INDEPENDENT COMMUNICATIONS
AUTHORITY OF SOUTH AFRICA

The State of 5G in South Africa

From Readiness to Recommendations

2021

Foreword

5G, the fifth-generation standard for wireless communications, has, along with the notion of the Fourth Industrial Revolution, become a buzzword and a hype, an optimistic horizon beyond the dark cloud of the Covid-19 pandemic.

The Fifth Generation (5G) Council Committee of the Independent Communications Authority of South Africa ("ICASA/Authority") was tasked with preparing an annual report on the current status of 5G in South Africa.

This report derives both from research undertaken internally within the Authority, and from a survey sent out to stakeholders in the sector who are members of the 5G Forum. It sets out to ascertain the current state of the 5G landscape in the country, examining the status of current infrastructure and its readiness, identifying the associated spectrum requirements and challenges, and examining use cases and opportunities which may facilitate the deployment and uptake of 5G networks in the service of national economic development and social upliftment.

The report aims to assist in establishing a baseline position for the development of 5G infrastructure and services across the country. Further, it aims to set the scene for legislative and regulatory approaches intended to facilitate the implementation of 5G technologies as and when required. Its recommendations will, we hope, assist in enabling South Africa's deployment and uptake of 5G infrastructure and services in the national interest.

Thanks go to the team that worked as a collective in the preparation of the report - in particular, Project Leader Bomkazi Somdyala and Project Manager Pumla Ntshalintshali, supported by and with contributions from the members of the project team, Roshan Algu, Refiloe Motsoeneng, Keitumetse Setshedi, Silas Phoshoko, Ncele Phutha, Mandla Mchunu, Nsizwa Gumede, Tshegofatso Magano, and Joyce Malimavhi. Without them this report would not have happened.

Thanks also in particular to Cllrs Charley Lewis and Yolisa Kedama, Chair and Deputy Chair of the Council 5G Committee. Without their leadership and active participation, this project would have been the poorer.

Dr Keabetswe Modimoeng, Chairperson

Executive Summary

This research report provides an analysis and evaluation of the current status, readiness, and prospects for 5G in South Africa.

The report emanates from initial thinking about the state of 5G readiness in South Africa and is informed by a stakeholder survey, conducted amongst the members of the 5G Forum. Accordingly, the objective of the survey is to benefit the ICT sector at large in order to pave the way to get South Africa fully ready to roll out and benefit from 5G.

The analysis in relation to the state of 5G infrastructure readiness reveals that there are constraints in terms of current 4G infrastructure deployments, restricting the ability to achieve 5G capabilities. These include the fact that the Authority has not yet adopted relevant standards for 5G user and network equipment. As a result, the majority of base stations and CPE equipment have not been fully type-approved.

An analysis of possible use cases for 5G reveals that there is much expectation that the quality of Internet coverage will improve significantly, and the cost of broadband services will reduce drastically. This will open the way to a wide range of use cases for 5G, including improved remote working, enhanced distance learning, telemedicine and e-health, surveillance and cybersecurity, manufacturing, and financial services.

The analysis in relation to spectrum management concludes that 5G will be enabled by new radio technologies, stable and secure sources of power, and greater availability of spectrum. Fragmented frequency bands have been identified as something that will have adverse effects on the deployment and uptake of 5G. A minimum of 80-100 MHz of contiguous spectrum in the mid-bands, and 400 MHz to 1GHz in the high bands, is needed to fully enable 5G, and to achieve speeds that are twenty times faster than current 4G technologies. Current spectrum assignments do not necessarily maximise benefits for industry players. Further, affordability has been raised as a concern regarding spectrum pricing and fees.

An examination of the role and functioning of the 5G Forum concludes that the structure of the South African body is in line with its international counterparts. The membership structure is also aligned not only with international 5G forums, but with the recommendations presented by stakeholders as well.

In respect of policy and regulation, the analysis reveals that access to wayleaves is a key issue for the respondents.

The respondents also viewed the issue of 5G security as being important for the adoption and success of 5G.

Recommendations discussed include the following:

- It is recommended that a **clear framework for infrastructure deployment** be put in place, covering the standardisation of a digitised wayleave and right-of-way approval processes.
- It is recommended that the Authority should ensure the relevant **5G standards** are added to the Official List of Regulated Standards. A new paradigm in the **type approval** process is recommended.
- Fixed Wireless Access and Satellite are recommended options to help bridge the **digital divide** in areas where optical fibre cannot be deployed.
- **5G use cases** recommended for South Africa include improved remote working, enhanced distance learning, telemedicine, surveillance and security, agriculture, mining, manufacturing, and financial services.
- It is recommended that a **minimum contiguous assignment** of 80-100 MHz of spectrum in the mid-bands, and 400 MHz to 1GHz in the high bands, is needed to enable optimum, high-speed 5G services. There is a need for **defragmentation** and clearing of prime bands across all band ranges that have been identified for 5G.
- The Authority needs ensure the **renewal of spectrum licences** to provide certainty to the industry and to facilitate network investment and enable planning.
- **Spectrum pooling** is recommended to maximise benefits of available spectrum, as there is not enough bandwidth for all the mobile operators.
- **Spectrum trading** is also recommended to promote efficient spectrum use, as it allows spectrum rights to be transferred to those who will use spectrum efficiently.
- It is recommended that auction **spectrum prices** be reduced, and that the AIP spectrum formula be adjusted to reduce the cost of using large, contiguous blocks of high band spectrum.

- The issue of **spectrum assignment** for **industry verticals** in priority 5G bands needs further research and investigation in order to develop an approach that caters for all stakeholders.
- It is further recommended that the Authority should take an active role in facilitating alternative **sources of power supply** to enable 5G in the communities where there are electrification challenges.
- It is recommended that, for the **South African 5G Forum** to become an effective collaboration research hub, collaboration needs to be strengthened, research be conducted, and more frequent meetings be arranged.
- A concerted public information campaign in collaboration with the Ministry, the Regulator, and private sector and civil society stakeholders, is needed to address the prevalence of 'fake news', **misinformation and disinformation** regarding 5G.
- It is recommended that the following be adopted to mitigate a range of **cybersecurity risks**:
  - designing security into policies, regulations and processes through the amendment of the Electronic Communications Act, 2005 (Act No 36 of 2005), as amended, ("ECA") and the Protection of Personal Information ("POPI") Act, No 4 of 2013;
  - Screening be undertaken of potential suppliers, to assess their risk profiles, and to ensure that the risk posed to the 5G network is minimised;
  - South Africa should consider adopting 5G assurance specifications and 3GPP security architecture guidelines, which have been tried and tested.

Contents

1 Introduction

5G is a catalyst for innovation, giving an opportunity to industry and service providers, communities, and individuals to advance their digital agendas towards economic growth, job creation and socio-economic development.

The role of the 5G in South Africa cannot be understood independently from the current state of industrialisation, the role of politics and stakeholder organisations, state relationships, multilateral agreements, and more.

This report by ICASA, 'The State of 5G in South Africa: From Readiness to Recommendations', emanates from initial thinking about the state of 5G readiness in South Africa, and aims to benefit the ICT sector at large in order to pave the way to get South Africa fully ready to roll out and benefit from 5G.

The report is structured around two approaches:

- An internal analysis conducted by ICASA identified and summarised key areas pertaining to the deployment and uptake of 5G infrastructure and services in South Africa;
- A stakeholder survey canvassed views and information from players active in the sector in relation to the key areas identified above.

The substance of the report and its associated survey therefore covers 6 sections, as follows:

- Section 1: Demographics
- Section 2: 5G Infrastructure Readiness
- Section 3: 5G Use Cases for South Africa
- Section 4: Spectrum Management for 5G
- Section 5: The 5G Forum and
- Section 6: Policy, Regulation and General

1.1. Questionnaire

A draft questionnaire was developed by the ICASA 5G Council Committee, and initially circulated to the chairpersons on the various working groups of the 5G Forum for their input, feedback and validation.

Subsequently a revised version of the questionnaire was sent out to all members of the 5G Forum, inviting their responses.

Some of the questions were very specific, whilst others were open-ended.

1.2. Responses

A total of 16 responses were received from industry stakeholders, broken down below by stakeholder sector (note that some respondents fall into more than one sector category). This represents a low rate of return, but covers stakeholders from most of the main sectors.

Sector	Number of Responses
Academic / Research	1
ECNS Licensee	4
ECS Licensee	4
Equipment Supplier	5
End User	
Government / Regulatory	
Operator	6
Standards Body	1
Other, please specify	4

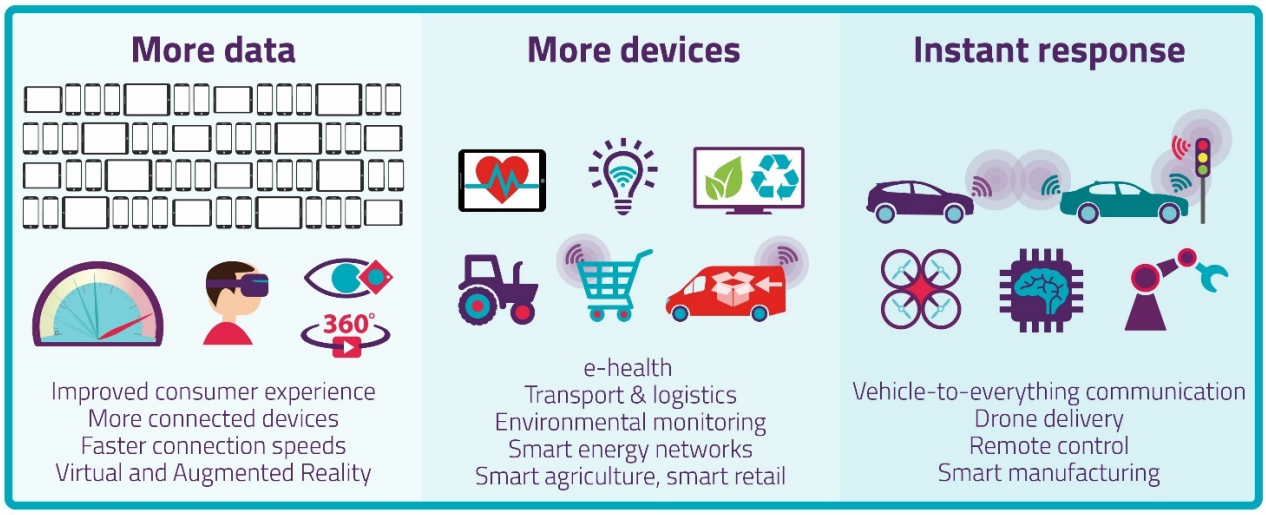
2 5G Infrastructure, Technologies and Standards

5G, the fifth-generation technology standard for broadband cellular networks, developed under the umbrella of the 3rd Generation Partnership Project (3GPP), is the planned successor to fourth generation (4G) networks. Mobile providers began deploying 5G worldwide in 2019, with some 162 commercial 5G networks across 38 countries launched by early 2021, and over 400 5G-compliant devices now commercially available[1].

5G networks are characterised by high speed data throughput, low latency and massive availability of bandwidth. This translates to a highly responsive network, capable of high levels of densification, and catering to large volumes of data.

High density. 4G can't "connect everything" as we intend to do with homes, cars and wearables, not to mention industrial devices.

Figure 1: Some Characteristics of 5G networks



Source: Ofcom[2]

5G offers theoretical peak downlink speeds of 20Gbps, support for one million devices per square kilometre and latency as low as 0,5 ms[3]. It will leverage all three spectrum layers (i.e. Coverage Layer, Coverage and Capacity Layer, and Super Data Layer). The "Coverage Layer" exploits spectrum below 2 GHz (e.g. 700 MHz),

[1] GSA (2021) '5G - 5G Market Snapshot: April 2021 – Member Report', Global Mobile Suppliers Association, https://gsacom.com/paper/5g-market-snapshot-april-2021-member-report/.
[2] Ofcom (nd) 'What is 5G', https://www.ofcom.org.uk/phones-telecoms-and-internet/advice-for-consumers/advice/what-is-5g.
[3] ITU (2017) 'Minimum requirements related to technical performance for IMT-2020 radio interface(s), https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-PDF-E.pdf.

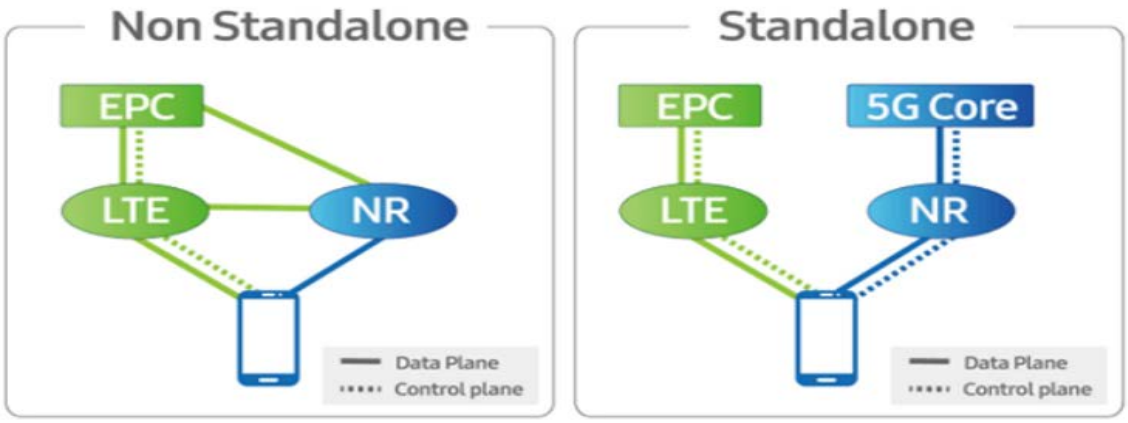
providing wide-area and deep indoor coverage. The "Coverage and Capacity Layer" relies on spectrum in the 2 - 6 GHz range to deliver the best compromise between capacity and coverage. The "Super Data Layer" relies on spectrum above 6 GHz, addressing specific use cases that require extremely high data rates.

Global applications for 5G include: high resolution virtual reality (VR); video gaming and augmented reality (AR); autonomous vehicle technologies; smart city and smart health applications, all supported under Enhanced Mobile Broadband (eMBB), Ultra Reliable & Low Latency Communications (URLLC), and Massive Machine-type Communications (mMTC) technology services. These services are key enabling technologies for the much awaited Fourth Industrial revolution (4IR). Further to this, 5G will have a huge impact on Big Data by accelerating data collection with high implications for cloud storage, machine learning, artificial intelligence (AI), 3D printing and data-analytics , thus providing actionable insights that can be applied in several societal and industrial applications. The high speeds that come with 5G offer the level of connectivity needed to realise many of the technologies of the so-called 4IR.

These different services have different requirements in terms of speed, coverage and reliability, which in turn will demand different network solutions (the evolution of existing network, and potentially the creation of new networks) and different deployment models (including many small cells), an appropriate network infrastructure (which will include both fibre and wireless connectivity to the core network) and access to different spectrum bands.

Deployment of 5G follows two different standard deployment pathways: either standalone (SA), where a single 5G generation of radio access technology is rolled out; or non-standalone (NSA), where two generations of radio access technologies (4G/ LTE and 5G) co-exist, using the existing network's control functions (see Figure 2). It should be noted that NSA will use frequency ranges that overlap with 4G LTE frequencies.

Figure 2: High level architecture of 5G Network Deployment Standards



Source: GSMA[4]

Considering that 5G is intended to support converged communications and computing across public networks, within the 5G architecture end-to-end (E2E) network slicing, service-based architecture, Software-Defined Networking (SDN), and Network Functions Virtualisation (NFV) Massive MIMO, Beamforming, Full Duplex are the fundamental pillars/enablers or mobile technologies that will support the heterogeneous key performance indicators (KPIs) of the use cases in a cost-efficient way[5].

[4] GSMA (2019) 5G Implementation Guidelines, https://www.gsma.com/futurenetworks/wp-content/uploads/2019/03/5G-Implementation-Guideline-v2.0-July-2019.pdf

[5] 5GPPP (2019) '5G PPP Architecture Working Group: View on 5G Architecture, https://5g-ppp.eu/wp-content/uploads/2019/07/5G-PPP-5G-Architecture-White-Paper_v3.0_PublicConsultation.pdf

3 The State of 5G Readiness: SA

3.1 5G Infrastructure Readiness

On a global scale, with 5G services now widely available, and mobile 5G deployments under way in all regions, operators, service providers and users alike are facing the early phase of massive 5G adoption. This section is aimed at understanding the current state of readiness of South Africa's ICT infrastructure for the rollout and uptake of 5G across the country, and to identify issues and areas where policy and regulatory intervention may be required.

3.1.1 Current Status of Network Infrastructure

The 5G network demands substantial infrastructure deployment to meet its requirements (dense small cells, Massive Multiple-Input Multiple-Output (MIMO) capacity and millimetre wave spectrum). There is a need for South Africa to realise the most cost-effective deployment solutions, which will entail different scenarios for different geographical areas (e.g. dense urban, peri-urban, informal settlements and rural areas).

Several South African mobile network operators (i.e. MTN, Vodacom, Rain, Liquid Telecom) have already deployed non-standalone and commercial-standalone 5G networks. This was largely through the allocation of spectrum approved by the Authority, on a temporary basis, for operators to meet increased traffic demands and increased utilisation of spectrum during the Covid-19 pandemic. It is evident that this could exacerbate the digital divide, as the initial deployments are in urban areas (namely: Cape Town, Pretoria, Durban, Johannesburg, Gqeberha / Port Elizabeth, Port Alfred, Hopetown, Virginia, Queenstown and Tsantsabane[6].

Government policy documents have repeatedly identified[7] that, despite the policy and regulatory framework, network roll-out remains skewed towards urban areas – and the prospects of providers rolling out modern broadband services in rural and less affluent

[6] Africa Analysis (2021) 'South Africa 5G Market Outlook Report', available via https://africaanalysis.co.za/2021/02/16/2021-south-africa-5g-market-outlook-report/.

[7] Cf: NPC (2012) 'National Development Plan 2020', http://www.npconline.co.za/MediaLib/Downloads/Downloads/NDP 2030 - Our future - make it work.pdf; DoC (2013) 'South Africa Connect: Creating Opportunities, Ensuring Inclusion – South Africa's Broadband Policy', Government Gazette No 37119, https://www.ellipsis.co.za/wp-content/uploads/2013/10/NBP-2013.pdf; DoC (2015) 'National Integrated ICT Policy Review Report', https://www.dtps.gov.za/index.php?option=com_phocadownload&view=category&download=477:ict-review-report-march-2015&id=102:ict-policy-review-reports-2015&Itemid=143

areas without government intervention are minimal. According to the White Paper[8], the main challenges that have underpinned the rural digital divide include an ineffective policy regime, the concentrated broadband infrastructure market and the high cost to communicate.

There is considerable concern that the rollout of 5G could simply serve to aggravate the digital divide[9]. For example, in sub-Saharan Africa less than half the population has access to mobile services, and the dominant technology remains 2G[10]. Even in South Africa, around a third of subscribers do not have access to a smartphone[11].

To mitigate this challenge different deployment options have been researched and adopted. Even though fibre is the most reliable terrestrial transmission technology for both access and backhaul networks, and will see to the achievement of the speeds, services and applications from 5G, Fixed Wireless Access (FWA) is a compelling alternative to wired solutions, such as next generation cable, copper-based Giga-fast and various fibre topologies (FTTx)[12].

Use cases and operating environments demand a consideration of several extreme factors, including the diversity of settlement patterns, ranging from low density rural areas to rapidly expanding ultra-dense conurbations, as well as informal settlements with highly unreliable or non-existent power grid networks. This could be mitigated by making use of spectrum sharing (such as TV Whitespaces (TVWS) and dynamic and opportunistic spectrum access (DSA)), FWA, and satellite access and backhaul.

Considering the 5G use cases such as eMBB, URLLC and mMTC, satellite will play an important complementary role. Mobile network operators will be able to complement their 5G services with satellite connectivity to offload their terrestrial networks on a large scale. In the words of one report:

> *they will be able to take advantage of satellite's inherent multicasting/broadcast functionality for new use cases, such as connected*

[8] DTPS (2016) 'National integrated ICT Policy White Paper', Government Gazette No 40325.
[9]Bloom, P (2019, 18 April) '5G won't reduce the digital divide and might even make it worse', https://www.rhizomatica.org/5g-wont-reduce-the-digital-divide-and-might-even-make-it-worse/
[10] GSMA (2020) 'The Mobile Economy: Sub-Saharan Africa 2020', https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/09/GSMA_MobileEconomy2020_SSA_Eng.pdf
[11] ICASA (2021) 'The State of the ICT Sector Report in South Africa, https://www.icasa.org.za/uploads/files/State-of-the-ICT-Sector-Report-March-2021.pdf.
[12] Ofcom (2018) 'Review of spectrum used by fixed wireless services', https://www.ofcom.org.uk/__data/assets/pdf_file/0017/115631/statement-fixed-wireless-spectrum-strategy.pdf.

cars, while preserving high-value wireless spectrum for latency-sensitive services. Alternatively, they can use satellite's longer range to complement the buildout of 5G in remote areas where building terrestrial networks for enhanced broadband services is simply too cost prohibitive.[13]

Infrastructure sharing is another key solution to facilitate quick deployment of 5G networks and to bridge the digital divide, considering the high cost of up-front investment required to deploy a mobile network. Various forms of network sharing can assist by lowering barriers to entry and by ramping up the speed of deployment. As the GSMA notes:

Network sharing may take many forms ranging from passive sharing of cell sites and masts to sharing of radio access networks and other active elements such as network roaming and the core network. Network sharing can enhance competitiveness in the telecommunication sector by reducing investment costs.[14]

In South Africa, the success of an MNO, and particularly that of the smaller operators, is directly linked to their access to key infrastructure. Regulators are required to balance the objective of accommodating smaller rivals against the potential advantages of sharing arrangements and consolidation. To date, smaller rivals do not seem to have been profitable.[15]

South Africa needs to develop innovative regulatory and nationally streamlined policy frameworks to accelerate new business creation, network and spectrum innovations and broadband Internet service deployments.

3.1.2 Stakeholder Response Analysis

The stakeholder questionnaire posed a number of questions covering issues pertaining to the readiness of South Africa's infrastructure for the rollout and adoption of 5G. In the section below, we summarise the responses to these questions in the survey. Some

[13] iDirect (2019) 'The 5G Future and the Role of Satellite', https://www.idirect.net/wp-content/uploads/2019/01/The-5G-Future-and-the-Role-of-Satellite-White-Paper-2019.pdf

[14] GSMA (2012) Mobile infrastructure sharing, https://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf

[15] Hawthorne, R. (2014). 'Review of economic regulation of the telecommunications sector', https://ryan-hawthorne.squarespace.com/s/1400407_EDD-UJ_RECBP_ProjectReport_App10_TelecommunicationsSectorReview_Final.pdf

stakeholders did not respond to all questions in Section 2, with one respondent focusing only on question 12.

Question 3. To what extent is the current 4G network infrastructure adequate for the rollout of 5G technologies and networks? Please explain and give reasons for your answer.

Most of the respondents believe that, in general, 4G/LTE is capable of providing a basis for the deployment of 5G. At the same time, responses highlighted a number of limitations, including:

- Significant investment is still needed in passive infrastructure (base stations, fibre, power supply, and edge data centres);
- Utilities to (existing 2G, 3G, and 4G) infrastructure is limited, such that infrastructure sharing will become critical to ensure that all operators are able to deploy 5G networks. This takes into consideration that emerging architectures and higher frequency bands will require a significant increase in the densification of towers and rooftop infrastructure, and the installation of smaller coverage base stations;
- National utilities do not have the necessary self-healing and resilient mesh network topology, that 5G can thrive;
- Ongoing and chronic lack of availability of the necessary spectrum; and
- The limitations of current 4G infrastructure, which does not cater for technologies such as carrier aggregation, Massive MIMO, beamforming, etc, which are needed for the various 5G deployment models.

Question 4. What limitations do you see in the ability of the current 4G infrastructure to support 5G? Please explain and give reasons for your answer.

Most respondents highlighted the massive requirements under 5G for additional bandwidth, which will require additional infrastructure in the transport network. This, in turn, will necessitate the use of street furniture (e.g. lamp posts, billboards and other urban furniture that can host radio antennae etc) for base station sites.

It might not always be possible to upgrade existing sites, due to practical considerations, including space limitations and the wind loading on masts. In addition, depending on the

spectrum made available for 5G deployment, it is expected that grid densification for C-band (3,5 GHz) of 1,6-1,8 times more sites will be required, and up to 10 times more small cell sites for mmWave band (26 GHz) deployments.

South Africa's current power challenges also need to be urgently resolved in support of 5G networks, because 5G equipment will increase the power density required at sites. The provision of electricity supply at existing and new sites in a reliable and timeous manner is, therefore, very important.

One respondent further highlighted that capacity may need to be increased on the highly-loaded 1800 and 2100 MHz bands. These bands are FDD and very suitable for Dynamic Spectrum Sharing of LTE and 5G, at the same time, utilising the same spectrum.

Another respondent stated that the cost of new spectrum and for the renewal of existing spectrum needs to be significantly reduced, pointing out that the 5G mid-bands will require the availability of at least 80-100 MHz contiguous spectrum per operator in order to ensure a tenfold increase in user experience at one tenth of the data cost. This would relieve providers of the cost burden of new network deployment.

A number of respondents were concerned that misinformation about 5G is fuelling vandalism of mobile infrastructure by some communities and organisations, suggesting that measures to counteract this are necessary.

Question ***5. In your view, what are the main enablers of 5G? Please explain and give reasons for your answer.***

Most respondents listed the key 5G enablers as including: the new network architecture along with new radio technologies; provision of stable and secure sources of power; and the availability of radio-frequency spectrum. Further to this a clear framework for infrastructure deployment is necessary. This should cover: the standardisation of wayleave approval processes; uniformity of technical requirements by municipalities; the removal of barriers imposed by state entities; and the prevention of rent-seeking behaviour (e.g. excessive pricing) from all land-owners. An effective type approval framework for both network and user equipment was also noted as a key enabler.

Question 6. In your view, which of the two standard network options - Stand Alone vs Non-stand-alone - will impact on the rollout of 5G in South Africa,

considering issues such as speed of deployment, costs vs benefits, use case development etc? Please explain and give reasons for your answer.

The consensus view from respondents is that South African network operators should be following a phased approach, starting with NSA, as this will help see their return on investment (ROI), but noting that deployment is dependent on business case solutions.

Several respondents pointed out that NSA mode was developed by the standards bodies to expedite the deployment of 5G technologies through reuse of the existing 4G Radio Access Network (RAN) and Evolved Packet Core (EPC) network. While this approach has enabled virtually all networks globally to deploy 5G rapidly and with relatively minimal CAPEX investment, it only caters for enhanced Mobile Broadband use-cases. They contend that the more advanced 5G use cases require the capabilities enabled by a dedicated 5G Radio Access Network with the new 5G Next Generation Core Network in a Stand-Alone configuration.

Question 7. To what extent, and in what ways (if any), do you think the deployment of 5G infrastructure can help narrow the digital divide in South Africa. Please explain and give reasons for your answer.

The feedback from most respondents suggests that narrowing the digital divide is limited by current policies in South Africa, which do not allow sufficient use of utilities' infrastructure (better national footprint) to offer broadband. Further to this, LTE would be key, and should be further entrenched, as most rural areas do not even have 4G, after which 5G would be seamlessly enabled. Fixed wireless access (FWA) was also highlighted as enabling reliable and affordable broadband connections to the Internet, meaning that it can play a substantial role in bridging the digital divide at a household level.

Other important measures highlighted that will aid in using 5G to help close the digital divide and provide coverage and affordability include:

- Assignment of sufficient amounts of mobile spectrum to operators in a timely manner - including coverage bands (taking advantage of the propagation characteristics of low bands to extend 5G coverage and capabilities to rural and underserved areas);

- Providing accessible spectrum, and making trade-offs between reduced spectrum fees and universal service obligations;
- Avoidance of licence terms and conditions that discourage network investment, hamper innovation and increase costs;
- Reduced mobile-specific taxes and fees, to improve rollout and Internet affordability;
- Provision of non-discriminatory and timely access to public infrastructure;
- Simplified and streamlined planning approval processes to speed-up deployments;
- Voluntary active and passive infrastructure sharing; and
- State intervention only when all market-driven mechanisms have been exhausted.

Several respondents suggest that continued collaboration between government and the broader digital telecommunications industry could swiftly address the digital divide.

Question 8. Considering the current fibre footprint in South Africa, what other technologies or approaches can address the lack of backhaul infrastructure in under-serviced areas, in order to realise real 5G value? Please explain and give reasons for your answer.

Fibre is cited as not being the only backhaul solution. There are high-capacity microwaves / E-band microwaves currently in use and capable of delivering 5G services. The view is that microwave is easy to deploy and not as expensive as fibre. One stakeholder made mention of a microwave link deployed in the Faroe Islands that spans across 37km with a capacity of over 8Gbps. Further mention was made of countries with a high Mobile Connectivity Index score that have implemented licensed or light-licensed frameworks in the E and V bands in order to ensure their national critical infrastructure is well protected against harmful interference through managed coordination.

Wireless terrestrial backhaul links will be key to supporting access networks. Timely availability and wider channel assignments for wireless backhaul will be required to support the high data-rate load on 5G access networks. Licensed spectrum in high (E & V) bands will be key to successful 5G deployments in the absence of adequate availability

of fibre backhaul infrastructure. Stakeholders further suggested that the Authority should take an active role in facilitating alternative power supply to enable 5G in the communities where there are power supply challenges.

Another approach suggested is that the WOAN needs to be operated by the private sector, while regulated by government, in order to ensure free, fair and effective access to infrastructure resources. Stable and reliable access to power and telco infrastructure is also a major driver to improved backhaul. By consolidating backhaul, the WOAN can ensure increased capacities. However, policies to control high site rental fees are required to ensure commercially feasible offerings.

A study is suggested to be undertaken, covering the following:

- A list of towns that do not have sufficient fibre backhaul to support a full 5G Stand-Alone network roll-out;
- The distance between identified towns and the nearest available fibre backhaul network;
- An assessment of the suitability of fixed network versus microwave backhaul solutions to provide this backhaul requirement; and
- The estimated cost of providing such backhaul.

Question 9. What role can active and passive infrastructure sharing play in expediting 5G deployment, minimising rollout costs etc? Please explain and give reasons for your answer.

Several respondents cite active and passive infrastructure sharing studies, which prove that it is the most efficient cost-saving mechanism, one which will lead to operators remaining competitive, and provide increased capacity and coverage. Most respondents share the same sentiments, noting that traditional infrastructure sharing models will continue into 5G with passive (e.g. fibre ducts, towers) and active (e.g. RAN Slicing) infrastructure sharing becoming more widespread.

Another key point noted is the importance of the role of the proposed WOAN, a policy instrument developed by government to facilitate competition. This is especially also relevant in the deployment of 5G, where a substantial number of additional base stations is required, which is not economically viable if several competing networks are built, especially in less populated areas. Under the WOAN, the network is envisaged to be

shared between many providers of retail services, which will substantially reduce network deployment costs.

Network slicing is also seen as a benefit to enhance consumer choice, by increasing the number of providers that can operate in certain areas and preserve service-based competition, as operators will be sharing the same infrastructure.

Question 10. In your view, are there any unintended consequences arising from infrastructure sharing (e.g. degradation of quality of service / experience etc.)? What measures need to be taken to mitigate this? Please explain and give reasons for your answer.

Several respondents pointed out that measures to address unintended consequences arising from infrastructure sharing is a mature practice, but that there is always a risk. They noted that infrastructure sharing may present a single point of failure in instances such as infrastructure vandalism and the like. Another challenge is intermodulation and interference caused by multiple operators all transmitting at the same power in close proximity, although this could be mitigated by spectrum pooling or by making use of filters. Accurate database of the use of spectrum in a geographic area will be key, together with a cognitive radio system.

The respondents note that structured agreements and performance service level agreements are important to ensure that the expectations are clear. It is further recommended that contractual obligations of sharing vendors need to be measured and regulated commercially as customers of carriers do already.

Question 11. What is your view on the readiness of the 5G ecosystem (e.g. standards, device and network manufacturers, MNOs, service/application providers etc)? Please explain and give reasons for your answer.

Many respondents suggest that the 5G ecosystem is currently ready to accommodate commercial deployments of 5G infrastructure and services.

However, some respondents point out that current 5G services are limited to mobile communications and fixed-wireless access. If South Africa is to take full advantage of the opportunities created by 5G communications technologies, then it is critical that the country starts developing testbeds and incubators to encourage 5G use case research

and development. Doubt also arises regarding readiness from a standardisation perspective. One respondent raised concerns about the continued viability of SABS, given its role as a technology guardian. Another respondent raised the absence of cost-effective 5G-enabled smartphones as a bottleneck.

Question 12. Do you foresee any challenges with respect to type approval of 5G equipment? If so, how can these be resolved? Please explain and give reasons for your answer.

Several respondents pointed to a major type approval challenge, in that ICASA has not yet adopted the new resolutions by the ITU-R and ETSI on beam-forming and high-gain multi-antenna node sector equipment. Further, there is not yet a fully-published ETSI set of standards for 5G, meaning that there is currently no legal framework by which ICASA can type approve IMT-2020 5G equipment for the market. As a result, the majority of 5G base station and CPE equipment has not been fully type approved, and some mmWave 5G FWA vendor equipment has not been fully type approved since 2018.

One respondent stated that ICASA has not yet updated its regulations and policies to address this matter. Since late 2020, stable draft versions have been available. Although this represents significant progress, ICASA's regulations do not provide for these versions, catering only for published ETSI standards. Relevant standards for 5G user and network equipment should be adopted by SABS TC74 SC05 (Radio Communications) as national standards. ICASA should include the relevant standards in the Official List of Regulated Standards.

5G capabilities will enable massive machine type communications, expected to result in millions of devices in the networks, it is clear that traditional type approval processes requiring individual devices to be submitted to and evaluated by regulators are inappropriate. A new paradigm in type approval and acceptance will be required.

Question 13. Are there any specific leapfrogging opportunities where developing countries like South Africa can benefit from the early adoption and deployment of 5G technologies? Please explain and give reasons for your answer.

The view from most respondents is that leapfrogging opportunities do exist, due to 5G's big capacity, high data speed and high reliability, which mean that 5G networks enable eMBB, home broadband, and an opportunity for SMMEs. Points raised include:

- 5G MBB for Mobile: 5G enables mobile users to enjoy HD mobile video, HD 4K live video on 5G smartphones, cloud gaming, cloud video with AR/VR and more;
- 5G FWA for Home: in terms of opportunities for business and home connections, FWA supports home entertainment (4K TV, PAD video, remote working, video meeting and real-time content sharing) and home security (home camera video surveillance);
- 5G FWA for SMMEs: 5G's big bandwidth capacity can support high data demand for SMMEs, either those that are outside optical fibre coverage, or as a backup for fibre to guarantee always on Internet continuity.

Another view from one respondent is that advantages, such as 5G application development, 5G IoT devices and 5G services, have already been explored by international players, and that, therefore, leapfrogging in terms of early adoption opportunities may be limited. 5G may offer opportunities to catch-up with other, more developed economies, and to lay the foundation for South Africa to become significantly more prepared for the coming technology revolution.

Question 14. What is your view on the current status of investment in 5G infrastructure and services in South Africa? What are your projections for future market trends and developments? Please explain and give reasons for your answer.

Most respondents highlighted that the current investment status in 5G infrastructure and services in South Africa is quite visible as mobile operators deploy 5G networks, but noted that the subscriber penetration is still below 2% of the population as at 2020. Most respondents believe it has been very limited due to various reasons:

- Limited access to spectrum;
- Limited access to infrastructure in consumer coverage areas;
- Economic instability;
- Lack of supporting government policies;

- Lack of municipal and local government support for infrastructure builds,
- Power instability;
- Battery-related crime and its associated financial impact; and
- Social misunderstandings surrounding 5G technologies.

Respondents further note that these items must be addressed in order to ensure growth in the sector. Development of the 5G infrastructure will initially be concentrated in areas that offer high ROI for mobile network operators. It is expected that, with the introduction of 5G SA mode, and the allocation of 5G spectrum, the investment in 5G infrastructure will increase exponentially, thereby resulting in rapid adoption of 5G within the market.

Question 15. To what extent, if any, has the Covid-19 pandemic changed the landscape and projections for the rollout of 5G in South Africa? Please explain and give reasons for your answer.

The majority of respondents noted that the COVID-19 pandemic forced many South Africans to work remotely from home, and that this has increased the demand for connectivity services throughout the country. In addition, the lockdowns have increased the demand for digital education and healthcare services, e-commerce, and logistics services. The respondents are of the view that, it is very likely that the 5G adoption will increase as the trend of remote working and distance learning continues. In addition, the respondents further state that the pandemic has highlighted the importance of access to high-speed broadband connections for all.

On the downside, the pandemic has had a massive negative impact on the rollout of 5G:

- Globally, lockdown has resulted in excessive delays in chipset and product developments; and
- Lockdown-associated economic slowdown has delayed infrastructure investments because of market uncertainty.

Question 16. How will high-speed, low-latency fifth generation (5G) networks, enhance through artificial intelligence (AI), and linking of billions of devices through the Internet of Things (IoT) advance the 4IR. Please explain and give reasons for your answer.

Most respondents note that the advancement of 4IR technologies is dependent on the capabilities of 5G networks. Globally, and in South Africa, 5G will become the foundation for key digital platform ecosystems, which will drive the 4IR in the country. Connecting billions of devices requires stable networks that will be able to offer the capacity and the speed required.

They further highlight that intelligent connectivity is the combination of high-speed, low-latency 5G networks, cutting-edge artificial intelligence (AI) and the linking of billions of devices through the Internet of Things (IoT). When these three revolutionary technologies combine, they will enable transformational new capabilities in transport, entertainment, industry, public service delivery and much more. South Africa specifically could benefit from a Smart Grid solution to assist with the sustainable supply of electricity.

Conclusion and Recommendations

Taken together, the submissions from the respondents point to the current state of readiness of South Africa's ICT infrastructure for the rollout and uptake of 5G across the country, and identified issues and areas where policy and regulatory intervention may be required.

It is apparent that most South African network operators have deployed 5G Non-Stand-Alone (NSA) networks, which will allow them to see their return on investment (ROI). However, further development is dependent on business case solutions (see next section). To achieve theoretical peak downlink speeds of 20 Gbps, support for one million devices per square kilometre, and latency as low as the 0,5ms of the Stand-Alone (SA) deployment standard, there are limitations that need to be addressed.

It is evident that, with 5G, there will be a massive increase in demand for bandwidth, which will require an upgrade in most parts of the network (i.e. transport network, radio access network, and the core network) to cater for the increase. This increase can be achieved, provided that sufficient spectrum is assigned in the 'Coverage and Capacity Layer', and in the 2 to 6 GHz range to deliver the best compromise between capacity and coverage, as well as in the "Super Data Layer" which relies on spectrum above 6 GHz and addresses specific use cases requiring extremely high data rates.

It is therefore recommended that the Authority expedite the assignment of the required spectrum, and consider how to reduce the costs of new spectrum and for the renewal of existing spectrum.

The costs of investment in 5G network deployment are clearly high. Infrastructure sharing (passive and active) plays a key role in alleviating such costs.

It recommended that adoption and implementation of the Rapid Deployment Guidelines be expedited as a significant stimulant to the deployment of 5G network infrastructure.

Sparsely populated areas can gradually be connected by removing the limitation posed by policies that do not allow sufficient use of utilities' infrastructure to improve the national broadband footprint. Further to this, LTE is a key starting point, and should be further entrenched, as many rural areas do not even have 4G as a basis for seamless extension to 5G. FWA, terrestrial wireless and satellite enable reliable and affordable broadband connections to the Internet, meaning that they can play an important complementary role in bridging the digital divide at a household level.

Research is recommended to be undertaken by the Authority to identify the following:

- A list of towns that do not have sufficient fibre backhaul to support a full 5G Stand-Alone network roll-out;
- The distance between identified towns and the nearest available fibre backhaul network;
- An assessment of the suitability of the fixed network versus microwave backhaul solutions to provide this backhaul requirement; and
- The estimated cost of providing such backhaul.

Relevant standards for 5G user and network equipment should be adopted by SABS TC74 SC05 (Radio communications) as national standards. ICASA should ensure that the relevant 5G standards are included in the Official List of Regulated Standards.

Greater collaboration between the Ministry, the Authority and the broader digital telecommunications industry could swiftly address misinformation and 'fake news' about 5G. While education with respect to the safety of 5G is the responsibility of MNOs, this

education and communication needs to be strengthened by the Regulator, the Ministry, and even the Presidency where appropriate.

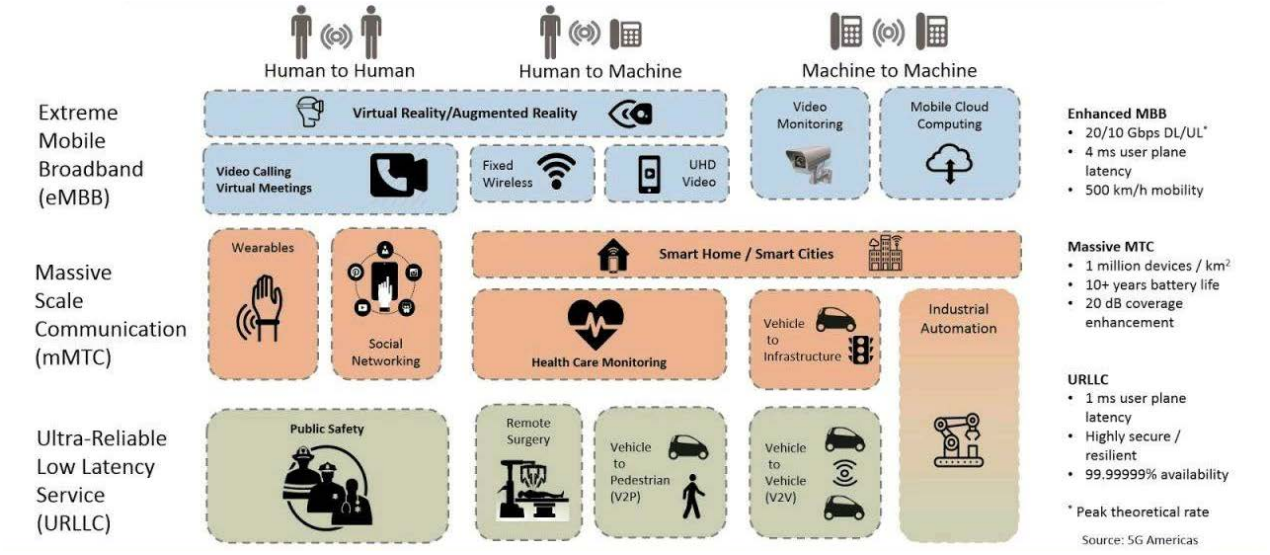
Consideration of the above recommendations will help achieve intelligent connectivity, which is the combination of high-speed, low latency 5G networks, cutting-edge artificial intelligence (AI) and the linking of billions of devices through the Internet of Things (IoT). Together these are the foundation for key digital platform ecosystems, which will drive national development of 4IR technologies, applications and services.

3.2 5G Use Cases for South Africa

3.2.1 Current Status of 5G Use Cases

The ability of 5G to transform the mobile broadband experience has been widely touted, along with its role in driving new intelligent automation, and in supporting many of the technologies of the so-called 4th Industrial Revolution. The deployment and uptake of 5G depends on the ability to develop and support appropriate use cases. Taking into consideration all the enablers of 5G, this section aims to get a view on use cases that are best fit for South Africa for the initial phases of 5G deployment.

Figure 3: 5G Use Cases



Source: 5G Americas[16]

When South Africa went into lockdown in March 2020, the ability to work remotely or the access YouTube tutorials and livestreaming for students appeared business as usual for the more fortunate, but presented a very different picture for the digitally disconnected. For many citizens "the shutdown of schools, universities and businesses has put the brakes on their ability to grow and learn — at a time when they could and should be growing and learning as much as they can."[17]

In similar vein, the International Monetary Fund (IMF) points out that in order for Sub-Saharan Africa to create a sufficient number of jobs for its increasing population, the

[16] https://www.5gamericas.org.
[17] Duncan-Williams (M&G, 19 Apr 2020) 'South Africa's digital divide detrimental to the youth' https://mg.co.za/article/2020-04-19-south-africas-digital-divide-detrimental-to-the-youth/

countries will need to "fully exploit the opportunities from the Fourth Industrial Revolution, by bridging Digital Divide" as evidence shows that "if there is an adequate digital infrastructure and a supportive business environment, new forms of business will flourish, providing employment opportunities for the educated as well as the less educated"[18].

Beyond connectivity, 5G will be a key enabler of the Fourth Industrial Revolution or Industry 4.0 – a time when technology is seamlessly embedded within society and especially in commercial and industrial processes. In Sub-Saharan Africa, 5G can enable new and existing technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), to have a transformative impact on business processes, helping drive productivity and efficiency.

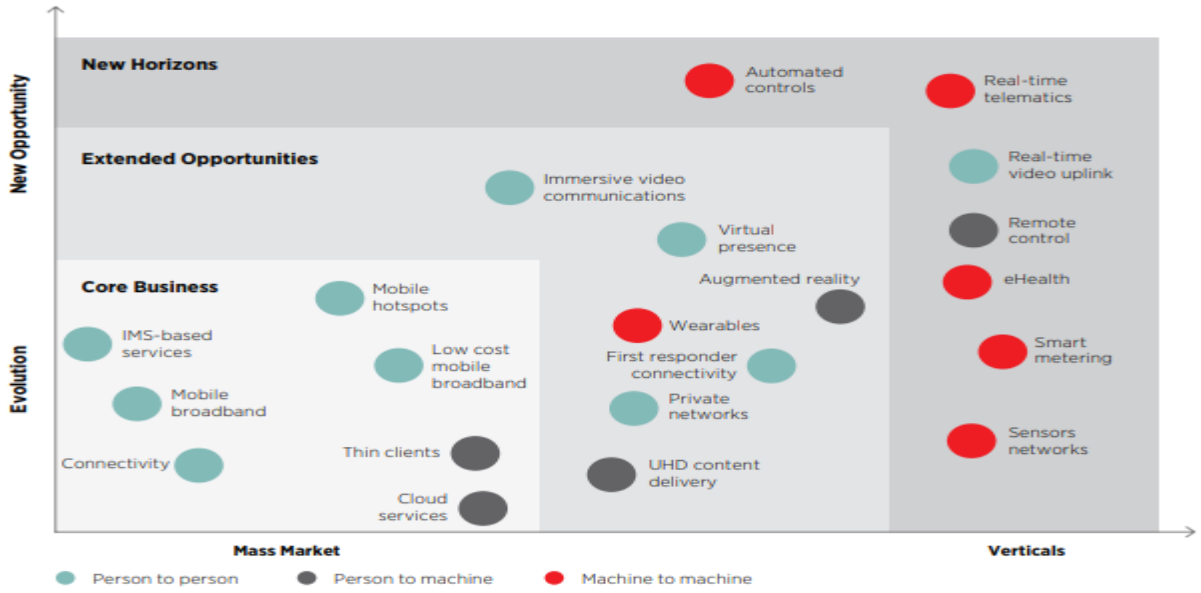
A much better customer experience will be realised through 5G, due to its higher data throughput. 5G will play a major role in unlocking new use cases by enabling new capabilities and the flexibility for mobile operators to better serve the specific needs of enterprise customers. This improved capability and performance will come from a more advanced core network, increased spectral efficiency and capacity, and further network densification.

The lower latency of 5G will support an increasing existing and new use cases as depicted in the figure 4 below.[19]

[18] IMF (2019), 'Bridging the Mobile Digital Divide in Sub-Saharan Africa: Costing under Demographic Change and Urbanization', https://www.imf.org/-/media/Files/Publications/WP/2019/wpiea2019249-print-pdf

[19] GSMA (2019), '5G in Sub-Saharan Africa: laying the foundations', https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=45121572&file=2796-160719-5G-Africa.pdf

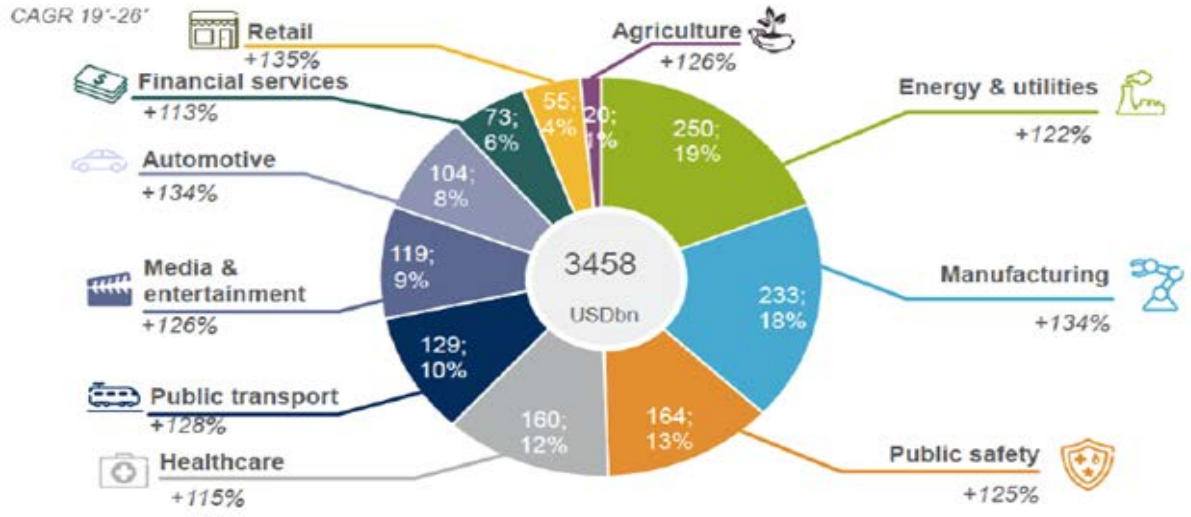
Figure 4: 5G - Existing and New Use Cases



Source: GSMA

A survey of 400 potential industry use cases across 10 industries predicted transformative benefits to virtually all sectors resulting from the interaction of digitisation and connectivity as enabled by 5G – amounting to an incremental $3,5 trillion of revenues, from a current operator service revenue base of ca. $1,5 trillion[2]. This is represented in figure 5 below.[20]

Figure 5: Transformative Benefits of 5G



Source: Ericsson

[20] 5G RuralFirst (2019) 'New Thinking Applied to Rural Connectivity - 5G RuralFirst', https://www.5gruralfirst.org/wp-content/uploads/2019/10/5G-RuralFirst-New-Thinking-Applied-to-Rural-Connectivity-1.pdf

Within the agriculture, land management and real estate sectors, the following use cases are being developed and deployed with 5G and full fibre solutions[11]:

- Public and private safety, monitoring and response;
- Driverless tractors and other automated vehicles;
- Drone and light aircraft surveys and image processing for crop management;
- Augmented reality (AR) solutions for livestock care;
- Milk yield monitoring systems;
- Crop sensors;
- Water flow and irrigation management;
- Property and land security solutions;
- Real-time, cloud-based processing systems;
- Improved tenant occupancy rates; and
- Enhanced property values.

5G networks with low latency and 'ultra-reliable' communications networks will support the delivery of critical communications to support public safety use and playing a role in the technology ecosystem supporting autonomous vehicles[21]. The development of autonomous vehicles will enable several social benefits for transportation, including reducing traffic congestion - which could be proactively reduced by smart city traffic management systems that are informed by machine-to-machine communications with autonomous vehicles.

Road safety is also expected to be improved because of autonomous vehicles, as most car accidents are caused by human error. Autonomous vehicles can have a valuable role in both financial savings and in saving human lives.

[21] Australian Government (2017), '5G—Enabling the future economy', https://www.communications.gov.au/file/31661/download?token=CgV_CF5x.

3.2.2 Stakeholder Analysis of Use Cases for SA

A number of questions in the stakeholder survey addressed the issues pertaining to use cases for 5G, and their role in driving the deployment and uptake of 5G infrastructure and services.

Question 17. What use cases for 5G can you recommend as applicable to the South African market and environment? Please explain and give reasons for your answer.

The feedback from the respondents to this question was very diverse, cutting across many industries, with the most common themes including the following:

- Distance learning: Recent environmental factors have shown that school or campus-based education is no longer essential. Learners need to be able to access education from anywhere, and whenever they want to, without worrying about connectivity or the speed of connectivity. Access to educational material, increasing collaboration and advancing experimentation can all be improved using 5G networks.
- E-health: There will be improved healthcare in locations lacking trained specialists, which impacts positively on patients who do not have the means or capability to travel long distances to hospitals providing this care. 5G will also allow doctors and other staff members to collaborate more efficiently. Connectivity within hospitals and health centres needs to be stable and fast. This also applies to connectivity between hospitals. This will reduce the need of hospital transfers.
- E-commerce and digital banking: 5G Technology will unlock the world of virtual banking, ushering in an era of financial inclusion, which will act as a catalyst for innovative mobile solutions and services to those previously disenfranchised due to geographic location.
- Manufacturing and utilities: Most industries, like manufacturing and production facilities that rely on process automation or robotics, will benefit from 5G. This will allow them to introduce ‘smart’ IoT devices for ‘smart’ factories and homes, mission critical applications, tele-protection for utilities, drones, CCTV specifically for backhaul to control for real time surveillance, and more. 5G will also enable broadband access on high-speed trains and other modes of public transport.

- Improved Public Safety: 5G will enable smart public safety and emergency systems and Disaster and Emergency Management (DEM) solutions. 5G will also facilitate unmanned vehicles for rescue and reconnaissance. Smart surveillance which allows for high-definition, real-time security monitoring, will also be facilitated by 5G.
- Broadcast-like Services: 5G is expected to play a significant role in live media production and distribution to consumers. With high-capacity and multicast / broadcast capabilities, TV operators will be able to stream TV channels over 5G.
- e-Agriculture: 5G technology will improve agricultural production through monitoring, tracking and automation control of environmental data and production information, such as humidity control, soil analysis, feeding regimes and weather prediction.
- Affordable Broadband Access: The cost of fibre connectivity requires high capex spending, and is not always economical in lower LSM areas. 5G Fixed Wireless Access (FWA), using mmWave spectrum, offers affordable broadband access at a fraction of the capex cost of fibre.
- Enhanced Broadband Access: 5G will bring about enhanced broadband access in densely populated areas, boosting indoor and outdoor coverage in high-rise buildings, crowded city centres, concerts and sporting events.

Question 18. Are there any 5G use cases specifically appropriate for bridging the digital divide in South Africa? Please explain and give reasons for your answer.

Respondents identified a number of 5G use cases as specifically appropriate for bridging the digital divide, including:

- Digital government: It is expected that 5G could positively impact government agencies in areas such as facilitating the digitisation of public services (e.g. Smart ID), increasing citizen engagement, and helping make public institutions more inclusive and effective.
- Affordable technologies: 5G promises improved manufacturing facilities which will result in lower technology costs which will help to bridge the digital divide as this will promote more use of technologies and opportunities in poorer communities.

- Affordable Broadband Services: 5G fixed wireless access (FWA), using mmWave spectrum, has the potential to deliver affordable broadband services. This will result in significantly reduced data prices. By extending affordable broadband Internet access into more South African homes, and increasing the availability of public Wi-Fi in key areas, the digital divide can be bridged.
- Expanded Coverage: The economics around mmWave 5G FWA make it particularly attractive to lead the buildout of broadband Internet services to areas that are unlikely to attract fibre interest, such as lower LSM suburbs in metropolitan areas, or smaller towns with limited fibre coverage.
- Digital Inclusion: 5G deployments to rural communities will provide the increased data rates of enhanced Mobile Broadband, which will enrich the quality of connectivity, and open up opportunities that this quality of connectivity can provide. Access to social services will be enhanced, and services will be improved to meet financial inclusion objectives. Additionally, massive IoT applications that will be built on 5G networks will be tailored to meet the needs of rural dwellers in enabling e-Agriculture, e-Education, and e-Health services. This will help to achieve a 'Smart Countryside', the rural equivalent of Smart Cities.
- Digital Flexibility: In a post COVID-19 environment, or even in a new future pandemic in South Africa, the ability to quickly adapt to modes of remote working and studying becomes essential. 5G FWA will provide for continuous Internet access for households to access applications ranging from 4K TV to PAD video, video meetings, live streamed lectures and more. Using 5G connectivity and VR headsets, teaching by experienced teachers can be brought to students around the country.

One respondent suggested that "ICASA consider the use of the Universal Service Fund monies as provided in Section 88 of the ECA in instances where there is an affordability and accessibility challenge to 5G services and infrastructure".

Question 19. What business and any other opportunities can be unlocked by the deployment of 5G technologies within South Africa? Please explain and give reasons for your answer.

Respondents to a number of such business and other opportunities, including:

- Drones: The advent of drones has brought about innovative ways to perform expensive and labour-intensive tasks. SA can invest in the youth of SA to bring about increased employment.
- Supporting SMMEs: Increased digital access at more affordable cost will enable the informal sector to market their services and to reach their customers in a more effective way. Digital payment options will allow SMMEs to transact using cashless payments, which will allow for more competitive pricing, as well as increase security due to this being a cashless environment.
- Distributed Data centres - The requirement for EDGE computing and large data warehousing will require server farms closer to the data source for near real-time applications.

Question 20. Can you identify 5G initiatives that can strengthen the country's economy and promote investment in line with the National Development Plan. Please explain and give reasons for your answer.

Respondents listed a number of 5G initiatives that can strengthen the country's economy and promote investment in line with the National Development:

- Youth employment: Youth employment is paramount. New technologies, such as drones, digital marketing, and application design, tend to appeal to young minds.
- Economic Opportunities: With a large percentage of the population connected to high-speed low-latency networks there will be many new opportunities for digital livelihoods, including mobile application (App) development, e-commerce and e-payments.
- Maximise Job Opportunities: Digital marketing will result in increased levels of youth employment, which will help address the current high level of unemployment. Most telcos have programmes which open opportunities.
- Manufacturing Opportunities: Opening of additional assembly plants for the automobile sector will help to develop country's economy, as most of these plants will be able to interact anywhere around the world.
- Remote Learning: Tertiary Institutions are faced with new ways of conducting lectures. The new normal entails virtual learning methods, where students can connect online and be able to interact remotely with their lecturers. This method

requires a stable wireless network to give access to video on demand and reliable live content.

- eCommerce: The advent of the COVID-19 pandemic has changed the way things are done. People no longer need to travel to places and to shopping malls. Customers can now buy groceries, order medication online, and more.
- Digital agriculture: Farmers can monitor livestock and crops and vegetation, using online cameras and digital sensors.

Question 21. In what ways, if any, do you think 5G infrastructure and services can contribute to the development of the informal economic sector or SMMEs or both. Please explain and give reasons for your answer.

Some respondents believe that the introduction of 5G infrastructure and services will not make a difference to the development of SMMEs, as the emphasis is placed on previous sector experience as opposed to giving new opportunities to SMMEs. As a result, the beneficiaries and benefits from 5G will be the same as they were for 4G.

Other respondents have identified the following opportunities regarding 5G contributing to the informal economic sector and SMMEs:

- Digital payment options will allow SMMEs to transact with clients; and
- Entertainment during long distance travel in taxis will be provided using 5G digital technology.

Conclusion and Recommendations

Based on the feedback from respondents on the 5G use cases for South Africa, there is much expectation that the quality of Internet coverage will improve significantly, and the cost of broadband services will reduce drastically.

There are a wide range of use cases identified for 5G, including improved remote working, enhanced distance learning, eHealth, surveillance and security, manufacturing, and financial services.

Many submissions noted that the lower cost of broadband, together with broadband being made available to remote and densely populated areas, will provide new opportunities to those who did not have these previously, leading to closing the digital divide.

Most of the respondents' submissions received highlighted the benefits of 5G in South Africa. For these benefits to be achieved, an affordable and stable broadband access network must be deployed in order to open wider opportunities to a number of use cases. Fixed Wireless Access will be a recommended option in areas where optic fibre cannot be deployed, thus helping to bridge the digital divide presently observed in South Africa.

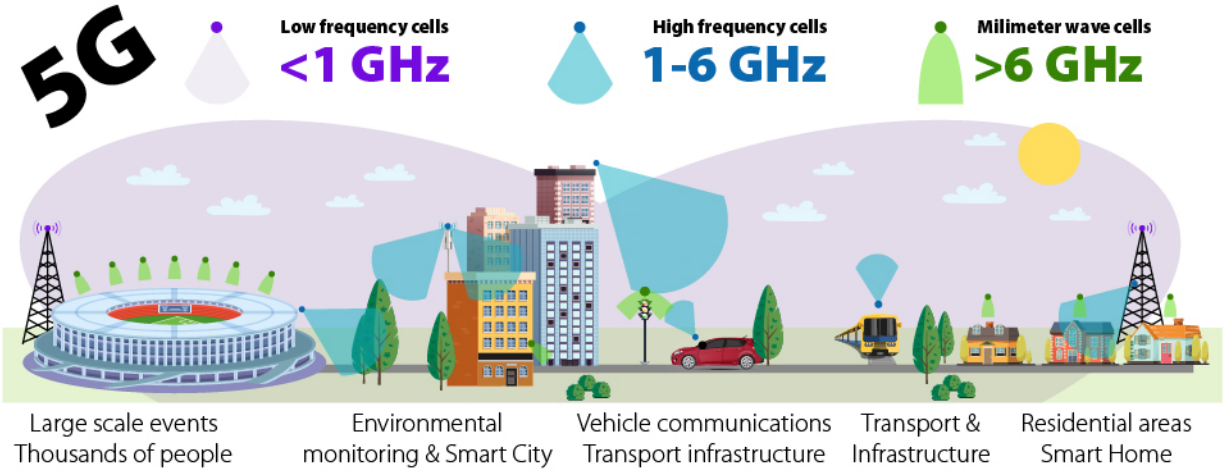
SMMEs will be able to reach customers wherever they are, by making use of digital access systems, resulting in greater cost savings for doing business. Digital marketing and skills improvement for the youth will be some of the spin offs.

It has also been recommended by some of the respondents that, for formal and informal business operations to grow, mobile operators will have to provide Internet connectivity of acceptable quality. This can be achieved through robust network deployment, preceded by a market study of the ICT sector. Furthermore, universal access and zero-rating has the potential to break down the digital divide by providing access to digital opportunities and information.

3.3 Spectrum Management for 5G

To enable cost-efficient, wide-area 5G coverage and improve mid-band and high-band spectrum utilisation, it is necessary to consider both current and innovative ways to utilise spectrum. This section aims to solicit views on the current spectrum regulatory environment to identify possible innovative approaches to the utilisation of spectrum to achieve 5G capabilities.

Figure 6: 5G Main Spectrum Bands



Source: Cablefree

Mobile devices typically contain multiple antennas and associated radio frequency front ends to enable operation in multiple bands in order to facilitate roaming. While mobile devices can benefit from common chipsets, variances in frequency arrangements necessitate different components to accommodate these differences, which leads to higher equipment design complexity and cost. In addition to reducing interference, the benefits of harmonised spectrum include facilitating economies of scale, helping build markets, enabling global roaming and reducing the cost and complexity of equipment design.

No single frequency range satisfies all the criteria required to deploy International Mobile Telecommunications (IMT) systems, particularly in countries with diverse geographic and population density. Therefore, to meet the capacity and coverage requirements of IMT systems, multiple frequency ranges are needed.

While the International Telecommunication Union (ITU) 2015 World Radiocommunication Conference (WRC-15) made good progress in identifying additional frequency bands and globally harmonised arrangements below 6 GHz for the operation of IMT, it also recognised a potential future requirement for large contiguous blocks of spectrum at higher frequencies for these systems. Consequently, it called for 11 frequency bands within the range 24 GHz–86 GHz to be studied by ITU–R for possible identification for use by IMT at the World Radiocommunication Conference in 2019 (WRC-19).

Figure 7: Global Snapshot of 5G Spectrum Targeted and Assigned

Source: Qualcomm

Since Africa is part of Region 1 within the ITU, it is of utmost importance, according to Ngcaba et al[22], that the regulatory strategy and framing by Africa be along the same lines as those of European countries, as this will enable the leveraging on the consequent economies of scale for network equipment and device manufacturers. Ngcaba et al further highlight the importance of regulators releasing the requisite spectrum quickly and to also ensure the reuse of the currently allocated spectrum. Quick release of the 5G spectrum by Africa will, according to them, assist to realise the full benefits of 5G and drive innovation and competition.

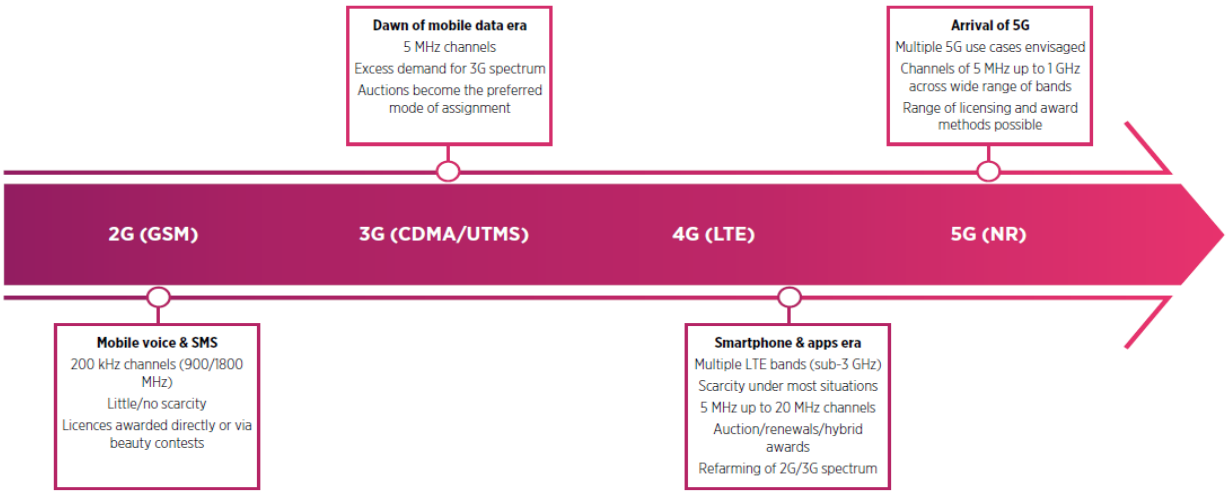
[22] Ngcaba, A, Pie, D & Venkatesh, P (2020) 'Is Africa ready for Private 5G Networks', weblog, http://andile.co.za/index.php/2020/11/02/is-africa-ready-for-private-5g-networks-the-answer-is-yes/.

A total of 17,25 GHz of spectrum was identified for IMT after the Conference, in comparison with the 1,9 GHz of spectrum identified before WRC-19. Out of this, 14,75 GHz of spectrum has been harmonised worldwide, reaching 85% of global harmonisation.

5G requires spectrum in the low bands (below 2 GHz), mid bands (2 GHz to around 6 GHz) and high bands (above 6 GHz) to achieve the full IMT-2020 vision of mobile broadband for the mass-market, including serving rural areas that have not always benefitted from mobile communications. New spectrum in the high bands, such as 26 GHz, 28 GHz and 40 GHz, is being made available, depending on regional availability, and harmonisation of these bands will facilitate the rapid deployment of the ecosystem and 5G networks. Those high bands will be important in delivering high capacity in urban hot-spots and for in-building deployments. 5G is also highly relevant in the low frequency bands such as 600 MHz, 700 MHz and 800 MHz, and will enable the mobile industry to deliver rural mass market home broadband along with the mid and high bands.

The need for IMT spectrum is driven by the requirements for 5G as set out in the ITU-R requirements for IMT-2020 contained in the ITU Report ITU-R M.2441. Roughly every 10 years, a new generation of mobile technology comes along, bringing fundamental improvements to the capabilities of mobile networks and changes to spectrum management approaches as illustrated in Figure 8 below.

Figure 8: Evolving Spectrum Management Approaches



Source: GSMA

3.3.1 Spectrum Allocation for 5G

A third cluster of survey questions sought to tease out the issues and challenges associated spectrum management, assignment and deployment for 5G.

Question 22. How much contiguous spectrum at the minimum do you believe is required in 5G mid-band (between 1 GHz to 6 GHz) for the effective delivery of 5G services? Please explain and support your answer.

There was widespread consensus from respondents that 80 – 100 MHz is the minimum amount of contiguous spectrum required in the 5G mid bands (i.e. 2300–2690 MHz, 3300–3600 MHz and 4800–4990 MHz).

Some respondents indicated that the bands 2300-2400 MHz and 2500–2690 MHz can be used jointly as a single range to enable large contiguous channels. They conclude that based on 5G trials, launches and deployments around the world, there is a clear pattern of investments in 3300-3800 MHz, which, when considered with the recent development in identification of 4800 -4990 MHz, creates a tuning range of 3300 – 5000 MHz

One respondent put forward the fact that in some bands (e.g. 3,5 GHz) it might be impossible to have 100 MHz per operator bandwidth. In those cases, it is recommended to assign 50 MHz per operator.

Question 23. How much contiguous spectrum at the minimum do you believe is required in 5G high band (>6 GHz) for the effective delivery of 5G services? Please explain and support your answer.

Whilst most respondents recommend contiguous spectrum of 1 GHz for 5G high band (>6 GHz) for the effective delivery of 5G services, some respondents believe a 400 MHz channel is sufficient since 400 MHz is the maximum carrier size.

Those recommending 1 GHz channel bandwidth refer to an ITU report that recommends minimum contiguous bandwidth of up to 1 GHz in the high frequency bands[23]. Given the divergent views, it is recommended that ICASA study the issue further.

[23] ITU (2017) 'Minimum requirements related to technical performance for IMT-2020 radio interface(s)', https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-PDF-E.pdf.

Question 24. What role can spectrum sharing / pooling play in enabling the successful deployment of 5G technologies? Please explain and support your answer.

Most respondents support and consider spectrum pooling a necessity, as there is not sufficient bandwidth available for the number of Mobile Network Operators (MNOs). There is a need for a legislative framework that will provide for MNOs' cooperation and govern the entry into managed services agreements with pooled spectrum to reach the ideal bandwidths required for 5G.

One respondent pointed out that spectrum sharing and pooling are different concepts, which should be considered on their respective merits as follows:

- **Spectrum sharing** to deploy 5G is particularly well suited to FDD-based spectrum, and for this reason already widely adopted. FDD spectrum also happens to be the currently available spectrum used for LTE, notably 1800 MHz and 2100 MHz in South Africa. Globally 700 MHz, 800 MHz and 900 MHz can be included as well.
- As 5G subscriptions currently form only a small subscriber base - which will substantially increase according to most predictions - Dynamic Spectrum Sharing (DSS) between 5G and LTE is being deployed. Even in South Africa such DSS has already been demonstrated and adopted. DSS in most cases involves a software upgrade, with little to no hardware changes, and can even be performed remotely. This is how, for example, 5G was provided in a mere fortnight in Switzerland in 2019. The advantage, apart from that of economics and speed, is that the existing resources provided by licensed FDD spectrum gradually migrate to 5G as the subscriber base increases, and eventually move to 5G, reducing the need to support what will then be legacy LTE.
- **Spectrum pooling,** on the other hand, can be used to increase peak speeds, assuming that resources are available. Pooling is also adopted between operators with different but complementary strengths - for example, one with substantial subscriber base but constrained spectrum, and another with substantial spectrum holdings but fewer subscribers. In essence, it means that one party makes surplus resources available for a commercial return. In cases where providers have equally large numbers of subscribers and similarly constrained spectrum, it is unlikely that they would have surplus resources to pool and share, unless there

are other motivating factors. Similarly, peak traffic tends to occur at similar times, meaning that resources available in a pool would likely be needed by all participants.

One respondent stated that voluntary spectrum trading allows interested parties to optimise their spectrum resources and use them more efficiently. For such voluntary activity to take place, a simple secondary market for voluntary spectrum trading would permit operators to optimise their spectrum holdings through trading, leasing, and swapping of spectrum.

Question 25. Are there any other innovative spectrum management approaches that could be considered in support of the successful deployment of 5G technologies? Please explain and support your answer.

This question drew an extensive number of detailed responses.

Some respondents referred to the possibility of Dynamic Spectrum Assignment being used, with a Geolocation Spectrum Database (as for TV Whitespaces) and a Spectrum Access System (SAS) as used in the US's 3,5 MHz Citizens Broadband Radio Service (CBRS)[24]. One respondent saw CBRS as the possible basis for enterprises to build their own private 4G/5G networks, result in improved 4G/5G offerings.

Another respondent likened 'spectrum sharing/pooling/management' to resource sharing. It is about sharing capacity implemented over a certain fixed resource (the spectrum) with certain quality of service agreements / SLAs. To share the capacity there are several options, amongst others:

- Sharing the spectrum provides certain additional freedoms to the holders of the spectrum resource: for example, decision-making over implementation, choice of technology to maximise its use. This would typically require timewise allocation of spectrum. Shared allocation, a la CBRS, could be as fast as in hourly intervals if automated, but would typically be in longer intervals.
- Sharing the 'Mbps' would happen at a higher level, and likely have a common technology and implementation method shared. Technically Multi Operator Core Network (MOCN) and Multi Operator RAN (MORAN) are such standardised sharing

[24] Cf: Blinq Networks (nd) 'CBRS, SAS and Spectrum Sharing: The Complete Guide', https://blinqnetworks.com/cbrs-sas-spectrum-sharing-guide/.

methods. They require commercial and SLA alignment between the respective parties. The advantage to those participating is that the 'implementation infrastructure' is shared as well, which may have commercial benefits to smaller incumbents. This assumes that:

a) the spectrum of the smaller incumbents is sufficient to provide benefits when added to the shared pool;

b) capacity can be shared and is not needed all the time;

c) smaller incumbents can and do actively participate.

Such sharing has already been implemented successfully for legacy technologies in Spain and Sweden, but in remote areas (for commercial reasons), while still having separate networks in urban and city areas (ARPU-generating areas).

One respondent recommended Dynamic Spectrum Sharing in the context where a single operator can in essence re-farm licensed spectrum in real time. They further indicate that this differs from the context where ICASA has previously used it, where multiple operators can utilise the same spectrum based on geographical location and timing.

Another respondent proposed a combination of spectrum management approaches:

- Unlicensed spectrum: which is made available for non-exclusive usage, subject to some regulatory constraints (such as restrictions in transmission power and without guarantee of interference protection) - as in the case of the 5 GHz, 6 GHz and 60 GHz bands in the US - and with technology neutral rules that allow various technologies like Wi-Fi, MulteFire and 5G NR-U (unlicensed 5G New Radio).
- Operator-provided spectrum: where vertical industries can directly access spectrum licensed to operators by subleasing or accessing it through direct negotiation with the operator. Examples include subleasing of 3,4-3,8 GHz band in Italy or Finland, local licensing of underutilised bands in the UK, access to Globalstar's 2,4 GHz spectrum in the US.
- Locally licensed spectrum: in which case spectrum is assigned on an exclusive basis in defined geographical regions to operators or vertical industries. Examples include the 2,6 GHz band in France, 3,7-3,8 GHz band in Germany, 26 GHz in Finland and 28 GHz in Japan.

- Dedicated licensed spectrum: with spectrum identified and reserved at regional or national level for specific applications like public safety and transportation. This includes spectrum reserved for railways, connected cars, public safety and utilities. Examples include 700 MHz for public safety in the US.
- Managed shared spectrum: in which approach, “dynamicity” is present - e.g. via dynamic configuration of channel centre frequency or bandwidth, subject to maximum permitted power and allowed time for transmission. Channel allocation and operational parameters are controlled by an operational entity (SAS, repository). Examples include CBRS in the US or eLSA in Europe.

Question 26. Which frequency bands, if any, do you believe can be re-farmed for 5G? Please explain and support your answer.

Initially, 5G will require new spectrum as the current 900 / 1800 / 2100 MHz bands are already fully utilised to provide 2G/3G/4G services, with limited possibilities for refarming. Most respondents see the IMT600, IMT700 and IMT800 digital dividend bands as promising, but only after the migration to digital terrestrial TV. They see the millimetre wave bands, with their small cells radius as best suited for ‘campus’ licences, typically in the manufacturing sector. Most recommend the frequencies below:

- N257 (26500 – 29500 MHz);
- N258 (24250 – 27500 MHz);
- N260 (37000 – 40000 MHz) and
- N261 (27500 – 28350 MHz).

One respondent was of the view that, while the existing 1800 MHz and 2100 MHz bands already make use of dynamic spectrum sharing (DSS) to cater for LTE and 5G concurrently, coverage spectrum is very much needed, and that the current TDD bands of 2300, 2600 and 3500/3700 MHz could benefit from re-alignment to ensure larger contiguous spectrum allocations in line with a long term (~10 year) view. A special candidate for re-alignment is the 900 MHz band. The spectrum is 35+35 in total, accommodating 3 parties of ~11 MHz each, but appears for historical reasons to be fragmented. Re-alignment would, however, be a hot topic due to existing sharing agreements and competitive concerns.

A number of respondents suggest that phasing out 3G services could cater for meaningful LTE in both spectrum bands (900 and 2100 MHz), resulting in GSM and LTE/NR with LTE/NR dynamically shared. Support would be needed for such a move, as current legislation requires operators to offer alternatives to their subscriber base, but regulatory support through a strategic migration roadmap could assist all involved.

One of the respondents was of the view that the following bands can be re-farmed:

- 700 MHz band (3GPP Band 28a: UL- 703 – 733 MHz / DL- 758 – 788 MHz);
- 800 MHz band (3GPP Band 20: DL – 791 – 821 MHz / UL- 832 – 862 MHz);
- 2300 – 2 400 MHz; and
- 2500 – 2 690 MHz.

Another respondent alluded to the fact that TV broadcasting services could switch to operate in the satellite band, via Direct-to-Home, and that this can make a large amount of spectrum available for 5G operations.

A few respondents believe that all mobile frequency bands currently assigned can, and will, over time, be re-farmed for 5G use, based on the licensee's business requirements. The timing for re-farming will be determined by many factors such as current customer base and services (voice, data, SMS, etc.), availability of end user devices supporting 5G, and new spectrum for 5G, inter alia.

Question 27. Please identify any specific frequency bands that are appropriate for the deployment of 5G in vertical industries and sectors (e.g. private networks, industrial applications, non-traditional operators)? Please explain and support your answer.

Most respondents argue that setting spectrum aside for industry verticals in priority 5G bands could jeopardise the success of public 5G services and may waste spectrum. The recommendation is that sharing approaches like leasing are better options where verticals require access to spectrum. It is suggested that verticals can also partner with telecommunications providers, including public mobile operators, using licensed spectrum. This would allow them to benefit from telecomms operators' more extensive networks, more substantial spectrum assets, expertise and, typically, the operators' lower cost base.

Two respondents, however, support the allocation of some spectrum for verticals. They argue that:

- The spectrum needed will depend on the specific industry environment needing to be supported (for example, Germany has reserved parts of 3 700 to 3 800 MHz band for industrial use); and
- In mining, for example, where above-ground operations are typically localised within a few square kilometres, the use of 1800, 2100, 2300, 2600 and even 3500/3700 MHz bands would be of value, as well as 450 MHz band.

Question 28. Are there any specific spectrum approaches that can be adopted to support the deployment and uptake of 5G in such vertical industries and sectors? Please explain and support your answer.

Some of the spectrum approaches that were suggested by the respondents are: a more effective spectrum licensing regime; timeous license renewal; publication of a spectrum roadmap; making available additional spectrum in capacity and coverage bands; permitting voluntary spectrum sharing and trading; and the introduction of pseudo-private network 5G spectrum slicing. which would as submitted enable the highest efficiencies.

Question 29. What regulatory interventions do you propose to ensure that spectrum licence fees for 5G high bands are kept to a reasonable figure? Please explain and support your answer.

Most respondents support the view that ICASA should consider reducing spectrum licence fees in order to encourage large contiguous spectrum usage.

One respondent cites the example of how China dramatically reduced 5G spectrum fees in order to encourage deployment, by:

- Waiving 5G up-front spectrum auction fees;

- Reducing usage fees on a 6-year glide path, initially by around 90%in the high-bands, and by around 50% in the mid-bands.[25].

A similar view from another respondent proposes that operators be allowed an initial period without spectrum fees, to enable licensees to concentrate on investment in the roll-out, and the spreading out payment of applicable fees over time once operators are generating revenue.

One respondent recommends that a cost-benefit analysis of radio frequency spectrum licence fees be conducted, to consider, amongst others:

- The 'value capture' that licence-holders obtain for the right of exclusive use of the spectrum;
- The distribution of benefits between different industries regarding access to 5G networks and services; and
- The distribution of the costs of providing, accessing, and using 5G services between different industries.

Similarly, again, another recommends the exploration of new models for monetising and calculating the value impact of spectrum towards the country and the fiscus.

Several respondents suggest revisions to the current, inflexible Administrative Incentive Pricing (AIP) formula applied to spectrum fees. One respondent argues that the current formula is not reasonable for frequencies above 30 GHz. They propose that the easiest solution to support the introduction of mmWave 5G systems in the 26 GHz band is therefore to amend the FREQ factor for the bands 23 GHz to 30 GHz to a lower value, leaving other factors unchanged. As an example, the FREQ factor of 0,1 may be changed to 0,025. Another respondents suggests relaxing the ASTER figure be relaxed from the current 600 to 400 or even 180 for higher bands, be since propagation in the 3,5 GHz and > 6 GHz bands propagation is extremely limited, an intervention which will have a significant impact in keeping the fees more reasonable.

Conclusion and recommendations

[25] China (nd) 'National Development and Reform Commission', https://www.ndrc.gov.cn/xxgk/zcfb/tz/201804/t20180424_962716.html.

In conclusion, having considered and compared the submissions, the responses by and large recommended the use of the 80 – 100 MHz as the minimum amount of contiguous spectrum required in the 5G mid bands, and 400 MHz - 1GHz in the high bands. Whilst there is recognition that carrier aggregation can used for non-contiguous blocks there are also shortcomings in terms of increased latency and signalling overheads as more carriers are added.

It is further clear that many respondents are concerned that spectrum allocation should be done in such a way that it maximises benefits for industry players, as that would be most beneficial to all stakeholders leading to economic growth. To this end the concept of spectrum pooling is highlighted as one of the innovative concepts to maximise benefits of available spectrum as there is simply not enough bandwidth available for all the mobile operators.

Over and above this, many respondents alluded to the issue of affordability in as far as spectrum pricing is concerned, both in respect of reduced auction prices, and by relaxing spectrum fees during the post-auction deployment period. Further, suggestions included adjustments to the AIP spectrum fee formula to reduce the cost of using large, contiguous blocks of high band spectrum.

Additional recommendations by several respondents are:

- New 5G-suitable spectrum needs to be assigned as a matter of urgency, with the IMT 600, IMT700 and IMT800 digital dividend bands as a priority, since the current 900 / 1800 / 2100 MHz bands are already fully used to provide 2G/3G/4G services.
- Millimetre waves spectrum for small 5G cells with limited radius best suited for ‘campus’ deployments, also needs to be made available, particularly in the 26 500 – 29 500 MHz, 24 250 – 27 500 MHz, 37 000 – 40 000 MHz and 27 500 – 28 350 MHz bands.
- Voluntary spectrum sharing, and trading should be encouraged to promote efficient spectrum use as sharing and trading encourage efficiency by allowing spectrum rights to be shared or transferred to those who will make better or more efficient use of them.

- Whilst the spectrum set aside for verticals is discouraged by some respondents, sharing approaches such as leasing can enable verticals where such services requires spectrum.

Spectrum assignments for industry verticals in priority 5G bands needs further investigation, since there a diametrically opposed views from different groups of respondents.

3.4 The 5G Forum

The South African Fifth Generation Mobile Technology Forum ("the 5G Forum") is an independent advisory body constituted by stakeholders in the ICT Sector to undertake research and render advice to the policymakers and the regulators on 5G. This section aims to get views on improving and better coordinating the work of the 5G Forum.

Research was conducted on several 5G forums from various countries (namely: India, Korea, the UK and Europe) in order to ascertain the nature of such 5G Forums, and compare them to the South African 5G Forum. To improve and better coordinate the work of South Africa's 5G forum, we looked at a number of similar 5G structures around the world in terms of vision, governing structures, sub-committees and more.

3.4.1 Europe[26]

The 5G Infrastructure Public Private Partnership (5GPPP) is made up of the European Commission and the European ICT Industry. Some industry members include telecommunications companies, manufacturers and research institutions. The governance structure of the 5GPPP includes the 5G IA, which represents private companies and the European Commission which is a public entity. The 5G IA board consists of eleven (11) members and is supported by the 5G IA Office. Membership to the 5GPPP is open to any interested parties subject to terms and conditions.

There are several working groups under the 5GPPP namely, Pre-Standardisation Spectrum, Test Measurement and KPI Validation, 5G Automotive, Trials, SME, Security, Vision and Societal Challenges, Network Management & QoS, Software Networks and 5G Architecture.

3.4.2 South Korea

The Korean 5G Forum is an open forum for different entities interested in the area of 5G Research and Development. One of the aims of the Korean 5G Forum is the realisation of the 4th Industrial Revolution in South Korea. The Korean 5G Forum aims to bring innovation and collaboration with its members in various fields such as IoT, Cloud, Big

[26] European 5GPPP, https://5g-ppp.eu-5g-infrastructure-association/

Data, Mobile. Its membership includes: industry-academic research institutions, manufacturers and service providers.

The Korean 5G Forum aims to become a foundation for future progress in the knowledge and service industry by actively supporting small businesses and a start-up culture. Further, the Korean 5G Forum issues regular research reports and annual white papers.

The governing structure of the Korean 5G Forum consists of a general assembly, advisory council, an auditor, an executive committee, and a secretariat.

3.4.3 United Kingdom[27]

UK5G aims to bring innovation and collaboration through its members in the field of 5G. There is an emphasis on research and application of 5G in the UK to ensure that the UK is a front runner in 5G development.

UK5G is independent and thus impartial in providing industry with feedback on its research and future development areas.

Membership is free and open to businesses, academia, government and communications and computing sectors working in the field of 5G, and those interested in 5G development in the UK.

UK5G has several working groups including connected places, SME's and Regions, Security, Creative Industries, Manufacturing, International Testbeds and Trials.

3.4.4 India[28]

5G Forum India aims at developing the national policy on 5G along in partnership with India's Department of Technology. Further, it aims at developing consensus within India on 5G systems, infrastructures, services, as well as preparing a vision document on India's priorities with respect to 5G. This will assist with identifying the societal, economic, environmental, business and technological benefits obtainable by an early adoption of 5G in India.

[27]UK5G Forum, https://uk5g.org/about/working-groups/
[28] India 5G Forum, https://www.coai.com/5g_india_forum

5G Forum India supports the development of collaboration between players in 5G services, as well as with international forums working on 5G. It casts itself as a national initiative, strategically aimed at including all relevant stakeholders in meeting 5G challenges and applying 5G in India to meet global timelines.

Its membership consists primarily of industry players, but accepts applications to participate from the Indian Government and its agencies, while academia participates on an invitation basis.

The following working groups are noted under 5G Forum India: 5G Spectrum; 5G Equipment and Devices Committee, 5G Policy and Regulatory.

Respondents' Analysis

Question 30. What role do you see the 5G Forum playing in advancing the deployment of 5G in South Africa? Please explain and support your answer.

Most respondents agree that the 5G Forum is a good initiative that will aid South Africa in reaching its 5G goals and aspirations. The view is that the Forum will be a tool to aid the policy-makers and the regulator in developing policy and regulation, along with supporting the development of use cases and the resultant deployment of 5G services in South Africa. This is due to the collaborative nature of the Forum with various stakeholders being involved.

However, respondents feel more research should be conducted, particularly with respect to use cases.

There are complaints that the Forum has not aided the sector, since only a couple of meetings have been held, and no real benefit has come from such meetings.

Some respondents believe that the 5G Forum can be an aid in dispelling conspiracies about 5G, and can instead educate, inform and make people aware of 5G and its uses and benefits.

One or two submissions saw the forum as a possible platform to address some of the Authority's perceived failures.

Question 31. What can be done to strengthen the work of the 5G Forum in advancing the deployment of 5G in South Africa? Please explain and support your answer.

Most responses recommend improving the work of the 5G Forum simply by meeting more regularly and more frequently, and ensuring that matters are followed up more quickly whilst still top of mind to reduce the protracted time between meetings and submissions.

There is a substantial emphasis on the 5G Forum facilitating meetings and collaboration between relevant stakeholders. A call to include manufacturers and industry vertical sector members is emphasised as well as government departments that might realise benefits from 5G.

Again, more research should be conducted, with proper budgets set aside, websites created, discussions and think tanks supported, such that the 5G Forum becomes a properly financed research hub.

This is seen in other 5G Forums where there is substantial emphasis on research, active involvement by government and the necessary budget to support the activities of the forum. Such research can make an important contribution to the government strategy for 5G deployment.

Question 32. What can be done to encourage the participation and contribution of stakeholders in the 5G Forum? Please explain and support your answer.

Most of the responses received in terms of this question relate to a lack of a clear plan for the 5G Forum, and call for the development of a yearly plan or schedule. In addition, more frequent meetings, better follow up on meetings, setting clear deadlines and assessing the purpose or impact of the work provided on 5G deployment, also are necessary.

It appears that the submissions require more meetings and extensive engagement, and a clear plan and path being forged to reach a goal. With the absence of a goal it seems the work has no impact and thus discourages participation where there is no vision, mission and end goal.

Question 33. What external partnerships could the 5G Forum develop in order to advance its work? Please explain and support your answer.

A number of collaborations were recommended, some of which are already part of the Forum.

These include: International standards institutions, research institutions and academia, pioneering countries and institutions that are leading the way in 5G rollouts, NAB, IEEE 5G World Forum, the ITU (ITU-Radio, ITU-Telecommunications and ITU-Development, and the World Telecommunications Standardisation Assembly), the GSM Association (GSMA), Third Generation Partnership Project (3GPP) and Global Mobile Suppliers Association (GSA), as well as 5GAA (5G Automotive Association) and 5G ACIA (5G Alliance for Connected Industries and Automation).

Conclusion and Recommendations

It is clear from research conducted that the structure of the 5G Forum is in line with its international counterparts. The membership structure is also aligned with not only international 5G forums, but with the recommendations presented by respondents as well.

It is clear from the submissions that more frequent and regular meetings should be held with a clear plan, schedule and outline of the work that needs to be accomplished and the outcome of such work.

More financing and monitoring is required for the 5G Forum.

Particularly, a huge emphasis was placed on the 5G Forum becoming a research hub, a space for stakeholder participation and collaboration, a test bed and research agency, particularly with respect to identifying use cases to aid in the deployment and success of 5G in South Africa.

International 5G Forums have a significant emphasis on research and stakeholder engagement at all levels to reach the objectives of 5G. As such, in order for the South African 5G Forum to be effective, more collaboration is needed, extensive research is to be conducted and frequent meetings need to be arranged to this end. Meetings and

involvement with international Forums, and countries that have moved further along than South Africa in the deployment of 5G, are needed to enhance the 5G Forum.

3.5 Policy, Regulation and General

5G Technology touches on a number of key areas that are within the jurisdiction of policy-makers and regulators internationally, such as device regulation, spectrum policy, national security and supply chain. There are several important practical, legal, and policy issues arising from 5G. The success of 5G deployment is highly dependent on international policy and regulatory activities, such as global technical standards and spectrum harmonisation for wireless services. The policy and regulatory regime governing 5G is dictated by the ITU regional demarcation, as well as by spectrum band allocations, technical and licensing conditions of 5G technologies, which in turn determines the success of 5G technologies' deployment.

In the international fora, the global decision on the direction of 5G with regards to spectrum bands is taken at the ITU's World Radiocommunication Conference (WRC), while 5G standards regionally and internationally reside with or are the competence of organisations like 3GPP, the IEEE and ITU's technical working groups.

Nationally, the deployment and uptake of 5G depends upon effective policy and regulation. Issues such as coordination of wayleave applications and processes, a national infrastructure programme, as well as the development of an effective cybersecurity framework are key.

For example, the US congress changed the law to promote deployment and streamline the review of facilities and sites, while the FCC has intervened to tackle regulatory challenges and reduce burdens on the construction of these facilities[29]. Further, the ITU notes that 5G will require a significant increase in the number of small radio cells deployed on street furniture and on the sides of buildings[30]. In the UK, the Department for Digital, Culture, Media & Sport has started working with local authorities to repurpose and redevelop planning regulations in the municipalities.

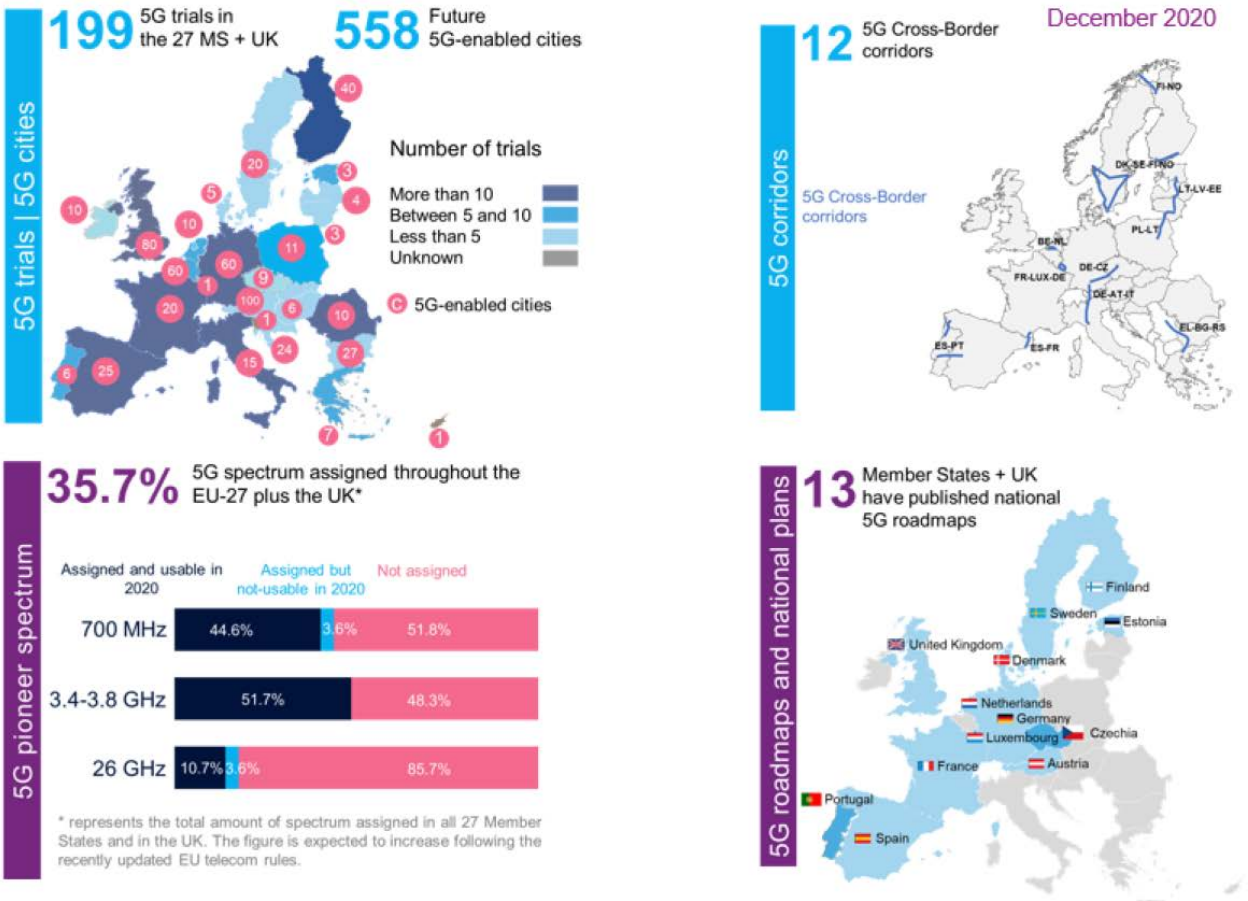
With regards to cybersecurity, according to the GSMA, although 5G represents a significant shift in existing data privacy regimes, these are already technology neutral and currently address a wide range of uses of data collected through apps, mobile device

[29] Wiley (2021) 'Wiley 5G Roadmap', https://www.wiley.law//media/handbook/550_2021-Wiley-5G-Roadmap.pdf
[30] ITU (2018), 'Setting the Scene for 5G: Opportunities & Challenges' https://www.itu.int/myitu/-/media/Publications/2018-Publications/BDT-2018/En---Setting-the-scene-for-5G--opportunities-and-challenges.pdf

operating systems, social media, websites and network operators. [31] Current data privacy regimes are therefore likely to be sufficient to address the use of new 5G capabilities within the online ecosystem.

On the development of country 5G strategies, some countries have embarked on the development of strategies to guide their efforts in implementing 5G. For, example Europe's 5G Observatory tracks 5G progress in respect of a number of key parameters, such as: 5G trials, 5G spectrum assignment, 5G national roadmap development, and more (see Figure 9 below).

Figure 9: Europe and the UK – 5G Scoreboards



Source: 5G Observatory[32]

[31] GSMA (2020) '5G and Data Privacy', https://www.gsma.com/publicpolicy/wp-content/uploads/2020/07/GSMA_5G_and_Data_Privacy_July_20.pdf

[32] 5G Observatory (2020) '5G scoreboard (December 2020)', https://5gobservatory.eu/observatory-overview/5g-scoreboards/.

Respondents' Analysis

Question 34. Given the current challenges experienced in respect of wayleaves applications in various municipalities, are there any specific policy and regulatory interventions needed in respect of rapid deployment, in order to facilitate the rollout of 5G? Please explain and support your answer.

The most prevalent sentiment among the respondents was a call for the development of a uniform framework, with standardised wayleave processes and alignment of bylaws across all municipalities. In addition, a number advocated the automation of processes and systems, coupled with stringent turnaround times or SLAs for feedback and approvals, based on an updated, relevant and accurate information system.

A number of respondents also emphasised the need for policies that strengthen the protection of 5G infrastructure against vandalism and theft.

Question 35. Can you identify any specific implications for cybersecurity that may be associated with the deployment of 5G networks and services? Please recommend suitable approaches and interventions necessary to address such implications, if any. Please explain and support your answer.

The most prevalent concern raised by respondents was reliance of network operators on third-party suppliers in the 5G supply chain, which increases overall attack surface.

The majority of respondents also advocated designing security into policies, regulation and processes, in order to achieve protection of personal information and network security.

Some respondents also alluded to the fact that 5G-enabled government networks, utilities, transportation networks, healthcare and other services relying on 5G, would form a new class of critical infrastructure requiring special security scrutiny, going on to suggest the necessary responses, including:

- Assessment of the risk profile of suppliers of 5G networks by screening potential suppliers;
- A combination of different mitigation scenarios and frameworks, e.g. adopting 5G assurance specifications and 3GPP security architecture.

3.5.3 Other Issues Relevant to 5G

Question 36. Are there any other specific policy issues and regulatory challenges that need to be addressed in order to promote 5G in South Africa? Can you identify specific infrastructure policy and regulatory interventions that are required? Please explain and support your answer.

Apart from the 5G the need for a national 5G strategy, suggested by most respondents, other recommendations include:

- Urgent assignment of high-demand spectrum, in particular the urgent licensing of 3500 MHz band, at a reasonable price, to support the roll-out of 5G technology;
- Finalisation and implementation of a national policy on the rapid deployment of infrastructure;
- Addressing the misperceptions around the use of 5G and its health impact through public awareness campaigns and national policy in collaboration with the Department of Health;
- The need for carefully structured and drafted net neutrality rules to allow Quality of Service differentiation.

37. Finally, please provide any additional information or recommendations or comments you deem relevant to the deployment and uptake of 5G in South Africa.

The most common recommendations from respondents were the need for the following:

- Speeding up the digital migration clearing process of the 700 / 800 MHz to get rid of the remaining broadcasters in these bands;
- Defragmentation, clearing and in-band migration of prime bands across low, mid and high ranges to ensure assignments are contiguous; and
- Timely renewal decisions to facilitate network investment and enable planning.

Conclusion and Recommendations

The issue of wayleaves is very important for almost all the respondents. They shared their frustration on the application process for wayleaves. It is recommended that the application process be standardised and digitised across the different municipalities.

The respondents view the issue of 5G security as being important for the adoption and success of 5G. It is recommended that the following be adopted to mitigate cybersecurity risks:

- Designing security into policies, regulation and processes through the amendment of the ECA and the POPI Act;
- Screening of potential suppliers to ensure that the risk posed to the 5G network is minimised, which can be achieved by assessment of the risk profile of suppliers; and
- South Africa should consider adopting 5G assurance specifications and 3GPP security architecture guidelines, because they have been tried and tested.

The respondents raised few issues that they thought need to be taken forward by policy makers in order to advance the adoption of 5G. The following is recommended:

- Finalisation of policy and policy guidelines on the rapid deployment of infrastructure;
- Addressing the misperceptions around 5G and health issues in collaboration with the Department of Health; and
- The development of carefully structured and drafted net neutrality rules to allow Quality of Service differentiation.

The issue of fragmented frequency bands has been identified as something that will have adverse effects on the deployment and uptake of 5G. Therefore, there is a need for defragmentation and clearing of prime bands by ICASA across all band ranges that have been identified for 5G.

Finally, South Africa needs to develop a national 5G strategy and roadmap.

4 Conclusion and Recommendations

The purpose of the 5G research presented here is to investigate the current status, readiness, and prospects for 5G in South Africa. The survey emanates from initial thinking about the state of 5G readiness in South Africa.

The objective of the survey is to benefit the ICT sector at large in order to pave the way to get South Africa fully ready to roll out and benefit from 5G. The research draws on the survey conducted with the members of the 5G Forum.

5G will unlock various applications such as mMTC, URLLC and eMBB, which will enable high speed connection of people and things to the Internet (i.e. Internet of everything (IoE)), responding to the ever-increasing demand for mobile broadband in our digital economies.

Unlocking these capabilities, amongst several factors, relies on robust nationwide network infrastructure. Different elements come into play to achieve adequate infrastructure deployment. Whilst there has been progress, with several South African MNOs deploying 5G networks, the survey results suggest there are still limitations in respect of the current 4G infrastructure, inhibiting the ability to achieve 5G capabilities.

The analysis of infrastructure readiness shows that there are limitations within and around the current 4G infrastructure deployments, leading to a restricted ability to achieve 5G capabilities.

It is recommended that a clear framework for infrastructure deployment be developed, covering the standardisation of wayleave and rights of way approval processes, removal of barriers imposed by state entities, and standard pricing from landowners.

The Authority has not yet adopted the new resolutions by the ITU-R and ETSI on beam-forming and high gain multi-antenna node sector equipment. As a result, the majority of base station and CPE equipment has not been fully type approved. It is recommended that the Authority should include the relevant standards in the Official List of Regulated Standards. Relevant standards for 5G user and network equipment should be adopted by SABS as national standards, so that ICASA can include these in the Official List of Regulated Standards. A new paradigm in type approval process is recommended.

The need for interventions to bridge the digital divide remains urgent and paramount. Continued collaboration between government and the broader digital telecommunications industry in this area remains essential. Fixed Wireless Access and Satellite will be a recommended option to help bridge the digital divide in areas where optic fibre cannot be deployed. MNOs will be able to take advantage of satellite's inherent multicasting broadcast functionality for new IoT use cases, such as connected cars, while preserving high-value wireless spectrum for latency-sensitive services. Alternatively, they can use satellite's longer reach to complement the buildout of 5G in remote areas.

There is a wide range of use cases for 5G which can be adopted in South Africa, including improved remote working, enhanced distance learning, telemedicine, surveillance and security, agriculture, mining, manufacturing, and financial services. Further research, however, is needed to identify and document and develop recommendations is respect of use cases most appropriate to the South African context.

5G will be enabled by new radio technologies, stable and secure sources of power, and availability of radio-frequency spectrum. Licensed spectrum in high E and V bands is recommended for 5G deployments in the absence of adequate availability of fibre backhaul infrastructure, along with net neutrality rules to allow Quality of Service differentiation. Further, it is suggested that the Authority take an active role in facilitating alternative power supply to enable 5G in the communities where there are power supply challenges.

Amongst several factors, spectrum will play a huge role in the operation, development and roll-out of 5G. The expected peak data rates are driven by the amount of spectrum that is available to the service. The issue of fragmented spectrum will have adverse effects on the deployment and uptake of 5G. Therefore, the defragmentation and clearing of prime bands by the Authority is needed across all bands that have been identified for 5G. Further, a minimum contiguous assignment of 80-100 MHz of spectrum in the mid-bands and 400 MHz to 1GHz in the high bands, is needed to enable optimum, high-speed 5G services. Again, the Authority needs ensure the renewal of spectrum licences to provide certainty to the industry players and to facilitate network investment and enable planning. Spectrum pooling is recommended to maximise benefits of available spectrum as there is not enough bandwidth for all the mobile operators.

Sufficient frequency spectrum will be needed for the connection of 5G base stations, which must be considered in spectrum planning for 5G. Spectrum sharing is a very prominent area for innovation, standardisation and spectrum regulation in the next few years and beyond. It is recommended that a number of key 5G sharing technologies and approached be investigated, including Licensed Assisted Access (LAA), Licensed Shared Access (LSA) and TV Whitespaces. Spectrum trading is also recommended to promote efficient spectrum use as it allows spectrum rights to be transferred to those who will use spectrum efficiently. Further, affordability has been raised as a concern regarding spectrum pricing. It is recommended that auction prices be reduced and that the AIP spectrum formula be adjusted to reduce the cost of using large, contiguous blocks of high band spectrum.

The issue of spectrum assignment for industry verticals in priority 5G bands needs further research and investigation in order to develop an approach that caters for all stakeholders.

5G security is important for the adoption and success of 5G. It is recommended that the following be adopted to mitigate the cybersecurity risks:

- designing security into policies, regulation and processes through the amendment of ECA and POPI Act;
- Screening of potential suppliers to ensure that the risk posed to the 5G network is minimised;
- Adoption of 5G assurance specifications and 3GPP security architecture guidelines.

Covid-19 has proven the importance of high-speed, reliable broadband services, with the shift from commuting more towards working from home. A forward-looking regulatory environment is essential. Policymakers and the regulator can play a major role in expanding access to and adoption of mobile broadband.

The South African 5G Forum can be effective collaboration and research hub. To this end, it is recommended that collaboration be strengthened, research be conducted, and more frequent meetings be arranged. Meetings and engagement with international Forums, and countries that have moved further along the 5G road than South Africa, are needed to enhance the effectiveness and impact of the 5G Forum.

The analysis relating to the 5G Forum concludes that the structure of the South African 5G Forum is in line with its international counterparts. The membership structure is also aligned with not only international 5G forums but with the recommendations presented by stakeholders as well. However, the international 5G Forums have a significant emphasis on research which is not the case in South Africa.

A concerted public information campaign in collaboration with the Ministry, the Regulator and private sector and civil society stakeholders, is needed to address the prevalence of 'fake news', misinformation and disinformation regarding 5G.

In respect of policy and regulation, the analysis concludes that access to wayleaves is very important among all the respondents. The respondents also viewed the issue of 5G security as being important for the adoption and success of 5G.

In conclusion, the research set out and documented here provides only a preliminary assessment of the state of readiness in South Africa in respect of 5G. However, its recommendations pave the way for the policy-maker and the regulator to undertake a range of interventions to make South Africa fully ready for 5G.

- - - 0 - - -

Annexure 1 - Stakeholder Questionnaire

Independent Communications Authority of South Africa

350 Witch-Hazel Avenue, Eco Point Office Park

Eco Park, Centurion

Private Bag X10, Highveld Park 0169

1. SURVEY - 5G READINESS IN SOUTH AFRICA

Dear Stakeholder

Through this survey, ICASA requests your feedback on the current status, readiness, and prospects for 5G in South Africa.

Please submit your responses to the questions below to Pumla Ntshalintshali (PNtshalintshali@icasa.org.za) by close of business on Friday 22 January 2021.

Your responses will assist us in preparing a report on 5G, to be circulated to stakeholders early in 2021.

Thank you in advance for your contribution.

Regards

Councillor Charley Lewis

Chairperson of ICASA 5G Council Committee

INTRODUCTION

5G is a catalyst for innovation, giving an opportunity to industry and service providers, communities and individuals to advance their digital agendas towards economic growth, job creation and socio-economic development.

The role of the 5G in South Africa cannot be understood independently from the current state of industrialisation, the role of politics and stakeholder organisations, state relationships, multilateral agreements, and more.

The questions set out below emanate from initial thinking about the state of 5G readiness in South Africa, and aim to benefit the ICT sector at large in order to pave the way to get South Africa fully ready to roll out and benefit from 5G.

The survey consists of 6 sections. The first section on demographics is intended to help identify potential differences in respect of stakeholder perspectives. Sections 2-5 can be responded to and submitted separately. The final section is an opportunity for the respondent to provide any further information that may have been left out, but which is still very relevant to the rollout of 5G.

- Section 1: Demographics
- Section 2: 5G Infrastructure Readiness
- Section 3: 5G Use Cases for South Africa
- Section 4: Spectrum Management for 5G
- Section 5: The 5G Forum
- Section 6: Policy, Regulation and General

1 DEMOGRAPHICS

2. Please indicate your stakeholder sector.

Sector	Tick All applicable sectors
Academic / Research	
ECNS Licensee	
ECS Licensee	
Equipment Supplier	
End User	
Government / Regulatory	
Operator	
Standards Body	
Other, please specify	

3. Are you filling out this survey in your own capacity or on behalf of a body? Please tick the applicable box.

Self ☐

On behalf of organisation ☐

2 5G INFRASTRUCTURE READINESS

On a global scale, with 5G services now widely available, and mobile 5G deployments under way in all regions, operators, service providers and users alike are facing the early phase of massive 5G adoption. This section is aimed at understanding the current state of readiness of South Africa's ICT infrastructure for the rollout and uptake of 5G across the country, and to identify issues and areas where policy and regulatory intervention may be required.

4. To what extent is the current 4G network infrastructure adequate for the rollout of 5G technologies and networks? Please explain and give reasons for your answer.

   _____
   _____

5. What limitations do you see in the ability of the current 4G infrastructure to support 5G? Please explain and give reasons for your answer.

   _____
   _____

6. In your view, what are the main enablers of 5G? Please explain and give reasons for your answer.

   _____
   _____

7. In your view, which of the two-standard network options - Stand Alone vs Non-stand-alone - will impact on the rollout of 5G in South Africa, considering issues such as speed of deployment, costs vs benefits, use case development etc? Please explain and give reasons for your answer.

   _____
   _____

8. To what extent, and in what ways (if any), do you think the deployment of 5G infrastructure can help narrow the digital divide in South Africa. Please explain and give reasons for your answer.

   _____
   _____

9. Considering the current fibre footprint in South Africa, what other technologies or approaches can address the lack of backhaul infrastructure in under-serviced areas, in order to realise real 5G value? Please explain and give reasons for your answer.

   _____
   _____

10. What role can active and passive infrastructure sharing play in expediting 5G deployment, minimising rollout costs etc? Please explain and give reasons for your answer.

    _____
    _____

11. In your view, are there any unintended consequences arising from infrastructure sharing (e.g. degradation of quality of service / experience etc.)? What measures need to be taken to mitigate this? Please explain and give reasons for your answer.

    _____
    _____

12. What is your view on the readiness of the 5G ecosystem (e.g. standards, device and network manufacturers, MNOs, service/application providers etc)? Please explain and give reasons for your answer.

    _____
    _____

13. Do you foresee any challenges with respect to type approval of 5G equipment? If so, how can these be resolved? Please explain and give reasons for your answer.

    _____
    _____

14. Are there any specific leapfrogging opportunities where developing countries like South Africa can benefit from the early adoption and deployment of 5G technologies? Please explain and give reasons for your answer.

    _____
    _____

15. What is your view on the current status of investment in 5G infrastructure and services in South Africa? What are your projections for future market trends and developments? Please explain and give reasons for your answer.

    _____
    _____

16. To what extent, if any, has the Covid-19 pandemic changed the landscape and projections for the rollout of 5G in South Africa? Please explain and give reasons for your answer.

    _____
    _____

17. How will high-speed, low-latency fifth generation (5G) networks, enhance through artificial intelligence (AI), and linking of billions of devices through the Internet of Things (IoT) advance the 4IR. Please explain and give reasons for your answer.

_____
_____

3 5G USE CASES FOR SOUTH AFRICA

The ability of 5G to transform the mobile broadband experience has been widely touted, along with its role in driving new intelligent automation and in supporting many of the technologies of the so-called 4th Industrial Revolution. The deployment and uptake of 5G depends on the ability to develop and support appropriate use cases. Taking into consideration all the enablers of 5G, this section aims to get a view on use cases that are best fit for South Africa for the initial phases of 5G deployment.

18. What use cases for 5G can you recommend as applicable to the South African market and environment? Please explain and give reasons for your answer.

    _____
    _____

19. Are there any 5G use cases specifically appropriate for bridging the digital divide in South Africa? Please explain and give reasons for your answer.

    _____
    _____

20. What business and any other opportunities can be unlocked by the deployment of 5G technologies within South Africa? Please explain and give reasons for your answer.

    _____
    _____

21. Can you identify 5G initiatives that can strengthen the country's economy and promote investment in line with the National Development Plan. Please explain and give reasons for your answer.

    _____
    _____

22. In what ways, if any, do you think 5G infrastructure and services can contribute to the development of the informal economic sector or SMMEs or both. Please explain and give reasons for your answer.

    _____
    _____

4 SPECTRUM MANAGEMENT FOR 5G

To enable cost-efficient, wide-area 5G coverage and improve mid- and high-band spectrum utilisation, it is necessary to consider both current and innovative ways to utilise spectrum. This section aims to solicit views on the current spectrum regulatory environment in order to identify possible innovative approaches to the utilisation of spectrum to achieve 5G capabilities.

23. How much contiguous spectrum at the minimum do you believe is required in 5G mid-band (between 1GHz to 6GHz) for the effective delivery of 5G services? Please explain and support your answer.

_____
_____

24. How much contiguous spectrum at the minimum do you believe is required in 5G high band (>6GHz) for the effective delivery of 5G services? Please explain and support your answer.

_____
_____

25. What role can spectrum sharing / pooling play in enabling the successful deployment of 5G technologies? Please explain and support your answer.

_____
_____

26. Are there any other innovative spectrum management approaches that could be considered in support of the successful deployment of 5G technologies? Please explain and support your answer.

_____
_____

27. Which frequency bands, if any, do you believe can be re-farmed for 5G? Please explain and support your answer.

_____
_____

28. Please identify any specific frequency bands that are appropriate for the deployment of 5G in vertical industries and sectors (e.g. private networks, industrial applications, non-traditional operators)? Please explain and support your answer.

_____
_____

29. Are there any specific spectrum approaches that can be adopted to support the deployment and uptake of 5G in such vertical industries and sectors? Please explain and support your answer.

_____
_____

30. What regulatory interventions do you propose to ensure that spectrum licence fees for 5G high-bands are kept to a reasonable figure? Please explain and support your answer.

_____

_____

5 THE 5G FORUM

The South African Fifth Generation Mobile Technology Forum ("the 5G Forum") is an independent advisory body constituted by stakeholders in the ICT Sector to undertake research and render advice to the policy-makers and the regulator on 5G. This section aims to get views on improving and better coordinating the work of the 5G Forum.

31. What role do you see the 5G Forum playing in advancing the deployment of 5G in South Africa? Please explain and support your answer.

    _____

    _____

32. What can be done to strengthen the work of the 5G Forum in advancing the deployment of 5G in South Africa? Please explain and support your answer.

    _____

    _____

33. What can be done to encourage the participation and contribution of stakeholders in the 5G Forum? Please explain and support your answer.

    _____

    _____

34. What external partnerships could the 5G Forum develop in order to advance its work? Please explain and support your answer.

    _____

    _____

6 POLICY, REGULATION & GENERAL

35. Given the current challenges experienced in respect of wayleaves applications in various municipalities, are there any specific policy and regulatory interventions needed in respect of rapid deployment, in order to facilitate the rollout of 5G? Please explain and support your answer.

    _____

    _____

36. Can you identify any specific implications for cybersecurity that may be associated with the deployment of 5G networks and services? Please recommend suitable approaches and interventions necessary to address such implications, if any. Please explain and support your answer.

    _____

    _____

37. Are there any other specific policy issues and regulatory challenges that need to be addressed in order to promote 5G in South Africa? Can you identify specific infrastructure policy and regulatory interventions that are required? Please explain and support your answer.

    _____

    _____

38. Finally, please provide any additional information or recommendations or comments you deem relevant to the deployment and uptake of 5G in South Africa.

    _____

    _____

39. Thank you for your contribution and support.