Analysys Mason – ETTelecom Report

5G EVOLUTION AND ROADMAP INCLUDING 5G READINESS OF INDIA

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Global developments on 5G and future roadmap

Introduction to 5G

The successive generations of cellular technologies (2G, 3G, 4G) has demonstrated the power of faster connectivity, quality service and digitalisation. The most recent development in mobile telecom space is the rise of 5G – the fifth generation of mobile technology, that is expected to transform the idea of communication. With capability of providing ultra-fast speed, lower latency and higher reliability, 5G services are expected to not just improve traditional mobile services but also open up new opportunities such as smart cities, connected cars, Industry 4.0, AR/VR and remote surgery. It is expected to possess the flexibility and scalability to provide a seamless wireless connectivity in a range of environments, devices and verticals.

5G use cases

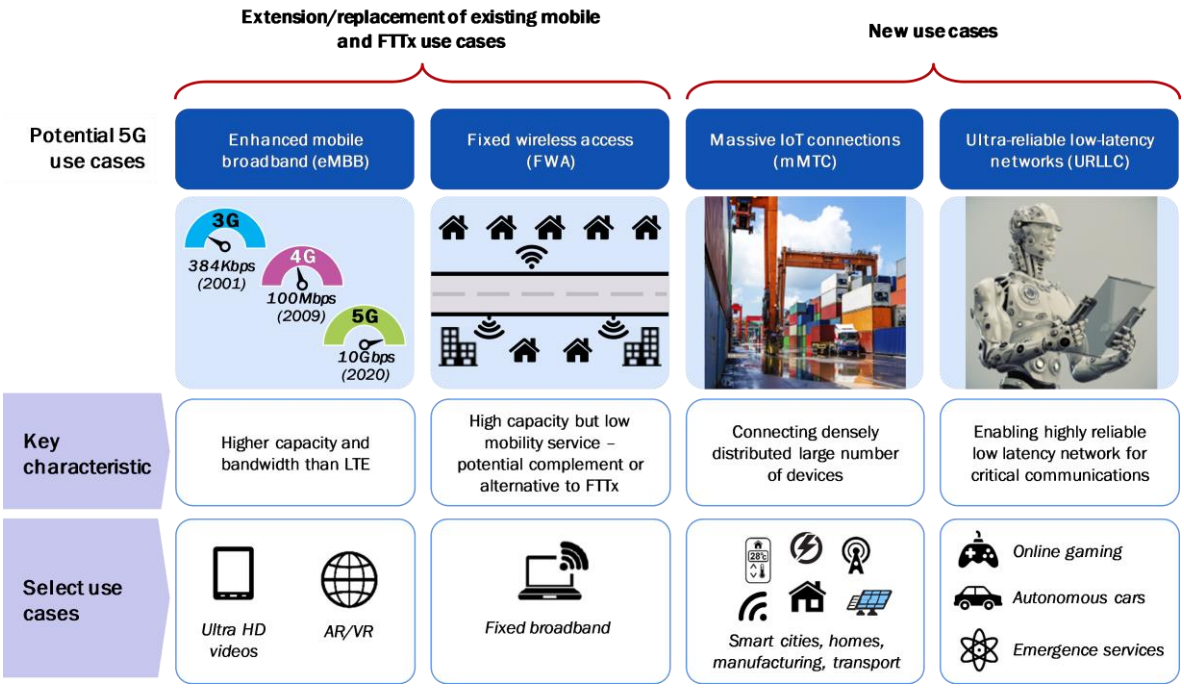
The potential use cases of 5G have broadly evolved into four categories – each with overlapping yet different requirements and services. Details are illustrated in *Figure 1*.

Enhanced mobile broadband (eMBB): Enhanced mobile broadband is intended to deliver over 100Mbit/s to indoor and outdoor locations, with over 1Gbit/s in dense indoor locations at an end-to-end (E2E) latency of less than 5ms.

Fixed wireless access (FWA): A competition for fixed broadband services by placing fixed and wireless backhaul to strengthen network capacity enabling it to cater to a large number of data users without compromising on the speed or quality of service.

Massive machine-type connections (mMTC): Massive IoT intends to support huge number of connected devices (for example, more than 1 million device connections per cell site or per km^2) and enable smart-city solutions. Ideally, mMTC will eventually use lower-band spectrum, with sub-6GHz the most likely candidate.

Figure 1: Use cases that can be supported on 5G [Source: Analysys Mason, 2018]



Ultra-reliable low-latency communications (uRLLC): Robotic manufacturing, autonomous vehicles, remote medical surgery and even gaming are the target commercial applications for ultra-reliable, low-latency (<1ms E2E delay) communications. uRLLC also targets virtual-reality applications, but in more confined spaces using wide-bandwidth channels (100MHz or greater).

In the initial phase, 5G services are expected to focus on enhanced mobile broadband (eMBB) and fixed wireless access (FWA), and expand over time to other use cases and verticals.

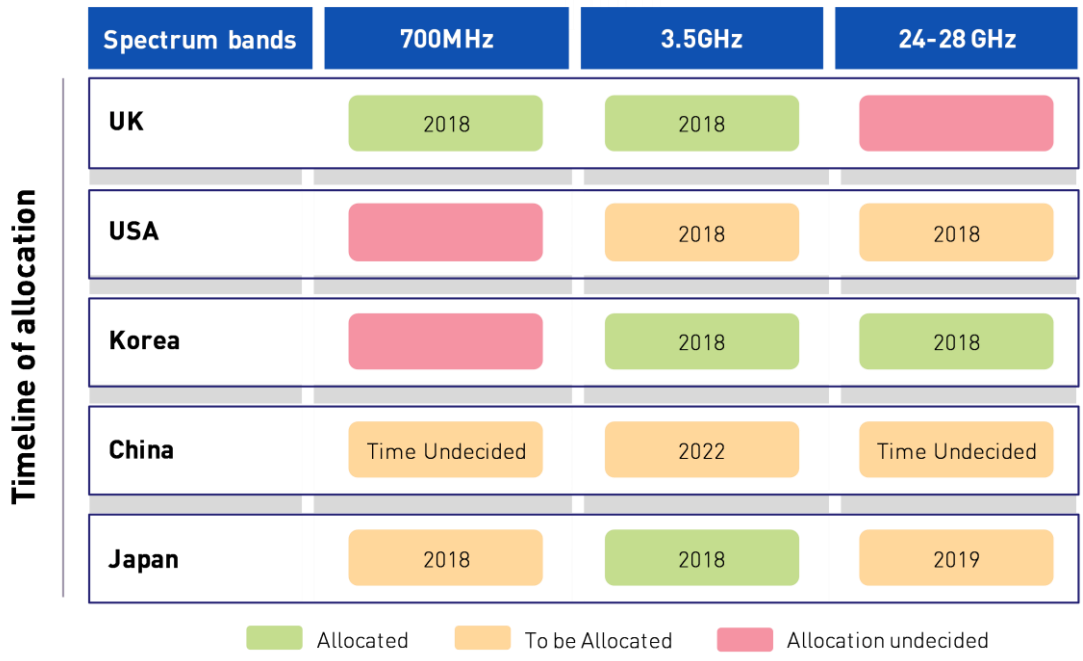
The 5G Spectrum Priorities

Globally, operators and vendors are investing heavily to test the 5G technologies. In order to support the low latency levels, higher speeds and larger capacity of 5G, spectrum allocation and availability become critical aspects of implementation of this new generation of network technology. The wide variety of 5G use cases will need spectrum across different frequencies. The initial global focus has been on low-frequency band of 700MHz, mid-frequency band around 3.5GHz and high frequency band in 26-28 GHz range. There has also been some interest in other mm-wave spectrum bands such as 39GHz, 42GHz and 66-76GHz for later deployments.

Network equipment and device vendors view global harmonization of spectrum for 5G as a key factor for the success of new 5G technology. Spectrum harmonization is particularly relevant in the mm-wave frequency bands where significant technological development has occurred to enable 5G utilization in frequencies that have not previously been used for mobile technology (and hence, where entirely new components are needed to develop a mobile ecosystem for equipment and devices). Each use case utilizes a different combination of the spectrum bands under consideration.

The spectrum bands available / proposed for 5G deployments planned in 2019 varies by market. This is illustrated for a few countries in *Figure 2* below. Going forward, timely availability of

Figure 2: Spectrum bands for 5G deployment across multiple markets [Source: Analysys Mason, 2018]



sufficient 5G spectrum is expected to play a key role in enabling and incentivising operators to commit to large-scale network deployment and investments.

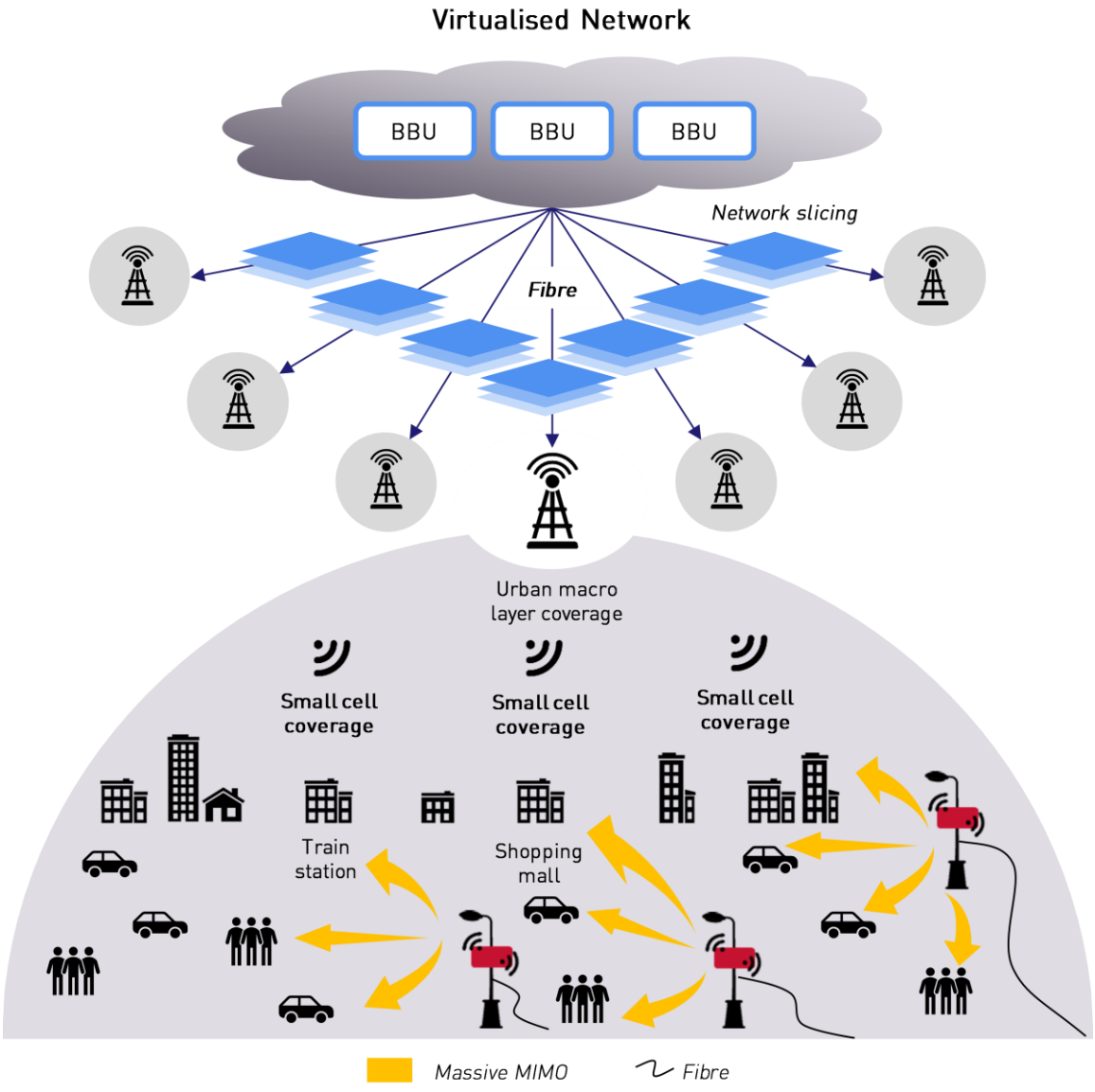
Infrastructure Support for 5G

The infrastructure needs of 5G technology will be unique as the use cases have specific architecture requirements. 5G is expected to be flexible and scalable. The 5G network architecture is detailed as below:

New radio interface (5G NR): While both a new access technology of 5G New Radio (5G NR) and core network (5GC) are being defined, 5G provides possibility to deploy network in different configurations. The 5G network can be deployed either to work in conjunction with existing 4G core (as non-standalone 5G NR) or as a standalone 5G NR network.

Heterogenous networks with small cells: To support substantially higher data traffic and provide seamless user experience in 5G, while

Figure 3: High level 5G network architecture [Source: Analysys Mason, 2018]



utilising high frequency bands (which have lower range), the mobile networks would need to be densified using small cells. Small cells would help deliver targeted cellular coverage and capacity, indoors and outdoors, to complement the macro network. This will also enable content and cloud services to be delivered close to the user. The compact size and low power (consumption and radiated) make small cells suitable for street level, lamp pole and indoor deployment.

Fiberisation: the high throughput offered by 5G will result in high traffic on cellular networks which will need to be backhauled from mobile sites to an operator's core network. This will lead to the roll-out of fibre to most mobile sites, although mmWave spectrum in the E-band (70–80GHz) may also be used to provide very-high-capacity microwave backhaul.

Advanced antenna array technology (Massive MIMO): Massive MIMO is the employment of large number of antennas at a base station. From 4X4 MIMO combination employed today, 5G is expected to feature arrays of 64 or 128 antennas. This part of architecture can leverage the tight interconnections and high computational capacity of BBUs (baseband units) within a centralized pool of the RAN architecture. Spatial diversity can be achieved by employing multiple transceivers which can improve signal strength.

Network virtualisation (Network slicing, Cloud-RAN): To allow utilisation of network to support a wide range of use cases with varying needs of speed, latency and reliability, 5G would enable flexible provisioning of network capabilities using 'network slicing'. Cloud-RAN would enable dynamic allocation of network resource through disaggregation of base station radio into its components (base band units and remote radio head), with virtualisation and centralisation of processing.

Developments and road ahead for 5G

There have been many significant developments in the field of 5G in the past one year globally including the areas of spectrum availability, numerous 5G trials, regulatory push towards 5G roadmap and industry proactiveness towards early 5G launch. There has also been significant progress in standardisation of 5G which is a landmark step towards 5G commercial launch. In December 2017, the 5G new radio (5G-NR) specifications for non-standalone (NSA) operation were finalized. Following this, the 5G-NR standalone (SA) specifications have been completed in June 2018. The finalisation of these specifications has a multi-fold impact on 5G enabling it to be a facilitator and accelerator of the ICT improvement process of industries and enterprises. It gives 5G the ability to deploy independently. A fresh network architecture opens gates for new business opportunities for industries beyond telecommunications. Many companies (including AT&T, British Telecom, China Unicom, China Mobile, Deutsche Telekom, DISH Network, Ericsson, Fujitsu Limited, Huawei, Lenovo, Nokia, Orange, Samsung Electronics and more) are supporting Release 15 of 3GPP and see this as an opportunity to build the 5G ecosystem.[1]

Adoption of 5G is dependent on the finalisation of global standards which are set to be finalized by 2019. Various countries have started rapid deployment of 5G technologies. 5G adoption is further dependent upon spectrum allocation and infrastructure-related investments across different countries, by different MNOs and via different vendors. The inter-related nature of decision-making for this technology creates a cyclical impact on the execution of the technology. The flow of investments will lead to setting up appropriate infrastructure which can be done only when 5G specifications have been agreed upon. Furthermore, ongoing trials can progress to commercial launch only once spectrum allocation is completed.

1 http://www.3gpp.org/news-events/3gpp-news/1965-rel-15_news

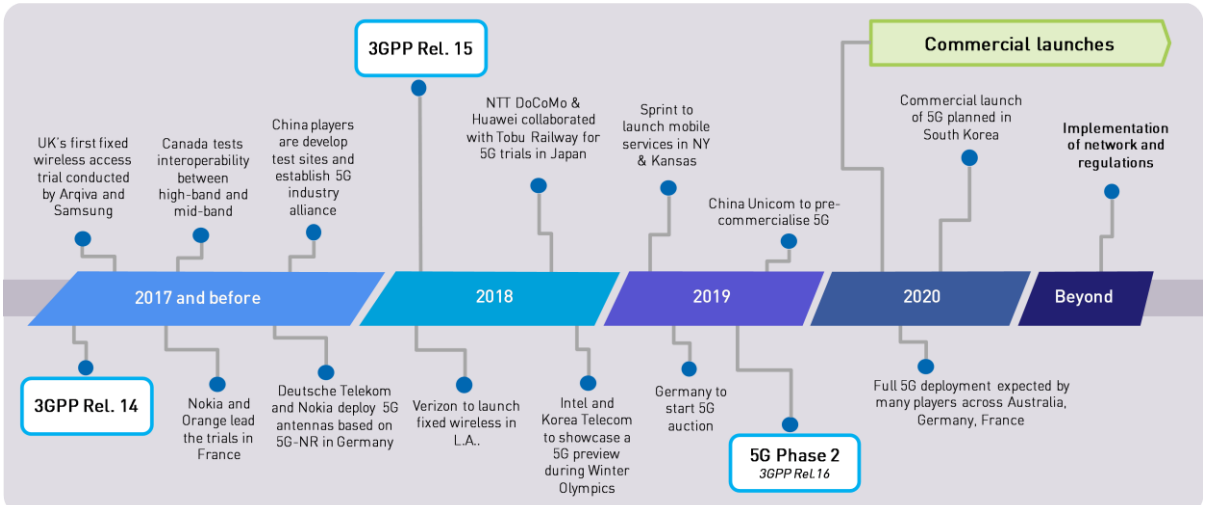
Operators are likely to follow different paths to 5G launch, with choice between deploying non-standalone 5G NR (connected to 4G core) or standalone 5G NR (with 5G core). Some markets (such as US) may look to launch non-standalone 5G to leverage existing 4G core network and accelerate time-to-market. Irrespective of the two choices, there is expected to be marked improvement from 4G in terms of mobile broadband speed and latency.

Since 2017, 5G has seen major developments – spectrum allocation, trials and attempts towards pricing. Some of the key milestones along with the vision for the coming years are detailed in *Figure 4*.

its telecom players in the 5G auction by means of concessions to encourage telecom players to enhance 4G coverage in various regions.[2]

Commercial launches in some developed markets are expected to be scheduled for next year. 2019 is expected to see 3GPP 5G Phase 2 Release 16. The 5G-NR standalone specifications have fuelled steps towards commercialisation. USA, Japan, Germany, China, France and the like will see pre-commercial activity and major developments in auctioning 5G. Trials and previews will enable operators, vendors and governments to start formulating pricing and business models. At current pace of developments, 5G services are expected to be introduced in the leading markets before 2020.

Figure 4: Expected timeline for 5G commercial launch [Source: Analysys Mason, 2018]



In March 2018, Canada, Quebec and Ontario governments announced investment for 5G corridor which is being supported by key players like Ericsson, Ciena, IBM, Thales and CGI. Europe has been seeing rapid developments in trials and spectrum allocation. With the establishment of testing sites across various cities of Europe, key telecom players are indulging in memorandum of understanding and alliances to develop the 5G network technology. Germany has taken a step towards supporting

[2] https://www.reuters.com/article/us-germany-telecoms/german-mobile-operators-pledge-to-boost-4g-network-coverage-idUSKBN1K222Y

5G market potential in India

With promise of improved speed, latency and reliability, 5G has potential to enable new use cases and transform many of the existing Indian industries. In short and medium term, it is expected to have a substantial economic impact on Indian mobile broadband market and some in IoT space. In this section, we would present a quantitative estimate of 5G's potential impact on these two sectors.

In long term, full economic impact of 5G may extend to several more areas where its use cases are evolving (such as connected cars). However, given the uncertainty associated with long term economic prediction of such early-stage technologies, these would not form the part of this quantitative forecast.

Indian mobile market

Driven by growth in mobile service adoption among new users as well as adoption of multiple SIMs by existing subscribers, active wireless SIMs in India have grown at CAGR of 6% over last six years to reach 972 million in FY2018, correspondent to population penetration of 73%. 3G and 4G SIMs together contributed to about 37% of total wireless SIMs as of FY2018. We expect the market to keep growing, reaching up to 1450 million active wireless SIMs by end of FY2026.

Technology-wise evolution: 2G, 3G and 4G

Increasing adoption of data-services, driven by increasing coverage of 3G/4G networks, fall in data prices, and declining prices of 3G/4G handsets, is leading to reduction in number of 2G-only users. Introduction of low-priced 4G featurephones is expected to substitute new 2G handset sales. Therefore, by FY2025, we expect all 2G installed device base to migrate to newer generations of technology (3G/4G/5G), allowing operators to fully re-farm 2G spectrum.

The price differential between 3G and 4G devices has been reducing because of rapid development of 4G device ecosystem and shifting prioritisation of operators towards 4G network roll-out. After 2018, we expect all 3G/4G device sales to be 4G-enabled, allowing 2G users to potentially upgrade directly to 4G. Further, considering a replacement cycle of 3 years, we expect all existing 3G users to migrate to 4G by FY22. Thereby, 3G can be switch-off and its spectrum can be re-farmed for 4G by FY22, a view also stated by many Indian operators in press releases.

4G has picked up rapidly since FY16 and it is expected to become one of the two dominant mobile technology generation after 2G and 3G switch-off by FY26, with other being 5G.

Technology-wise evolution: 5G

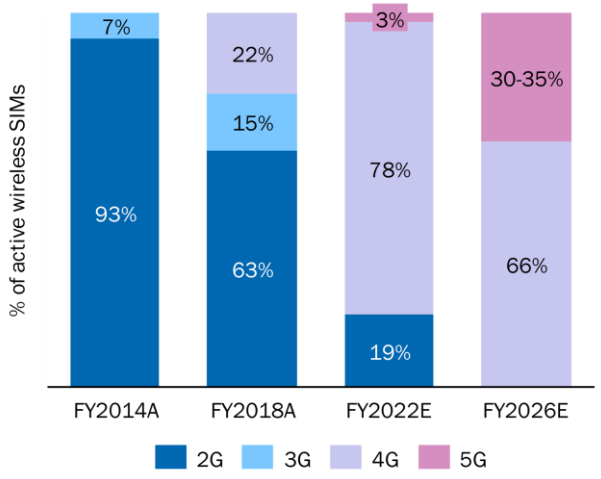
India lagged developed markets in 3G launch by about a decade and 4G launch by about four to five years. However, Indian mobile operators are optimistic about launching 5G by end of 2020, in-line with expected launch in many of the other leading markets. We expect initial deployments to be centred around eMBB.

The adoption of 5G mobile broadband among Indian mobile subscribers is expected to depend on several enabling factors such as availability of affordable 5G-enabled handsets, affordable 5G mobile data packages, content ecosystem and 5G network coverage. There is limited information on expected price of 5G-enabled handsets, but we expect only high-end mobile phone models to support 5G initially. Data tariffs are expected to fall as the 5G technology improvements and spectral efficiency gains reduce the cost per GB for operators. Such fall in data prices along with increase in end-user throughputs enabled by 5G would drive increase in mobile data usage. Proliferation of high-quality online content for masses, particularly in areas of high-definition/ultra-high definition videos and AR/VR applications are also expected to be both a key driver and key beneficiary of increase in mobile data usage.

In terms of 5G network roll-out, initial 5G deployment in 2020-22 time period is likely to be limited to high traffic dense urban areas. Ubiquitous urban and potentially rural coverage may likely be achieved only by 2025. Expansion to other use cases would follow in parallel, albeit likely at a slower pace than eMBB. Such phased approach to 5G deployment would also help smoothen out the network investments over time while allowing time for operators to observe and react to market and ecosystem developments.

To forecast the adoption of 5G, we have looked at historical trends of adoption of previous generation of technology (4G) upon introduction in India and in a sample set of 10 key developed and 10 developing markets. Based on the historical benchmarks from 4G adoption, we expect the 5G penetration in India to reach ~30 – 35% by FY26. This corresponds to about 440 to 500 million active 5G subscribers by FY26.

Figure 5: Historical trend and forecast of split of active wireless SIMs by technology generation, including 5G [Source: Analysys Mason, 2018]



Indian IoT/M2M market

Overall market size forecast

Indian Internet of things (IoT) and Machine-to-Machine (M2M) market is currently relatively nascent, however it represents a huge opportunity for the future. It is expected to have significant application in variety of industries including automotive, utilities, manufacturing, transport and logistics.

The size of India's IoT market is estimated at 13.5 million connections as of FY18. Going forward, we expect significant growth in the overall IoT market, with total connections growing to 300 million by FY26. The service revenue of the total value chain is estimated at USD900 million for FY18 and expected to grow to USD7 billion by FY26. The growth will be driven by huge demand for 'smart' technologies enabling interworking between large number of machines and devices. This demand would be met by supply-side network roll-out push by operators and improvements in technology fulfilling power, low cost and network reliability needs of the IoT applications.

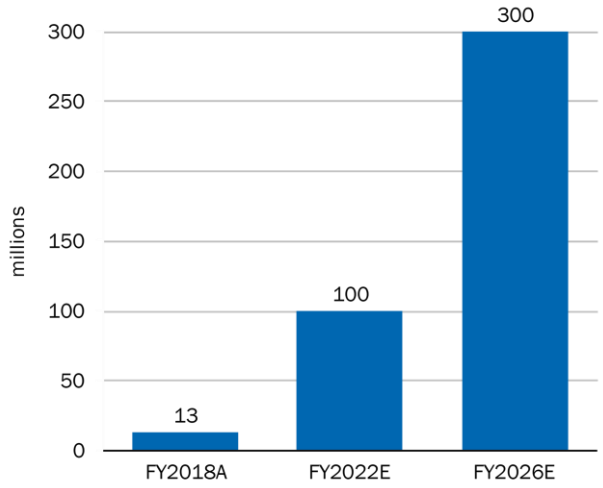
The IoT service revenues are expected to be split across the value chain of connectivity service, communication hardware, device, hardware installation, application, platform and systems integration. The value captured by companies would vary based on their capabilities and their areas of play in the value chain.

Forecast by technology

A number of different IoT technologies currently exist globally, each with different identified use cases depending upon their distinguishing capabilities and limitations. Static use cases such as smart meters, street lights etc. require very low bandwidths (<10Kbps) and can work well on LPWA technologies such as LoRa, Sigfox and NB-IoT. LTE-M and 2G are more suited to supported use cases such as fleet tracking, smart grids and smart watches which require mobility and/or a relatively higher bandwidth (100Kbps). For use cases which require high data throughput (>1Mbps) such as CCTV cameras and connected cars, 4G is more appropriate, with potential for 5G in the future.

The current Indian IoT market primarily focussed on cellular technologies (2G, 3G, 4G), with some use of other LPWA technologies such as LoRaWAN. However, going forward, the split of IoT connections by technologies is expected to change substantially.

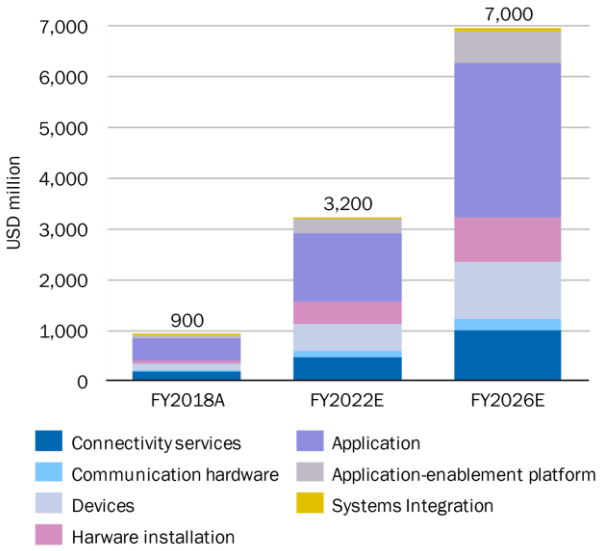
Figure 6: Forecast of total IoT connections [Source: Analysys Mason, 2018]



LPWA technologies such as NB-IoT and LTE-M are expected to gain significant traction, as also highlighted in recent press announcements of NB IoT roll-out plans of several Indian mobile operators. We expect that NB-IoT will be deployed at scale in future, although the support for other technologies will continue nevertheless.

Among cellular technologies, 2G is expected to grow initially, and then stabilise and decline. This will be driven by migration to other efficient technologies such as 4G and LTE-M. The number of 3G/4G connections are expected to grow strongly, with application in automotive and fleet sectors that may require higher bandwidth, and where benefits outweigh the higher associated costs.

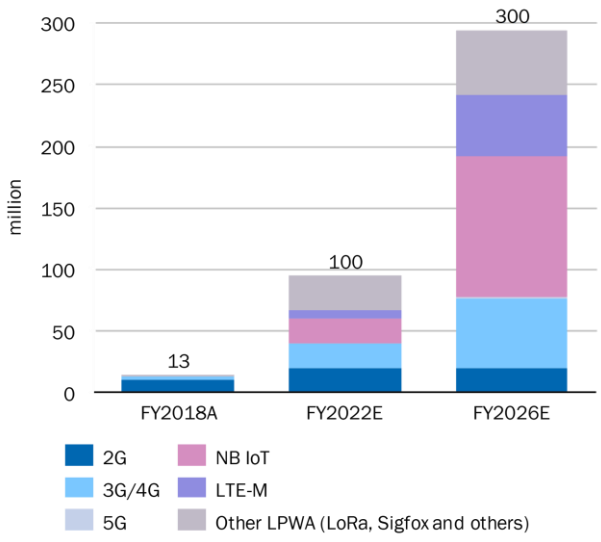
Figure 7: Forecast of IoT service revenues and split across value chain [Source: Analysys Mason, 2018]



Large-scale 5G IoT applications are expected to emerge after 2025, once the wide-scale network deployment happens and the ecosystem is ready. While 5G is often touted as an optimal platform for massive machine-type connections, there

will be few IoT applications initially that will either support the higher costs or require the attributes it provides. Self-driving vehicles will be the primary mass-market application to utilise 5G. While high-end cars will have 5G embedded reasonably early on to ensure that they are future-proofed, it will take time for such application to penetrate the mass market. The adoption will also be dependent on evolution of road infrastructure and regulations in the country, along with replacement cycles of the vehicles. Migration from other IoT technologies to 5G may get constrained by long lifecycles and contract lengths. Therefore, we forecast number of 5G connections by FY26 to be 1 million, contributing to USD42 million of service revenues for the total value chain.

Figure 8: Forecast of IoT connections by technology, including 5G [Source: Analysys Mason, 2018]



Industry views on 5G readiness of India

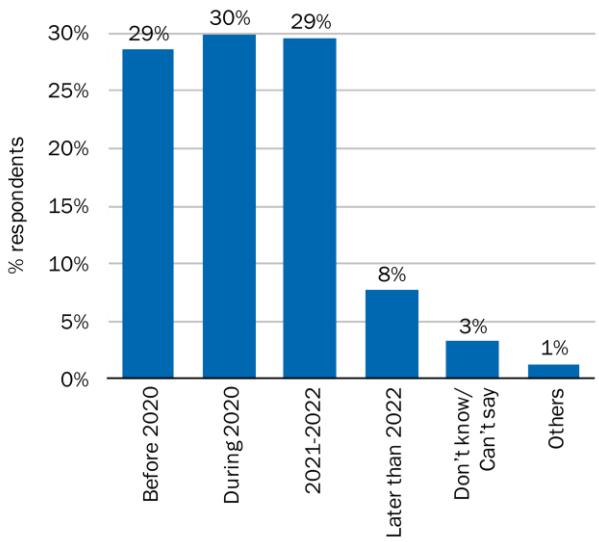
ETTelecom conducted a survey within its subscriber base to get perspectives from Telecom professionals on India's 5G readines. The section below is based on responses from 312 respondents and additional perspectives from interviews conducted by ETTelecom and Analysys Mason in the last 2 months with Telecom industry leaders and policy makers.

Expectations on the commercial launch of 5G, relevant use cases, challenges and key industries that will be impacted in India

► *Commercial launch of 5G in India*

As shown in *Figure 9*, a significant majority (88%) of the respondents believe that 5G will be ready for commercial launch during or before 2022. Interestingly, 50% of the respondents who work at a telecom equipment vendor firm (Nokia, Ericsson) believe that 5G will be deployed during 2020.

Figure 9: Expectation of 5G commercial launch in India [Source: Analysys Mason, ETTelecom]



While COAI (industry association that represents Bharti Airtel, Vodafone, Idea and Reliance Jio) has said that 5G spectrum auction should happen only around the second half of 2019, TRAI Chairman, Mr. R S Sharma, is of the view that spectrum is a perishable resource and hence should be auctioned at the earliest.

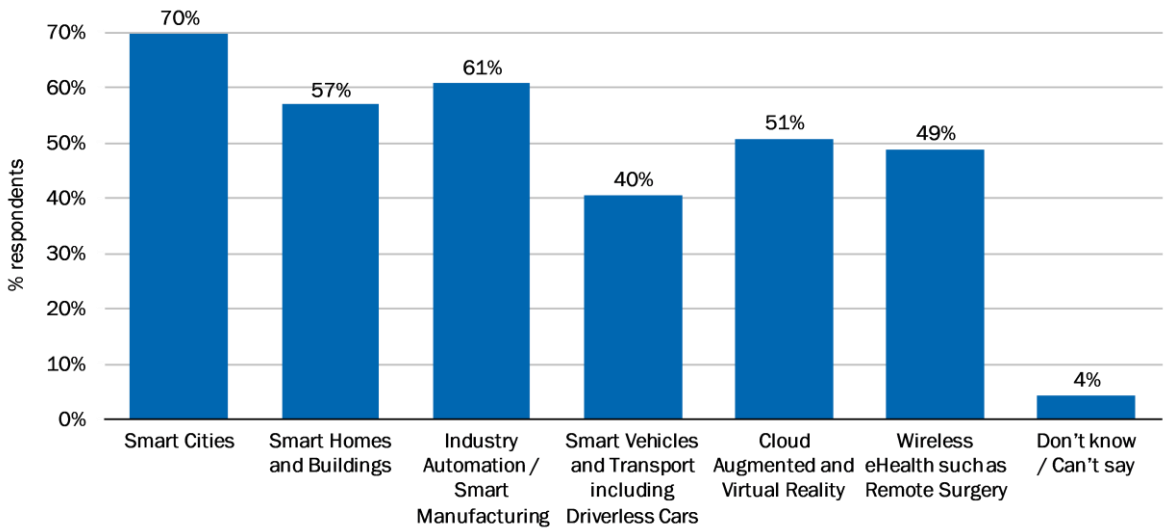
TRAI Secretary, Mr. Sunil K Gupta, believes that 5G is an upcoming technology and expects it to be launched in India by 2020-2021.

► *Use cases of 5G in India*

As shown in *Figure 10*, a large proportion of respondents believe that smart cities (70%) and high-speed broadband at home (69%) are relevant use cases of 5G in India. A significant proportion (>50% each) also believe that smart manufacturing, smart home and cloud, AR/VR are relevant. Respondents working at telecom equipment vendors believe high-speed broadband at home to be the most relevant use case with 85% responding positively. Smart cities are the most relevant use case according to respondents currently working at MNOs (Airtel, Idea, RJIO, etc.), with 78% mentioning it as a relevant use case. Some users, however, mention that basic use cases of internet browsing are going to remain the most relevant use case –

- "Internet browsing and applications on mobile phones (Average India is happy with faster speed on phone). Other deployments on IoT and medical areas are not of (sic) much preferred when it comes to 5G"

Figure 10: Most relevant 5G use cases in the Indian context [Source: Analysys Mason, ETTelecom]



According to Ms. Harmeen Mehta, the Global CIO of Bharti Airtel, Smart City is going to be a focus area for Airtel and the government can play a big role in the space.

► *Challenges to 5G adoption in India*

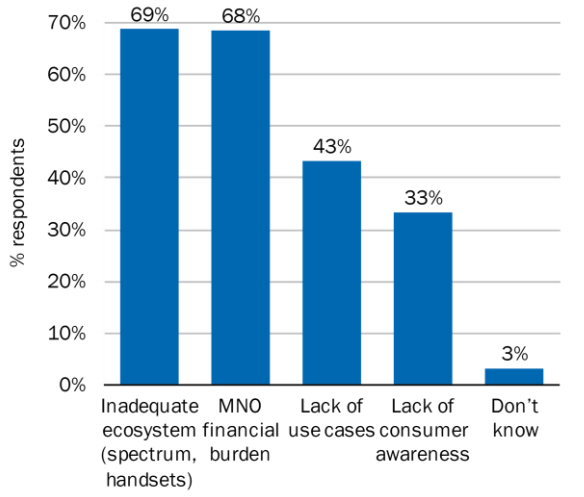
As shown in *Figure 11*, a large proportion of the respondents believe that an inadequate ecosystem in terms of spectrum and handsets (69%) and the financial burden on MNOs (68%) are the major challenges to 5G adoption in India. Moreover, 89% of the respondents working at C-level roles believe the financial burden on MNOs to be a major challenge. Some respondents mentioned telecom infrastructure as a major challenge as well –

- "passive infrastructure such as towers, Optical fiber cable"
- "lack of Fiber for backhaul"

According to the TRAI Chairman, Mr. R S Sharma, the critical challenges being faced by the sector are Right of Way (RoW) and the need to have a robust backhaul. Only 22% of towers in India are fiberised and 5G requires a fibre backhaul. Infrastructure sharing is another area that needs focus, and while tower sharing has already happened, fibre sharing is another possibility that could be looked at.

Juergen Hase, chief executive of Unlimit, Reliance ADAG's IoT company, believes that deferring the sale of 5G spectrum sale to FY20 would be beneficial in the long run because it will allow critical 5G device ecosystem to develop and will also lead to economies of scale benefits once large-scale rollout happens in other large and mature global markets.

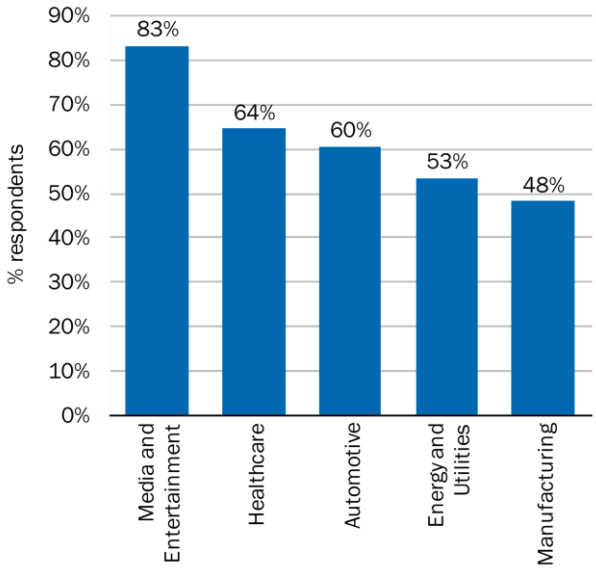
Figure 11: Challenges to 5G adoption in India [Source: Analysys Mason, ETTelecom]



► *Industries expected to benefit from and drive 5G adoption in India*

Media and Entertainment driven by higher throughput on mobile broadband is believed to be the industry that will benefit from 5G and drive adoption by a large majority of the respondents (83%). Healthcare (64%) and Automotive (60%) are other industries which the respondents feel will benefit from 5G and drive its adoption.

Figure 12: Industries expected to benefit from 5G and drive 5G adoption [Source: Analysys Mason, ETTelecom]



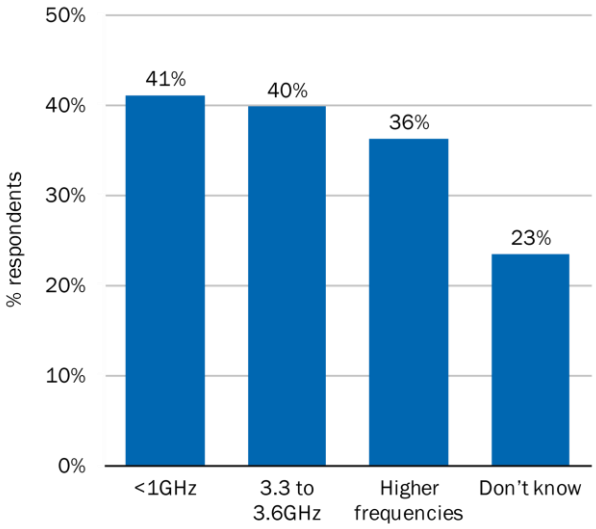
Ms. Harmeen Mehta, the Global CIO of Bharti Airtel, mentions that while Airtel maybe leading on the energy and utilities side (in the IoT space), it is also going to be heavily involved with the automotive side as well (for IoT). She also mentions that IoT products and services like autonomous car or remote surgery require very low latency and wouldn't be possible without a 5G network.

Expectations on the technological and operational aspects of deployment

► *Preferred spectrum band for 5G deployment in India*

There is a mixed response from respondents in terms of their expectations on the key spectrum

Figure 13: Expectation on the key spectrum bands for 5G deployment [Source: Analysys Mason, ETTelecom]



bands that would be preferred for 5G deployment with no clear spectrum band getting more than 50% positive response. However, 67% of the respondents working at C-level positions expect the sub-1GHz band to be the preferred for 5G deployment.

The Telecom Minister, Mr. Manoj Sinha, mentions that the Arogyaswami Paulraj committee has made recommendations on the bands fit for 5G deployment and the DoT will take a decision keeping all aspects in mind. The committee has spotted spectrum for 5G across 11 bands of which 4 (700MHz, 3.5GHz, 24GHz and 28GHz) can be made immediately available for the service. The committee has also recommended that the government should identify spectrum for 5G services in the 600MHz, 1.4GHz, 30GHz, 31GHz and 37GHz bands, while also exploring the feasibility of 5G

spectrum for the service in 500MHz and 3.7Ghz bands.

The TRAI Secretary, Mr. Sunil K Gupta, believes that 3.3GHz-3.6GHz spectrum bands would be important for the provision of high-speed bandwidth services considering the requirement for ultra-high-speed broadband, Machine-to-Machine (M2M) offerings and newer applications.

► *Technologies crucial towards the deployment of 5G in India*

According to the respondents (*Figure 14* below), fibre backhaul (68%) is clearly the most important technology which could be crucial towards deployment of 5G. Ultra-dense network of small cells (50%) and Massive MIMO (48%) are other technologies that respondents believe could be crucial. Moreover, 82% of the respondents working at MNOs believe fibre backhaul to be a crucial technology, while 85% of those working at telecom equipment vendors believe the same.

► *Role of legacy technologies (2G and 3G) by 2025*

As in *Figure 15*, 53% of the respondents believe legacy technologies (2G and 3G) could still co-exist with 4G and 5G by 2025, while 40% believe they will be replaced. However, 67% of the C-level respondents believe legacy technologies will be replaced and, on the other hand. Several users also point out that while 3G will be replaced, 2G will continue to co-exist –

- "2G will continue for voice services while 3G might die off."
- "3G can be replaced and 2G could be there for voice calls purpose if no 4g or 5g coverage in that specific area."
- "Can't say about 3G, but 2G still has applications in low power device. The key challenge for low power device manufacturers is power management and 3G, 4G, and 5G needs lot of power to operate."

Figure 14: Technologies which could be crucial towards deployment of 5G [Source: Analysys Mason, ETTelecom]

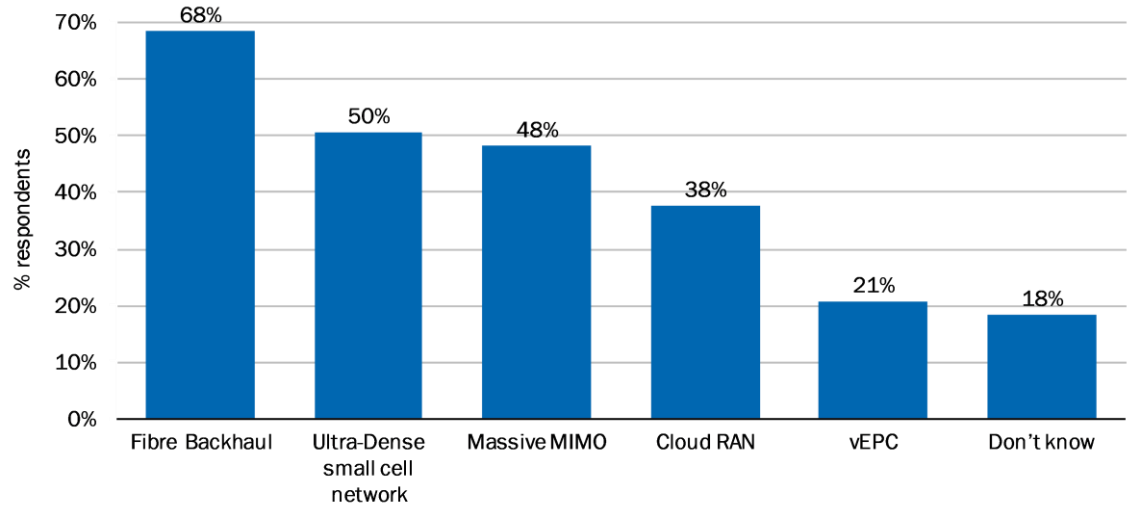
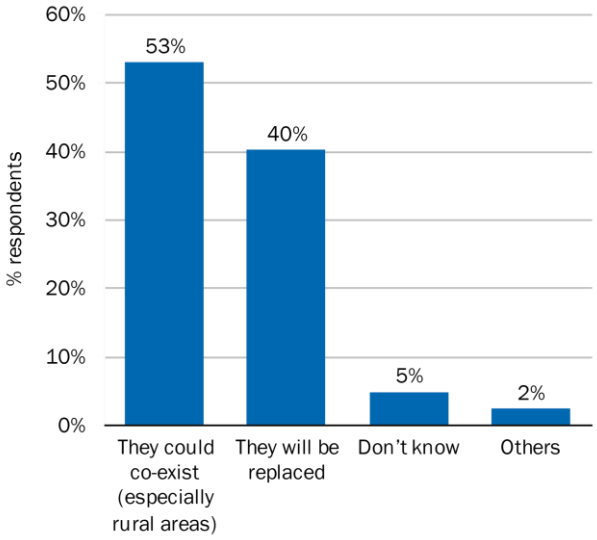


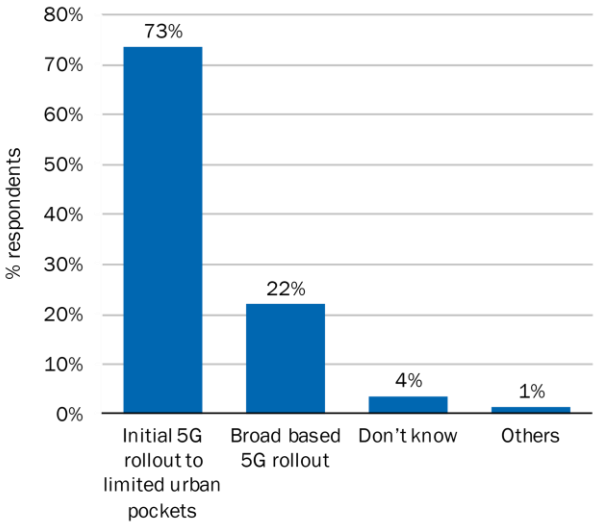
Figure 15: Role of legacy technologies (2G, 3G) by 2025 [Source: Analysys Mason, ETTelecom]



► *Operational aspects of 5G deployment in India*

A clear majority (73%) of the respondents believe that the initial rollout of 5G would be limited to urban pockets. The same expectation is prevalent across various segments of respondents, with an even larger proportion of C-level respondents (89%) believing the same.

Figure 16: Expectations on the way MNOs will deploy 5G [Source: Analysys Mason, ETTelecom]

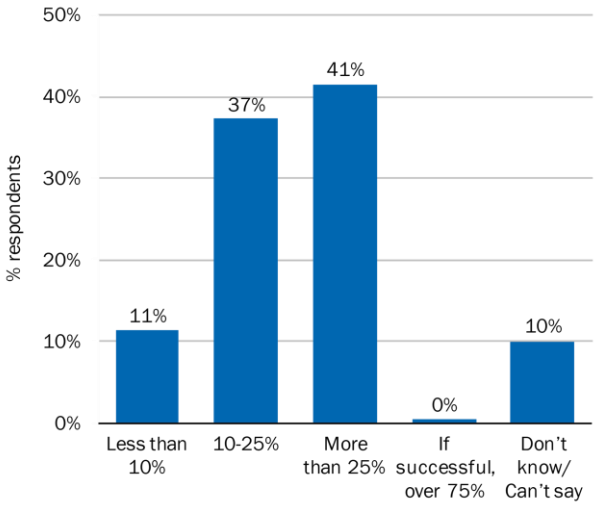


Impact of 5G deployment on the Telecoms industry

► *Proportion of operator revenues from 5G by 2023*

Respondents are relatively optimistic on the impact of 5G on operators with ~80% believing that 5G could account for more than 10% of operator revenues by 2023.

Figure 17: Percentage operator revenues that could come from 5G by 2023 [Source: Analysys Mason, ETTelecom]



► *Potential cannibalisation of fixed broadband in India due to 5G deployment*

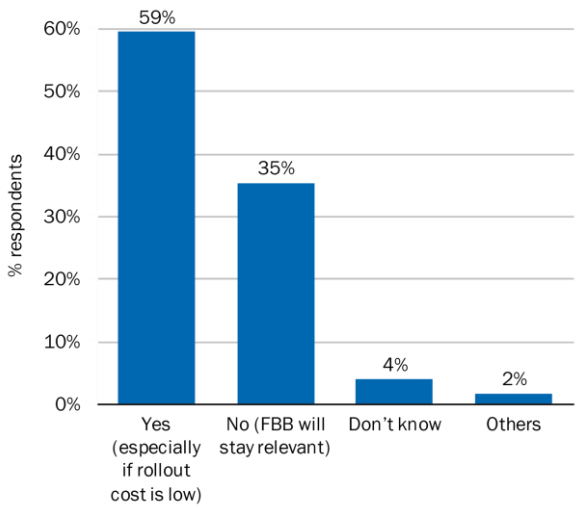
Majority of the respondents (59%) believe that 5G could cannibalise fixed broadband in India if it can offer high-speed broadband.

- "4G/3G present low pricing has replaced my Broadband & with 5G it would replace majority of fixed BB lines and also it will make hybrid (Fixed+wireless) networks more popular."

However, 35% of the respondents believe that that is not going to be the case and fixed broadband will remain relevant in the market.

- "Although 5G rollout may happen but it will be with limited potential which will not at all replace fixed broadband."

Figure 18: Potential for cannibalisation of fixed broadband in India by 5G [Source: Analysys Mason, ETTelecom]



Perspectives from telecom industry leaders and policy makers

"Although we have not reached a stage where 5G is the immediate need of the hour, we are not laggards in the work that is being done on 5G. We are not in those times when we started our 3G and 4G years later than others."

- Mr. Manoj Sinha, Telecom Minister

"We are seeing a couple of challenges like Right of Way (RoW) and the need to have a robust backhaul. Only 22% towers are connected to backhaul. 5G needs fibre.

Infrastructure sharing is another area that needs focus."

"Our view is that spectrum is a perishable resource and if it is not used today, it cannot be used tomorrow."

- Mr. R S Sharma, TRAI Chairman

"5G is an upcoming technology which is expected to be launched by 2020-2021, and considering ultra-high-speed broadband, Machine-to-Machine (M2M) offerings and newer applications, spectrum in the 3300-3600 MHz would be important for the provision of high-speed bandwidth services"

- Mr. S K Gupta, TRAI Secretary

"Our network is already geared towards 5G given deployment of vEPC and massive MIMO"

- Mr. Vishant Vora, Chief Technology Officer, Vodafone Idea Limited

"Airtel may be leading on energy and utility side (in the IoT space) but is going to be heavily involved with the automotive side as well. Smart City is going to be a focus for Airtel"

- Ms. Harmeen Mehta, CIO, Airtel

"5G spectrum auction should happen only around the second half of 2019 by which time telcos could stabilise from their current financial stress and the 5G handset ecosystem could develop further"

- COAI

Further reading

Analysys Mason regularly publishes reports and articles about 5G. The following reports (and others on our website, http://results.analysysmason.com/search?w=5g) are available free of charge (samples only for the reports):

Unlocking 5G
http://www.analysysmason.com/About-Us/News/Newsletter/unlocking-5g-Apr2018/

China holds narrow lead in global race to 5G
http://www.analysysmason.com/About-Us/News/Press-releases/china-holds-narrow-lead-in-global-race-to-5G-Apr2018/?bp=%252fPress%252f

The 700MHz band may largely be used for mobile in Europe by 2020, but 5G everywhere by 2025 is unlikely
http://www.analysysmason.com/About-Us/News/Newsletter/the-700mhz-band-by-2020-Jul18/

Authorising 26GHz spectrum for 5G use
http://www.analysysmason.com/Research/Content/Reports/authorising-26ghz-spectrum-for-5g-use/

A spectrum roadmap towards 5G:
http://www.analysysmason.com/About-Us/News/Insight/a-spectrum-roadmap-towards-5g/#16%20March%202017

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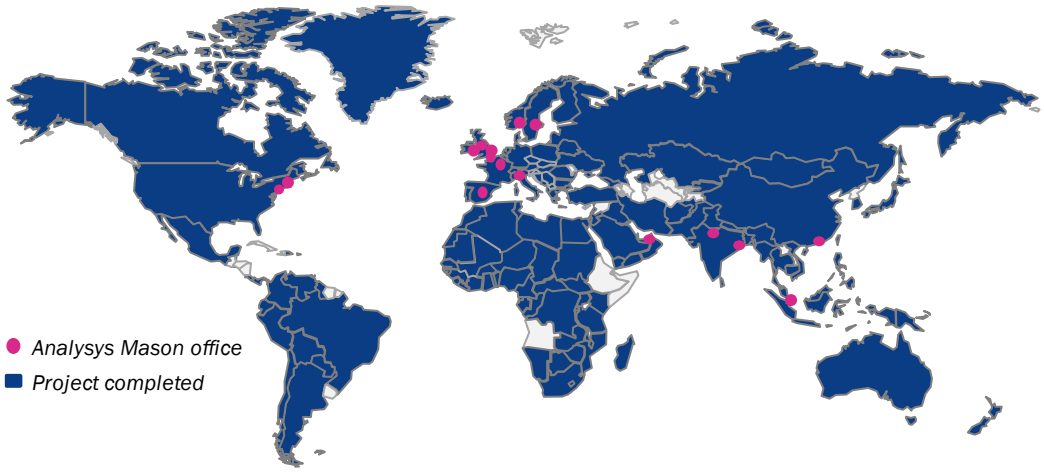

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