04 MARCH 2022

Vodacom's Submission on Draft Consultation Document on Spectrum Outlook.

1. INTRODUCTION

Vodacom Pty Ltd ("Vodacom") wishes to thank the Authority for the opportunity to make submissions in regard to its public consultation process regarding long term spectrum outlook in South Africa (the "Inquiry").

Vodacom believes that a process such as this set the country on a path to adequately prepare for the ever increasing spectrum demand currently being experienced on various networks and also future spectrum demand that must supply coverage and capacity to a wide range of technologies.

Vodacom wishes to highlight that the sequence of spectrum regulations emanating from the Authority would have been coordinated better if an enquiry such as this would have preceded the Radio Frequency Migration Planning (RFMP) and the Radio Frequency Spectrum Assignment Plan (RFSAP), IMT Roadmap proceeded by the implementation thereof.

2. RESPONSES TO THE AUTHORITY'S QUESTIONS

Note: For convenience to the reader, our sub-numbering refers to the corresponding question number from the Authority (e.g. Section 2.1. refers to Question 1 from the Authority)

2.1. "*Please comment on whether the above captures the relevant regulatory and policy aspects of long term spectrum planning*."

In the main, our current view is that The Authority has outlined several relevant factors affecting spectrum planning in South Africa. As such, the regulatory and policy frameworks outlined in the ATU recommendations contribute to providing guidance to the ICT industry on where the country and Authority wish to direct efforts, though we would recommend that Authority place greater emphasis on the role that infrastructure investment plays in achieving the intended objectives

Vodacom proposes that the shared use of spectrum should be regulated in a manner that balances the need for innovation against that consumer needs for sustained, reliable and cost-effective service delivery to the largest possible consumer base. Factors such as network resiliency, global terminal trends and investment into network infrastructure are key components of such as consideration.

Whilst broadband expansion is indeed a priority in the next 10 to 20 years in South Africa, many barriers still remain in place beyond spectrum assignment and allocation. Barriers such as the non-harmonised costs of new builds within municipality administrations may hinder the country and Authority's vision for universal broadband coverage. Furthermore, the deadlock of approvals at municipal level still hinders the swift deployment of broadband even today. Vodacom promotes net neutrality as well but does not support arbitrary service migration for different service classes by operators within the industry.

We note that Nigeria's National Broadband Plan (NBP 2020-2025) is a policy framework that sets a vision for its country. However, currently Nigeria is in the bottom percentiles when it comes to global internet speed. Nigeria currently sits at just over 50% of broadband internet user penetration nationally[1] with

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[1] https://www.statista.com/statistics/484918/internet-user-reach-nigeria/#:~:text=Nigeria%3A%20online%20usage%20penetration%202016%2D2026&text=Internet%20user%20penetration%20in%20Nigeria,million%20internet%20users%20in%20Nigeria.

broadband connections of around 13.95Mbps speeds meaning that 5GB of data can be downloaded in 1 hour 18 minutes; something that South Africa has already surpassed[2]. Nigeria's policy in principle has some positive elements, but the implementation thereof suggests that there are further complexities that have not been resolved, and as such may not serve for the moment as a useful example for South Africa. Nigeria will achieve 90% broadband penetration well beyond 2025 at its current rate of progress. Moreover, Vodacom discourages the Authority from nominal price comparisons with other countries as there are many factors involved in the pricing of data than just the comparison of nominal pricing data in isolation.

2.2 "***Are there services, in addition to broadband, that ought to be considered as important for economic growth? If so, please explain what these services might be and what the trade-offs are between using spectrum for broadband and alternative services. Please provide any evidence from other countries that may be relevant.***"

Whilst there are many services to consider, Vodacom is of the view that the sufficient supply of broadband forms the foundation for customer service delivery and affect the largest customer base. As such, Broadband is of the greatest national interest in regard to spectrum services. In most cases, broadband drives demand for other services (e.g., backhaul), but other spectrum services rarely rely on broadband for their service delivery. The World Bank conducted a study which showed that a 10% increase in fixed broadband penetration would increase GDP growth by 1.21% in developed economies and 1.38% in developing ones and that an increase of 10% in broadband penetration would increase GDP per capita growth by 0.9-1.5%[3]. According to studies conducted by management consulting firms Accenture[4], BCG[5] and PWC[6] for US/ Canada a common theme amongst them all is that 5G will contribute significantly to GDP, job creation and will shape key industry use cases such as healthcare, manufacturing, automotive and retail to name a few. This is in line with the Katz (2013) study conducted for SA mentioned by ICASA. Therefore, it is clear of that broadband services will provide the country with significant economic growth, provided sufficient spectrum is made available. According to the GSMA, mobile technologies and services in Sub-Saharan Africa generated 9% of GDP in Sub-Saharan Africa in 2019 – a contribution that amounted to more than $155 billion of economic value added. The mobile ecosystem also supported almost 3.8 million jobs (directly and indirectly) and made a substantial contribution to the funding of the public sector, with $17 billion raised through taxation. By 2024, mobile's contribution will reach around $184 billion as countries increasingly benefit from the improvements in productivity and efficiency brought about by the increased take-up of mobile services [7]. Any other services need to be considered in the context of the contribution of mobile broadband.

With broadband as a foundation, Vodacom believes that other emergent technologies will compound the effect of broadband on any economy.

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[2] https://www.dataphyte.com/latest-reports/economy/61-unconnected-rural-dwellers-other-key-figures-nigeria-must-rewrite-towards-becoming-an-all-inclusive-digital-economy/

[3] https://documents1.worldbank.org/curated/en/178701467988875888/pdf/102955-WP-Box394845B-PUBLIC-WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

[4] https://www.accenture.com/us-en/insights/high-tech/5g-economic-impact

[5] https://www.bcg.com/publications/2021/5g-economic-impact-united-states

[6] https://www.pwc.com/gx/en/industries/technology/publications/economic-impact-5g.html

[7] https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/09/GSMA_MobileEconomy2020_SSA_Eng.pdf

2.3 "***Please comment on the above assessment of the status quo on broadband penetration in South Africa, and what role spectrum may play in addressing the gaps identified***."

Currently, MNOs networks are severely strained due to the increased demand that was caused by the COVID-19 pandemic, and this increase in traffic still continues significantly. Upgrading sites to utilize new spectrum with more efficient technologies can be deployed at competitive costs and with urgency as compared to densifying a network with new sites, to the benefit of consumers. In addition, new low band spectrum will assist in providing further coverage than what is currently available due to more favourable propagation characteristics. Thus, if high and low band spectrum is made available, fewer sites will be required for both coverage and capacity requirements. Sufficient spectrum plays a vital role in lowering the cost of mobile data to consumers and in connecting the unconnected. Vodacom is already running several rural programs[8,9] that are yielding a positive impact to rural communities prior the release of new spectrum, as it is dedicated to providing connectivity to South African citizens at large. In addition, Vodacom is committed to connecting all of SA, as seen by its latest investment in Mpumalanga, helped the region expand connectivity in deep rural areas and townships that had no connectivity before[10] and the launch of SA's first smartphone only town[11]. The release of additional spectrum will accelerate South Africa's journey toward the SA Connect, ICASA's and government's ambitions.

2.4 "***What future changes, if any, should ICASA examine with regard to the existing licensing regime to better plan for innovative new technologies and applications and allow for benefits that new technology can offer, such as improved spectrum efficiency***?"

The GSMA succinctly summarized the challenge that "For licence renewal, uncertainty about future rights to spectrum can lead operators to reduce or delay investment in upgrading their networks and deploying new services."[12]. Certainty is a key signal to MNO's, and their respective investors, that the industry is stable enough to guide investment opportunities in the right direction. Furthermore, the licensing governance and regulatory framework (new and renewing licenses) should be underpinned by a long-term roadmap that indicates which direction the Authority wishes to take in bands receiving new occupants, any possible changes in legacy band migration, including timeframes to achieve these goals. Frequent considerations or analysis of efficient spectrum use should also form part a better licensing regime going forward[13].

4G LTE and 5G mobile technologies have accelerated the pace of global IMT adoption by creating what is arguably the world's most ubiquitous deployment of a common mobile service. These standards are meeting the demands for greater bandwidth or frequency capacity driven by the growing demand for bandwidth-hungry applications. Thus, regulators globally are under pressure to accelerate the identification and assignment of IMT spectrum. We urge the Authority to heed the global trend and unlock the potential of South Africa's economy by accelerating the pace at which IMT is spectrum is made available

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[8] https://mybroadband.co.za/news/cellular/421776-vodacom-builds-two-4g-towers-for-villages-that-havent-had-coverage-for-30-years.html

[9] https://mybroadband.co.za/news/cellular/400095-vodacom-spends-r100-million-on-84-base-stations-in-the-middle-of-nowhere.html

[10] https://mybroadband.co.za/news/cellular/434364-vodacom-pumps-r450-million-into-mpumalanga-network-coverage.html

[11] https://www.itweb.co.za/content/RgeVDvPomwXqKJN3

[12] https://www.gsma.com/spectrum/wp-content/uploads/2013/04/GSMA-Policy-Position-on-Spectrum-Licensing.pdf

[13] https://digitalregulation.org/the-role-of-the-regulator-on-national-spectrum-issues/

through a fair and transparent assignment process. In particular, it is vital that IMT spectrum is assigned in a manner that allows efficient deployment at scale.

2.5. "***What future emerging technologies are to be taken into consideration and which technologies will have a significant impact? When are these technologies expected to become available***?"

Mobile broadband continues to evolve with the transition toward 5G providing exciting new opportunities and use cases. According to Ericsson's Mobility Report[15], it is expected that global 5G subscriptions are forecasted to be approximately 4.4 billion by 2027.

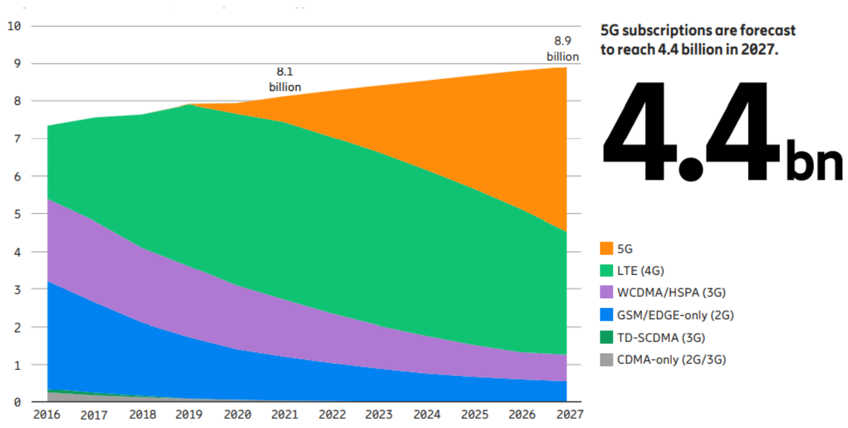

Figure 1: Mobile subscriptions by technology (billion)[15]

In addition, the uptake of 5G subscription would be much more rapid than that experienced by 4G. Ericsson predicts that it would take nearly 4 years less for users to start using 5G once it is deployed vs. the uptake experienced of 4G once it was deployed.

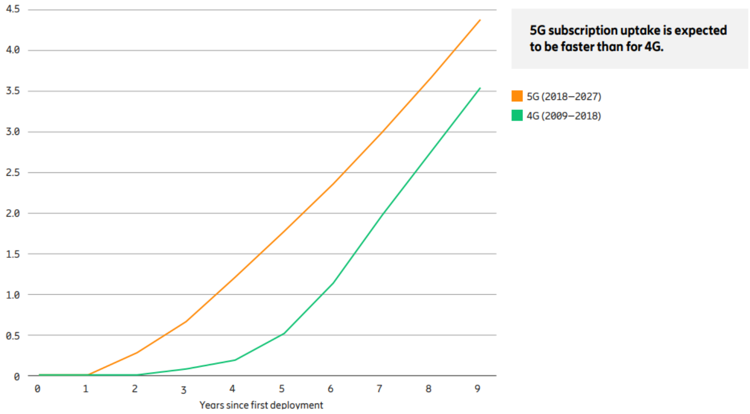

Figure 2: Comparison of 5G and 4G subscriptions uptake in the first years of deployment (billion)[15]

While the above provide a global view of subscriptions, within Africa, ITU-D's Digital trends in Africa 2021[14] report indicates that SA has the second highest number of mobile subscriptions and has more subscriptions when compared to the world average.

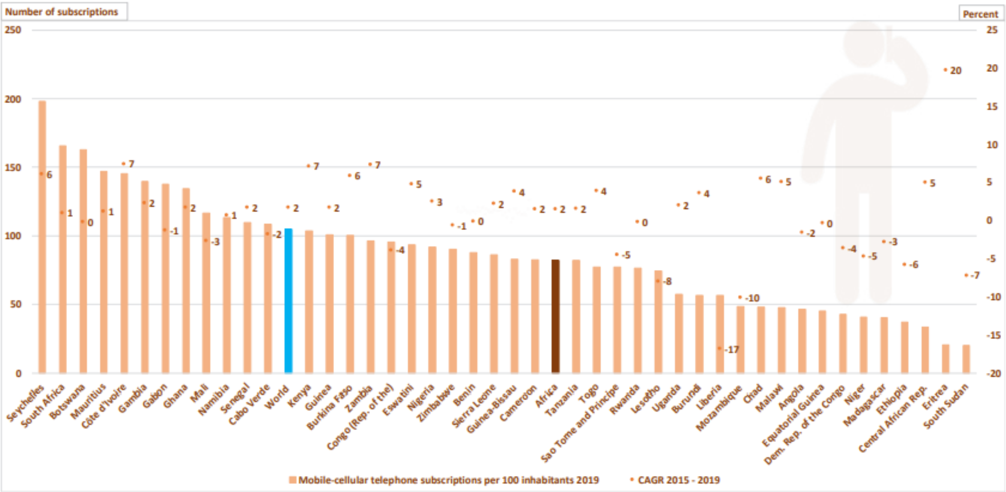

Figure 3: Mobile cellular subscriptions, African countries, 2019 and CAGR [14]

With the lower latency higher network energy efficiencies and better throughputs of 5G, a higher IoT demand is expected to emerge with use-cases crossing each of the market verticals (this is further expanded in question 7).

According to Ericsson, broadband IoT mainly includes wide area use cases that require high throughput, low latency and large data volumes. By the end of 2027, it is predicted that 40% of cellular IoT connections will be broadband IoT, with 4G connecting the majority. As 5G New Radio (NR) is being introduced on old and new spectrum, throughput data rates will increase substantially for this segment. Meanwhile, the Massive IoT technologies NB-IoT and Cat-M1 – primarily consisting of wide-area use cases involving large numbers of low-complexity, low-cost devices with long battery life and relatively low throughput – continue to be rolled out around the world. Although emerging from a relatively small base now, these Massive IoT technologies are expected to overtake broadband IoT during the forecast period. IoT devices connected via 2G and 3G have been in decline since 2019. The forecast of the number of connections for IoT can be found below.

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[14] https://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-DIG_TRENDS_AFR.01-2021-PDF-E.pdf

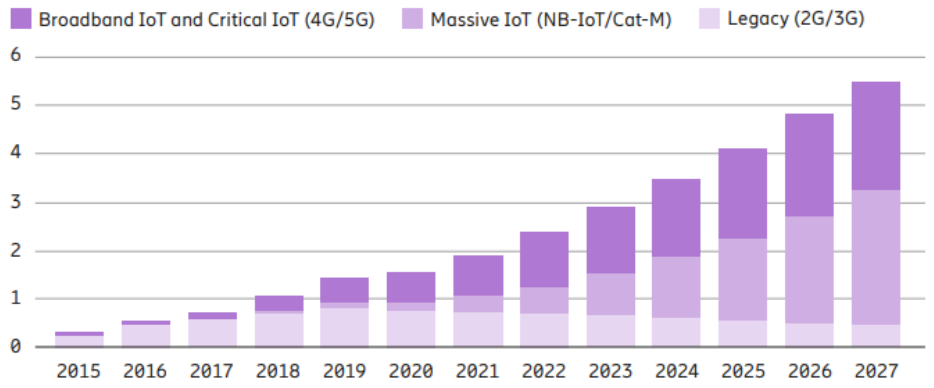

Figure 4: Cellular IoT connections by segment and technology (billion)[15]

It is vital that the Authority ensure a structured and harmonised spectrum management framework that is able to sustainably accommodate 100s of Millions of IoT connections nationally and make the most efficient use of spectrum. In particular, we urge the Authority to consider the harmful medium-long term effects of vertical licensing of spectrum that has the effect of sanitising its use for the masses. Instead, we recommend a model of managed access, in order for multiple uses cases to be accommodated in a particular area.

2.6 "***What and how will technology developments and/or usage trends aid in relieving traffic pressures? When are these technologies expected to become available***?"

Traffic pressures will continue to increase with global demand for data connectivity. The current trends indicate that demand for IMT services far exceeds the demand for other services. Given the global scale of deployment, IMT has continued to evolve faster than other similar services, with the time between each new generation roughly having in duration.

The Authority captures the tremendous growth of IMT in South Africa as illustrated below, whereby we observe a 5-fold increase in the number of mobile connections from 2004 – 2020. In addition, our response to question 5 highlights the ever growing increase in mobile data traffic, as well as highlights the density of active connections within South Africa.

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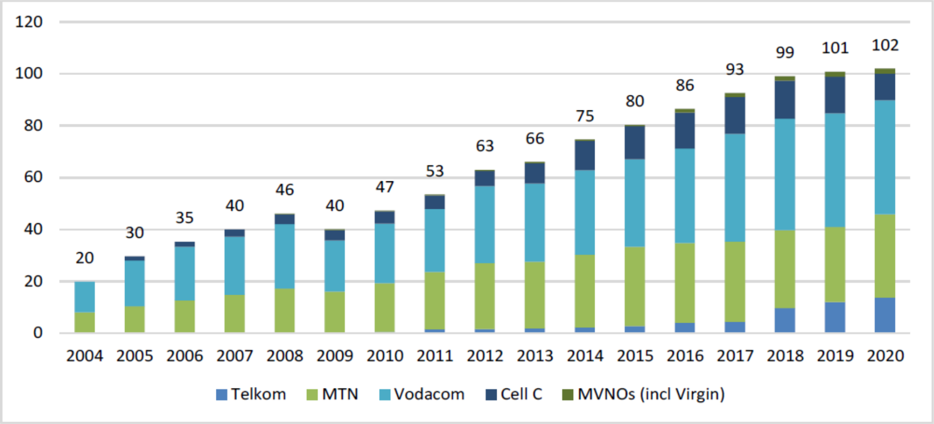
[15] https://www.ericsson.com/4ad7e9/assets/local/reports-papers/mobility-report/documents/2021/ericsson-mobility-report-november-2021.pdf



Source: Operator annual results

Figure 5: Mobile Connections in SA

As illustrated in the table below, South Africa has kept up with the global deployments of each major 3GPP cycle. The first 5G network launched in SA was within the same year as the first global deployment. MNOs in SA are always willing to adopt the latest technologies in order to improve their network capacities and to provide their end users with the best network experience. It can be seen as well that the development of each 3GPP recycle is being reduced over the years, it took 9 years from 3G to have the 4G standard developed and 7 years from 4G to develop the 5G standard. The 6G standard is currently delayed due to the Covid-19 pandemic.

Technology	**3GPP Standard Release**	**First Commercial Deployment Globally**	**First Commercial Deployment in South Africa**
3G	R99 (1999)	2003	2004
LTE	R8 (2008)	2009	2012
LTE-A	R10 (2010)	2013	2014
NR	R15 (2015)	2019	2019

The following technologies could help alleviate traffic pressures

a. 5G is currently available, however full adoption will only occur in the next 5 years and beyond.
    i. Larger bandwidths supported: The maximum defined bandwidth for 5G devices in FR1 is 100 MHz and in FR2 is 400 MHz. Compared to LTE, which had a maximum bandwidth of 20 MHz, all 5G devices will be able to support 100 MHz straight out of the box, whereas on a limited number of 4G devices could make use of a maximum of 100 MHz through carrier aggregation. Larger bandwidths imply faster speeds which implies more capacity.
    ii. Massive MIMO: 5G deployments in the higher bands will utilize massive MIMO which further improve capacity. While trials have been conducted with 96 and 128 antennas, currently 64 is the most available commercially[16]. As time progresses, higher combinations may be introduced which could further increase capacity.
    iii. Additional Carrier Aggregation Combinations: While LTE was only able to aggregate a maximum of 100 MHz, 5G is able to aggregate up to 400 MHz in frequency range 1 (FR1) and up to 700 MHz in FR2.

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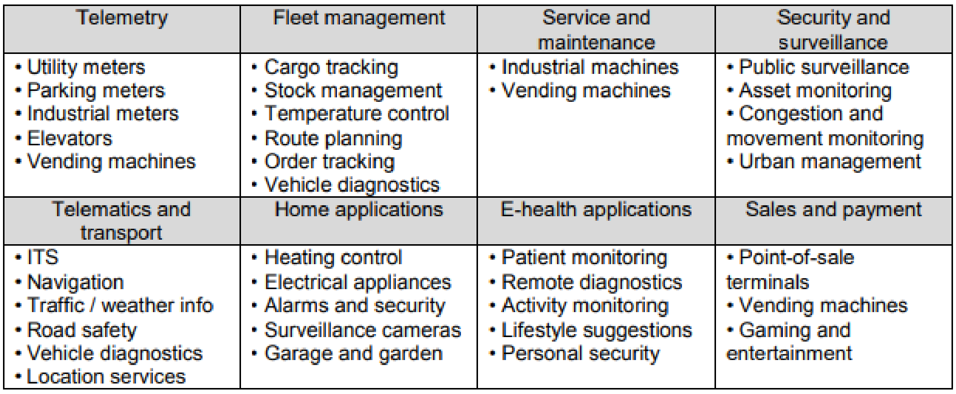
[16] https://5g.co.uk/guides/what-is-massive-mimo-technology/

b. 6G

i. 6G development is still in its very early stages. Currently, the ITU have made reference to IMT-2030[17], which would be an upgrade to 5G rather than 6G similarly to how LTE-A was an upgrade to LTE. 6G networks are expected to exhibit even more heterogeneity (be even more diverse) than their predecessors and are likely to support applications beyond current mobile use cases, such as virtual and augmented reality (VR/AR), ubiquitous instant communications, pervasive intelligence and IoT on a much larger scale. It should be noted that 3GPP Release 8 defined the standard for LTE, Release 10 introduced LTE-A and 7 years later Release 15 defined the standard for 5G. Therefore, 6G would fall within the 20-year timeline.

2.7 "**Are there any IoT applications that will have a large impact on the existing licence-exempt bands? If so, what bands will see the most impact from these applications**?"

The IoT/M2M domain covers a wide range of vertical sectors, and within those there are both established and emerging use cases [18].



Telemetry	Fleet management	Service and maintenance	Security and surveillance
• Utility meters • Parking meters • Industrial meters • Elevators • Vending machines	• Cargo tracking • Stock management • Temperature control • Route planning • Order tracking • Vehicle diagnostics	• Industrial machines • Vending machines	• Public surveillance • Asset monitoring • Congestion and movement monitoring • Urban management
Telematics and transport	**Home applications**	**E-health applications**	**Sales and payment**
• ITS • Navigation • Traffic / weather info • Road safety • Vehicle diagnostics • Location services	• Heating control • Electrical appliances • Alarms and security • Surveillance cameras • Garage and garden	• Patient monitoring • Remote diagnostics • Activity monitoring • Lifestyle suggestions • Personal security	• Point-of-sale terminals • Vending machines • Gaming and entertainment

5G NR-U is the first global cellular standard with both license-assisted and standalone use of unlicensed spectrum. Release 16 begins with 5G NR-U in the 5 GHz unlicensed-exempt band, followed by the 60 GHz millimeter wave band which is being developed as part of Release 17. It is critical for the Authority to ensure that license-exempt services do not result in a spectrum 'land-grab' akin to the scenario that has developed for traditional Wi-Fi. Anchored NR-U can be deployed to combine unlicensed spectrum with licensed spectrum, i.e., licensed-assisted access, or shared spectrum to boost deployments for a better user experience with higher 5G speeds. Until such time as the IoT demand resembles consumer demand, it may be prudent for the Authority to consider licensing spectrum for IoT applications requiring resiliency and mobility as a subset of nationally assigned spectrum for all consumer applications.

There are 3 main types of IoT technologies to support different use-cases as illustrated below, namely:

- LTE Cat-1: aimed towards high throughput, high mobility use cases.
- LTE Cat-M1: aimed towards low power high mobility use cases.

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[17] https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20190218/Documents/Nigel_Jefferies_Presentation.pdf

[18] https://circabc.europa.eu/sd/a/a0faa1a5-ca41-42c3-83d5-561b197419b0/RSPG17-006-Final_IoT_Opinion.pdf

- LTE Cat-NB1: aimed towards low-cost massive deployment applications.

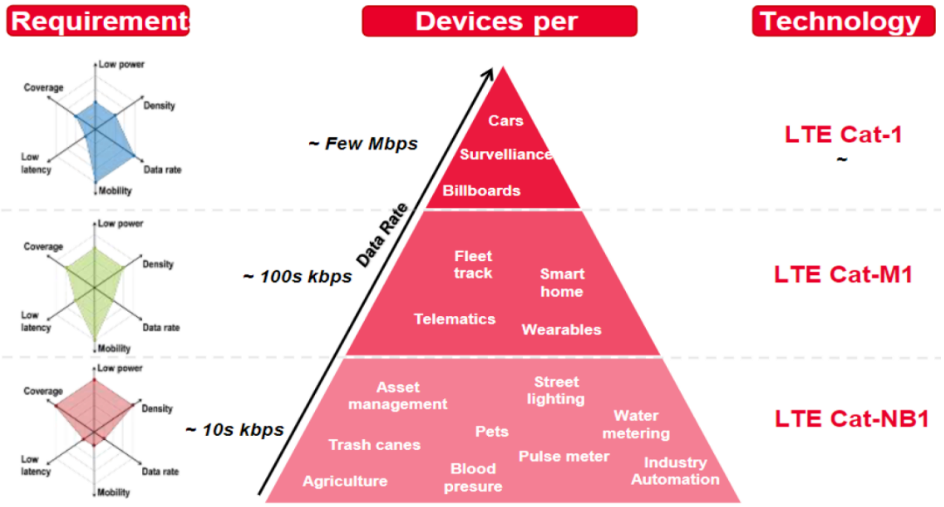
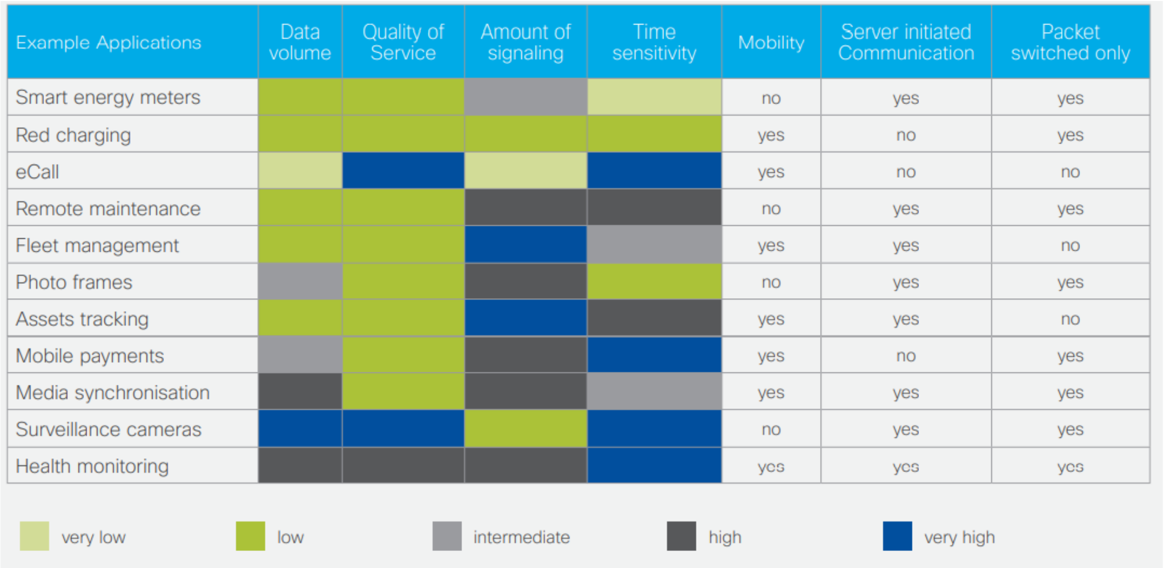


Figure 6: IoT technologies

Although the names have LTE in them, these standards have been adopted by 5G. In addition, IoT in 5G will play a vital role in support ultra-reliable low latency communications (uRLLC) and Massive Machine-Type Communications (mMTC). Of the 11 applications listed below, 8 of them will require mobility.



Example Applications	Data volume	Quality of Service	Amount of signaling	Time sensitivity	Mobility	Server initiated Communication	Packet switched only
Smart energy meters	🟩	🟩	▨	🟨	no	yes	yes
Red charging	🟩	🟩	🟩	🟩	yes	no	yes
eCall	🟨	🟦	🟨	🟦	yes	no	no
Remote maintenance	🟩	🟩	⬛	⬛	no	yes	yes
Fleet management	🟩	🟩	🟦	▨	yes	yes	no
Photo frames	▨	🟩	⬛	🟩	no	yes	yes
Assets tracking	🟩	🟩	🟦	⬛	yes	yes	no
Mobile payments	▨	🟩	⬛	🟦	yes	no	yes
Media synchronisation	⬛	🟩	⬛	▨	yes	yes	yes
Surveillance cameras	🟦	🟦	🟩	🟦	no	yes	yes
Health monitoring	⬛	⬛	⬛	🟦	yes	yes	yes

🟨 very low 🟩 low ▨ intermediate ⬛ high 🟦 very high

Figure 7: Different IoT Applications with Different Characteristics[19]

Based on the above table, we see that 3 of the 8 use cases have mobility as a requirement. In addition, the mobility applications such as fleet management, asset tracking and mobile payments will have orders of magnitude more connections compared to surveillance, smart energy meters or remote maintenance. Vodacom's expectation based on the above is that there is a shift from IoT demand being localised to a small personal area, to rather being connected on a much larger scale, with enhanced mobility.

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[19] https://www.itu.int/en/action/broadband/Documents/Harnessing-IoT-Global-Development.pdf

According to Cisco[20], the number of M2M connections is expected to increase from 6.1 to 14.7 billion connections from 2018 to 2023.

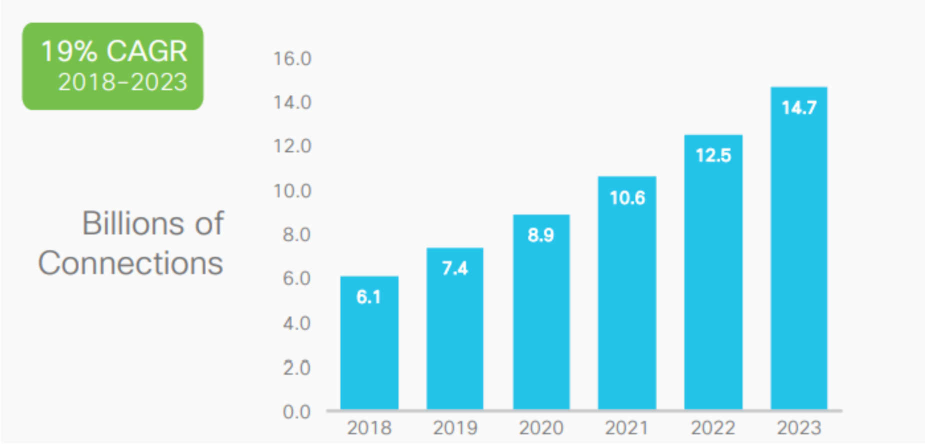

Figure 8: Global M2M Connections[20]

Vodacom sees the 5 GHz and 66 GHz bands the most likely to be used for license exempt IoT and that the 6GHz band be considered for licensed IMT band with evidence provided in question 59.

2.8 "***Please provide your views regarding the standardization of the naming of applications in the NRFP in accordance with CEPT ECC decision 1(03) approved 15 November 2001 and its subsequent revisions.***"

Vodacom supports the decision of the EFIS standardized naming convention as this will prevent ambiguity in the future. Vodacom would like to request that the frequency database be made available to the industry so as to help industry understand current incumbents to better inform future consultations – this is a vital component of transparent and fair spectrum management. This will help alleviate the issue of spectrum warehousing of legacy assignments and can help further expedite new bands for assignment.

2.9 "***What are your forecasts for data traffic and radio frequency spectrum needed over the next 5, 10 and 20 years for each of the EFIS application layers?***"

According to Coleago Consulting[21] and supported by the GSMA[22], the ITU methodology (Recommendation ITU-R M.1768-1) was driven by traffic volume which was a reasonable approach because LTE is predominantly used for best effort smartphone connectivity. This approach was useful to forecast spectrum requirements in the medium term in the context of WRC-15. In contrast the 5G vision is for a ubiquitous high-speed user experience and connectivity for a wide range of new uses coupled with new features. Therefore, a key factor in driving the demand for capacity is the vision that 5G should provide a 100 Mbps user experienced data rate in the downlink and 50 Mbps in the uplink, which are captured in the ITU-R IMT-2020 user experienced data rate requirements. This forecast is for the time period between 2025 – 2030. A similar approach could be adopted to meet the goals of the IMT-2030 and beyond vision. It is

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[20] https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.pdf

[21] https://www.coleago.com/app/uploads/2021/01/Demand-for-IMT-spectrum-Coleago-14-Dec-2020.pdf

[22] https://www.gsma.com/spectrum/wp-content/uploads/2021/07/Estimating-Mid-Band-Spectrum-Needs.pdf

expected that all of the current bands, together new with additional bands, will be required to support the IMT-2030 and beyond vision.

The framework used to calculate the spectrum requirements is based on the capacity currently available and the future capacity demand, with the spectrum required being the delta between the demand and the supply.

The following variables and assumptions were used to determine Capacity Demand:

- ITU requirement of 100 Mbps in the downlink and 50 Mbps in the uplink user experience
- Population density of the city (in the densest areas)
- Activity factor, which is made up of the concurrent demand from human users as well as the concurrent demand from new use cases e.g. M2M, IoT, etc. and represents the concurrent demand for capacity at busy hours
- Offload factor of traffic to indoor small cells and mmWave sites (%)

The following variables and assumptions were used to determine the Capacity Supply:

- Number of Macro sites per km^2
- Macro site sectorization
- Spectrum (MHz) of currently available spectrum deployed on the Macro site which is categorized as follows:
    - Low band which is up to 900 MHz
    - Lower mid bands which are up to 2600 MHz
    - Upper mid bands which are up to 10 GHz
    - High bands which are 24 GHz and above
- Spectral efficiency of the Macro site
- Number of Small cells per km^2
- Small Cell sectorization
- Spectrum (MHz) of currently available spectrum deployed on the Small cell
- Spectral efficiency of the Small cell

More details on the assumptions can be found in the report regarding the above variables.

Based on the above, the following spectrum needs were calculated for 36 cities around the world, with varying population densities and income levels. The table shows the total spectrum requirement for the lower and upper mid bands. While the spectrum requirements have been calculated for a variety of activity factors and high-band offload factors, the values highlighted in blue are the most likely values to be experienced within that city. The GSMA report suggests that Johannesburg South Africa would require a total of 1690 MHz (15% Activity Factor, 25% Offload Factor) as a lower limit and 2010 MHz (20% Activity Factor, 30% Offload Factor) as an upper limit of mid band spectrum, as illustrated below. It should be noted that these offload and activity factors were based on the income of the city, among other factors. However, it did not factor in the sharp increase in data traffic due to Covid-19. As an example, Vodacom experienced an 85% increase[23] and MTN experienced a 100% increase[24] in data traffic due to the lockdowns. Therefore,

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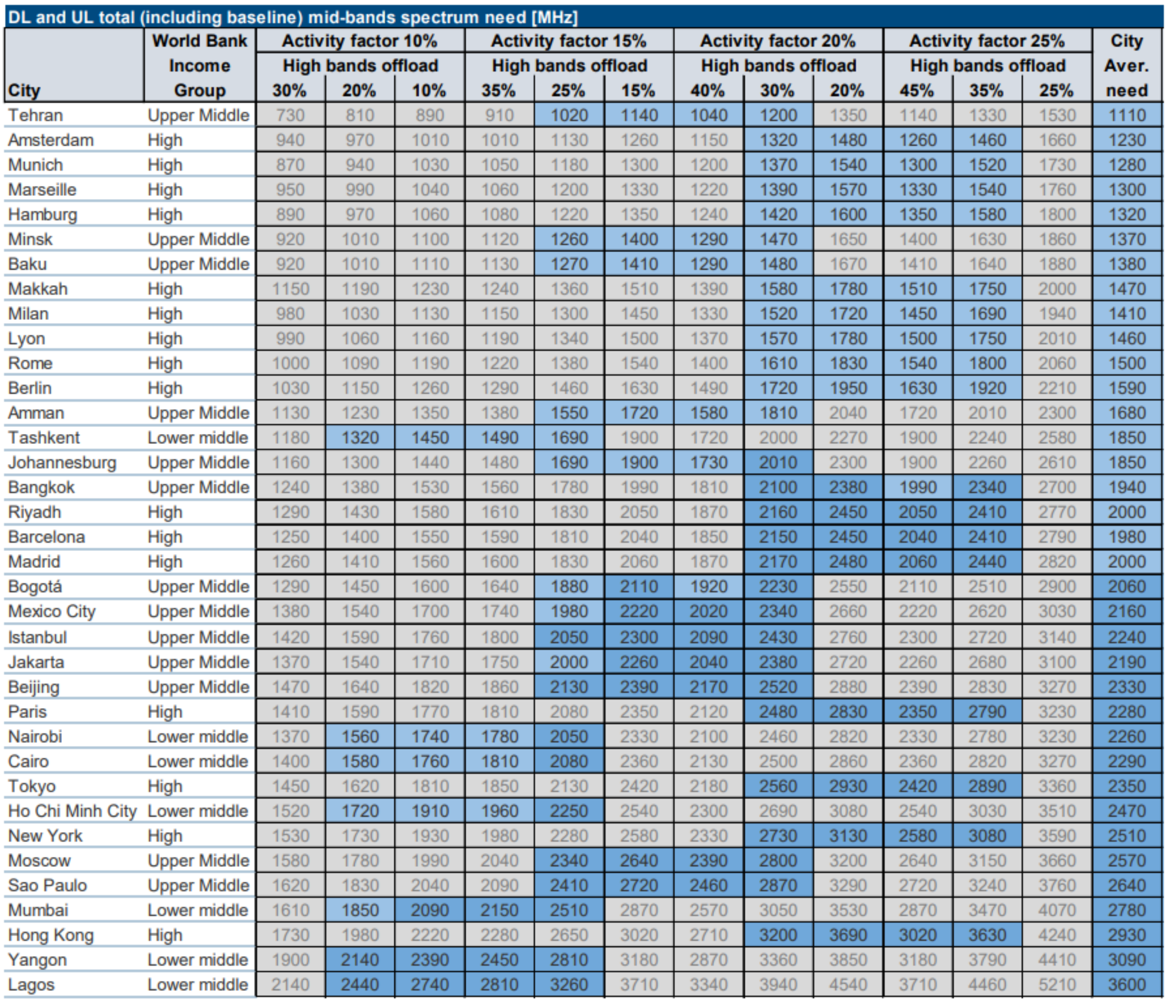
[23] https://www.businessinsider.co.za/more-than-3-million-new-users-for-vodacom-as-connectivity-demands-picks-up-2020-11

[24] https://www.itweb.co.za/content/DZQ587VPG42qzXy2

it is expected that the baseline activity and offload factors would have shifted based on the above increase in demand.



DL and UL total (including baseline) mid-bands spectrum need [MHz]

City	World Bank Income Group	Activity factor 10%			Activity factor 15%			Activity factor 20%			Activity factor 25%			City Aver. need
		High bands offload			High bands offload			High bands offload			High bands offload			
		30%	20%	10%	35%	25%	15%	40%	30%	20%	45%	35%	25%	
Tehran	Upper Middle	730	810	890	910	1020	1140	1040	1200	1350	1140	1330	1530	1110
Amsterdam	High	940	970	1010	1010	1130	1260	1150	1320	1480	1260	1460	1660	1230
Munich	High	870	940	1030	1050	1180	1300	1200	1370	1540	1300	1520	1730	1280
Marseille	High	950	990	1040	1060	1200	1330	1220	1390	1570	1330	1540	1760	1300
Hamburg	High	890	970	1060	1080	1220	1350	1240	1420	1600	1350	1580	1800	1320
Minsk	Upper Middle	920	1010	1100	1120	1260	1400	1290	1470	1650	1400	1630	1860	1370
Baku	Upper Middle	920	1010	1110	1130	1270	1410	1290	1480	1670	1410	1640	1880	1380
Makkah	High	1150	1190	1230	1240	1360	1510	1390	1580	1780	1510	1750	2000	1470
Milan	High	980	1030	1130	1150	1300	1450	1330	1520	1720	1450	1690	1940	1410
Lyon	High	990	1060	1160	1190	1340	1500	1370	1570	1780	1500	1750	2010	1460
Rome	High	1000	1090	1190	1220	1380	1540	1400	1610	1830	1540	1800	2060	1500
Berlin	High	1030	1150	1260	1290	1460	1630	1490	1720	1950	1630	1920	2210	1590
Amman	Upper Middle	1130	1230	1350	1380	1550	1720	1580	1810	2040	1720	2010	2300	1680
Tashkent	Lower middle	1180	1320	1450	1490	1690	1900	1720	2000	2270	1900	2240	2580	1850
Johannesburg	Upper Middle	1160	1300	1440	1480	1690	1900	1730	2010	2300	1900	2260	2610	1850
Bangkok	Upper Middle	1240	1380	1530	1560	1780	1990	1810	2100	2380	1990	2340	2700	1940
Riyadh	High	1290	1430	1580	1610	1830	2050	1870	2160	2450	2050	2410	2770	2000
Barcelona	High	1250	1400	1550	1590	1810	2040	1850	2150	2450	2040	2410	2790	1980
Madrid	High	1260	1410	1560	1600	1830	2060	1870	2170	2480	2060	2440	2820	2000
Bogotá	Upper Middle	1290	1450	1600	1640	1880	2110	1920	2230	2550	2110	2510	2900	2060
Mexico City	Upper Middle	1380	1540	1700	1740	1980	2220	2020	2340	2660	2220	2620	3030	2160
Istanbul	Upper Middle	1420	1590	1760	1800	2050	2300	2090	2430	2760	2300	2720	3140	2240
Jakarta	Upper Middle	1370	1540	1710	1750	2000	2260	2040	2380	2720	2260	2680	3100	2190
Beijing	Upper Middle	1470	1640	1820	1860	2130	2390	2170	2520	2880	2390	2830	3270	2330
Paris	High	1410	1590	1770	1810	2080	2350	2120	2480	2830	2350	2790	3230	2280
Nairobi	Lower middle	1370	1560	1740	1780	2050	2330	2100	2460	2820	2330	2780	3230	2260
Cairo	Lower middle	1400	1580	1760	1810	2080	2360	2130	2500	2860	2360	2820	3270	2290
Tokyo	High	1450	1620	1810	1850	2130	2420	2180	2560	2930	2420	2890	3360	2350
Ho Chi Minh City	Lower middle	1520	1720	1910	1960	2250	2540	2300	2690	3080	2540	3030	3510	2470
New York	High	1530	1730	1930	1980	2280	2580	2330	2730	3130	2580	3080	3590	2510
Moscow	Upper Middle	1580	1780	1990	2040	2340	2640	2390	2800	3200	2640	3150	3660	2570
Sao Paulo	Upper Middle	1620	1830	2040	2090	2410	2720	2460	2870	3290	2720	3240	3760	2640
Mumbai	Lower middle	1610	1850	2090	2150	2510	2870	2570	3050	3530	2870	3470	4070	2780
Hong Kong	High	1730	1980	2220	2280	2650	3020	2710	3200	3690	3020	3630	4240	2930
Yangon	Lower middle	1900	2140	2390	2450	2810	3180	2870	3360	3850	3180	3790	4410	3090
Lagos	Lower middle	2140	2440	2740	2810	3260	3710	3340	3940	4540	3710	4460	5210	3600

Source: Coleago

Figure 9: Mid-band Spectrum needs for 2025-2030 of 36 Cities around the World. The values highlighted in blue are the most likely activity factors and offload ratios to be experienced by that city[29]

From the above table, we can extract the following:

- The most common lowest activity factor and high band offload factor is 10% and 20%, respectively. The minimum spectrum requirement, excluding low band and high band spectrum is 1320 MHz
- The most common average activity factor and high band offload factor is 20% and 30%, respectively. The minimum spectrum requirement for this range is 1200 MHz, the median being 2100 MHz and the maximum being 3200 MHz.
- The most common highest activity factor and high band offload factor is 25% and 35%, respectively. The maximum spectrum requirement, excluding low band and high band spectrum is 3630 MHz

Based on the above, 1320 MHz of mid-band spectrum should be required as a minimum coverage layer to meet ITU-R IMT 2020 vision, 2100 MHz (additional 780 MHz) of mid-band spectrum should be required to deal with the additional traffic from urban and sub-urban areas, and 3630 MHz (additional 1530 MHz) will be required in extreme cases to hot spot capacity areas to provide further capacity. As mentioned in question 3, low band spectrum is essential to provide base coverage and to connect the unconnected and its importance should not be forgotten based on this analysis.

Using the same methodology from the report, assuming high-band spectrum will be deployed on all small cells and assuming that high-band small cells have the same spectral efficiency as mid-band small cells, we can calculate the high-band spectrum needs as presented below. The high-band offload here reflects the traffic carried by the high-band.

City	Activity Factor 10%			Activity Factor 15%			Activity Factor 20%			Activity Factor 25%		
	High Band Offload			High Band Offload			High Band Offload			High Band Offload		
	30%	20%	10%	35%	25%	15%	40%	30%	20%	45%	35%	25%
Johanessburg	1100	820	540	1860	1440	1020	2740	2200	1640	3780	3080	2400

This shows that at a minimum, at least 1.02 GHz of high-band spectrum would be required. This excludes the use cases of unlicensed high bands and of other high bands where use cases are still being developed.

Post the 2022 ITA, the following bands will be available for operators to use:

ƒ (MHz)	**Duplex mode**	**Common name**	**Category**	**Present Allocation after ITA**
700	FDD	APT	LB	30
800	FDD	Digital Dividend (EU)	LB	30
900	FDD	Extended GSM	LB	35
1800	FDD	DCS	MLB	72
2100	FDD	IMT	MLB	60
2010-2025	TDD	IMT	MLB	15
2300	TDD	S-Band	MLB	100
2600	TDD	IMT-E	MLB	50
3400-3600	TDD	C-Band	MHB	200

This baseline is summarized in the table below.

Scenario	**LB**	**LB**	**MLB**	**MLB**	**MLB**	**MHB**	**LB**	**MLB**	**MHB**	**Total**
	FDD	**SDL**	**FDD**	**SDL**	**TDD**	**TDD**	**Total**	**Total**	**Total**	**Total**
SA Present Allocation after ITA	190	0	264	0	165	200	190	429	200	819

Based on the above 3 scenarios, the following mid-band spectrum (excluding baseline spectrum) was calculated.

City	Activity Factor 10%			Activity Factor 15%			Activity Factor 20%			Activity Factor 25%		
	High Band Offload			High Band Offload			High Band Offload			High Band Offload		
	30%	20%	10%	35%	25%	15%	40%	30%	20%	45%	35%	25%
SA Present Allocation after ITA	490	630	770	800	1020	1230	1060	1340	1620	1230	1590	1940

From the calculation, it can be seen that at least an additional 1340 MHz of mid-band spectrum will be required post ITA to meet the 100 Mbps DL and 50 Mbps UL. We expect that 1340 would be the minimum as the demand brought about due to Covid has shifted the baseline activity and offload factors. It is important to note that these values exclude both low bands for coverage and other niche and unlicensed bands.

2.10 “*How much spectrum is allocated to each of the EFIS application layers, and what is the economic value of spectrum used in each of the above EFIS application layers? What are the opportunity costs for current spectrum allocations for EFIS these application layers (what is the value to alternative users of these allocations)?*”

As highlighted in question 2, there are numerous studies that show that the adoption of broadband has a direct correlation with positive economic growth. Our Question 9 response has highlighted the expected spectrum required for IMT Mobile. The response to Question 11 highlights that South Africa has one of the highest adoptions of mobile broadband per 100 people in Africa and is above the world average. In addition, it highlights the decreasing demand of satellite and shows how the number of fixed subscriptions in Africa is orders of magnitude lower than mobile broadband. Our Question 30 response shows that broadcasting demand in ITU Region 1 is decreasing based on the fact that nearly half of all administrations that responded have less than 50% of their populations receiving television through terrestrial digital broadcasting. Further information on these demands can be found in the respective responses to each of the questions. Therefore, to conclude, the demand for mobile broadband in South Africa continues to grow and because it is widely accessible to the largest population base when compared to any other service, spectrum assigned for IMT will serve the greater good of the nation’s population.

2.11 “*How should demand for commercial mobile services and IMT in the next few years be determined? What traffic model should be used in South Africa for traffic demand expectations? What are your comments on the spectrum requirements set out on Table 2?*”

According to ITU-D’s Digital trends in Africa 2021[14], South Africa has the highest number of active mobile subscriptions, 102 per 100 inhabitants within Africa and has 36% more active connections per 100 inhabitants compared to the world average and 210% more when compared to the average of Africa.

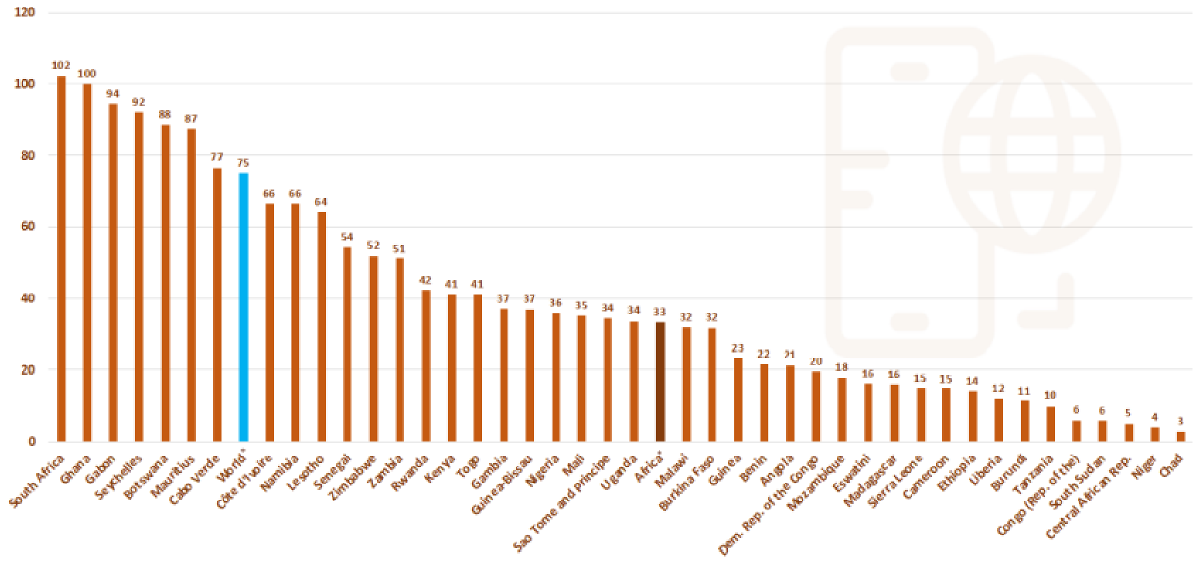


Figure 10: Active mobile broadband subscriptions per 100 inhabitants, 42 African Countries, 2019[25]

This is impressive, considering how limited South African operators are in terms of access to IMT spectrum resources and further emphasizes the high demand for mobile services in South Africa and the urgency to release additional IMT spectrum to support this demand. As an example, neither of South Africa's largest operators hold the spectrum held by the average operator globally nor that of developing or developed countries, as tabulated below[26]. In addition, by going through press releases published within in the past 2 years[23, 24], MNOs have experienced double digit percentage increases in the amount of traffic their networks are now carrying due to Covid-19.

Segment	**Average Spectrum Holding (MHz) per Operator**
Developing (excl. Africa)	100
Global (excl. Africa)	150
Developed	180
Vodacom/ MTN South Africa	76 (2x11 MHz in 900 MHz 2x12 MHz in 1800 MHz 2x 15 MHz in 2100 MHz)

In contrast, compared with other regions, Africa has one of the lowest fixed broadband subscription rates, given the absence of legacy fixed access infrastructure, and the relatively lower costs of deploying wireless broadband infrastructure vs. deploying a fixed access network. ITU estimated a fixed broadband subscription rate of 0.5 per 100 inhabitants for Africa in 2020, a figure that is well below the global average of 15.2 subscriptions per 100 inhabitants[14].

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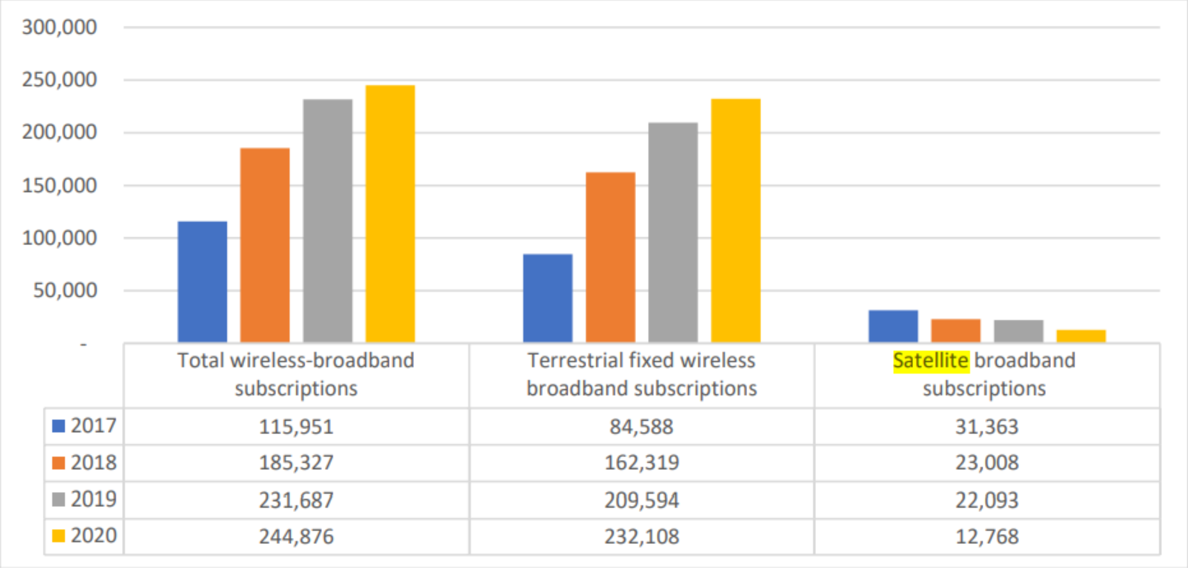
[25] https://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-DIG_TRENDS_AFR.01-2021-PDF-E.pdf

[26] https://www.gsma.com/spectrum/wp-content/uploads/2020/11/Effective-Spectrum-Pricing-Africa.pdf

ICASA's The State of ICT Report 2021[27], shows that the demand for satellite broadband subscriptions has been declining YoY for the past 4 years. While the report does show some increase in terrestrial fixed wireless broadband adoption, these subscriptions are orders of magnitude lower than that of mobile subscriptions and are typically applicable to a narrow segment of the user base.

Vodacom is of the recommends that spectrum needs to be assigned proportionally to the user-subscription demand of the different use cases. Spectrum should thus not be equally assigned for all applications irrespective of the subscription demand of the service, as this will likely lead to spectrum warehousing. Instead, spectrum needs to be assigned based on demand for each of the services which will serve the needs of the greater population of South Africa.



	Total wireless-broadband subscriptions	Terrestrial fixed wireless broadband subscriptions	Satellite broadband subscriptions
🟦 2017	115,951	84,588	31,363
🟧 2018	185,327	162,319	23,008
⬜ 2019	231,687	209,594	22,093
🟨 2020	244,876	232,108	12,768

Figure 11: Wireless-broadband subscriptions, as at 30th September each year[27]

According to Coleago Consulting[28] and supported by the GSMA[29], the ITU methodology (Recommendation ITU-R M.1768-1) was driven by traffic volume which was a reasonable approach at the time because LTE was essentially used for best effort smartphone connectivity. This approach was useful to forecast spectrum requirements in the medium term in the context of WRC-15. In contrast the 5G vision is for a ubiquitous uplift of user experience to higher speeds, and connectivity for a wide range of new uses coupled with new features. Therefore, a key factor in driving the demand for capacity is the vision that 5G should provide the 100 Mbps user experienced data rate in the downlink and 50 Mbps in the uplink, which are the ITU-R IMT-2020 user experienced data rate requirements. As mentioned by ICASA, these throughput values are in line with the SA Connect targets. While fundamentally a particular speed cannot be guaranteed in a mobile network, there is a high probability of experiencing this data rate, with sufficient assigned spectrum. This means networks should be designed to deliver a data rate (Mbps) rather than data volume (GB/month). As a result, as we transition to 5G, the need for throughput capacity will grow faster than traffic volume in order to support the application that have high throughput and low latency requirements.

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[27] https://www.icasa.org.za/uploads/files/State-of-the-ICT-Sector-Report-March-2021.pdf
[28] https://www.coleago.com/app/uploads/2021/01/Demand-for-IMT-spectrum-Coleago-14-Dec-2020.pdf
[29] https://www.gsma.com/spectrum/wp-content/uploads/2021/07/Estimating-Mid-Band-Spectrum-Needs.pdf

*2.12"**Provide your support or reasons for objections on the bands being considered internationally for 5G commercial mobile allocations.**"*

Vodacom supports the assignment of the spectrum bands listed in Table 3 and has provided sufficient evidence in both its submissions to the Draft National Radio Frequency Plan 2021 and The Inquiry for the Implementation of the Radio Frequency Migration Plan and the IMT Road Map highlighting the benefits, ecosystems and so on of each of the ranges. Vodacom has also indicated the bands in currently utilizes for microwave backhaul.

Please refer to the following sections which further discuss the advantages of assigning the bands to IMT vs. to other services

Item	**Refer to Question**
Economic Benefit of IMT	2
Demand by IMT	5, 9, 11
Broadcasting Demand on the Decline	30, 31
Fixed Demand on the Decline	11
Satellite Demand on the Decline & C-Band not fully utilized	11, 19
Benefits of licensing the 6 GHz	19, 59

As mentioned in question 16, spectrum should be assigned:

a) To services that best serve the population as a whole.
b) To services that will be easily accessible to the general population
c) To services that will stimulate growth and investment into ICT Infrastructure.
d) To services that have a high demand by the population

IMT should therefore be prioritized for assignment to the core mobile bands being considered internationally, as global harmonization will provide the economies of scale which will ultimately have the greatest impact on the end user.

*2.13 "**Are the spectrum allocations comprehensive enough for spectrum demand projections for commercial mobile services in South Africa for the next 10 to 20 years?**"*

Based on the analysis in question 9, in addition to the 1960 MHz required for RATG1 & 2, at least roughly an additional 2000 MHz of mid-band spectrum and 1000 MHz of high-band spectrum will need to be released to meet the IMT 2020 vision. This does not include bands that will be used to provide niche or unlicensed services or low bands which will be used as coverage layers. This will be required in the timeframe between 2025 – 2030 to meet the IMT 2020 vision. Additional bands will be required to meet the IMT 2030 and beyond vision. Please refer to our response to question 17 for the bands that will need to be assigned.

*2.14 "**Is there a demand for more flexible frequency licensing and frequency assignment/allotments processes on a regional basis required to complement the national frequency licensing and frequency assignments/allotments in the next 10 to 20 years?**"*

We assume for the moment that the Authority refers to regional licensing with the borders of South Africa and not regional assignment with a multi-national geography. With this assumption, we recommend that the Authority approach regional spectrum assignment, especially for IMT and planned-IMT bands on a cautious basis. Globally, countries are finding extreme difficulty in unwinding and migrating regional networks when they are usurped through the expansion of national mobile networks. Such cases result in regional licensees holding incumbent national licensees as well as Regulator's hostage, when decisions are made to migrate their services. Such scenarios also incentivise speculative licensees to obtain regional licensees with the aim of IMT conversion or speculative trading. Deploying on a regional level is suboptimal as it will not bring the efficiencies of large-scale national deployments and as a result, the economies of scale to the end user. Regional deployment will not stimulate investment into deployment into areas that need currently have no connectivity. National level licensing is best suited to close the digital divide in South Africa.

2.15 "***Are there any other frequency bands that should be considered for release in the next 10 to 20 years for commercial mobile that are not discussed? Provide motivations for your proposal***."

Please refer to our response to question 17 that highlights the short and mid-term bands that should be released for IMT. Vodacom recommends that the following bands be considered for release for commercial mobile in the next 10-20 years that were not included in table 3. Motivation for the bands can be found in Vodacom's previous submissions to the Draft National Radio Frequency Plan 2021 and The Inquiry for the Implementation of the Radio Frequency Migration Plan and the IMT Road Map. For brevity, we do not repeat this submission here, but advise the Authority to look in particular at Section 3 in the Draft National Radio Frequency Plan 2021 and Section 2 of The Inquiry for the Implementation of the Radio Frequency Migration Plan and the IMT Road Map.

The below table highlights the band to be assigned based on priority

Frequency Range	Usable Bandwidth	Device Variants (GSA)	Priority
450 – 470 MHz	5 MHz	194	Immediately
614 – 698 MHz	30 MHz	257	Immediately on a secondary basis, mid-term on a primary basis
733 –758 MHz	25 MHz	2	Immediately
1427 – 1518 MHz	91 MHz	5	Immediately
3300 – 3400 MHz	100 MHz	848 (n78)	Immediately
3600 – 3800 MHz	200 MHz	848 (n78), 658 (n77)	Immediately, but licensed post migration of FWA incumbents
24.25 – 27.5 GHz	3250 MHz	41 (n257), 31 (n258)	1GHz Immediately in 26.5-27.5 GHz range
66 – 71 GHz	5000 MHz	3	Immediately
1980 – 2010 // 2170 – 2200 MHz	30 MHz	1	Mid-term
3800 – 4200 MHz	400 MHz	848 (n78), 658 (n77)	Mid-term
4400 – 5000 MHz	600 MHz	658 (n77)	Mid-term

5150 – 5925 MHz	775 MHz	220	Potentially using LAA
37 – 40 GHz	3000 MHz	70	Mid-term
26.5 – 29.5 GHz	2000 MHz as it overlaps with above	41 (n257)	Mid-term
5925 – 7125 MHz	1200 MHz	1	Mid-term
5855 – 5925 MHz	70 MHz	12	Long-term
39.5 – 43.5 GHz	3500 MHz as it overlaps with above	0	Long-term
47.2 – 48.2 GHz	1000 MHz	0	Long-term

2.16 "***Which vertical markets will require the most secured licensed spectrum to overcome their current interference and congestion issues?***"

Commercial mobile operators support the needs of a wide variety of vertical sectors and will have added capabilities with 5G. Spectrum should be assigned based on the following principles:

a. To services that best serve the population as a whole

b. To services that will be easily accessible to the general population

c. To services that will stimulate growth and investment into ICT infrastructure.

d. To services that have a high demand by the population

Spectrum that is set-aside exclusively for niche services in core mobile bands risk being underused, and potentially sterilising particular areas, akin to a land-grab. In addition, spectrum in core mobile bands that is set-aside for niche services can also threaten the wider success of 5G – including slower rollouts, worse performance and reduced coverage. As highlighted in our response to question 11, fixed and satellite services serve users that are orders of magnitude less in numbers than mobile subscribers. In order to bridge the digital divide, spectrum needs to be assigned to mobile as it is most easily accessible to the general public.

We recommend that the Authority only consider dedicated licensing of spectrum for industry verticals once options to exploit current national networks have been exhausted, and where the impact on other users, such as consumers and emergency services have been adequately accounted for. In addition, we recommend that the Authority consider the impact of National Networks expanding in future into areas that have niche solutions – global experience suggests that niche solutions that cannot be accommodated with the aggregate mobile network deployment, need to be licensed on frequencies that are not likely to impinge on future mobile network growth, or necessitate time-consuming migrations when mobile networks are expanded.

2.17 "***Assuming that South Africa follows the ITU's recommendations to assign up to 1,940MHz of spectrum for IMT-2000 and IMT-advanced services, and that South Africa follows trends in Europe for potentially another 2,000 MHz of spectrum for IMT-2020, what bands would need to be freed up?***
"

It should be noted that some of these bands will be used for niche applications such as 5855 – 5925 MHz for ITS (Intelligent Transport Systems) and some of the higher bands, while some bands will be used for license-exempt access. In South Africa, it is crucial to release additional sub 1GHz spectrum, as this will alleviate some of the traffic pressure placed on mid-bands, as well as will help improve coverage and capacity in rural areas. Excluding currently assigned bands, as well as bands that will be assigned post-ITA, the following bands will likely need to be freed up:

Frequency Range	Usable Bandwidth	Device Variants (GSA)	Priority
450 – 470 MHz	5 MHz	194	Immediately
614 – 698 MHz	30 MHz	257	Immediately on a secondary basis, mid-term on a primary basis
733 –758 MHz	25 MHz	2	Immediately
1427 – 1518 MHz	91 MHz	5	Immediately
1980 – 2010 // 2170 – 2200 MHz	30 MHz	1	Mid-term
3300 – 3400 MHz	100 MHz	848 (n78)	Immediately
3600 – 3800 MHz	200 MHz	848 (n78), 658 (n77)	Immediately, but licensed post migration of FWA incumbents
3800 – 4200 MHz	400 MHz	848 (n78), 658 (n77)	Mid-term
4400 – 5000 MHz	600 MHz	658 (n77)	Mid-term
5150 – 5925 MHz	775 MHz	220	Potentially using LAA
5855 – 5925 MHz	70 MHz	12	Long-term
5925 – 7125 MHz	1200 MHz	1	Mid-term
24.25 – 27.5 GHz	3250 MHz	41 (n257), 31 (n258)	1GHz Immediately in 26.5-27.5 GHz range
26.5 – 29.5 GHz	2000 MHz as it overlaps with above	41 (n257)	Mid-term
37 – 40 GHz	3000 MHz	70	Mid-term
39.5 – 43.5 GHz	3500 MHz as it overlaps with above	0	Long-term
47.2 – 48.2 GHz	1000 MHz	0	Long-term
66 – 71 GHz	5000 MHz	3	Immediately

This translates into a total of 260 MHz of low band spectrum, 579 MHz of mid-low band spectrum and 3545 MHz (2770 MHz exclude LAA 5GHz band) of high-band spectrum (including spectrum currently assigned and that will be assigned post ITA).

2.18 "***What are your views on reallocating the following bands for IMT over the next years? Table 3: List of possible future IMT bands (please supplement or delete as your organisation considers reasonable)***"

450-470 (20MHz)

617-698 (70MHz)

1 427-1 518 (91MHz)

1 710-2 025 (315MHz)

3 300-3 400 (100MHz)

3 400-3 600 (200MHz)

3 600-3 800 (200MHz)

4 800-4 990 (190MHz)

24 250-27 500 (3250MHz)

37 000-43 500 (6500MHz)

45 500-47 000 (1500MHz)

47 200-48 200 (1000MHz)

66 00-71 000 (5000MHz)"

Vodacom supports the assignment of the spectrum bands listed in Table 3. We recommend that the Authority start engaging immediately with licensees running transmission services on these band to agree on a migration path and timeline. We have provided substantial motivation for such an approach in in both our submissions to the Draft National Radio Frequency Plan 2021 , as well as The Inquiry for the Implementation of the Radio Frequency Migration Plan and the IMT Road Map, highlighting the benefits and ecosystems of each of the ranges. To the extent that spectrum can be assigned immediately, such as in the case of the range 26,5-27,5GHz, we encourage the Authority to proceed to immediately assigned this spectrum on a competitive, fair and transparent basis to industry

2.19 "***Provide your support or reasons for objections on the bands being considered internationally for 5G commercial mobile, fixed, satellite, or licence-exempt allocations.***"

The 6 GHz band is a potential golden capacity band for 5G/6G and should follow the WRC-23 routine to study the possibility for IMT identification. Beyond the 3GHz & 4GHz bands (which still suffer from legacy incumbent use), the next available capacity band for IMT is in the 6GHz range. When compared to the limited user connectivity of Wi-Fi (typically being constrained to users with alterative fixed access), the prospect of providing high capacity IMT services to large numbers of users is a more compelling proposition in a country such as South Africa that has very limited fixed access as highlighted in our response to question 11. In regard to local Wi-Fi networks, there are other short-range spectrum alternatives to expand personal area networks. If allocated to Wi-Fi, and the spectrum is to be used to generate a Mobile hotspot, the data traffic will be backhauled over the scarcer Mobile network's spectrum. Therefore, it would mean that there is duplicate use of spectrum, as traffic would be carried over the operator's spectrum while the Wi-Fi spectrum will merely act as a relay to the local network. This will be inefficient use of the spectrum resources. For these reasons, we urge the Authority to reconsider their position on the 6GHz band, as the demand for IMT allocation for the full band is gaining momentum and represents a better consumer outcome. Our response to Question 55 provides further motivation on the socio-economic benefits of licensing the entire 6GHz band.

A recent study published by Systems House[30] indicates that satellite usage in the C-band is under-utilized. Based on measurements conducted in Johannesburg, the following fill-factors were obtained. A fill-factor is the ratio of bandwidth being used over the total bandwidth allocated - the lower the fill-factor, the lower the utilization of the spectrum assigned.

Band	**Fill-Factor**
3600 – 3700 MHz	35%
3700 – 3800 MHz	59%
3600 – 3800 MHz	50%
3800 – 4200 MHz	58%
3600 – 4200 MHz	57%

From the results, it can be seen that the current utilization of the C-band is low, as indicated by a minimum fill-factor of 35% and a maximum of 58%. In addition, our response to question 11 further highlights the decline in satellite subscriptions. Therefore, this range needs to be reconsidered for IMT as the current utilization is low, resulting in inefficient use of the spectrum.

2.20 "***Provide your support or reasons for objections on the bands being considered internationally for fixed applications. Please provide a list of such bands for potential fixed use.*** "

According to the GSMA[31], new backhaul bands are needed to support evolving network requirements and growing traffic. In the near-term the E-band (70/80 GHz) will be most important, especially to support initial 5G growth, but the W-band (92-114 GHz) and D-band (130-175 GHz) will also be vital to help power 5G backhaul networks in subsequent years. V-band (66-71 GHz) is also likely to be used for backhaul and portions will be used for 5G access as well.

The E-band, D-band and W-bands can handle 15-50 times more traffic than typical popular mid-microwave backhaul bands (e.g., 14 GHz-25 GHz). This is possible because they can support channel sizes of up to 2 GHz, as opposed to between 7-224 MHz, in traditional bands. Therefore, regulators should plan to support

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[30] https://gsacom.com/paper/african-c-band-satellite-report-the-systems-house-2021/ & https://www.youtube.com/watch?v=7tjE6Ugg0KU&list=PL-w3m3Fi4ZVkqHJ9xU9NqpjVREfgFQ13j&index=8

[31] https://www.gsma.com/spectrum/wp-content/uploads/2021/02/wireless-backhaul-spectrum-positions.pdf

very wide channels in order to extract the maximum capabilities from the bands. Current backhaul bands will still play an important role but need support to maintain relevance in the 5G era – especially through wider channel sizes. These bands cannot be replaced with higher frequency bands without incurring costs that may ultimately render sites in some areas economically unviable. Regulators need to ensure they are making sufficient spectrum available in these bands, and in sufficiently wide channel sizes, to address various backhaul scenarios.

The higher frequency bands are expected to be used mostly in urban and suburban environments as they travel relatively short distances (e.g., 2-3 km) due to their limited propagation and susceptibility to bad weather. However, it is expected that aggregation technologies should allow them to be paired with lower frequency backhaul bands to offset each other's weaknesses. The lower band provides a reliable and resilient core connection, even in bad weather, while the higher frequency band can provide significant additional capacity on a best effort basis. For example, lower bands (such as 15, 18 or 23 GHz) combined with E-band links could support 7-10 km links with capacities that exceed 10 Gbps. Regulators also need to carefully consider interest in these bands from alternative use cases – including 5G access.

2.21 "***Are the spectrum allocations comprehensive enough for spectrum demand projections for fixed services in South Africa for the next 10 to 20 years?***"

The adoption of fixed wireless broadband has been very low in South Africa and Africa, as highlighted in our response to question 11. The evolution of mobile networks and the continued rise in data usage mean that fibre and terrestrial wireless backhaul dominate the market today and will for the foreseeable future, as they are expected to connect 97% of all base stations by 2027[31]. Satellite backhaul continues to play a minor role in rural areas where mobile operators today have no other options and constitutes around 2% of backhaul connections worldwide. Although fibre is the optimum backhaul method due to its increased capacity, terrestrial wireless backhaul links will play a vital role as fibre will not be accessible or affordable at all sites. In fact, terrestrial wireless backhaul links are expected to represent at least 60 per cent of the global market from 2021 to 2027 (this includes microwave and mmWaves frequency bands which range from 6 GHz to 175 GHz).

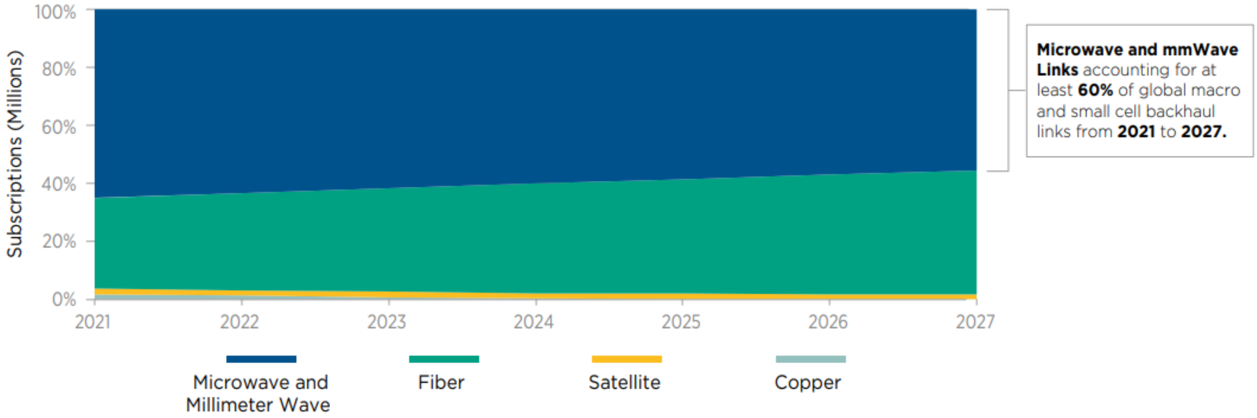

Figure 12: Backhaul Connections

Terrestrial backhaul bands can be divided into ranges with different properties. Lower bands travel longer distances (known as hops) but typically support less data as they have narrower bandwidths. The ranges can be defined as:

- Low (below 11 GHz and able to support 10-50 km hops)
- Medium (11-23 GHz and able to support 8-20 km hops)
- High (above 23 GHz and able to support hops below 8 km)

No list of bands was provided by the Authority in Table 4, therefore making it difficult to judge if the current demand projections are comprehensive.

2.22 "***Is there a demand for more flexible frequency licensing and frequency assignment/allotments processes for fixed services on a regional basis required to complement the national frequency licensing and frequency assignments/allotments in the next 10 to 20 years?***"

Please refer to our response to question 14.

2.23 "***Are there any other frequency bands that should be considered for release in the next 10 to 20 years for fixed services that are not discussed? Provide motivations for your proposal.*** "

Please refer to the bands listed in our response to question 20, as no bands were provided in Table 4.

2.24 "***Will the demand for commercial mobile, licence-exempt, satellite, or fixed wireless services/applications impact the demand for backhaul spectrum? If so, how and which of these***"

The demand for IMT Mobile will definitely have an impact on the spectrum required for backhaul services as 5G becomes universally adopted and during the transitional period to when the next generation (6G) will be deployed. Please also see our response to Question 20.

2.25 "***Are there adequate spectrum allocations for video backhaul for broadcast and security services in South Africa? What is the realistic demand for these services in the next 10 to 20 years?*** "

No Comment at this stage.

2.26 "***How much will transmission technology improve the volume of traffic in the next 10 to 20 years?***"

According to ABI Research[32], aside from operators requiring more spectrum for 5G backhaul, operators will also leverage on the below technologies to further increase the capacity and efficiency of their backhaul networks:

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[32] https://www.abiresearch.com/press/microwave-backhaul-pivotal-5g-microwave-backhaul-links-grow-9-million-2026/

- Cross polarization (XPIC): transmits signals on horizontal and verticals planes using the same radio channel to double spectrum efficiency by cancelling the self-generated interference.
- Band and Carrier Aggregation (BCA): bonds multiple discrete radio channels to support greater capacity and extend the life of traditional narrower microwave channels
- Integrated Access Backhaul (IAB): allows access bands (i.e., the connection between user terminals and base stations) to be used for backhaul as well.
- Line of Sight MIMO: allows several independent radio transmissions over the same channel.

2.27 "***What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for backhaul services? When are these technologies expected to become available?***"

To fully realize the intended objectives of 5G, operators must upgrade the capabilities of their wireless backhaul networks to accommodate the increased network capacities and lower latency standards that characterize this next-gen network. Please refer to our response to question 26 which refers to the backhaul technologies that will further improve capacity. The growth in demand of traffic has exceeded the rate of rollout of fibre.

2.28 "***How much bandwidth for backhaul will be saved due to the deployment of fibre networks in South Africa for the next 5, 10 to 20 years?***"

While links will be cut over from microwave to fibre, existing sites that rely on microwave links will be modernized for high-capacity requirements. Therefore, the spectrum allocations will just be utilized on another site, rather than it being saved due to fibre implementation. Certain bands cannot be replaced within the fixed network without incurring significant costs as a different band will have different propagation characteristics and additional sites will be required to fill in the coverage shortfall.

In addition to the above, our experience has suggested that particularly in South Africa, redundant microwave links in critical areas are of the network are necessary, even if those sites have fibre backhaul. This is largely due to the high number of fibre breaks on critical routes.

2.29 "***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Aeronautical services in South Africa?***"

No comment at this stage.

2.30 "***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Broadcasting services in South Africa?***"

In a recent investigation which presented a proposal for a revision to Annex 1 of Report ITU R BT.2302-1 "Spectrum requirements for terrestrial television broadcasting in the UHF frequency band in Region 1 and the Islamic Republic of Iran" as part of WP6A Rapporteur Group on WRC-23 Agenda Item 1.5, 106 Administrations were asked to comment on the proportion of users who receive television by terrestrial broadcasting. The illustration below summarizes the results.

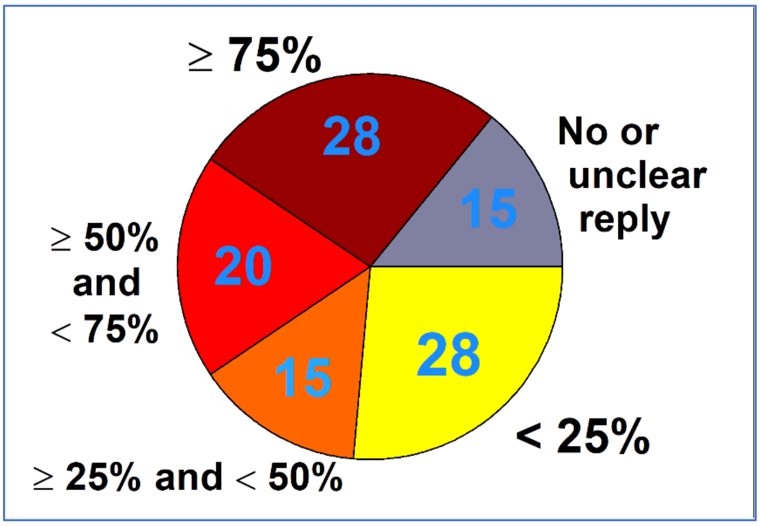

Figure 13: Proportion of Users who Receive Television by Terrestrial Broadcasting in 106 Administrations

Of the 91 Administrations who responded, it is evident that nearly 48% of the administrations have less than 50% of their population receiving television through digital broadcastings. This illustrates a fundamental shift in media consumption and a drastic decrease in terrestrial broadcasting demand. This leads us to believe that the demand for terrestrial broadcasting will decrease within in the next 10-20 years.

2.31 "***How much spectrum should be maintained for terrestrial broadcasting in the band 470MHz to 694MHz in the next 10 to 20 years?***"

Media consumption has seen a fundamental shift in the past decade, with more consumers opting for on-demand streaming services over DTT services. This is evident as many broadcasters have launched their own online streaming services such as DSTV online, Showmax, eVOD and SABC planning to launch their streaming service within this year[33]. The SABC recently explained that the broadcaster had observed a decline in audience, primarily due to the global trend to shift to digital platforms, which was the motivation for it to launch its own streaming service[34]. Services such as Netflix and Showmax offer cheaper Mobile only packages. These packages place additional strain on mobile networks due to the continuous consumption of high bitrate videos as consumers prefer the mobility over consuming media in a fixed location. This shift in behaviour is also evident from our response to question 30, whereby it can be seen that nearly 48% of the administrations have less than 50% of their population receiving television through digital broadcastings. Therefore, the amount of spectrum required by broadcasters is expected to decrease in the next 10-20 years, similar to that of Region 2 & 3 countries.

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[33] https://www.news24.com/channel/tv/news/sabc-to-launch-its-video-streaming-service-by-march-2022-20210823-2

[34] https://mybroadband.co.za/news/broadcasting/436116-sabcs-netflix-competitor-in-testing.html

2.32 “***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Defence services in South Africa?***“

Spectrum that is set-aside exclusively for defence in core mobile bands (4940 – 4990 MHz) risks being underused. The Authority should consider assigning spectrum to IMT Mobile in core Mobile bands. In the event there is a strong defence requirement, mobile services can be allocated on a secondary basis in the band. This will allow more efficient use of the band as opposed assigning a band exclusively for defence. From the ITU Radio Regulations, footnote No. 5.441B currently lists South Africa as one of the countries who have identified the 4800 – 4990 MHz range for IMT.

2.33. “***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Maritime services in South Africa?***“

No comment at this stage.

2.34. “***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Meteorological services in South Africa?***“

No comment at this stage.

2.35 “***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for PMSE services in South Africa?***“

No comment at this stage. We do, however, recommend that the Authority establish

2.36. “***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for PPDR services in South Africa?***“

Deploying a PPDR is a significant undertaking in that infrastructure has to be invested at a national level. While countries like the UAE, Qatar and South Korea have deployed dedicated PPDR networks in Mobile IMT bands, a more recent trend is for PPDR companies to team up with mobile network operators to jointly deploy a PPDR network. MNOs have already invested significantly in providing population coverage and therefore it makes sense for them to deploy PPDR as there is already infrastructure. Typical deployments of PPDR consist of a 2x5 MHz bandwidth.

2.37 “***Can mobile broadband currently be used for PPDR purposes? If not, will this be possible in the future with better quality of service and lower prices?***“

Report ITU-R M.2291-1 refers to the use of International Mobile Telecommunications (IMT) for broadband Public Protection and Disaster Relief (PPDR) applications[35], specifically to LTE. ICASA has its own research about broadband PPDR in its gazette titled The Inquiry for the Implementation of the Radio Frequency Migration Plan and the IMT Road Map, which refers to bands being considered as well as positions and deployments. FirstNet in the USA has deployed a 4G/5G network in collaboration with AT&T for PPDR services[36]. FirstNet allows AT&T to roam on their 2x10 MHz carrier, but only after it services its own customers. This leads us to believe that the 2x10 MHz allocation provides a surplus of capacity for their PPDR services. In addition, countries like the UK, Mexico and Australia have had PPDR companies join forces with mobile operators on a commercial basis to deploy efficient PPDR networks.

2.38 "***Are there any reasons to consider further spectrum from broadcasting in the band 470MHz to 694MHz to public protection and disaster relief (PPDR) services in the next 10 to 20 years?***"

The current roadmap for PPDR sees the use of PPDR broadband services in the 450 MHz and 430 MHz bands, with work ongoing to standardize a 3GPP band in the 380 – 400 MHz range for PPDR. ICASA is aware of this as published in The Inquiry for the Implementation of the Radio Frequency Migration Plan and the IMT Road Map. Vodacom sees band n71(617 – 652 // 663 – 698 MHz) as a crucial band in closing the digital dividend within South Africa. There are currently 257 device variants supporting band n71/ B71. Vodacom recommends that the band be assigned for IMT usage on a secondary basis, until such time as the aggregate demand for DTT broadcast systems becomes more apparent, and that PPDR utilize the 430MHz and 380 – 400 MHz bands.

2.39 "***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Satellite services in South Africa?***"

According to 3rd party industry research estimates of hundreds of satellites are to be launched every year by 2028 taking the growth of these services possibly beyond the next 10 years[37]. This will compliment the growth primarily driven by mobile broadband in multiple sectors driving bandwidth cost marginally down and making expansion of services over satellite more cost effective.

However, the costs for this technology are still not viable as this technology is still majority in the R&D phase. The promise offered by LEO Satellites, high speed and low latency, bringing meaningful impact to communities may be hindered by the costs of implementing such solutions, further exacerbated by satellite services also being a niche market geared towards far flung areas. The USA with a population of over 4 times that of South Africa only envisions satellite users to be 5.2 million by 2026[38], just over 1% of their population whilst their mobile subscriptions will be well beyond 450 million[39]. By 2026 in South Africa,

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[35] https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2291-1-2016-PDF-E.pdf

[36] https://www.firstnet.gov/network

[37] http://www.parabolicarc.com/2020/01/19/euroconsult-forecasts-satellite-demand-to-grow-four-fold-over-next-10-years/

[38] https://www.telecomreview.com/index.php/articles/satellite-and-broadcasting/4859-satellite-broadband-market-5-2-million-users-by-2026-4-1-billion-in-revenue

[39] https://docs.fcc.gov/public/attachments/FCC-20-188A1.pdf

it is highly unlikely that an equal number percentage of consumers of satellite may be reached, ceteris paribus.

2.40 "***Which applications and allocations will require the most frequency spectrum demand in the following frequency bands***? **C-band**, **Ku-band**, **Ka-band**"

Vodacom envisions satellite users being migrated out of the C band to Ku band as the C band has been cited as key strategic band for IMT and also there being waning demand for C band satellite applications. Ku band provides wide beam coverage, and its antennae are smaller in size contributing to cost efficiencies of deployment[40]. We expect that mobile operators will primarily be focusing on using Ku-Band spectrum, this will be for cellular backhauling, enterprise service and broadband over satellite niche market. Services operating within the Ku-band frequency can include fixed service (microwave towers), radio astronomy service, mobile service, mobile-satellite service, radiolocation service, amateur radio service, and radio navigation. This shows how versatile Ku band is in terms of accommodation a spectrum of services. Because of its higher power, Ku band satellites (vary in size from 2′ to 5′ in diameter) are generally smaller than C band satellites and the power of uplinks and downlinks can be increased as needed or directed by demand. Users with a C-band system in place can retrofit for it Ku-band use as well[41].

The most likely case for Ka-band is that it may not be very active now in providing many services, however access to Ka band spectrum in the future will ensure that there is limited reliance on a single form of satellite backhaul. In the long term, the Ka band will be instrumental in providing additional support to other core bands.

2.41 "***What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for satellite services? When are these technologies expected to become available?***"

Vodacom sees the demand of satellite services as dwindling as IMT is more ubiquitous and more easily and readily available to the general public. This is clearly evident in our response to question 11 and 19, which highlights how the order of magnitude is much lower and, on the decline, when compared to IMT, as well as that satellite is not fully utilizing their spectrum in the C-band. ICASA needs to reassess the demand for satellite services within South Africa.

2.42 "***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Astronomy services in South Africa?***"
No Comment at this stage.

2.43 "***What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Short-range services in South Africa?***"

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[40] https://www.rfwireless-world.com/Terminology/Ku-Band-Frequency.html
[41] https://www.satmodo.com/blog/2019/11/25/ku-band-and-its-use-in-satellite-communications/

No Comment at this stage.

2.44 "***Which vertical markets will require most secured licensed spectrum to overcome their current interference and congestion issues?***"
Please refer to our response to question 16.

2.45 ***"How much will spectrum management and orderly frequency planning improve the interference situations in certain frequency bands?***"
In a traditional "Command and Control" framework, the national regulator of the radio spectrum attempts to avoid harmful interference by controls on access to the radio spectrum such as: 1. Dividing the radio spectrum into bands, taking into account constraints such as the Table of Allocations in the ITU-R Radio Regulations. 2. Allocating bands to services such as Mobile, Broadcasting, Fixed, etc (again taking into account international constraints); 3. Determining if there should be guard bands to avoid interference and if so how wide; 4. Deciding the approach to use for licensing each band (as described below); 5. Issuing licenses to spectrum users to meet their demand for the radio spectrum[42].

In addition to the administrative framework, the Authority needs to further develop its supervision framework, with particular emphasis on interference testing, and legal recourse if necessary. We currently see these aspects as being fundamental shortcomings in the management of interference. Without a robust framework that is executed against by the Authority, we expect that there will be limited benefit from any future attempt to automate interference detection and reporting.

2.46 "***Please provide input on future spectrum requirements for the different service allocations as well as the urgency for such additional frequency allocations for such a service.*** "

Please refer to our response to question 17 for future bands that will be required for IMT Mobile.

2.47 "***Which Service allocations require RFSAP's and for which frequency bands. Also specify the urgency for the creation of such RFSAP's.*** "

The following bands should have RFSAPs developed for IMT Mobile

Band	**Priority**
450 – 470 MHz	Immediate
733 – 758 MHz	Mid term
1427 – 1518 MHz	Immediate
2025 – 2110 // 2200 – 2285 MHz	Long term
3300 – 3400 MHz	Mid term
3600 – 3800 MHz	Mid term
4400 – 5000 MHz	Immediate
5150 – 5925 MHz	Immediate

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[42] https://www.itu.int/osg/spu/stn/spectrum/workshop_proceedings/Background_Papers_Final/Spectrum%20Liberalisation%20and%20Interference%20Management.pdf

5925 – 7125 MHz	Long term
24.25 – 27.5 GHz	Immediate, 1 GHz for 26.5 – 27.5 can be assigned immediately to operators.
37 – 42.5 GHz	Immediate

2.48 "***Please provide your organisations strategy and suggestions on how the Authority can ensure that spectrum outlook and demand studies can contribute to stimulation of the South African economy. "***

Vodacom is of the view that the potential of South Africa's economy can be unlocked by accelerating the pace at which IMT spectrum is made available through a fair and transparent assignment process. It is vital that IMT spectrum is assigned in a manner that allows efficient deployment at scale. The Authority must ensure that there is regulatory certainty as this provides confidence to both internal and external investors into the country. This will help alleviate the issue of spectrum warehousing of legacy assignments and the issue of incumbents squatting on non-IMT spectrum with the intention for that spectrum to be converted to high-demand IMT spectrum.

Spectrum should be assigned on the basis:

a) To services that best serve the population as a whole.
b) To services that will be easily accessible to the general population
c) To services that will stimulate growth and investment into ICT Infrastructure.
d) To services that have a high demand by the population

South Africa has the highest number of active mobile subscriptions, 102 per 100 inhabitants within Africa and has 36% more active connections per 100 inhabitants compared to the world average and 210% more when compared to the average of Africa and yet has the lowest spectrum assignments per operator when compared the average of global operators, developing and developed countries. ICASA needs support MNO is speeding up the process to assign and expedite spectrum through a fair, transparent and open process. MNO's need a variety of different bands to support different use-cases for both coverage and capacity and spectrum should be assigned on an exclusive basis in core mobile bands in order to bring the economies of scale to the end users.

2.49 "***The spectrum outlook described above in Section 4, and in particular the substantial additional requirements for IMT and fixed-wireless spectrum, suggest that a number of additional bands will need to be assigned for the purposes of internet access, and incumbent users will need to be migrated out of the bands mentioned in the list on Table 3 and on any bands your organisation suggests on Table 4. What are the costs of migrating these users so that radio frequency spectrum is allocated to its highest value use***?"

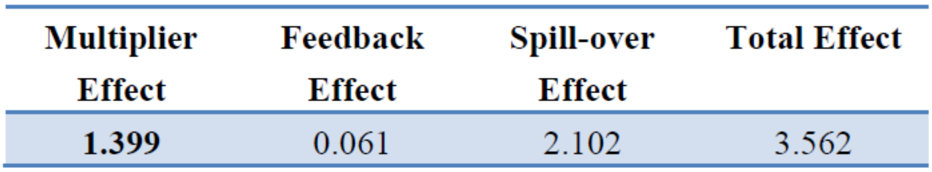
Within the timeframe and scope of the current consultation, it was unfortunately not feasible to develop a comprehensive cost analysis view for migrating legacy users. We expect that such a process would span several months and would by necessity require a view on the target bands for such legacy services.

Vodacom is willing to cooperate with the Authority in such an exercise, and recommends that the process allow sufficient time for consultation of all affected stakeholders. In particular, we recommend that the Authority focus on the relative benefits of legacy users when compared to the impact of IMT services being deployed. In addition, some legacy services are now defunct, and to the extent feasible, it may be possible to migrate relatively small user bases to existing services in other bands, alleviating the need for a new target to be made available.

2.50 "***What would the costs of freeing up spectrum for commercial fixed and mobile use be (considering the bands mentioned above on Table 3 and Table 4)? What would the economic benefits of doing so be, in respect of increase consumer surplus, and increased producer surplus***?"

The economic contribution of spectrum as measured through industrial relations can be divided into three kinds of effect: multiplier effect, feedback effect and spill-over effect[43], which may contribute to an average of 3.4% GDP growth[44]. With a corresponding total effect of 3.56 (the impact measured at almost 4 times the input of freeing up spectrum) in economic benefits.

Multiplier effect: The change in the level of production caused by the unit of final demand within an industry is the influence of internal demand upon itself for the industry, with its effect to be seen in the industrial capacity of development. **Feedback effect**: After the unit of final demand in a certain industry has influenced upon other sectors, this influence will in its turn produce a feedback effect upon the very industry, illustrating the ICT sector as a sector that gains less compared to other industries that derive more gains from having ICT as part of their production technologies. **Spill-over effect**: The spill-over effect can be defined as the sum of both direct and indirect influence of the unit of final demand in a certain industry upon the output of other sectors. This effect is a single-directional effect, reflecting the industry's impact capacity[45]. Overall, the ICT industry creates a total effect in the economic of almost 4 times the input made by spectrum investments. Below is an illustration of how these multipliers work:



Multiplier Effect	Feedback Effect	Spill-over Effect	Total Effect
1.399	0.061	2.102	3.562

Source: GSMA, Socio Economic Impact of Spectrum in China

The level of digitalisation in social enterprises (especially small businesses) will be improved steadily. Better social cohesion is evident by providing government services for all with improved communication and faster responses. Serving the rural communities in providing access to internet services for education, agriculture and health allowing lives to be improved and ultimately creating jobs.

Using the lenses of rudimentary supply and demand analysis, the below illustrates that core effect, benefits and change in the actual economy itself.

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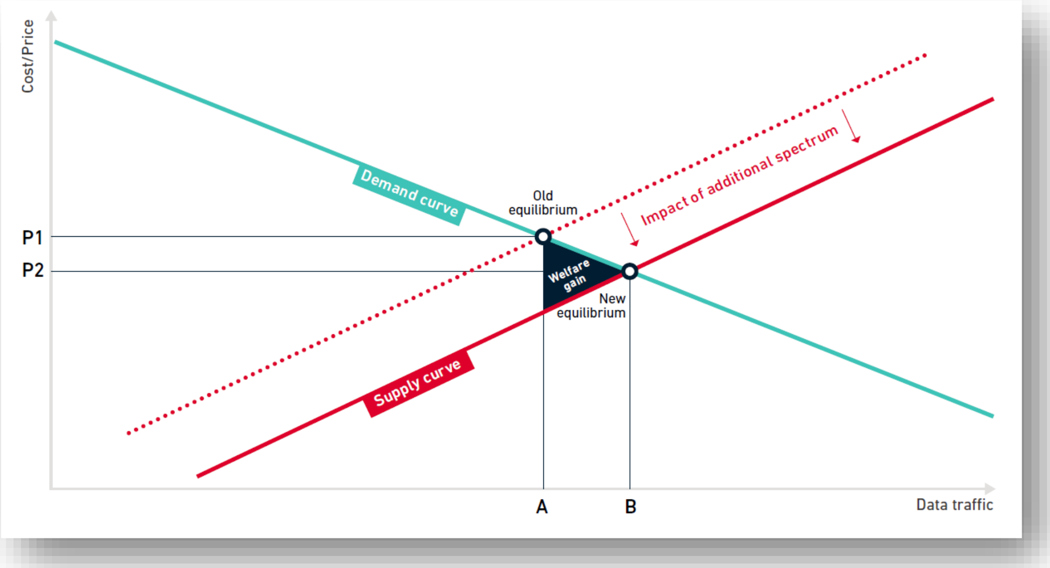
[43] https://www.gsma.com/spectrum/wp-content/uploads/2013/01/SOCIO-ECONOMIC-IMPACT-OF-SPECTRUM-IN-CHINA.pdf

[44] https://www.bcg.com/publications/2020/coming-battle-for-spectrum

[45] https://www.gsma.com/spectrum/wp-content/uploads/2013/01/SOCIO-ECONOMIC-IMPACT-OF-SPECTRUM-IN-CHINA.pdf



Source: GSMA Intelligence

As the supply of spectrum in the next 5, 10 and 20 years increases (red line), there is a lower shift in the price change which activates more demand from consumers. Point B is the new equilibrium with a lower data cost and more data traffic in demand by the market. The area in black called the welfare gain, is a 50/50 split between consumer and producer surplus. Therefore, there is an equal gain in any economy, including South Africa's for consumers and producers alike[46].

2.51 "***Assuming that South Africa follows the ITU's recommendations to assign up to 1,940MHz of spectrum for IMT-2000 and IMT-advanced services, and that South Africa follows trends in Europe for potentially another 2,000 MHz of spectrum for IMT-2020, what would the costs of freeing up the various spectrum bands be? In this regard, please refer to Table 3 and Table 4, as explained above.***"

Please refer to our response to question 49.

2.52 "***Due to the scarcity of high demand spectrum and the consequential fact that Spectrum Sharing in certain bands are non-negotiable, how shall you describe the best sharing conditions for the South African scenario?***"

With the principle of exclusive spectrum assignment, licensees in the same band get the opportunity to maximise their investments in an environment that provides certainty to investors in the ICT industry and its infrastructure. According to GSMA, "Exclusive licensing has been central to the success of mobile services and must continue. Spectrum sharing decisions should be mindful of the need for additional exclusive spectrum"[47]. Exclusive licencees have the certainty of access to spectrum, a critical component of mobile networks, to motivate huge investments in high quality, wide area mobile networks worldwide. This exclusive licensing approach has been central to connecting well over 5 billion people to mobile

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[46] https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=69042233&file=310121-The-socioeconomic-benefits-of-the-6-GHz-band.pdf

[47] https://www.gsma.com/spectrum/wp-content/uploads/2021/06/Spectrum-Sharing-Positions.pdf

services worldwide. Additionally, sharing with other services does not replace the need to clear bands and assign them for mobile use. For example, clearing some UHF TV spectrum and exclusively licensing it for 4G services has connected far more people to affordable broadband than the use of TV whitespaces[48].

A further recommended principle relates to addressing rising demand for mobile services by opening up access to vital new spectrum in areas where it is in-demand and where it is under-used by incumbent users. In cases, it is vital that spectrum sharing is negotiated and settled on commercially agreed terms, through a supportive regulatory framework.

Lastly, spectrum sharing should only be considered where it is available and usable in sufficient quantities, and at times where needed. Spectrum sharing can risk creating overly fragmented bands which makes re-farming more complex and can even undermine international spectrum harmonisation.

2.53 "***Due to the convergence of technologies and the changes in regulatory licensing environment do you believe that certain service allocations categories will or need to change***?"

Yes, certain service allocations will need to change. For example, IMT is needing to go into bands that have previously served legacy services/technologies such as fixed (e.g., previous FDD spectrum to be allocated to TDD services). Thus, relicensing the band (through a fair and transparent process) after a successful migration of legacy users is required. Considering mobile demands that markets and economies are reporting, repurposing spectrum bands should be centred around reprioritization of market needs as indicated by the demand.

Furthermore, Vodacom encourages the Authority to assign spectrum to those that maximise the use of spectrum through investment. This will have the greatest multiplier effect on our economy.

2.54 "***What existing licence-exempt frequency bands will see the most evolution in the next five years?***"

Vodacom sees the 5 GHz and 66 GHz bands as the most likely to be used for license exempt IoT and that the 6GHz band should be considered for licensed IMT with evidence to motivate this provided in our response to question 59.

2.55 "***How much spectrum, and in which bands, should be made available for licence-exempt purposes (such as Wi-Fi) over the 5, 10 and 20 years? What would the costs of freeing up these bands for IMT be? What would the economic benefits of doing so be, in respect of increase consumer surplus, and increased producer surplus? Which vertical markets will require most secured licensed spectrum to overcome their current interference and congestion issues***?"

The GSMA recently published a study on the socio-economic benefits of the 6 GHz band[49]. The scenarios were analyzed:

a. Scenario 1 licenses the entire 5925 – 7125 MHz range for IMT.
b. Scenario 2 keeps the entire 5925 – 7125 MHz range as unlicensed.

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[48] ibid

[49] https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=69042233&file=310121-The-socioeconomic-benefits-of-the-6-GHz-band.pdf

c. Scenario 3 licenses 6425 – 7125 MHz and keeps 5925 – 6425 MHz unlicensed.

The following was concluded based on the above scenarios:

i. **Scenario 1 will deliver the largest benefits across all countries if fixed broadband technologies do not provide maximum user speeds above 5 Gbps**. Based on existing spectrum availability, spectrum will not be a bottleneck for Wi-Fi unless fixed broadband offers speeds that can exceed at least 5 Gbps to all FTTH/B and cable users. This is because there is already sufficient capacity with existing unlicensed spectrum.

ii. **Scenario 1 will still deliver the largest benefits across most countries if in those countries fixed broadband provides maximum user speeds up to 10 Gbps and if a portion of Wi-Fi traffic is offloaded to the 60 GHz band**. In most countries, 5G has access to (or is expected to have access to) high-band frequencies above 24 GHz. This spectrum is expected to address specific areas with extreme traffic density. Similarly, for Wi-Fi, while it will not be possible to meet all Wi-Fi demand with high-band spectrum in the 57–71 GHz frequency range, this spectrum can still support connectivity for certain use cases requiring extremely high throughput such as AR/VR. If up to 30% of household Wi-Fi traffic can be offloaded to the 60 GHz band going forward, then there will be no Wi-Fi capacity constraint in most countries – even if fixed technologies enable access to speeds up to 10 Gbps for all FTTH/B and cable users. This means that assigning the full 6 GHz band for licensed use will drive the largest benefit across most countries considered in the study.

iii. **Scenario 3 will deliver the largest benefits if FTTH/B and cable broadband adoption is widespread, they support maximum user speeds of 10 Gbps and the 60 GHz band is not utilized by Wi-Fi**. Assigning the lower 6 GHz band (5925–6425 MHz) for unlicensed use and the upper 6 GHz band (6425–7125 MHz) for licensed use will be the suitable policy choice for most of the countries considered if all the following conditions apply: there is significant fibre and cable adoption; fibre and cable can offer maximum speeds of 10 Gbps to all FTTH/B and cable users by 2030; and high-band spectrum is not utilized for Wi-Fi. It should be noted, however, that not using the 60 GHz band would represent an inefficient use of spectrum.

iv. **Scenario 2 was not found to be the most beneficial allocation in any of the considered analyses**. Even in countries with very high Wi-Fi demand, and if fixed broadband speeds reach 10 Gbps, allocating an additional 500 MHz of spectrum for unlicensed use in the lower 6 GHz band (as in Scenario 3) is sufficient to meet expected demand. This means that there are no additional gains from allocating the full 6 GHz frequency band for unlicensed use

As highlighted in our response to question 11, when compared with other regions, Africa has one of the lowest fixed broadband subscription rates, given the absence of legacy infrastructure and the relatively lower costs of deploying wireless broadband infrastructure. ITU estimated a fixed broadband subscription rate of 0.5 per 100 inhabitants for Africa in 2020, a figure that is well below the global average of 15.2 subscriptions per 100 inhabitants[14]. In addition, our response to question 19 highlights that there is duplicate use of spectrum in that traffic would be carried over the operator's spectrum while the Wi-Fi spectrum will merely act as a relay to the local network. Since South Africa has very low fixed broadband penetration and fibre is not widely available, the greatest socio-economic benefit of the 6 GHz band would be to license it for 5G usage.

2.56 "***How much spectrum, and in which bands, should be made available for dynamic spectrum access over the next 5, 10 and 20 years? What would the costs of freeing up these bands for IMT be? What would the economic benefits of doing so be, in respect of increase consumer surplus, and increased producer surplus***?"

Exclusive licences have provided the certainty of access to spectrum, a critical component of mobile networks, to support huge investments in high quality, wide area mobile networks worldwide. This exclusive licensing approach has been central to connecting well over 5 billion people to mobile services worldwide. Mobile technologies continue to evolve to make the most efficient use of licensed spectrum to deliver better services to more people in more places. Spectrum sharing presents a complementary approach to exclusive licensing that, when well planned, could assist in providing early access to mobile services on a secondary basis, while preserving the primary status of the incumbent services. However, sharing does not replace the need to clear bands and assign them for mobile use – and is not always a better option. For example, clearing some UHF TV spectrum and exclusively licensing it for 4G services has connected far more people to affordable broadband than the use of TV whitespaces. Spectrum sharing approaches should not unnecessarily limit access to sufficient amounts of exclusive licensed spectrum for mobile services where this is possible. Mobile broadband services are dependent on wide frequency bands to offer high speeds and when little spectrum is made available then spectrum prices can also be artificially inflated which in turn harms consumers.

2.57 "***What existing licence-exempt frequency bands will see the most evolution in the next five years***?"

Please refer to our response to question 54.

2.58 "***Are there any IoT applications that will have a large impact on the existing licence-exempt bands? If so, what bands will see the most impact from these applications***?"

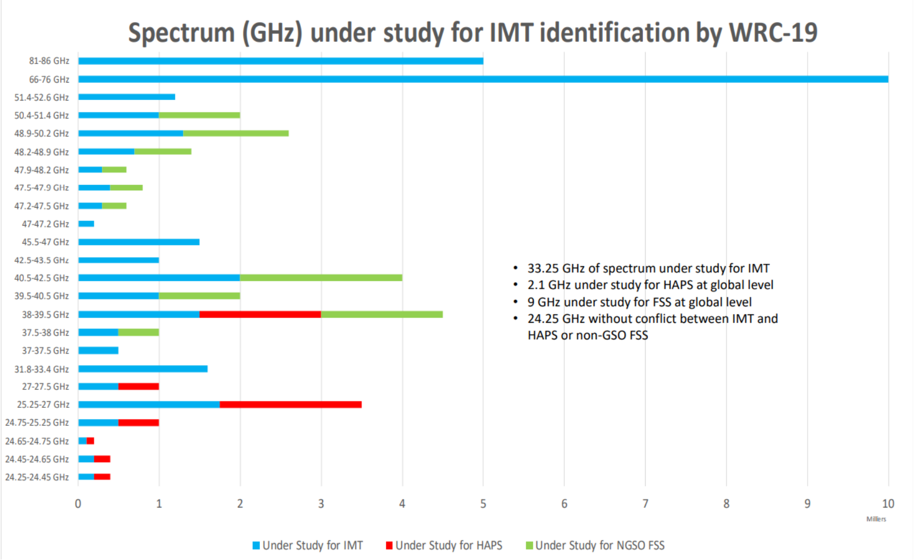
Please refer to our response to question 7. Vodacom sees the 5 GHz and 66 GHz bands the most likely to be used for license exempt IoT and that the 6GHz band be considered for licensed IMT band with evidence provided in our response to question 58 and 19.

2.59 "***Will the trend for offering carrier-grade or managed Wi-Fi services continue to increase over the next five years? If so, will this impact congestion in Wi-Fi bands and which bands would be most affected***?"

Please refer to our response to question 19 and question 58.

2.60 "***Are there specific frequency bands that will be in higher demand over the next 10 to 20 years and do you expect higher demands for spectrum in these frequency bands in South Africa? Are there any other frequency bands that should be considered for release in the next 10 to 20 years for commercial mobile, fixed, satellite, or licence-exempt that are not discussed above? Provide motivations for your proposal***."

In the short term, please refer to question 15, which highlights bands that would be critical to delivering 5G services. In the long term, a study published by the IEEE suggests that frequencies from 100 GHz to 3 THz are promising bands for the next generation of wireless communication systems because of the wide swaths of unused and unexplored spectrum. These frequencies also offer the potential for revolutionary applications that will be made possible by new thinking, and advances in devices, circuits, software, signal processing, and systems[50]. ICASA should note developments on future bands that will be considered for IMT which at this point, have not yet been identified for study. The following bands have been identified for study for IMT identification at WRC-19.



- 33.25 GHz of spectrum under study for IMT
- 2.1 GHz under study for HAPS at global level
- 9 GHz under study for FSS at global level
- 24.25 GHz without conflict between IMT and HAPS or non-GSO FSS

Source: Spectrum Under Study for IMT Identification by WRC-19[51]

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[50] https://ieeexplore.ieee.org/document/8732419

[51] https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/RED-2019/presentation/4.5-%D0%A0%D0%B5%D1%81%D1%82%D1%80%D0%B5%D0%BF%D0%BE.pdf