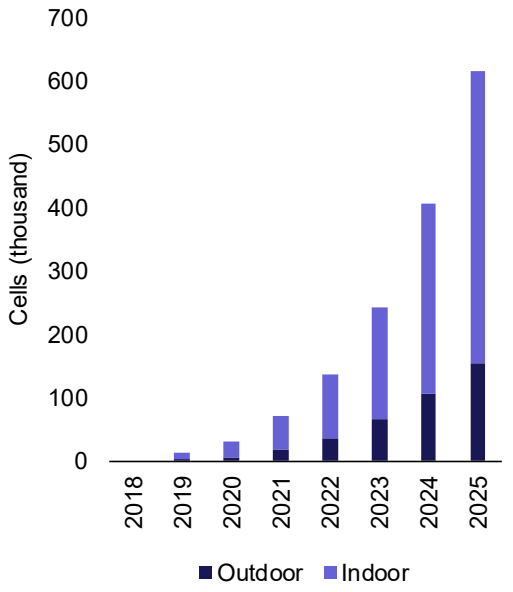
9 The combined area of all six countries is over 10 million km^2. Assuming that a conservative 1% of this area is the total indoor area that requires small-cell coverage by 2023 and a small-cell density of 150 small cells per km^2, this creates a requirement for the deployment of a cumulative number of 16 million small cells, far higher than operators' plans for 360 000 indoor small cells by 2023 (or even 1.1 million by 2025).

Figure 5.2: Indoor 5G data traffic as a share of total 5G traffic by vertical sector in the six countries



Source: Analysys Mason

Figure 5.3: Incremental number of small cells deployed by operators in the six countries



Source: Analysys Mason

5.3 Government policies for cross-industry collaboration around 5G remain scarce

To achieve a detailed understanding of the 5G business case and improve their confidence in launching services, operators need to work closely with a variety of vertical sectors. In many cases, there is little history of deep collaboration between operators and verticals, and they have developed their applications in siloes. However, governments have access to all sectors and so can be best-placed to establish policies that remove barriers to collaboration across industries on 5G tests and use cases and facilitate communication. Governments can also lift barriers to co-investment in network deployment (as is happening in Japan, for instance), by easing the rules limiting cross-sector investments in infrastructure, by state funding for multi-sector testbeds and trials, or by setting up and co-ordinating taskforces or innovation centres to drive co-operation between different stakeholders.

In the six countries, apart from Australia – which has an active programme of working with industry stakeholders to accelerate 5G – governments have yet to develop detailed policies for cross-industry collaboration or to encourage vertical market use cases. This contrasts with the 5G leadership markets such as China or Japan where the publication of national roadmaps and significant government involvement in cross-industry collaborations have helped to shorten the operators' 5G timescales by building confidence in new industrial business cases.

Figure 5.4: Government initiatives on cross-industry collaboration

Country	Key initiatives
Australia	The government is actively collaborating with industry stakeholders to accelerate 5G deployment across all verticals. In 2017, it established a 5G working group bringing together representatives from across the government and different industries. The ACMA has set aside spectrum in the 900MHz band for specific IoT use cases, with incentives and deregulation planned to encourage 5G IoT trials. The government is engaging with cross-vertical stakeholders to assess the capabilities around 5G.

Country	Key initiatives
Singapore	There are few policies supporting cross-industry collaboration. The government launched a heterogenous network (HetNet) in line with its 'Infocomm Media 2025' vision for a smart Singapore. The HetNet was expected to enable mobility between different networks, with commercial roll-out commencing in August 2017.
New Zealand	Policies on cross-industry collaboration are in the preliminary stage. The government is working closely with operators and vendors to encourage cross-industry support for 5G, such as consultations on the allocation of spectrum to support new 5G-specific IoT use cases across industry verticals. The government is also looking to adjust its regulatory framework around new technologies including remotely piloted and autonomous vehicles.
Malaysia	Policies encouraging cross-industry collaboration towards 5G are not yet well-established. The MCMC recently implemented its 5G task force to develop a strategy for 5G deployment, with 31 permanent members comprising various stakeholders. The country's Industry 4.0 vision for a 'smart' Malaysia does not address 5G directly but looks to develop several core 5G use cases across various industries.
Indonesia	There are plans for cross-industry collaboration to develop in the future. The MCIT expects to publish its strategy for using 5G-enabled IoT technology across multiple verticals in 2019. The government is working with research bodies and industry stakeholders to develop the digital economy, of which 5G is considered a key enabler.
The Philippines	There are few policies addressing cross-industry collaboration. The government is considering the establishment of a telecoms and ICT training institute to enable the adoption of new communications technology in cross-vertical use cases. There is also research into the capabilities of new wireless technology in different industries, but no policies to deliver these benefits.

5.4 Limited emphasis on 5G role in government vertical policies may reduce the speed of adoption across sectors

Another important way in which governments can drive a strong, commercially-focused roadmap to 5G, and therefore accelerate its roll-out, is to place 5G at the heart of policies for key industries. In many cases, 5G only features prominently in the plans and visions for the telecoms sector itself, or in generic national broadband plans. While these can result in benefits for businesses, they do not address the specific connectivity and service requirements of individual industries. For example, many government programmes for manufacturing include visions for advanced robotics, but scarcely address the role of 5G in supporting some of those next-generation, fully mobile robots.

In all the countries covered in this report, except Australia, reference to specific 5G use cases in roadmaps for non-telecoms verticals is scarce or non-existent (see Figure 5.5). That risks a situation in which many industries do not understand the potential benefits of 5G or may even build their plans around an alternative technology. The result would be that operators miss valuable business opportunities, while enterprises may settle for a sub-optimal connectivity solution for their needs.

Figure 5.5: References to 5G in key vertical policies by country

Country	Description
Australia	The government has recognised the benefits of 5G in key verticals. The Department of Communication and the Arts has mapped the role of 5G in the future economy through state-funded test laboratories. In manufacturing, 5G use cases include network slicing and real-time data collection and analytics. 5G has also been linked with IoT solutions and smart farming in agriculture. Numerous trials of smart infrastructure have occurred alongside state investment in autonomous vehicles to improve road safety.
Singapore	There is little reference to 5G, with some discussion of the need for using wireless connectivity. Transportation has seen investment in collaborative projects with industry partners and plans to establish autonomous vehicles through AI and big data analytics. The smart nation strategy refers to 'emerging communication technologies' to realise improved municipal services with real-time data in smart cities. The

Country	Description
	strategy also mentions the need for wireless connectivity for real-time data from wearables and the use of robotics.
New Zealand	There are few references to 5G in vertical policies. The Ministry of Transport has discussed the use of wireless connectivity for autonomous vehicles to improve road safety. New Zealand's Industry 4.0 also mentions the use of wireless connectivity to develop IoT applications across verticals. The Ministry of Health is tracking 5G adoption in their digital health index, with some references to the use of 5G-enabled telemedicine and real-time data analysis in the future.
Malaysia	There is little direct reference to 5G in vertical policies, but some discussion of relevant use cases. The manufacturing sector is seen to benefit significantly from 5G, with references to use cases such as IoT, AR, cloud computing and robotics. Existing smart cities have been used as test bed sites for 5G, with plans for further smart city development by 2020.
Indonesia	Vertical policies give little reference to 5G but discuss the need for improved connectivity. The economic masterplan outlines the need for enhanced connectivity in the transportation sector. Indonesia 4.0 mentions the need for improved connectivity in manufacturing, and the use of 5G for real time data analytics and logistics. 5G has not been mentioned in relation to smart cities, but 'wireless connectivity' is linked to use cases such as creating a V2X network, e-logistics, and real-time data management.
The Philippines	There is no mention of 5G, but some discussion of possible use cases. The need for low latency communications standards have been discussed in relation to transportation. The Philippines' Industry 4.0 mentions the need for 'emerging communication technologies' for real-time data analytics in manufacturing, and long-term investment in communications to be competitive worldwide.

6. Country profiles

The following section provides an overview of enterprise demand, publicly reported operator 5G plans (with a focus on trials and deployment plans) and regulatory developments (with a focus on spectrum and policies in favour of 5G) in each of the six countries covered by the study – Australia, Singapore, New Zealand, Malaysia, Indonesia, and the Philippines.

Figure 6.1: Colour coding used in the 5G launch timelines

6.1 Australia

Most enterprises (67%) expect 5G to be available in Australia by 2020. The industrial (88%), automotive (48%) and financial services (45%) sectors are expected to benefit the most from 5G. Unsurprisingly, most consumers (52%) appear "definitely" eager to get higher speeds for their mobile broadband services and a significant

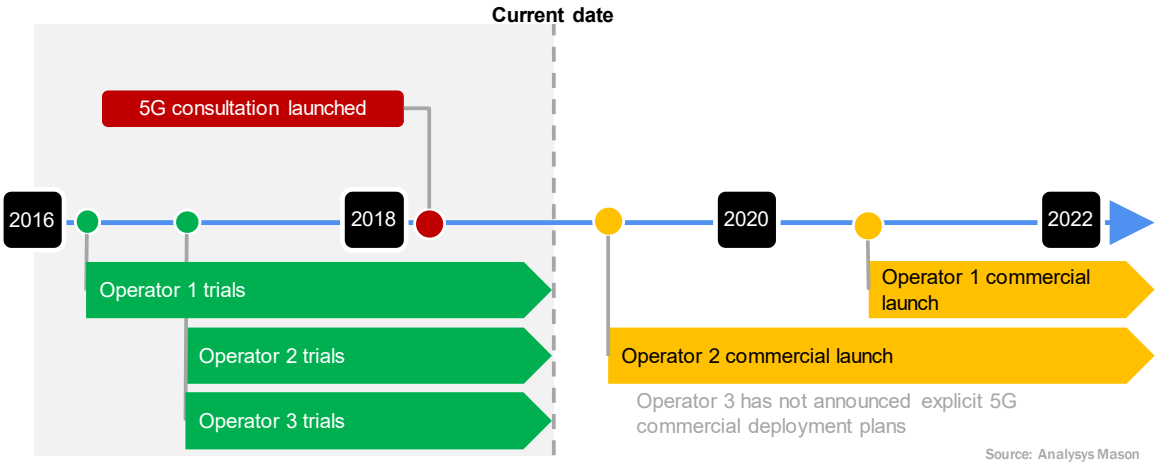
proportion (82%) show some interest in 5G fixed–wireless access services (fixed–wireless access is being used as part of the NBN programme to deliver fixed broadband connectivity to remote areas).

Australian operators have generally been active in preparing for 5G deployment – all three have conducted 5G trials across different bands (3.6GHz, 26GHz) and use cases (for example, enhanced mobile broadband, fixed–wireless access, connected cars, 8K video streaming). The first operator expected to launch commercial services (5G fixed–wireless access) will do so in early 2019, and a second will follow during 2019–2020. The third operator has not made any announcement.

In November 2018, the Australian Communications and Media Authority (ACMA) released 125MHz of spectrum in the 3.6GHz band, after several rounds of consultation to re-allocate incumbent operators to other spectrum bands. Low-band (890–960MHz) and high-band (24.25–27.50GHz) spectrum is expected to be released by 2020–2021, when adequate sharing frameworks will be developed to accommodate current users of these bands.

Policymakers have been pro-active in building business confidence in 5G. The ACMA and the Department of Communications have put in place several policies to facilitate infrastructure deployment, including reductions in planning requirements for small-cell deployments in the public space, and the removal of barriers between licence types to facilitate the re-allocation of incumbent spectrum holders. The government has adopted a collaborative approach with industry partners to encourage the development of a strong ecosystem, for example by setting up a 5G working group participating in the development of proof-of-concept trials with cross-vertical stakeholders. Several documents and roadmaps recognising and emphasising the importance of 5G to the future development of key sectors to the economy (such as manufacturing, agriculture, transport) have been published.

Figure 6.2: Australia – 5G launch timeline



6.2 Singapore

Enterprises anticipate 5G benefits to be greatest in the industrial (67%), financial services (65%) and automotive (61%) sectors. This slightly contrasts with operator plans, which focus on the media and entertainment (100%), public safety, automotive, industrial and healthcare sectors (all four cited by 67% of operators).

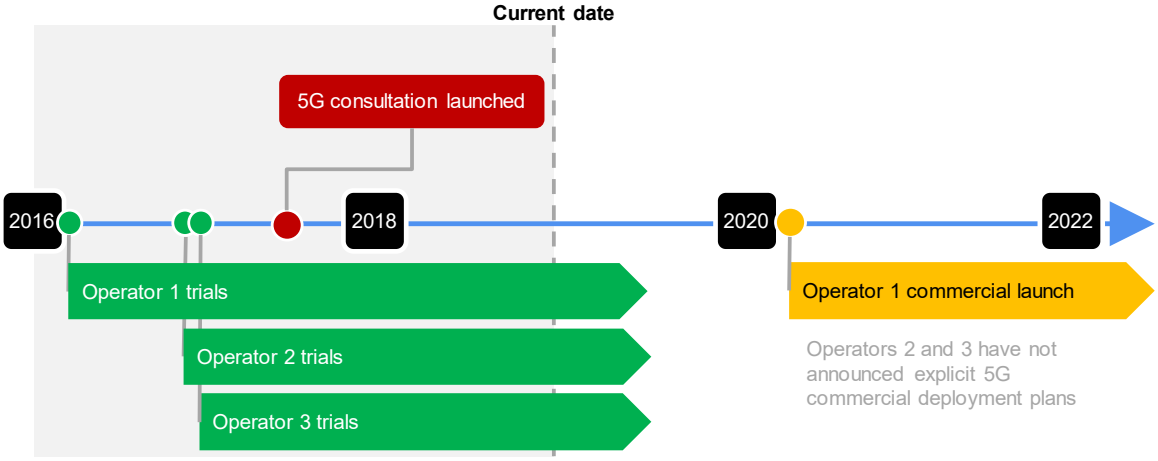
The majority of enterprises (81%) expect 5G to be available in Singapore by 2020, the highest proportion across the six countries reviewed in this paper. While all major operators have conducted 5G trials or demonstrations, only one has outlined a roadmap for commercial deployment by 2020, following four trials started in January

2015 in the 26GHz band, addressing use cases such as enhanced mobile broadband and fixed–wireless access, augmented reality, mobile gaming and IoT. The other two operators launched trials in late 2016 in the 3.5GHz and 73GHz bands (and 28GHz for one of them) but have yet to announce a timeline for network deployment or commercial roll-out.

No detailed timelines for 5G spectrum awards have been announced by the Info-communications Media Development Authority (IMDA), but consultations have been opened in 2017 to address the allocation of spectrum for 5G services and IoT deployments. The existing allocation of 4G spectrum in low-frequency bands (700MHz and 900MHz) is expected to be re-purposed for 5G in the future. A portion of the 800MHz band is scheduled to be released for mobile operators in 2021, while a cumulative 2900MHz of mm-wave spectrum (24GHz, 25GHz and 40GHz) is likely to be allocated in 2022. Further spectrum allocation for 5G awaits the IMDA's official spectrum roadmap in 2019 and the first commercial deployments.

The government is actively encouraging 5G deployment, although no legislation has been passed targeting cross-industry collaboration. The Ministry of Communications and Information's (MCI) Infocomm Media 2025 strategy for improving Singapore's communications connectivity has detailed plans for a HetNet to enable greater network mobility for users. M1 and Nokia began HetNet commercial deployment in August 2017. There is no dedicated task force working towards cross-industry engagement around 5G development, but the Smart Nation strategy discusses the application of 'emerging communication technologies'. The strategy, launched in 2014, targets diverse verticals, such as urban living, e-financing, transport, health, digital government and opportunities for start-ups and businesses.

Figure 6.3: Singapore – 5G launch timeline



6.3 New Zealand

Enterprises unanimously (100%) believe that the industrial sector will benefit from 5G, while the retail sector is the second-most commonly cited sector (40%), followed by the automotive and smart city verticals (both 37%). Consumers are predominantly interested in faster speeds, with enhanced mobile broadband (88%) and fixed–wireless access (79%) being the most cited 5G use cases.

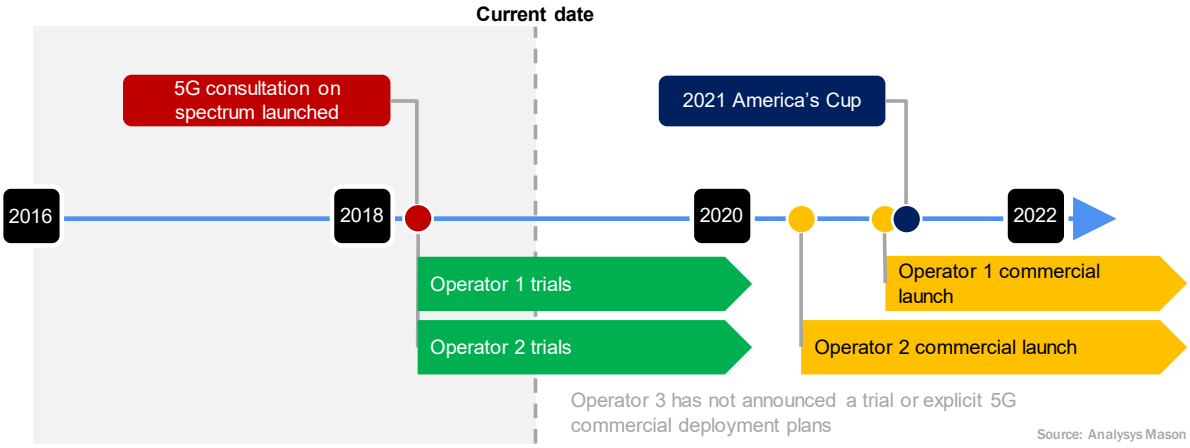
Most enterprises (70%) expect to have commercial access to 5G by 2020, while the rest believe that 5G will be available by 2021 at the latest. This is broadly in line with operator 5G developments in New Zealand, with one operator committing to a commercial launch by July 2020 and a second to follow in 2021. Both operators have conducted trials in various mid–high frequency bands (3.4–3.8GHz and 24.25–29.5GHz) in March 2018, across

multiple use cases such as robotics, live virtual reality, gaming and 4K live video streaming. No announcement has been made by the third operator regarding 5G trials or deployment.

The re-allocation of spectrum for 5G services has been limited by the presence of incumbent licence holders. The Radio Spectrum Management unit of the Ministry of Business, Innovation and Employment (MBIE) is expected to allocate mid-frequency spectrum to operators in the 3400MHz and 3500MHz bands in early 2019 and in the 1800MHz band in mid-2021, following the expiration of licences of current spectrum holders in these bands. However, high-frequency spectrum in the 26GHz band is not likely to be allocated until at least 2022 when incumbent licences expire.

The government's primary concern has been about addressing spectrum allocation issues and it has yet to legislate for cross-industry collaboration. Consultations addressing the allocation of wireless spectrum to support new 5G-specific IoT use cases have been held by the MBIE. Further consultations at the end of 2018 aimed at supporting 5G, IoT, ultra-high definition video and other high-bandwidth activities. The Ministry of Transport has also legislated to accommodate remotely piloted and autonomous vehicles in anticipation of a 5G future, but there is little direct mention of 5G in policies directed at cross-industry verticals, such as Industry 4.0.

Figure 6.4: New Zealand – 5G launch timeline



6.4 Malaysia

Enterprises overwhelmingly expect the industrial sector (92%) to benefit the most from 5G, with some further interest in financial services (57%) and public safety (49%). Consumers show a broad interest in the various sector benefits in both superior fixed–wireless and mobile broadband speeds, and newer services such as connected cars and augmented/virtual reality (>90% interest in each use case).

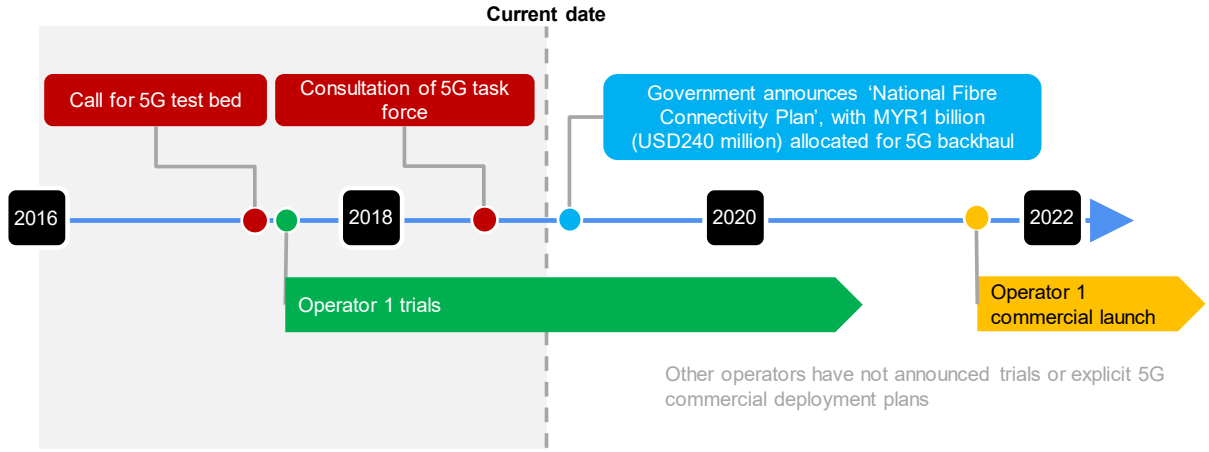
Only one operator has conducted commercial trials and has committed to a roadmap to launch 5G services by 2022. This contrasts with the expectations of most enterprises (69%) that 5G will become available as early as 2020. It launched a trial in May 2017 in the 28GHz high frequency band, across multiple use cases including robotic control, connected environment, IoT applications and VR, and 4K video streaming. A second operator claims to have begun laboratory tests of 5G with an eye to commercial trials beginning in 2019, although no possible spectrum bands or use cases have been disclosed.

The Malaysian Communications and Multimedia Commission (MCMC) has made efforts to encourage 5G roll-out, inviting stakeholders to commence trials and demonstrations of 5G capability in the country's technology

centres, Cyberjaya and Putrajaya. However, little direct mention of 5G spectrum allocation has been made, despite re-allocation of several low (700MHz and 900MHz) and mid-frequency (1800MHz, 2300MHz and 2600MHz) bands for 4G technology 'and beyond'.

The government has made efforts to coordinate broad industry and governmental strategies for 5G, although few policies directly related to this have been implemented. The MCMC's 5G task force aims to establish a 5G strategy in collaboration with 31 industry members. Various government departments, major operators, including those that have yet to commence 5G trials, and global telecoms vendors are permanent members indicating a broad scope of 5G application across industry verticals in the future. The Ministry of International Trade and Industry has launched its 'Industry 4.0'/Industry4WRD initiative to encourage enterprise investment into new technologies. No reference to 5G is made in this policy, however there is a strong focus on use cases such as IoT, VR/AR, cloud computing and robotics that are likely to use 5G. The Industry 4.0 initiative has stressed the need for greater strategic public-private partnerships across different industry verticals, particularly around research into emerging technologies and co-ordinating with the manufacturing sector, however there is no direct reference to 5G.

Figure 6.5: Malaysia – 5G launch timeline



6.5 Indonesia

The industrial (74%) and financial services (71%) sectors are expected to benefit most from 5G deployment. Consumers show an interest in multiple 5G-related services, including enhanced mobile broadband, fixed wireless access, but also more futuristic use cases such as connected cars and virtual/augmented reality.

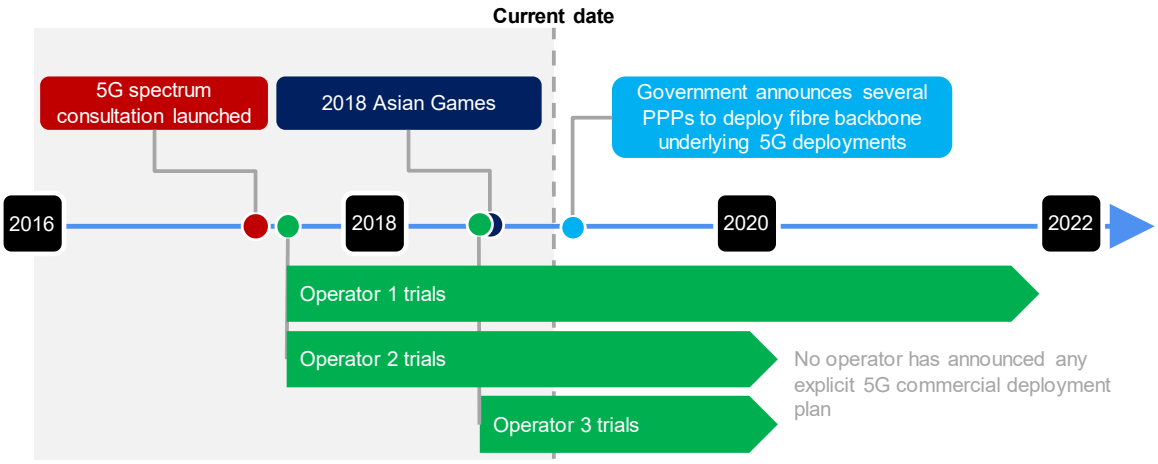
While over half (55%) of enterprises surveyed in Indonesia expect 5G to be launched by 2020, actual availability is likely to be delayed to a later date. The three largest operators in Indonesia have conducted 5G trials, but operators are yet to adequately deploy 4G infrastructure, which will delay the commercial roll-out of next-generation wireless technology. The earliest 5G trials held by two operators coincided with the 2018 Asian Games held in August–September 2018, across various high-frequency bands (28GHz and 72GHz) and use cases such as eMBB, mMTC, URLLC, 3D AR and high-capacity hotspots. While the third largest operator launched a trial in August 2018, none of the operators have committed to a roadmap towards commercial launch, with network deployment not estimated to commence until 2022.

The Ministry of Communications and Information Technology (MCIT) plans to release its 5G roadmap in 2021, stating that the mobile market is still adopting 4G (only 27% of active mobile connections use 4G). There are no planned spectrum auctions for 5G, but the MCIT has suggested the 3.5GHz and 28GHz spectrum bands will be

allocated to 5G. Spectrum in the 2100MHz and 2300MHz bands was auctioned in October 2017 for 4G use, but could be re-purposed for 5G in the future.

Government policies to encourage 5G are limited at this stage but are expected to support a quick 5G deployment. A public-private partnership project developed the Palapa ring, a national fibre backbone infrastructure for backhaul in 5G networks, however the focus has predominantly been on expanding 4G coverage. The government is also partnering with research bodies and industry stakeholders from different verticals to co-ordinate Indonesia's digital economy, with 5G labelled a key enabler. Tax breaks have also been implemented for venture capital firms investing in technology start-ups in line with a strategy for more-connected cities. Direct links between 5G use cases and cross-industry stakeholders are yet to be outlined with any clarity and await the MCIT's 5G roadmap.

Figure 6.6: Indonesia – 5G launch timeline



6.6 The Philippines

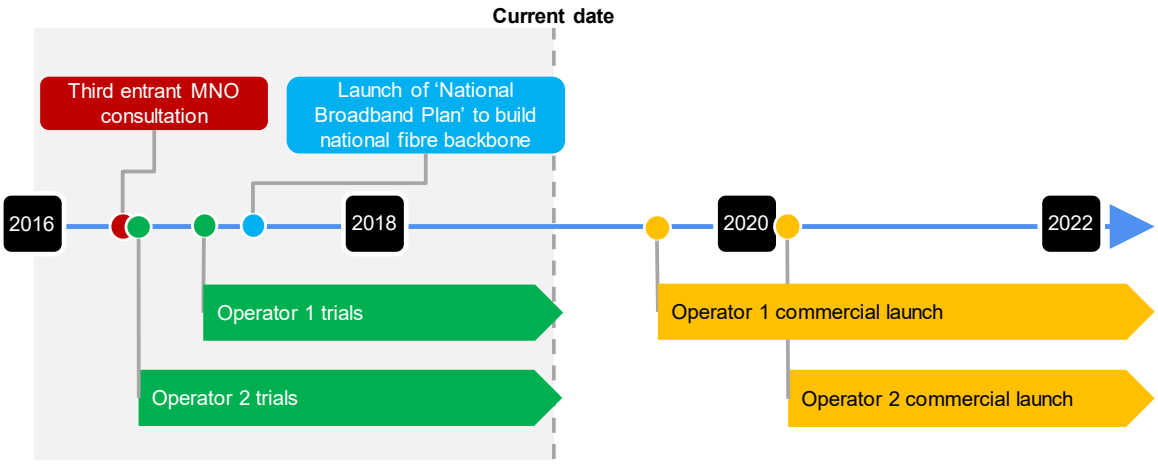
The industrial (65%), financial services (58%) and retail (52%) sectors are cited by enterprises are those most likely to benefit the most from 5G capabilities. Over 94% of consumers with 5G awareness (the second highest proportion of consumers across the six countries after Malaysia) show some interest in 5G fixed–wireless services.

While enterprises in the Philippines are cautious about 5G availability, with only 48% believing that 5G will be launched in 2020, 35% during 2021–2022 and 10% with no visibility as to when 5G will be available, operators are more optimistically anticipating the introduction of 5G as early as the first half of 2019. One operator launched a 5G trial in June 2016, highlighting 3D virtual reality-based broadcasting as a key use case, with commercial deployment expected in 2020. The other operator conducted a trial in 2017 using the 700MHz spectrum bands with a focus on mobile data service as a use case, and commercial launch is expected to be in mid-2019.

To that end, the National Telecommunications Commission (NTC) has plans to re-allocate the existing frequencies held by both operators, but only after the ITU standards are confirmed in early 2019. New spectrum in various low- to mid-frequency bands (700MHz, 800MHz, 2.1GHz, 2.5GHz and 3.4GHz) are expected to be awarded to a third mobile entrant, primarily for 3G/4G use, but with the potential for 5G usage in the future.

Efforts by the government to facilitate cross-industry collaboration regarding 5G deployment are scarce. It has yet to establish a dedicated group to oversee industry engagement and demonstrating 5G use cases, although it is considering establishing a telecoms and ICT training institute. This will encourage the adoption of new communication technology in cross vertical use cases for digital transformation. There is research into the capabilities of new wireless technology across different industries, through partnerships with industry organisations such as Microsoft, to establish how use cases such as artificial intelligence and cybersecurity can be developed via new communication technology. Vertical roadmaps in transportation and manufacturing discuss the use of new communication networks for reliable low-latency connectivity and remaining competitive with international communication standards, but do not refer directly to 5G.

Figure 6.7: The Philippines – 5G launch timeline



7. The ecosystem must adopt several remedies to address the challenges

7.1 Recommendations for operators

Figure 7.1: Recommendations for operators

	Details
Set out clear commercial and deployment priorities by vertical sector and use case	• Conduct large-scale enterprise surveys to prioritise vertical sectors and use cases • Use vertical and use case prioritisation to plan the timescales and geographical coverage of 5G roll-out and the launch of commercial services • Some use cases will be impossible to predict at launch – maintain the engagement with enterprises to make sure to quickly notice new requirements that may emerge in the future
Accelerate commercial trials of specific 5G use cases with industry partners to determine use case benefits and foster adoption	• Set up test beds and conduct trials with enterprises across high-demand vertical sectors to evaluate/validate the real-world benefits of key 5G use cases • Seek active participation in cross-industry initiatives to start building an ecosystem of partners to cooperate around innovative 5G use cases and trial solutions

	Details
Explore ways to take an enhanced role in the value chain across promising 5G use cases	• Build an in-depth understanding of the structure of the value chain across promising use cases and identify possible opportunities to expand from connectivity provision to other services • Develop an understanding of the key capabilities (e.g. technology, channels, skills) required to offer services and conduct a thorough and robust assessment of associated costs and benefits
Ensure communication with enterprise sectors to align network deployment efforts with enterprise objectives and manage expectations	• Engage with vertical sectors with limited 5G interest to increase awareness and improve communication of the benefits of 5G use cases • Communicate 5G geographical coverage timescales clearly for enterprises to plan/adjust their digital transformation efforts accordingly • Work with companies located outside of initial areas of 5G roll-out to evaluate whether their requirements could be met with 4G or to assess options to co-invest in network deployment to accelerate availability
Engage with an ecosystem of manufacturers to ensure device availability and affordability	• Work with multiple partners to ensure the availability of a range of devices at different price points • Explore ways to make handsets more affordable (e.g. financing schemes), especially in emerging markets, to accelerate customer migration to 5G
Evaluate network co-investment options to reduce the cost of 5G indoor deployments and plan for high-quality indoor coverage	• Options to consider could include infrastructure sharing with other operators, integration with neutral-host wholesalers, co-investment with enterprises from relevant sectors (e.g. manufacturing, retail). • Actively lobby national regulatory authorities to publish policies to encourage infrastructure sharing and facilitate indoor small-cell deployments.

7.2 Recommendations for policymakers

Figure 7.2: Recommendations for policymakers

	Details
Consider earmarking spectrum in the 3.5GHz and mmWave spectrum bands in priority	• Focus on 5G bands with a high chance of being adopted as global allocations at WRC-19 (3.4-3.8GHz, 24.25-29.5GHz) • If spectrum fragmentation or difficulties in obtaining satellite clearance for 5G C-band or mmWave spectrum, conduct spectrum feasibility study on using under-utilised 2.3GHz and 2.6GHz bands for coverage
Produce a formal national 5G roadmap document setting out a clear national 5G vision and outlining the path to introduction	• Publish a document outlining a clear 5G ambition for the country and a description of the role played by the government to support the successful introduction of 5G • Key areas for government intervention and typically discussed in 5G roadmaps include: expected schedule for spectrum release, initial thinking about the evolution of regulatory frameworks, programmes for 5G testbeds and trials, conditions for network deployments, development of technology and standards
Issue national-level planning guidelines to facilitate indoor small-cell deployments	• Produce guidelines to facilitate the acquisition of new sites to accelerate indoor small-cell deployments (e.g. greater transparency on available assets, streamlined processes to avoid lengthy deployment delays, pro-infrastructure siting and sharing policies to ensure the wider deployment of small cells). • Encourage co-investment and integration between national fibre wholesalers and operators to ensure that 5G/fibre reaches the rural population in a cost-effective manner.
Develop policies and allocate funding to facilitate cross-industry tests and trials between	• Facilitate collaborative tests and trials between operators, enterprises and suppliers (e.g. vendors, chipset providers), for example via subsidies, funding, test beds, workshops, to create an ecosystem of local suppliers across the value chain and encourage the development of innovative 5G-enabled solutions

	Details
operators, enterprises and suppliers	• Allocate direct funds to further accelerate research and 5G projects, for example for technology development, vertical use cases trials, test beds (e.g. V2X, smart manufacturing), that are expected to help stimulate demand for services and promote industry collaboration (e.g. some countries have already committed significant funding towards these types of 5G
Give a more prominent role to 5G as a key enabler of digital transformation in vertical sectors (e.g. smart cities, healthcare, utilities)	• Develop national strategies with clear objectives and roadmaps in relation to the development of key vertical sectors of the economy • Provide a clear description of the role played by the ICT industry in achieving these objectives and the extent to which technology-enabled initiatives are already implemented today, and place 5G at the heart of future industry policies

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Caroline Gabriel (Senior Contributor, Research) contributes to several Analysys Mason research programmes on topics related to mobile networks. She has been engaged in technology analysis, research and consulting for 30 years, and has focused entirely on mobile and wireless since 2002. Her focus is on critical issues and trends related to mobile and wireless infrastructure, particularly operator deployment intentions for 4G, 5G, cloud-RAN and other technologies.

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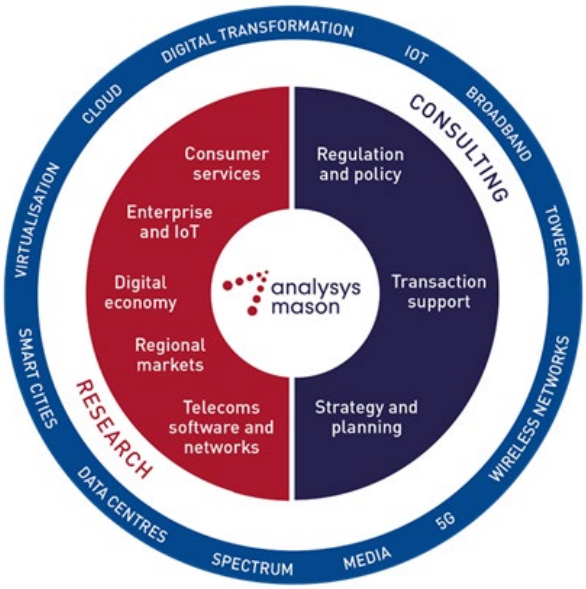

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