5G in Sub-Saharan Africa:
laying the foundations

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Preface

The world is on the cusp of the 5G era. By 2020, commercial 5G services will be available in at least 50 countries across Asia, Europe, the Middle East and North America. The 2020s will see more widespread deployment and adoption of the technology around the world, including in Sub-Saharan Africa.

To understand the outlook and expectations for 5G in Sub-Saharan Africa, GSMA Intelligence conducted a survey of key stakeholders to capture on-the-ground perspectives on the 5G era in countries across the region. The survey covered six areas: network deployment; spectrum; use cases; business models and financials; policy and regulation; and collaboration and future outlook. Respondents included:

- telecoms regulators from across the region

- mobile operators (group level and local operators) with a combined share of more than 75% of total connections in the region

- equipment vendors with a combined share of more than 90% of the network infrastructure market in the region.

The insights in this report have been generated from analysis of anonymised and aggregated responses to the 5G survey. We have also used GSMA Intelligence data and other related market surveys. These include the GSMA Intelligence Consumer Survey 2018, the GSMA Intelligence Enterprise IoT Survey 2018, the GSMA Mobile Connectivity Index, and the GSMA 5G Market Readiness Index.

This report forms part of a series of publications on 5G from GSMA Intelligence focusing on the transition to 5G around the world. It follows previous research on 5G in the US[1], China[2], Middle East and North Africa[3], Russia[4] and India[5]. 5G developments in these regions and countries will be closely watched by key ecosystem players in Sub-Saharan Africa, including policy-makers, mobile operators, vendors and enterprises, in order to learn lessons and best practices from 5G leaders.

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[1] The 5G era in the US, GSMA Intelligence, 2018
[2] 5G in China: the enterprise story, GSMA Intelligence, 2018
[3] 5G in MENA: GCC operators set for global leadership, GSMA Intelligence, 2018
[4] 5G in Russia: a local and global view on the way forward, GSMA Intelligence, 2019
[5] India: becoming 5G-ready, GSMA Intelligence, 2019

Executive summary

Digital technologies are having a profound impact on the way people live, work, play and communicate. This is especially true in Sub-Saharan Africa where such technologies increasingly provide access to life-enhancing services for individuals and communities that would otherwise be excluded, due to infrastructure, skills and funding shortages. Key trends in the region's digital landscape, including a youthful demographic and the increasing digital disruption of industries, point to growing demand for next-generation connectivity.

The transition to mobile broadband is underway

By the end of 2019, there will be more mobile broadband connections (3G and 4G) than 2G connections in Sub-Saharan Africa. This reflects a growing shift from basic voice to data-centric services. Ongoing investments in 3G and 4G networks have taken mobile broadband coverage to around a quarter of the total population, while smartphone adoption has doubled over the last three years and now accounts for two in five mobile connections.

5G will be part of the future digital landscape, but mass adoption is not imminent

5G in Sub-Saharan Africa is inevitable; it is a natural progression from previous technology generations. However, the 5G era is not imminent in most markets in the region as existing technologies are capable of supporting current use cases and demand for mobile internet connectivity. Around two-thirds of respondents to the survey for this report did not envisage commercial 5G services becoming available in their markets before 2025. That said, the time

lag before large-scale 5G deployment could have positive implications for the region: it would allow the technology to mature and be fully tested in other markets. It would also allow economies of scale to be realised in 5G equipment and devices, potentially lowering costs for operators and consumers.

Market readiness is crucial to maximise value in the 5G era

For all countries in the region, market readiness is necessary to determine the timing for the transition to 5G. This will help maximise value from 5G services for consumers, operators and the wider society. The GSMA 5G Market Readiness Index indicates that some countries are moving quickly towards a state of readiness, with 4G adoption approaching mass market and operators progressing with network modernisation initiatives. By 2025, there will be commercial 5G services in at least seven markets, including Kenya, Nigeria and South Africa, with 28 million 5G connections (equivalent to 3% of total mobile connections) between them.

Localised FWA will be a primary 5G use case across Sub-Saharan Africa

With fixed broadband penetration typically below 2% across the region, 5G fixed wireless access (FWA) will be a primary 5G use case, particularly in the early stages of network deployment and adoption. The cost benefit of addressing the growing demand for enhanced connectivity from households and businesses with FWA – relative to greenfield FTTx deployment – makes it an attractive proposition. However, the FWA opportunity is not universal; rather, it is dependent on local conditions. Localised and targeted deployments, as opposed to ubiquitous rollouts, will be the predominant approach as operators balance the potential cost of requisite cell densification with affordability constraints for many consumers.

The enterprise segment will drive initial 5G uptake in Sub-Saharan Africa

5G presents an opportunity for operators to better serve the enterprise market. Initial use cases will centre on 5G FWA, to address challenges around access, cost and reliability of current connectivity services, such as fixed broadband and satellite.

Beyond connectivity, 5G will be a key enabler of the Fourth Industrial Revolution or Industry 4.0 – a time when technology is seamlessly embedded within society and especially in commercial and industrial processes. In Sub-Saharan Africa, 5G can enable new and existing technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), to have a transformative impact on business processes, helping drive productivity and efficiency. A clear, supportive strategy and forward-looking policies to prepare for the 5G era and attract the necessary investment and skills are essential to realising the aspirations of the Fourth Industrial Revolution, and to fully capture the social and economic benefits for the region.

The consumer segment will be a long-term play

The consumer segment will be a long-term play as 5G adoption at the early stages of network deployment will be held back by a lack of affordable devices and immersive use cases, such as augmented reality (AR) and virtual reality (VR). Device subsidy will be crucial to 5G adoption in the consumer segment, but initial focus will likely target customer premise equipment (CPE) for FWA to the home, given the predominance of prepaid subscriptions in the mobile segment. In the meantime, therefore, 4G will continue to deliver high-speed mobile broadband, supporting the numerous and increasing connectivity needs of citizens and the economy.

The mobile ecosystem should lay the foundations now

Ahead of 5G network launches, operators and network equipment vendors in the region need to make plans to prepare existing network infrastructure for 5G, adopt cost-effective infrastructure deployment solutions, and develop a framework to manage the complexity of operating multiple networks (2G, 3G, 4G and 5G) simultaneously. Further next-generation network deployments and the first phases of 5G rollouts will require significant capital investment; mobile operators in the region will invest $60 billion in their networks between 2018 and 2025. A fifth of this will be on 5G infrastructure. Given the growing pressure on revenues and margins, operators, vendors and other ecosystem players will need to explore ways to ease the financial burden.

Policy-makers should look to foster a pro-investment environment

The 2020s will usher in the 5G era in Sub-Saharan Africa; 5G-related activities will become more widespread across the region from mid-way through the decade. Now is the time to begin to put in place the necessary building blocks to facilitate the transition to 5G. Governments and regulators need to consider market structures that foster a pro-investment and pro-innovation environment for the development of the 5G mobile ecosystem. Specifically, regulatory focus should be on four key areas – network deployment, network flexibility, spectrum access and regulatory costs – in order to bring 5G in particular, and next-generation connectivity more generally, to fruition.

1 The Sub-Saharan Africa digital economy in perspective

Digital transformation is well underway in Sub-Saharan Africa. This is evidenced by the emergence of new digital services and applications transforming the way people live, work, play and communicate. For a growing number of people in the region, digital platforms have become the first and preferred channel for accessing services, including shopping, entertainment, socialising and managing finances. Likewise, businesses and public institutions increasingly use digital platforms to interact with individuals, communities and other groups, as well as to improve operational processes.

This large-scale societal adoption and use of digital technologies is driving measurable economic, social and cultural value for individuals, businesses and governments across the region.

$94 billion, 5.6% of GDP

Productivity impact generated by mobile connectivity in the region during 2018

The interconnection of devices over intelligent networks is enabling seamless interaction and interoperability
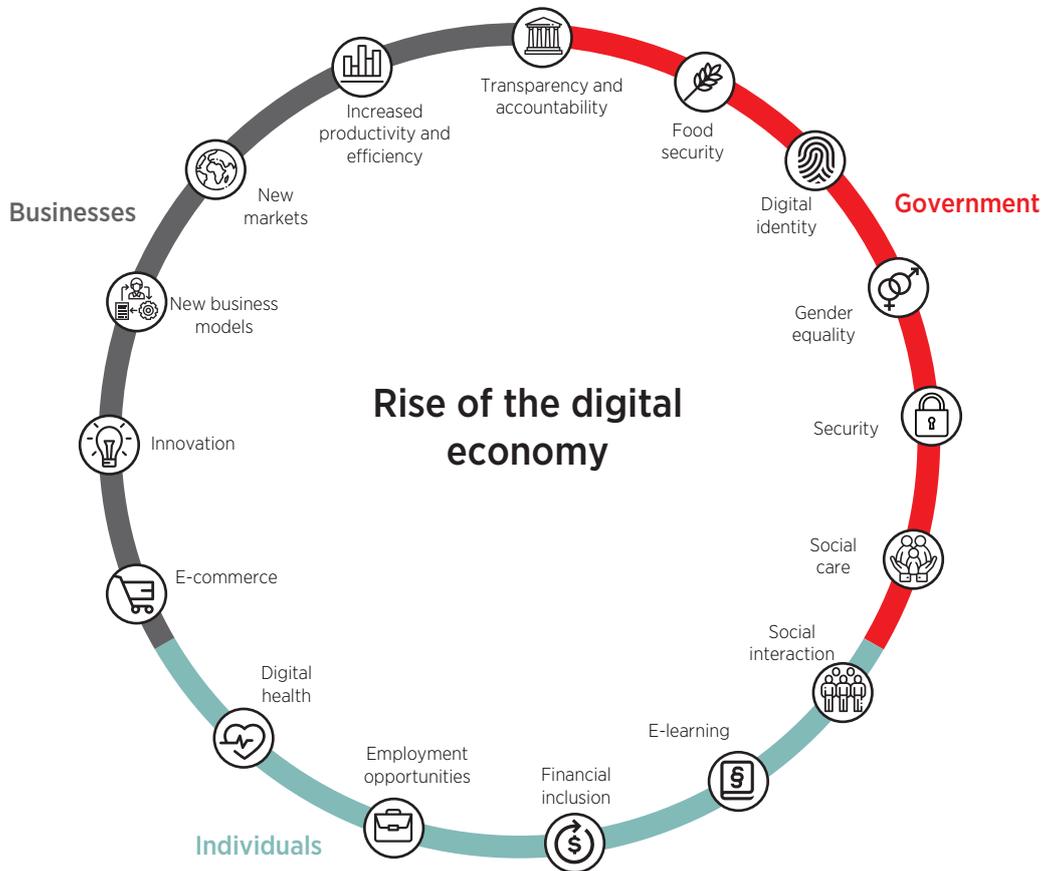
Source: GSMA Intelligence

The emerging digital landscape in Sub-Saharan Africa is shaped by demand- and supply-side factors, each with the potential for significant, long-term impact on the digital economy.

1.1 Transition to mobile broadband

By the end of 2019, mobile broadband (MBB) connections (3G and above) will for the first time account for the majority (54%) of total mobile connections in Sub-Saharan Africa. This is an important inflection point for the region, and reflects a growing shift in the way consumers use digital platforms. The supply side has contributed significantly to this trend; over the last five years, mobile operators have invested nearly $40 billion in capex – mostly deploying and expanding 3G and 4G networks. Over this period, 38 3G and 122 4G networks have been launched across the region, while 3G and 4G networks now cover 75% and 46% of the region's population, respectively.

1.2 The shift from voice to data

The increasing availability and adoption of mobile broadband services is driving a shift in consumer mobile engagement patterns, from basic voice towards data-centric services. Across the region, there is growing demand for online media and entertainment content, social networking and communications services, and information and education services. This trend further benefits from increasing investment in the creation and distribution of homegrown digital content and the rapid adoption of smartphones. The latest GSMA Mobile Connectivity Index[6] shows a significant increase in the aggregate score for mobile content and services, driven by e-government services and locally developed mobile apps, with content in local languages such as Swahili and Zulu. Meanwhile, smartphone connections have doubled over the last three years, reaching 300 million in 2018, with another 400 million smartphones expected to be connected to mobile networks by 2025.

Figure 2

MBB connections will overtake 2G for the first time in 2019

Increase in MBB connections reflects rapid coverage expansion and smartphone adoption

% of total connections

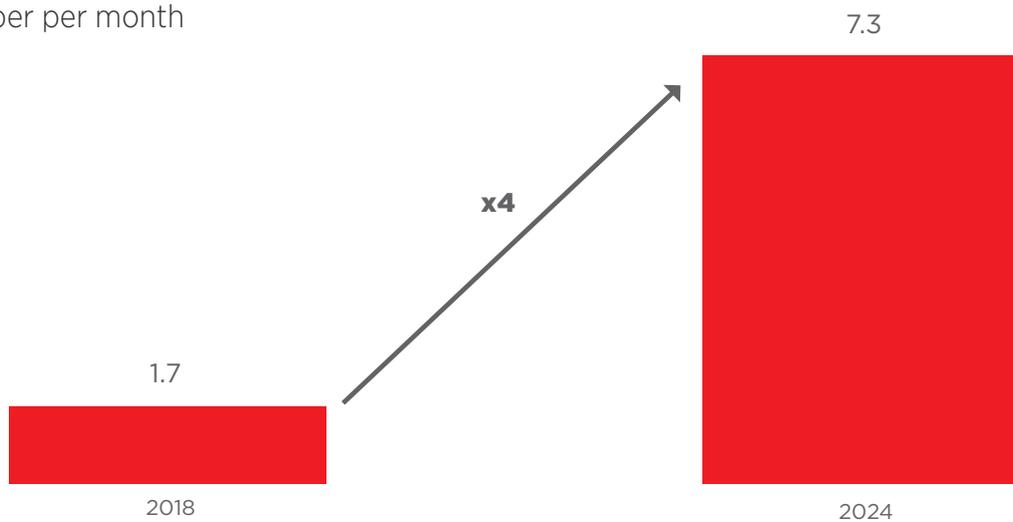|	2G	3G	4G
2013	87%	13%	
2016	70%	28%	2%
2019e	46%	45%	9%

■ 2G ■ 3G ■ 4G
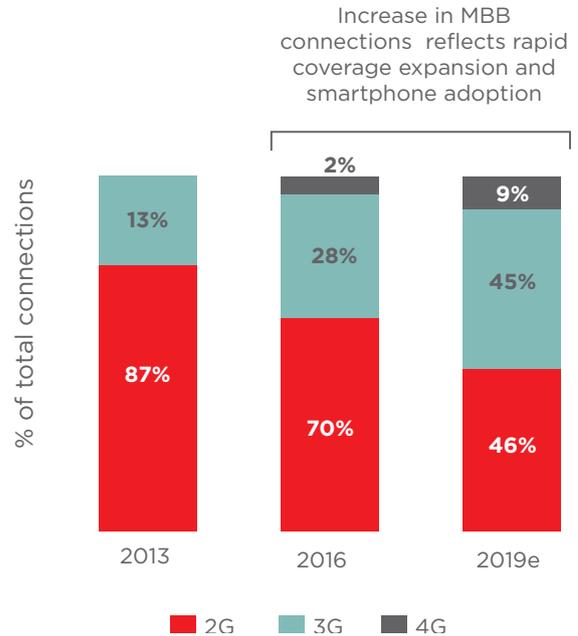
e = estimate

Source: GSMA Intelligence

Figure 3

Video content will drive a four-fold increase in data consumption in Sub-Saharan Africa by 2024

GB per subscriber per month

x4

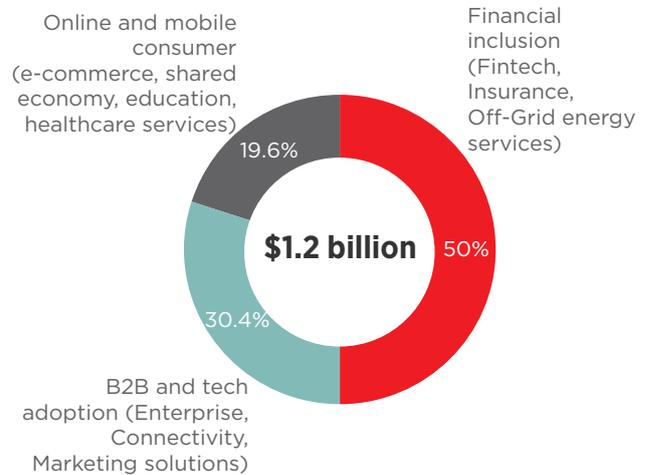| 2018	2024
1.7	7.3

Source: Ericsson, GSMA Intelligence

[6] See https://www.gsma.com/mobilefordevelopment/resources/state-of-mobile-internet-connectivity-2018/

1.3 Digital disruption of traditional value chains

A shortage of physical infrastructure, skills and funding means many people are unable to benefit from life-enhancing services, such as education, health and financial inclusion. However, digital technologies are enabling new business models. This is a prelude to the Fourth Industrial Revolution in the region, where digital connectivity and transformative technologies could help countries leapfrog traditional value chains in delivering life-enhancing services to citizens. Sub-Saharan Africa has a nascent but fast-growing innovation ecosystem, which will be a long-term driver of this trend.

Figure 4

VC funding in tech start-ups in SSA doubled to $1.2bn in 2018

Online and mobile consumer (e-commerce, shared economy, education, healthcare services)

Financial inclusion (Fintech, Insurance, Off-Grid energy services)

B2B and tech adoption (Enterprise, Connectivity, Marketing solutions)

$1.2 billion

19.6%
50%
30.4%

Source: Partech Partners

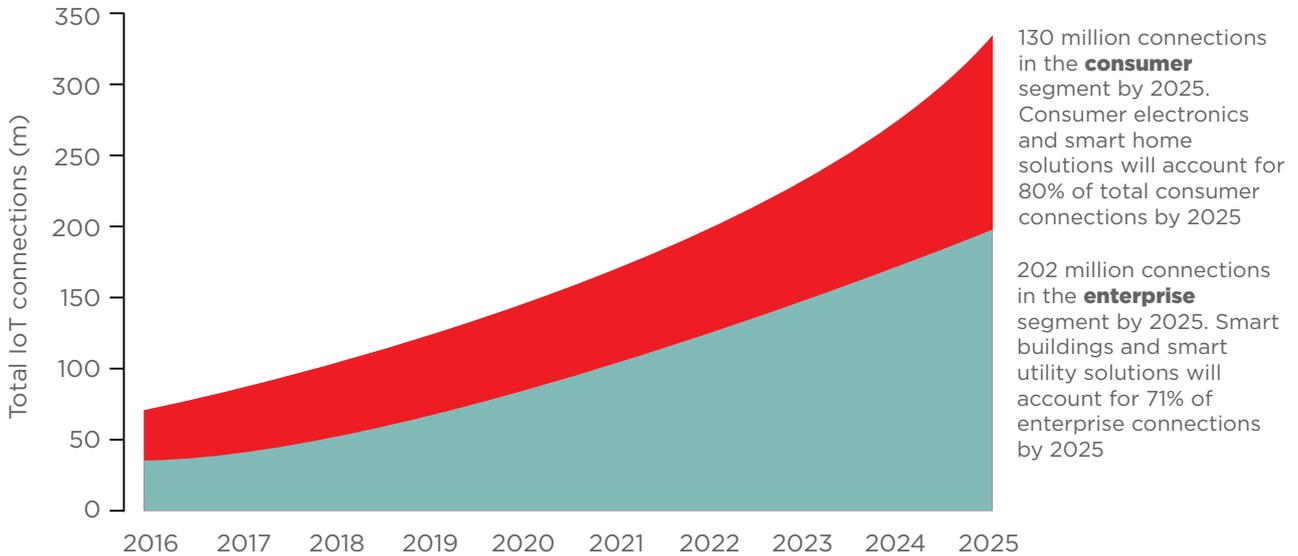## 1.4 Transformative tech: small beginnings, big potential

Transformative technologies, such as the Internet of Things (IoT), artificial intelligence and distributed ledger technologies (DLTs) are attracting interest from local and international ecosystem players, partly because of the role they could play in addressing social and economic challenges in the region.

• In April 2019, Google opened its first AI Lab centre in Africa, located in Accra, Ghana, to develop a solution that could help farmers diagnose plant diseases and boost production.

• In March 2019, Microsoft launched its first Africa Development Centre (ADC), with two initial sites in Nairobi, Kenya, and Lagos, Nigeria, to spearhead AI, machine learning and mixed reality innovation in the region.

• IBM is among several global and local organisations applying blockchain to use cases, including digital credit scoring and land registration.

While it is still early days, the impact on the digital economy could be significant. IoT will play a central role in new urban infrastructure and services, such as smart utilities and intelligent transport solutions as rapid urbanisation and the associated pressure on public infrastructure and services put the concept of smart cities under the spotlight. In Burkina Faso, for example, mobile operator Orange has deployed smart meters with prepayment mode in partnership with energy distribution company SINCO.

Sub-Saharan Africa will have 332 million IoT connections by 2025, with applications across a range of use cases

130 million connections in the **consumer** segment by 2025. Consumer electronics and smart home solutions will account for 80% of total consumer connections by 2025

202 million connections in the **enterprise** segment by 2025. Smart buildings and smart utility solutions will account for 71% of enterprise connections by 2025

Source: GSMA Intelligence

1.5 A new generation of digital consumers

44%

of Sub-Saharan Africa's population, equivalent to just over 450 million people, are under the age of 15 years. The majority of these will own a mobile phone for the first time over the next decade as they become young adults. This generation of 'digital natives' will take a digital-first approach to social interaction, education, work, communication and entertainment. This has significant implications for governments and businesses that engage with them, as well as the underlying network infrastructure providing connectivity to power new digital lifestyle services.

2 The 5G era: market readiness

It is universally accepted that high-speed, reliable and robust network infrastructure is critical to the growth of the digital economy.[7] In Sub-Saharan Africa, ongoing investment in 3G and 4G networks underscores the mobile industry's contribution to the advancement of the digital economy in the region. However, the world today is on the cusp of the 5G era. Indeed, the transition to 5G has already begun in several countries across the world, with commercial launches in 2018 and 2019. As digital trends in Sub-Saharan Africa point to growing demand for enhanced connectivity, what role will 5G play in the future connectivity landscape?

2.1 Understanding the 5G era: a global perspective

What are the expectations for the 5G era?

The mobile industry has demonstrated its ability to connect and transform society through its 2G, 3G and 4G networks over the last 30 years. Building on the successes of previous generations, 5G is expected to deliver a platform that enhances existing services and enables new business models and use cases. The GSMA has identified five mobile industry goals for the 5G era.

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[7] See https://www.gsma.com/publicpolicy/embracing-the-digital-revolution-policies-for-building-the-digital-economy

Figure 6

Mobile industry goals for the 5G era
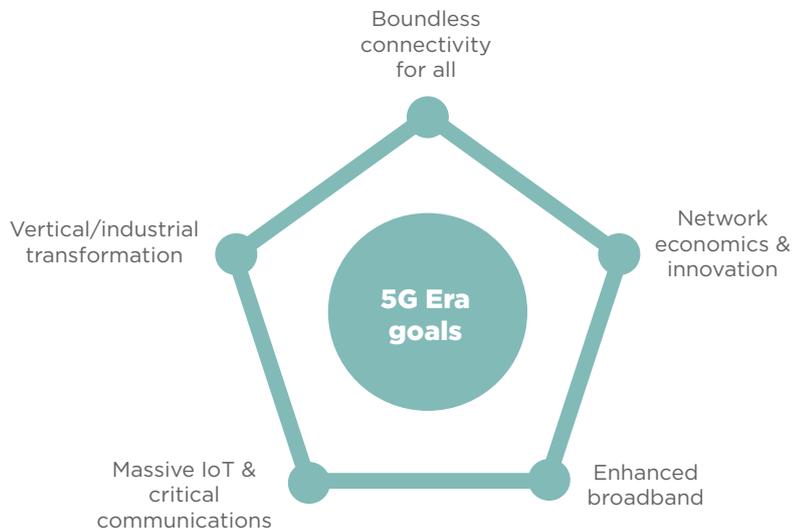
Source: GSMA

- **Boundless connectivity for all:** 5G networks will coexist with 4G networks and alternative network technologies to deliver a high-speed, reliable and secure broadband experience, and support a plethora of use cases.

- **Deliver sustainable network economics and innovation:** 5G era networks will rely on a combination of established and innovative technologies, and use both licensed and unlicensed spectrum, across different spectrum bands to cost effectively deliver better quality networks either independently or through sharing/partnerships.

- **Transform the mobile broadband experience:** 5G networks will enable an enhanced broadband experience with speeds of up to 1 Gbps and latency of less than 4 milliseconds, and provide the platform for cloud and AI-based services.

- **Drive growth in new use cases for massive and critical IoT:** 5G era networks will support the massive rollout of intelligent IoT connections for a multitude of scenarios and provide an enhanced platform to support widespread adoption of critical communication services.

- **Accelerate the digital transformation of industry verticals:** The mobile industry will provide the networks and platforms to accelerate the digitisation and automation of industrial practices and processes (including supporting Fourth Industrial Revolution goals).

How is 5G different from other technologies?

Traditional mobile technologies (1G, 2G, 3G) were heavily voice oriented with their primary circuit-switched network architecture. 4G introduced the first fully packet-switched network and the foundation for data services. As an evolutionary technology, 5G will perform all the functions of 4G with the potential for more, and at a significantly larger scale: super-fast download speeds, high levels of reliability and extremely low latency.

Figure 7

The evolution of mobile networks

1980s	1990s	2000s	2010s	2020s
• 1G	• 2G	• 3G	• 4G	• 5G
• Voice	• Voice + SMS	• Voice + SMS + Data	• Voice + SMS + Data	• Voice + SMS + Data
• Analogue	• 56~115 kbps	• 5.8~14.4 Mbps	• 100~1,000 Mbps	• Enhanced mobile broadband
• ~14.4 kbps	• Full interoperability	• Universal standard	• Optimised for MBB	• Industrial applications
• Little interoperability	• Global adoption			

Source: GSMA Intelligence

5G will provide much higher data throughput, enabling a significantly better customer experience. However, faster speeds are not the only determinant of overall customer experience. In particular, the reduction in latency (delay) for data's transit across the 5G networks and to end users will play a major role in unlocking new use cases by enabling new capabilities and the flexibility for mobile operators to better serve the specific needs of enterprise customers. As such, 5G will be a key enabler of the Fourth Industrial Revolution, as technology is seamlessly embedded within society and especially in commercial and industrial processes. This improved capability and performance will come from a more advanced core network, increased spectral efficiency and capacity, and further network densification.

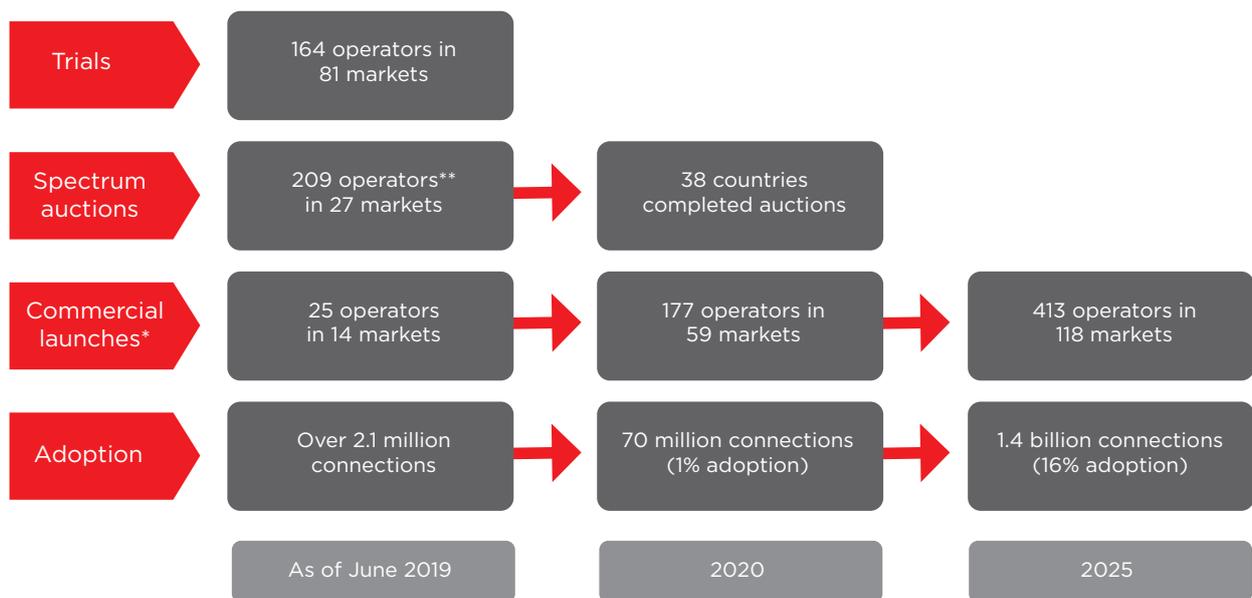Figure 8

5G will support existing and new use cases
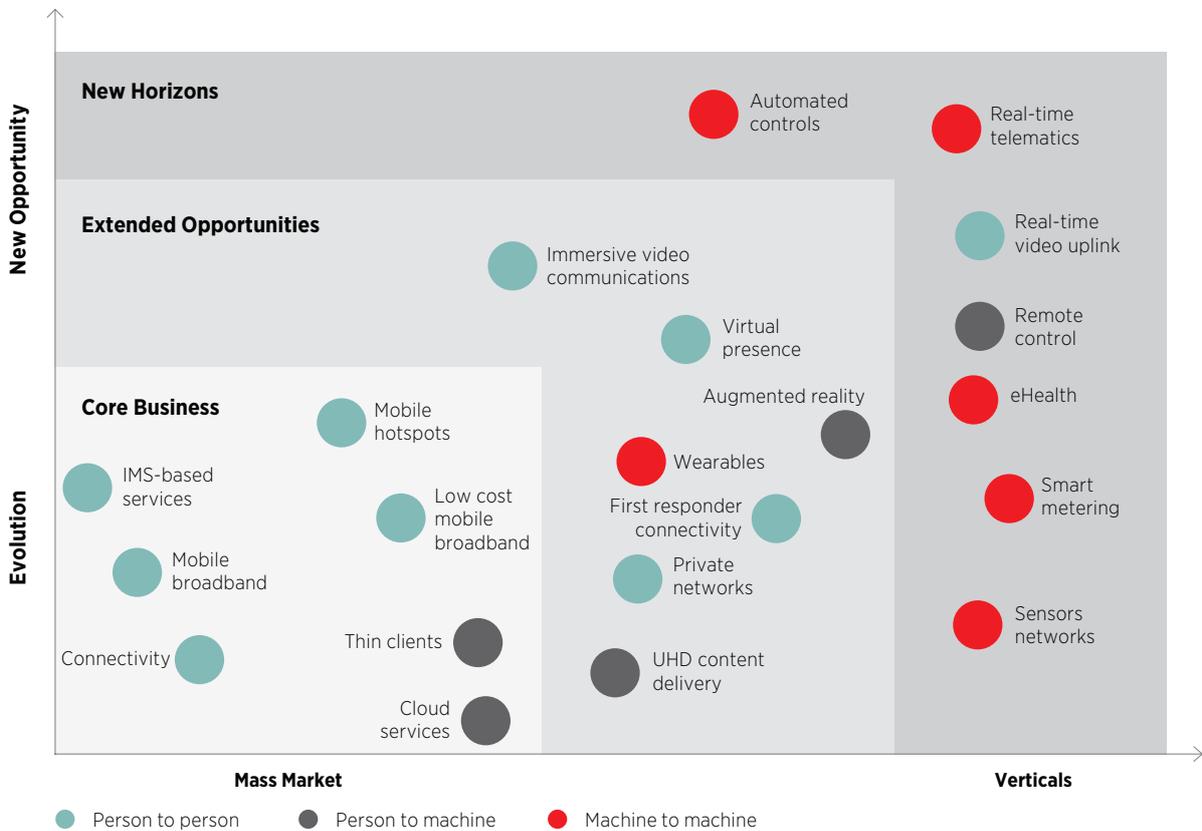
Source: GSMA

Where is 5G happening?

There have already been extensive 5G trials across the world; some 164 operators across 81 markets had undertaken trials as of the end of June 2019. The focus now is shifting to commercial launches. KT, LGU and SK Telecom launched commercial services in South Korea during the first half of 2019, while several other operators across Asia, Europe, the Middle East and North America have announced plans to launch commercial 5G services during the second half of the year.

Figure 9

5G developments worldwide

	As of June 2019	2020	2025
Trials	164 operators in 81 markets		
Spectrum auctions	209 operators** in 27 markets	38 countries completed auctions	
Commercial launches*	25 operators in 14 markets	177 operators in 59 markets	413 operators in 118 markets
Adoption	Over 2.1 million connections	70 million connections (1% adoption)	1.4 billion connections (16% adoption)

Source: GSMA Intelligence

* Launches of commercial mobile 5G services

** Includes regional US winners

2.2 5G in Sub-Saharan Africa – an oxymoron?

Sub-Saharan Africa's macroeconomic environment and relatively low uptake of digital services are sufficient reasons to take a dim view of 5G deployment and adoption in the region. Indeed, the notion of 5G in Africa comes across as an oxymoron and a situation that is far from becoming reality. There are pertinent questions around 5G market readiness, and the necessary steps stakeholders need to take to maximise value in the 5G era.

The concerns around 5G mirror those that heralded the arrival of 2G in Sub-Saharan Africa two decades ago. In 1999, GDP per capita in Sub-Saharan Africa, at $567 on average[8], was a tenth of global GDP, while literacy levels, access to electricity, existing telecoms infrastructure and other prerequisites for 2G deployment and adoption were among the lowest in the world. Despite these limitations, take-up of 2G exceeded expectations over the following decade.

[8] World Bank

Figure 10

Sub-Saharan Africa recorded the second fastest growth in mobile adoption, albeit from a low base, over the decade to 2010
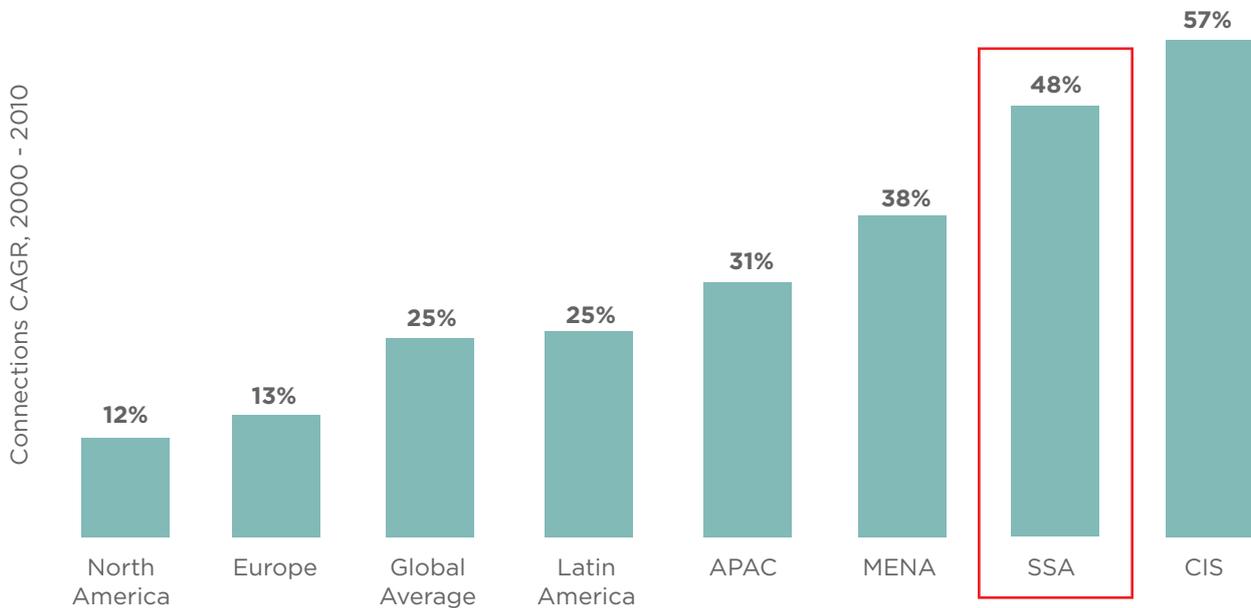
Source: GSMA Intelligence

The pre-2G scenario in 1999 is similar to the pre-5G scenario in 2019. Although GDP per capita has increased to more than $1,500, it represents just 14% of the global figure, while infrastructure and digital skills challenges persist. However, 5G is not likely to repeat the 2G performance over the next decade. The arrival of 2G in 1999 marked a revolution in the telecoms landscape, at a time when less than 1% of the population had access to any form of telecoms service. In contrast, 5G is more of an evolution as voice and data services have already reached mass-market levels in the region.

The common feature of both eras is the pent-up demand for the main communication service of the day. In 1999, it was voice; in 2019 it is data. The demand for data (see Section 1.2) will underpin growth in enhanced connectivity services during the 2020s, including initial take-up of 5G.

2.3 5G in Sub-Saharan Africa – market readiness assessment

It is possible to assess the readiness of countries and regions for 5G. Markets that score well on this front, such as South Korea and the US, are leading in launches of commercial services, with strong initial uptake. The GSMA has developed the Basic, Economic, Market, Enterprise, Consumer, Spectrum (BEMECS) indicator framework as an evaluation tool for the 5G market readiness of different countries. The tool covers more than 160 countries[9], including 37 in Sub-Saharan Africa, and uses a traffic light system (Green = Ready, Amber = Getting Ready, Red = Not Ready) to analyse the 40 indicators included, as summarised in the Appendix.

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[9] For consistency, all data used is based on full-year 2017 unless specified. Basic and economic indicators have been omitted in the analysis as they are exogenous to the telecoms industry. GSMA operator members have access to the complete 5G Readiness database via the GSMA Infocenter (5G Knowledgebase)

Table 1

Consolidated assessment for mass-market 5G readiness for 37 countries in Sub-Saharan Africa, 2018

5G enablers	Indicator	Status	Comments
Market	Competition	teal	There is open and fair competition in most markets in the region. Revenue and ARPU growth will remain stable over the next five years. However, unique subscriber penetration, at 44% on average, remains low, along with fibre penetration and access to key infrastructure, such as electricity.
	Mobile connections penetration	orange	
	Unique subscriber penetration	red	
	Average download speed (Mbps)	orange	
	4G penetration	red	
	Smartphone penetration	red	
	Revenue growth / GDP growth (2018 - 2023)	orange	
	Average ARPU (Q2 2017 - Q2 2018)	red	
	ARPU growth (2018 - 2025)	orange	
	Fibre (FTTH) penetration	red	
	Fixed broadband penetration	red	
	Internet backbone per user	red	
	Electricity availability per population	red	
Enterprise	IoT connections / population	red	Notable bright spots are the improving business environment and the increasing availability of homegrown apps, but overall availability of content and IoT adoption among enterprises remain low.
	Innovation potential: population with tertiary education	red	
	Innovation potential/availability of content: registered websites/1,000 people	red	
	Innovation potential/availability of content: apps developed/1,000 people	red	
	Barriers to innovation: apps in national language	orange	
	Barriers to innovation: ease of doing business	orange	
	Enterprise example: e-government availability	red	
Consumer	Affordability: ARPU/GDP per capita (monthly analysis)	red	The average selling price (ASP) of smartphones has fallen below $200[10], with more sub-$50 devices coming to market in the last 3–5 years. Literacy rates in the region are improving, while the lack of fixed broadband connectivity bodes well for the FWA opportunity.
	Affordability: internet device ASP / GDP per capita	teal	
	Usability: literacy rates	orange	
	Usability: household computer penetration	red	
	Consumer example: fixed wireless access opportunity	orange	
	Consumer example: mobile social media accounts (% of population)	red	
Spectrum (YE 2018)	<1 GHz availability	orange	An increasing number of countries have made sub-1 GHz spectrum available for mobile services, but the region as a whole is lagging in mid- and high-frequency band readiness.
	<6 GHz for 5G availability	red	
	>6 GHz for 5G availability	red	

Source: GSMA

[10] Statista

The Market Readiness Index paints a picture of a region not ready for 5G as of early 2019. Most markets in the region are still in the early stages of mass-market 4G rollout and this has yet to translate into widespread 4G adoption. Furthermore, there is limited availability of key 5G spectrum across most markets, particularly in the mid- and high-frequency bands.

Although country-level 5G readiness is a distant prospect across the region, localised (e.g. city-level) 5G readiness will be key in many countries as it offers a chance to address opportunities for enhanced connectivity solutions. These opportunities will exist in specific locations where customers have a need for 5G-specific capabilities – for example, low latency control systems in the mining industry.

5G could also play a role in addressing network congestion in city centres, as an important part of the infrastructure options to support high traffic density. The problem of high traffic density will become more pronounced in the region as the rate of urbanisation picks up and cities become more densely populated. Urbanisation in Africa will grow from 38% in 2015 to 55% in 2050[11], while around 100 cities in the region will have more than 1 million inhabitants by 2025.[12]

Figure 11

Two in five people in Sub-Saharan Africa now live in urban areas
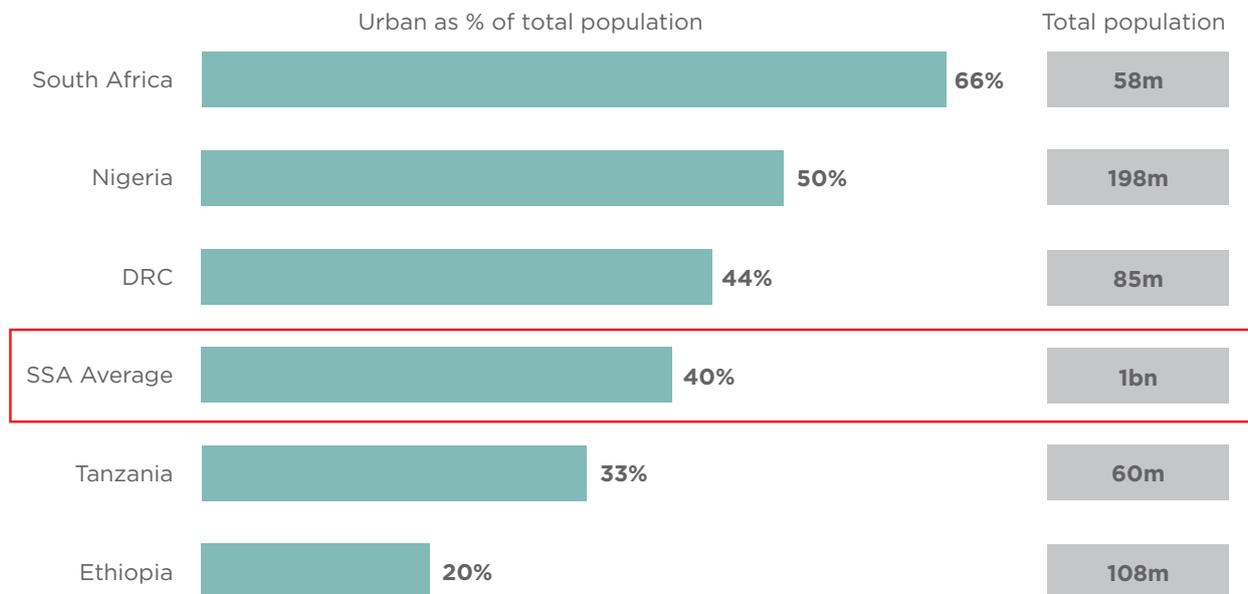
Source: GSMA Intelligence, World Bank

Table 2 shows that data traffic growth in the 'Developing mega-hub' and 'Crowded city' archetypes – typical for Africa – will be the highest in the world.[13]

Table 2

Data traffic growth in four megacity archetypes (2017–2025)

		Lower costs of site relative to ARPU **DEVELOPED**	Higher costs of site relative to ARPU, less developed infrastructure and higher demand growth **DEVELOPING**
Dense	Due to limited site-to-site distance and high traffic density, the limitations of the macro network are reached quicker and more small cells are required.	**URBAN POWERHOUSE** Examples: New York, Tokyo, Seoul **35% CAGR**	**DEVELOPING MEGAHUB** Examples: Shenzhen, Shanghai, Sao Paulo, Mumbai **51% CAGR**
Sparse	Due to the lower traffic density, the limitations of the macro network are reached later and fewer or no small cells are required	**SPRAWLING METROPOLIS** Examples: Paris, London, Los Angeles **42% CAGR**	**CROWDED CITY** Examples: Manila, Lagos, Lima **54% CAGR**

Source: GSMA, Boston Consulting Group

2.4 5G in Sub-Saharan Africa is inevitable, but not imminent

As a natural progression from previous generations, 5G is inevitable in Sub-Saharan Africa. The advent of the 5G era in the region is a question of 'when' rather than 'if'. This view is supported by the GSMA 5G Market Readiness Index and the GSMA Intelligence 5G in SSA Survey, with indications that some countries, such as South Africa and Kenya, are moving quickly towards a state of readiness, which will become evident nearer to 2025. However, the 5G era is not imminent for most markets as existing technologies are capable of supporting current use cases and demand for mobile internet connectivity.

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[13] Delivering the Digital Revolution, GSMA, 2018

Figure 12

More than two-thirds of respondents do not envisage commercial 5G being available in their market before 2025

Question: When will commercial 5G be available in your market?

Percentage of respondents
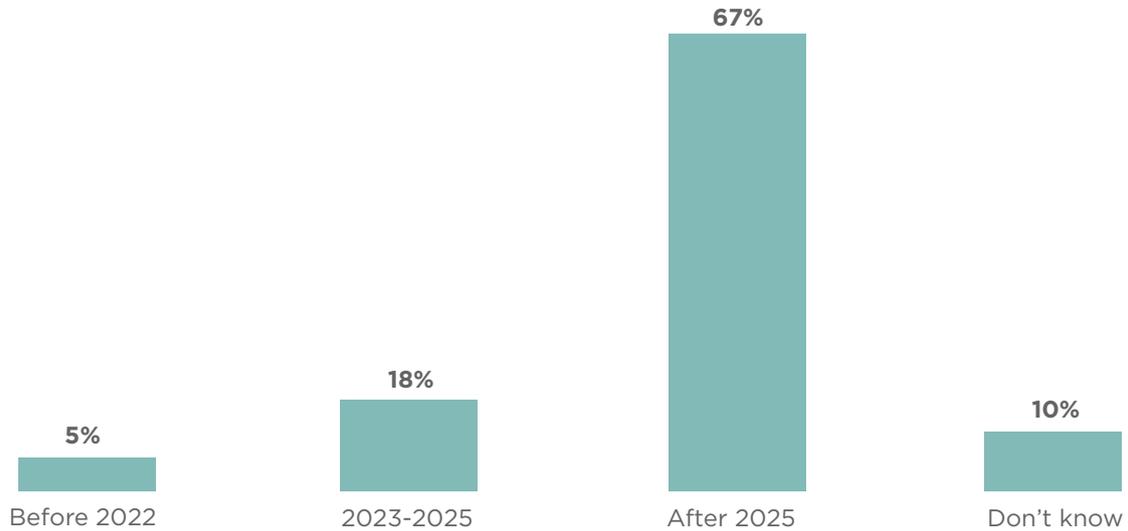
Source: GSMA Intelligence 5G in SSA Survey

Across Sub-Saharan Africa, it is important that all stakeholders, including policy-makers and mobile industry players, approach the 5G opportunity in their countries from a market readiness perspective. This will be crucial to maximising value for consumers and the wider society in the 5G era, as well as ensuring the best use of resources, including spectrum and capex, in the deployment of next-generation networks.

2.5 5G in Sub-Saharan Africa – outlook and market developments

Though mass deployment and adoption of 5G in Sub-Saharan Africa are still several years away, recent developments indicate what the 5G landscape could look like, and the potential value creation opportunities. The 2020s will see an increase in 5G activities, with South Africa – the most advanced market in the region – leading the way. By 2025, there will be 28 million 5G connections in the region, equivalent to 3% of total mobile connections, with commercial services available in at least seven markets, including Kenya, Nigeria and South Africa.

Figure 13

Key milestones in the Sub-Saharan Africa mobile landscape
5G to account for 3% of 1 billion connections by 2025

Source: GSMA Intelligence

Figure 14

5G market developments: Southern Africa dominates activities to date

MTN Group and ZTE announced plans to conduct technology verification tests and assessments for 5G. ZTE will work with MTN to complete lab and field tests for 5G-NR, virtualised network slicing, carrier-class DevOps and container-based vEPC.

MTN and Huawei announced a trial to demonstrate 5G FWA use cases with Huawei's 5G 28 GHz mmWave solution in a real-world setting. The trial reached speeds of 520 Mbps downlink and 77 Mbps uplink.

Comsol Networks and Samsung launched a pilot 5G FWA network in the Soweto township in Johannesburg. The network reached peak speeds of 1.75 Gbps. Samsung provided end-to-end FWA technology, including 5G outdoor routers, compact mmWave RFIC technologies, and ASIC-based 5G modems.

MTN South Africa and Ericsson announced a 5G customer trial, deploying a FWA site at tech company Netstar's headquarters in Midrand. The Ericsson 5G technology operates on the 28 GHz band, with a total operating bandwidth of 100 MHz, using Ericsson trial antenna integrated radio units and Intel 5G FWA equipment on customer premises.

Mobile data-only network Rain and Nokia unveiled a commercially ready 5G network in Cape Town, South Africa. The network utilises 3.6 GHz spectrum and Massive MIMO technology, and is expected to support a variety of use cases as end-user devices become available.

| March 2018 | May 2018 | August 2018 | September 2018 | November 2018 | February 2019 | April 2019 |

South African B2B-focused network operator Comsol Networks partnered with Verizon and Samsung to launch 5G FWA trials in South Africa. Comsol has access to the largest tranche of contiguous 28 GHz spectrum in South Africa and plans to offer 5G FWA to enterprises, in addition to its LPWA IoT offering.

Vodacom launched a standards-based, commercial 5G network in Lesotho. The service uses spectrum in the 3.5 GHz band and will initially deliver FWA broadband services to business customers.

Vodacom and Nokia demoed VR at a horse-racing event in Durban, South Africa, using 100 MHz of spectrum in the 28 GHz band. The VR experience showcased the high-speed and low-latency capabilities of 5G using 4K video cameras to record and stream live, immersive footage from two positions.

MTN launched a 5G trial network at Kyalami Grand Prix Circuit and International Convention Centre in Johannesburg, South Africa. MTN intends to evaluate the benefits that 5G connectivity could provide to corporate customers, ahead of more advanced 5G use cases. MTN used a 100 MHz block of 28 GHz spectrum for the trial.

Source: GSMA Intelligence

3 The 5G business case: key ecosystem considerations

As the 5G era approaches, ecosystem players around the world have highlighted the need to reflect on the 5G business case for a given market, based on supply-side and demand-side considerations. This is particularly pertinent in Sub-Saharan Africa where the facts on the ground, both within and outside the telecoms industry, point to a more complex path towards 5G, relative to more advanced markets. For ecosystem players in the region, careful assessment of these considerations is necessary to optimise the transition to 5G in the wider context of next-generation connectivity.

3.1 Supply-side considerations

5G network deployment in Sub-Saharan Africa will be mostly driven by supply-side dynamics. An overwhelming majority of respondents to the GSMA Intelligence 5G in SSA Survey (92%) expect investment in 5G infrastructure to precede customer demand for 5G services. This is based on two premises; firstly, experience from the 4G era where adoption has been limited despite considerable network coverage (Figure 15), mainly due to high device costs and insufficient use cases; secondly, ongoing network modernisation efforts by mobile operators, which could include the deployment of 5G-ready equipment even before there is demonstrable demand for the technology.

Figure 15

Significant mismatch between supply and demand as 4G adoption lags coverage by a significant margin (as of June 2019)

4G adoption (% of total connections) **4G coverage (% of total population)**
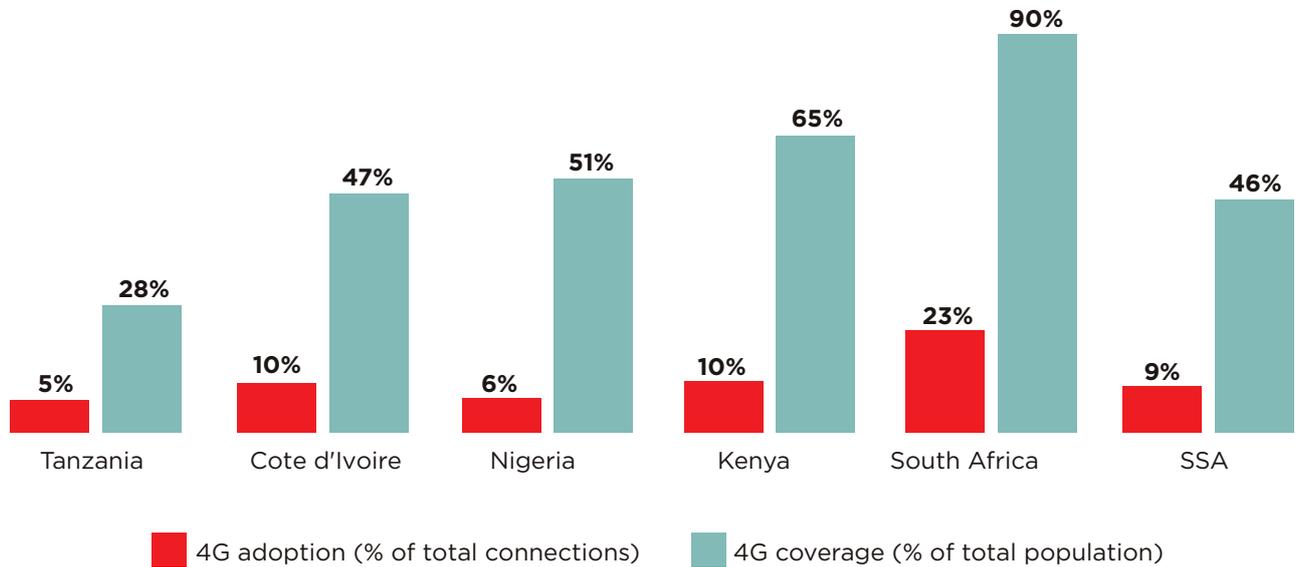
Source: GSMA Intelligence

Ahead of actual 5G deployments, there are three substantive considerations for mobile operators in the region to understand and plan for:

• Preparing the network for 5G

• Cost-effective infrastructure deployment

• Operational complexity with 2G/3G/4G/5G.

Preparing the network for 5G

Operators in the region have begun upgrading their networks to multi-generational RAN, which enables them to run 2G, 3G and 4G on the same radio. For 5G, however, operators will need to further upgrade their networks to multi-standard 5G-ready basebands and radio antennae, which can handle multiple bands. There is also a need to build out adequate transport networks to run 5G – for example, fibre to the site, cell densification, virtualised core network and datacentres for edge services. As operators increase coverage and capacity of their 4G networks, it is also important to invest in the latest LTE-Advanced technologies such as carrier aggregation and massive multiple-input multiple-output (MIMO).
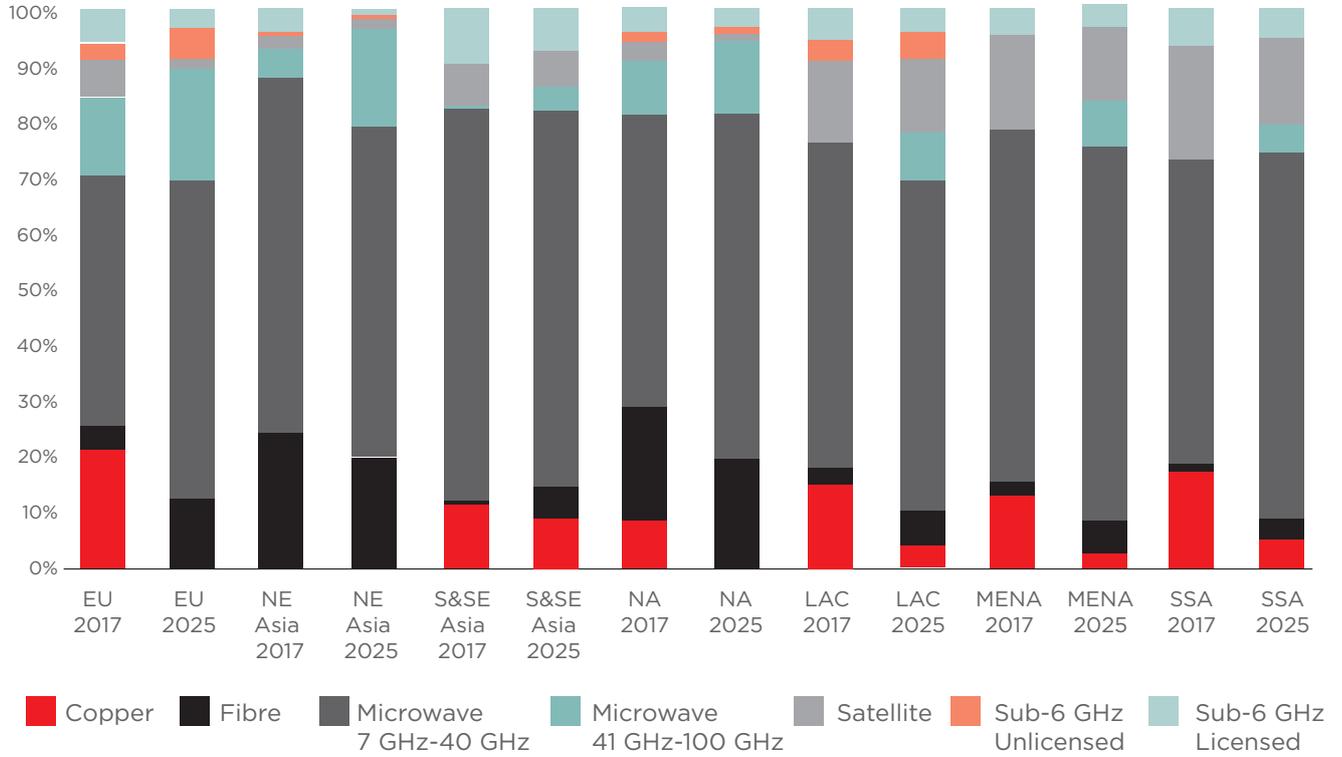
Centralised and virtualised RAN (C-RAN and vRAN) architectures will be at the centre of future mobile networks to allow for more capacity, network flexibility and scalability. Operators will also need to leverage the virtualisation of network management through software-defined networking (SDN) and network function virtualisation (NFV), both of which are enablers of network slicing in 5G.[14] Given the opportunity for localised deployment, operators will need to develop technical and commercial capabilities to identify the target areas for 5G deployments, which will need both granular data on local market conditions and data analytics to identify the most attractive areas.

The region is the most underserved by fibre – the ideal backhaul solution for 5G. Cell sites in the region rely disproportionately on microwave, satellite and copper. GSMA/ABI Research analysis projects that by 2025, fibre will only account for 4.4% of the region's backhaul, compared to 65.3% for microwave (7–40 GHz).[15] While improvements in microwave solutions mean they can support an increasingly higher traffic load, the low penetration of fibre will remain a challenge for mass-market 5G deployment. Additionally, vRANs might require fronthaul deployment to maximise the potential cost savings and efficiency from SDN and NFV.

Figure 16

Mobile backhaul options
Percentage of backhaul provided by technology

Legend: Copper | Fibre | Microwave 7 GHz-40 GHz | Microwave 41 GHz-100 GHz | Satellite | Sub-6 GHz Unlicensed | Sub-6 GHz Licensed

Source: GSMA/ABI Research

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[14] Network slicing is a form of virtual network architecture that allows a network operator to provide dedicated virtual networks with functionality specific to the service or customer over common network infrastructure. Thus it will be able to support the numerous and varied services envisaged for 5G.
[15] Mobile backhaul options, GSMA, 2018

Cost-effective infrastructure deployment

Further next-generation network deployments in Sub-Saharan Africa and the first phases of 5G rollouts will require significant capital investment by mobile operators. Operators in the region will invest $60 billion in their networks between 2018 and 2025 – a fifth of which will be on 5G infrastructure. This comes at a time when the outlook for revenue growth in the industry remains subdued and margins in many markets are under pressure. Operators will invest in new network capabilities, deploy fibre deeper into their networks, and build more cell sites to support network densification. Given the challenging financial situation, operators, vendors and other ecosystem players will need to explore ways to ease the financial burden.

Network sharing – The industry landscape to date has generally been shaped by infrastructure-based competition between operators, but the 5G era will likely see the introduction of new models of network ownership, with private 5G networks likely to proliferate in some regions. Passive infrastructure sharing and the use of tower companies is already a feature in Sub-Saharan Africa but will become more widespread, particularly to address some of the specific coverage challenges in the region.

Active network sharing has been shown to deliver much higher levels of both capex and opex savings compared to passive, resulting in the best outcomes for operators and society at large. Beyond the regulatory considerations, vendors and tower companies can look to facilitate active sharing; for example, ensuring robust operating models are in place to support the relevant operators and network operations, as well as standardising equipment to facilitate interoperability.

Energy efficiency solutions – With energy accounting for 20–40% of network opex, it is important that operators continue to invest in energy-saving solutions. Such moves will support commitments to reduce greenhouse gas emissions by 30% in absolute terms by 2020 and 50% by 2030. Given the unreliable electricity grid in many countries in the region, and the reliance on diesel generators (with the associated challenges of supply reliability, security and fuel theft), many operators in the region should seek ways to run their networks from renewable sources, especially solar.

Innovative network financing models – Vendors can consider new ways of financing network investment beyond traditional vendor financing. These include the lease-to-own-model, whereby the vendor funds the network build and then enters into a revenue share arrangement with the operator until the equipment vendor recovers the investment cost, with ownership then transferring to the operator.

Operational complexity with 2G/3G/4G/5G

The prospect of running a combined 2G/3G/4G plus 5G network will pose an operational challenge to operators in the region. The initial deployment of 5G will face the complexity of managing legacy networks, the need to integrate legacy networks with the new 5G network, and the resources and expertise required to address these challenges.

Respondents to the GSMA survey generally recognised the need for technology rationalisation, but there was no consensus on which of the previous generations should be phased out. The dilemma operators face in Sub-Saharan Africa with respect to legacy technologies is highlighted in Table 3.

Table 3

Challenges in moving away from legacy technologies

Technology	Key issues
2G	• Around 70% of voice traffic still runs over 2G networks. In addition, featurephones are still prevalent in the market, accounting for 60% of total mobile connections. • Moving 2G-only customers to 3G/4G will be expensive for the operator and the user, and will require 2G coverage levels (more than 90% in most markets) for 3G/4G.
3G	• Operators are yet to fully recoup significant investments in 3G, especially for licences and network buildout. • 3G coverage is up to 4x greater than 4G, so will play a vital role in achieving universal MBB coverage, unless operators can find the funds to ramp up 4G rollout and bring it to the same level as 3G in the next few years.

Source: GSMA Intelligence

Operators in the region need to develop a clear roadmap for rationalising their legacy 2G and/or 3G networks ahead of mass-market 5G rollout. Such a roadmap could have an implied bonus, when regulation permits, as spectrum can be refarmed for 5G rollout. It also means operators in the region need to take steps to replace circuit-switched communications with IP communications (VoLTE/RCS) to assure voice and messaging service continuity in the 5G era, although high device costs could weigh on adoption.

Is leapfrogging 4G to 5G an option?

It is possible to deploy a standalone 5G network in selected usage scenarios, such as for enterprises in the mining sector where there is no consideration for integrating legacy 2G, 3G and 4G networks.

However, the practicality of leapfrogging 4G to 5G is more challenging for mass-market scenarios, especially in the consumer segment. While it may sound like an attractive proposition, particularly for operators with less than 5% 4G adoption and less than 20% population coverage, it will be difficult to achieve due to technical, commercial and regulatory challenges.

Technically, as early 5G networks are based on non-standalone architecture[16] (NSA) which requires a 4G network, it is not possible to leapfrog until standalone architecture[17] (SA) 5G becomes available. In addition, a jump from 2G/3G to SA 5G, while feasible, will come with complications around managing voice handover, managing spectrum harmonisation and maintaining device interoperability.

Commercially, a jump to SA 5G from 2G/3G will likely require a costly outlay on greenfield, nationwide deployment of 5G, and with no fall-back and no inbound roaming. It also raises the risk that some investments (e.g. spectrum) made in anticipation of 4G rollout could become 'stranded assets'. Given the momentum towards 4G-to-5G migration, devices and equipment for 2G/3G-to-5G migration will struggle with economies of scale, potentially making them costlier.

From a regulatory perspective, the need to support traditional voice for the foreseeable future makes leapfrogging difficult. In markets where lots of voice traffic still runs over 2G, over devices on 2G mode, it will be difficult to skip 4G and migrate to 5G without first taking steps to migrate 2G/3G voice to VoLTE over 4G networks.

3.2 Demand-side considerations

Sub-Saharan Africa has more of a demand-side than a supply-side problem for mobile broadband. This is evidenced by the significant mismatch between 4G network coverage and 4G adoption across the region. Over 800 million people in the region are still unconnected, 62% of which are already covered by a mobile broadband network.
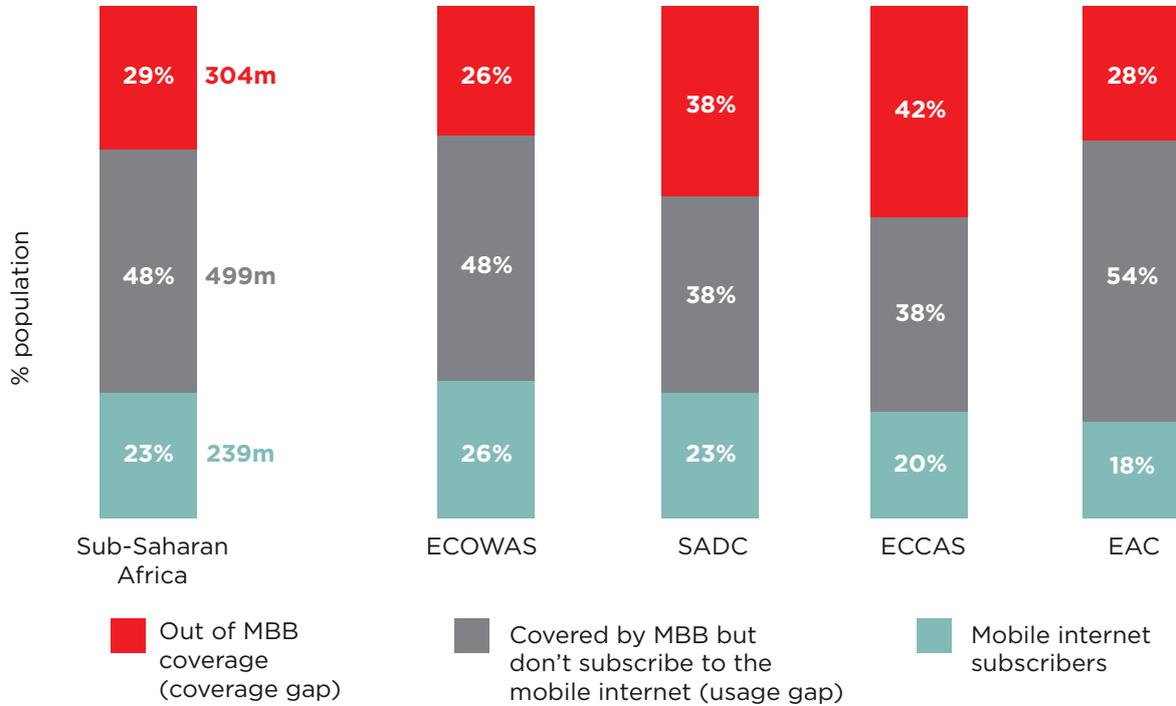
The reason for insufficient demand in the region is mainly socio-economic and exogenous to the telecoms industry. Broadly, it can be distilled down to the twin challenges of affordability and usability. Regarding affordability, at $4 per month, ARPU in the region is the lowest in the world, putting a severe strain on operator revenues. Customers in 22 out of 37 countries in the 5G Market Readiness Index spend more than 3% of their monthly income on mobile services, compared to less than 1% in more advanced regions. In addition, digital skills, smartphone adoption, access to electricity, and availability of locally relevant content and applications all affect the ability of customers to use mobile broadband services.

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[16] NSA configuration is suitable for providing more broadband capacity since 5G NR (new radio) can act as a supplementary capacity overlay to the 4G network. i.e the device is able to connect simultaneously to the 4G radio network and the NR (a technique known as dual connectivity)
[17] SA offers larger-scale economies and high performance as well as less complexity from legacy LTE integration, but it is more expensive in the early commercial stage

Figure 17

More than 800 million people across Sub-Saharan Africa don't use the mobile internet

% population

	Sub-Saharan Africa	ECOWAS	SADC	ECCAS	EAC
Out of MBB coverage	29% / 304m	26%	38%	42%	28%
Covered by MBB (usage gap)	48% / 499m	48%	38%	38%	54%
Mobile internet subscribers	23% / 239m	26%	23%	20%	18%

- Out of MBB coverage (coverage gap)
- Covered by MBB but don't subscribe to the mobile internet (usage gap)
- Mobile internet subscribers

Source: GSMA Intelligence

If the demand problem is to be addressed, all stakeholders, especially governments, need to work together to ensure that broadband usage can be optimised for consumers and businesses. The GSMA Intelligence Consumer Survey 2018 (see Figure 18) shows that, beyond the traditional use for making calls, many customers in developing countries use their smartphones for entertainment, especially watching free online video and playing games. As video overcomes the literacy challenge, its use will continue to grow and will increasingly account for the bulk of network traffic for most operators in the region.

Figure 18

Smartphone usage in Sub-Saharan Africa by type of activity (percentage of respondents)
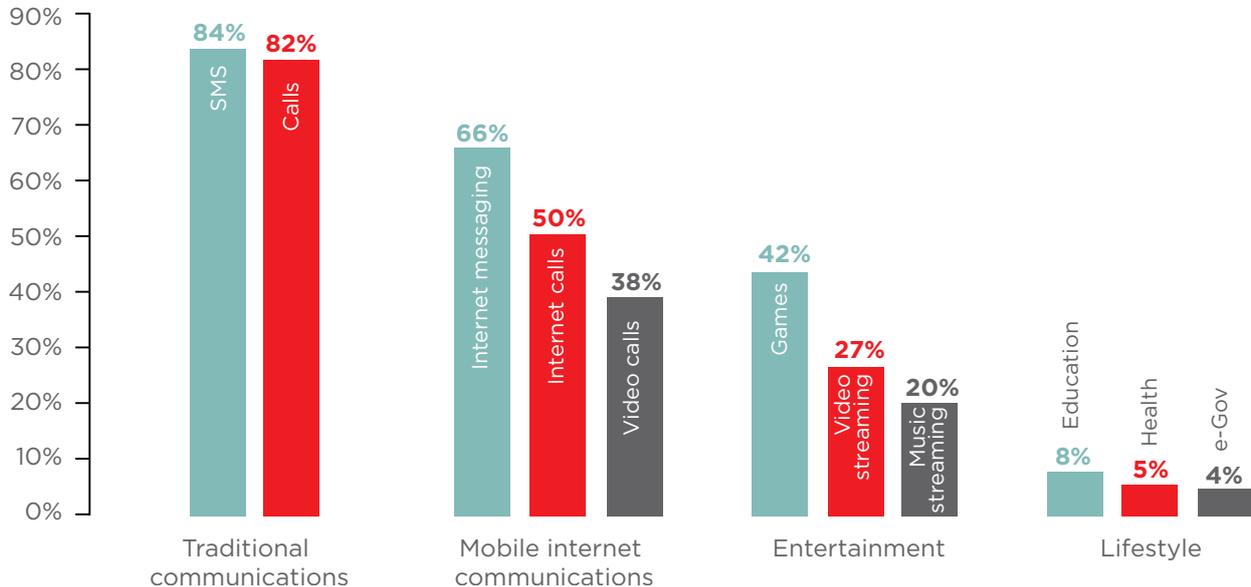
Source: GSMA Intelligence Consumer Survey 2018

Focus should be on high-quality broadband, not 5G

Given the relationship between broadband use and economic growth, governments and customers in the region want to see greater availability and use of broadband services in general. To this end, some governments have launched National Broadband Plans with universal coverage targets. For example, the Kenya National Broadband Plan stipulates a minimum broadband speed of 2 Mbps for all users[18], while the Uganda National Broadband Policy has a target of 4 Mbps.[19]

As the 5G era approaches, operators should have the flexibility to serve different segments of the market with the right technology that meets demonstrable demand for data connectivity, as opposed to technology-specific coverage obligations, especially for 5G. In most situations, customers will be well served by existing 3G or 4G networks. In others, 5G could play a role in meeting demand for enhanced connectivity.

Localised FWA presents an entry point to 5G in Sub-Saharan Africa

Availability of ample capacity from 5G and the lack of existing fixed broadband solutions are set to make 5G fixed wireless access (FWA) the biggest 5G use case in the region. This is the dominant view emerging from the GSMA Intelligence 5G in SSA survey. 5G FWA will build on initial efforts with early deployments of FWA-like services using proprietary wireless technologies (e.g. LMDS, iBurst), alternative cellular technologies (e.g. WiMAX) and default cellular technologies (e.g. 3G, 4G).

The primary driver for FWA in Sub-Saharan Africa is the low household fixed broadband penetration. Across the region, fixed broadband penetration is typically below 2%, except for Mauritius, an outlier with a penetration rate of nearly 20%.[20] As more households and businesses demand enhanced connectivity solutions, the cost benefit of addressing this opportunity with FWA, relative to greenfield FTTx deployment, makes it an attractive proposition. Huawei estimates the capex per subscriber range at between $500 and $1,000 for FTTx versus $100 to $400 for FWA.[21] This is based on calculations for 4G FWA; 5G may be cheaper.

[18] Public Consultation On The National Broadband Strategy For Kenya, Communications Authority of Kenya, 2019
[19] The National Broadband Policy, Ministry of Information, Communications Technology & National Guidance, 2018
[20] ITU
[21] 4G Wireless Broadband Industry White Paper, Huawei, 2017

The FTTx opportunity is not universal, however; rather, it is dependent on local realities. Using household PC penetration versus fixed broadband penetration as a framework for analysis, we group countries into three categories:

Red ocean	Fiercely competitive opportunity for home broadband. These are markets with household PC penetration of more than 40% and over 20% fixed broadband penetration.
Blue ocean	Sizeable, and relatively uncontested, mass-market opportunity for home broadband. These are markets with at least 40% household PC penetration but less than 20% fixed broadband penetration.
Deserts	Offer only a small, mass-market FWA opportunity because of low affordability and usability. These are markets with household PC penetration of less than 40% and less than 20% fixed broadband penetration.

Most markets in the region fall under the 'Deserts' grouping for 5G FWA (only Mauritius is 'Blue ocean'; there are no 'Red ocean' markets in the region). However, analogous to a dry, barren desert with isolated oases of greenery, there are pockets of FWA opportunity – especially in big cities and areas with a high concentration of businesses. The basis for localised and targeted deployments, as opposed to ubiquitous rollout, is even more pronounced when viewed against the backdrop of the potential cost for the requisite cell densification versus income constraints for many consumers.

The cost factor should be a key consideration for regulators in their plans for building out nationwide broadband services. Past experience has shown that a number of new entrants have competed for and won spectrum for FWA but then struggled to scale up because of lack of resources. As such, it is important that established operators take the lead in implementing 5G for the region.

Enterprises will drive initial uptake

Across the globe, operators and other ecosystem players see 5G as an opportunity to better serve the enterprise market. To capture this fully, operators need to tailor their value propositions to large organisations (including municipalities and government agencies) as well as SMEs within their local markets. In Sub-Saharan Africa, large enterprises in consolidated sectors, such as minerals, oil & gas, financial services, and the media, will likely be early adopters of 5G, but the SME market

presents significant long-term opportunities given the size of the informal economy in the region (accounting for 66% of total employment[22]) and the limited number of multinationals.

5G FWA will be a primary use case for enterprises of all sizes, given the challenges around access, cost and reliability of existing connectivity services, including fixed broadband and satellite. This sentiment was echoed by most respondents to our 5G in SSA survey, who also expect early 5G deployments to target locations with a high concentration of enterprises, including public institutions. The challenge for operators will be to increase awareness and understanding among enterprises of the opportunities of 5G.

Beyond FWA, operators in Sub-Saharan Africa are well positioned to provide a range of other technology solutions to enterprises – many of which could benefit from enhanced 5G capabilities. Ericsson estimates that 5G-enabled revenues in Africa will be worth $10.5 billion by 2026, about 15% of projected annual revenues in the region[23], with manufacturing, energy & utilities, public safety, mining, oil & gas, healthcare, public transport and media & entertainment providing significant opportunities.
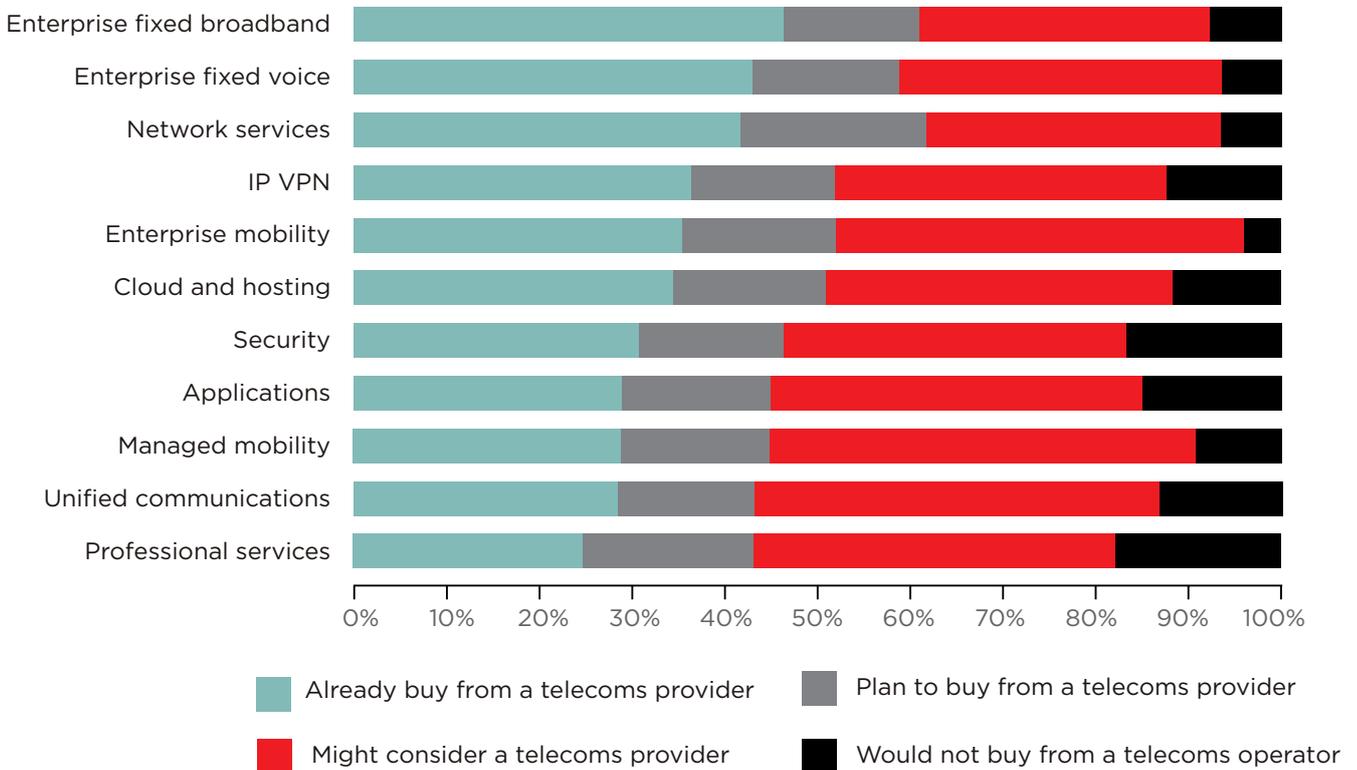
Insights from the GSMA Intelligence IoT Enterprise Survey[24] spanning 2,271 companies across eight verticals in 14 countries, including South Africa, underscore the opportunity for operators in enterprise services (see Figure 19).

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[22] World Bank
[23] Making 5G a reality for Africa, Ericsson, 2018
[24] IoT in business: Enterprise views on solution requirements, GSMA Intelligence, 2019

On average, more than half of enterprises in South Africa already buy or plan to buy technology solutions from operators

Question: Which services does your organisation already buy from a telecoms operator?

Source: GSMA Intelligence IoT Enterprise Survey

IoT is a key focus for operators looking to expand their enterprise revenues in the 5G era. In South Africa, 21% of surveyed enterprises chose mobile operators as their first-choice provider for IoT solutions, compared to a global average of 10%. This reflects mobile operators' strong track record in providing services to the enterprise segment in the region.

Many IoT applications are already well supported by existing networks. For example, massive IoT applications already benefit from the increasing adoption of LTE-M and NB-IoT in verticals, such as transport, utilities and automotive. Critical IoT, however, is yet to be fully defined but could benefit significantly from enhanced 5G capabilities, including greater capacity for scale, enhanced quality of service and lower latency. Additionally, currently unknown use cases could be developed, with the potential to revolutionise industries and consumer experiences.

Enterprise views on 5G IoT capabilities

Globally, 62% of enterprises plan to use 5G for their future IoT deployments. There is some variation in terms of vertical adoption; the strongest appetite is among enterprises in the utilities and consumer electronics verticals, while the weakest is in the public sector. The larger the enterprise, the more attractive the IoT-specific capabilities of 5G:

- **Higher data speeds:** 74% of enterprises across all verticals highlight speed as the most compelling feature of 5G.

- **Network slicing:** across the board, almost half of enterprises find this an attractive feature of 5G, with consumer electronics showing the strongest demand (59%). Larger companies find it more appealing (46%) than small companies (38%).

- **Edge computing:** utilities show the highest propensity to use edge computing (45%), with health, automotive and manufacturing close behind at 44%.

- **Low latency:** almost a third of enterprises find this a compelling 5G capability, with utilities (38%) retail (34%) and transport (33%) ahead of other verticals.

Insights from the GSMA Intelligence report, IoT in Business: Enterprise views on solution requirements

5G helping accelerate sustainability

Sustainability is crucial to realising the UN Sustainable Development Goals (SDGs). A key social benefit of the 5G era will be the productivity and efficiency gains by enterprises from 5G-enabled services and applications, which will have a direct positive impact on economic and environmental sustainability. For example, 5G-enabled sensors in factories, cities, farms and homes will provide the foundational elements to innovate and reduce carbon emissions. This will be particularly pertinent in Sub-Saharan Africa where there is an urgent need to accelerate efforts to achieve key SDG targets around sustainability.

The consumer segment is a long-term play

The cost of 5G devices will play a crucial role in 5G adoption rates in Sub-Saharan Africa, where smartphone affordability is a significant barrier to mobile access and ownership. The first wave of 5G devices will likely target the top end of the market, as with previous mobile generations. Immersive use cases such as augmented reality (AR) and virtual reality (VR), for which 5G's low latency capability is well suited, are still underdeveloped in the region.

Device subsidies will be crucial to 5G adoption in the consumer segment, but initial focus will likely target customer premise equipment (CPE) for FWA to the home, given the predominance of prepaid subscriptions in the mobile segment. That said, the prepaid model is now mature and evidence from other parts of the world suggests that a more sustainable model for the 5G era will be to move customers onto subscription models where they pay a fixed amount upfront periodically for a bundle of services.

In the meantime, 4G will continue to deliver high-speed mobile broadband, supporting the increasing connectivity needs of citizens and the economy, and paving the way for 5G. The later 5G launch dates expected in the region will mean that the technology will be more mature, with widespread global adoption enabling scale benefits in the 5G device market.
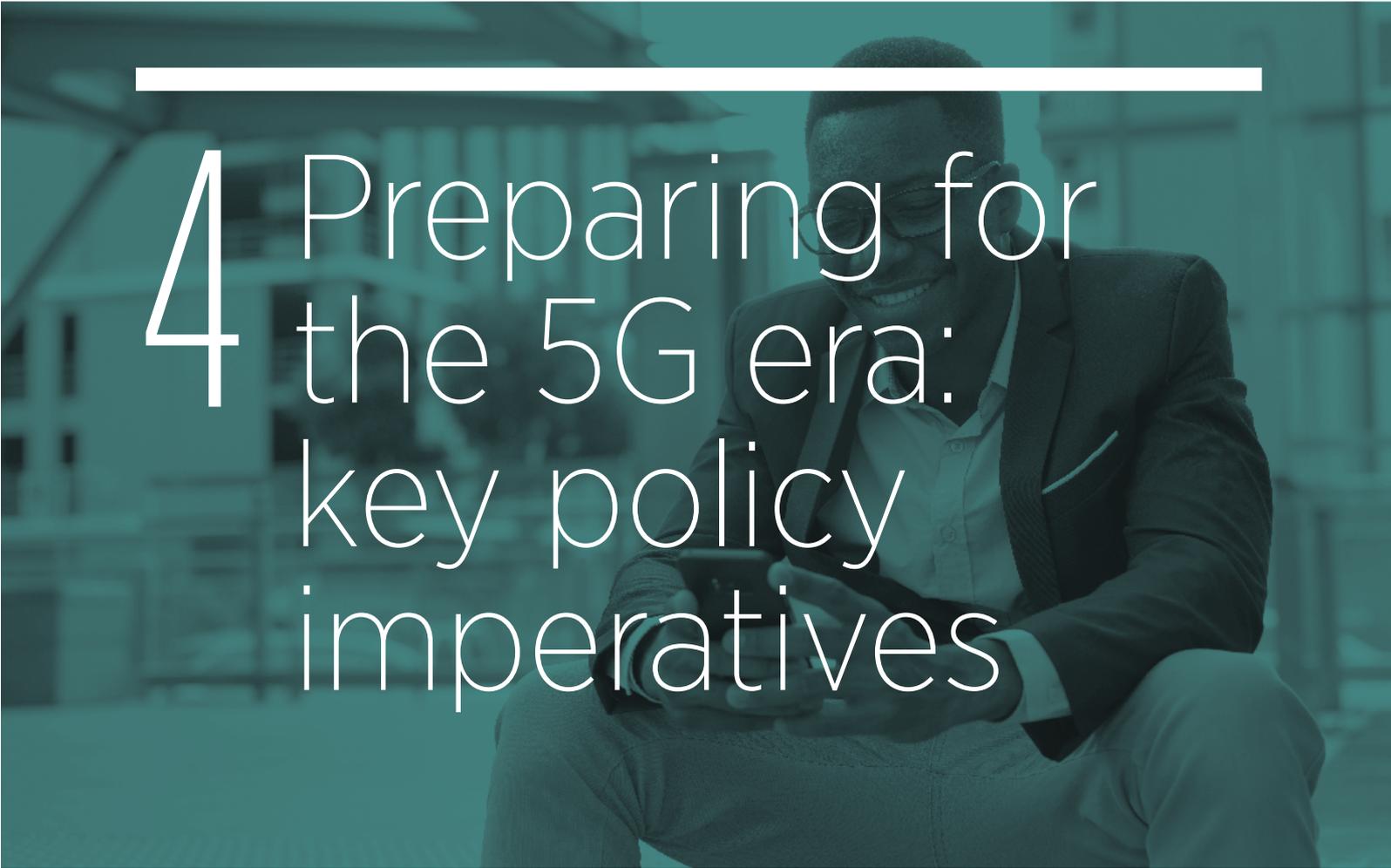
4 Preparing for the 5G era: key policy imperatives

The 2020s will usher in the 5G era in Sub-Saharan Africa. 5G-related activities will become more widespread across the region from midway through the decade. Intelligent connectivity will sit at the heart of new smarter ecosystems, as governments and enterprises embrace the Fourth Industrial Revolution, and use technology to tackle the biggest challenges faced by individuals and enterprises. 5G will be a key enabler, supporting new and existing technologies, such as AI and IoT, to transform industrial processes and generate significant social and economic benefits.

In view of the role 5G will play in driving future innovation and economic growth, now is the time to begin putting in place the necessary building blocks to facilitate the transition to 5G. The lessons learned in the 3G and 4G eras underscore the need for governments and other stakeholders to address key policy imperatives for the 5G era, both in the wider context of next-generation connectivity and advancement of the digital economy.

At a high level, governments and regulators need to consider market structures that will foster a pro-investment and pro-innovation environment for the development of the 5G mobile ecosystem. To this end, policy-makers, as vocal proponents of mobile network evolution and technology-led economic growth, should create the conditions for efficient and timely next-generation network deployment while reducing the regulatory costs for operators. Specifically, regulatory focus should be on the following four key areas: network deployment; network flexibility; spectrum access; and regulatory costs, in order to bring 5G in particular, and next-generation connectivity more generally, to fruition.

Figure 20

Key policy considerations for the 5G era

Streamline regulatory conditions to facilitate 5G deployment	**Provide regulatory flexibility** for innovative 5G propositions
Release sufficient spectrum for 5G that is harmonised and affordable	**Ease financial demands of 5G** by bringing down costs

Source: GSMA

Across a broad range of policy and regulatory issues, the industry position is no different in a 5G world to previous generations of mobile network technology. Positions published in the GSMA Mobile Policy Handbook,[25] spanning infrastructure sharing, taxation and spectrum, are just as relevant and applicable.

4.1 Regulatory conditions: streamlining the policy framework for network deployments

The densification of networks to cope with urban capacity demands requires significant new investment in additional sites and supporting infrastructure, including fibre as backhaul (both fixed and wireless). Complex planning procedures involving multiple layers of approval in some countries create additional regulatory burdens, which can significantly delay infrastructure deployment. To this end, policy-makers need to ensure that deployment regulations at the local level are streamlined to help deliver on national digital ambitions.

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[25] See https://www.gsma.com/publicpolicy/mobilepolicyhandbook/

Key steps to streamline the policy framework for network deployment

- Streamline planning procedures and regulations for site acquisition, co-location and upgrades of base stations.

- Provide operators with access and rights of way to public/government facilities for antenna siting on reasonable terms and conditions.

- Establish uniform electromagnetic field (EMF) rules that are no more restrictive than internationally agreed levels.

- Encourage and incentivise fibre investments, and enact appropriate policies to ease and expedite fibre rollouts.

- Strive to ensure that deployment regulations at the local level are streamlined to help meet national digital ambitions. This includes setting reasonable fees and other conditions for network deployment at a local level.

- Offer a reasonable expectation of approval for voluntary network sharing deals while avoiding mandated sharing agreements that may amount to an access obligation.

4.2 Spectrum: providing timely and affordable access to the right amount and type

2019 is not just a milestone in terms of the launch of commercial 5G services and devices in markets around the world; it is also an opportunity for national governments and regulators to set the stage for 5G for the next decade and beyond. The speed, reach and quality of 5G services rely on governments and regulators supporting timely and affordable access to the right amount and type of spectrum, and under the right conditions.

5G spectrum awards have already begun in many parts of the world. Variation in the amount of spectrum assigned, and the prices paid, means the potential of 5G services will differ between countries. Policy-makers should work in partnership with stakeholders to enable timely, fair and effective awards. Improving access to new spectrum is an opportunity to facilitate universal access to high-speed mobile broadband for everyone and everything.

Sub-1 GHz	1-6 GHz	Above 6 GHz
Sub-1 GHz bands provide good 5G coverage and support specific use cases such as wide-area IoT. Spectrum in this range will include refarmed (800/850/900 MHz) and new (600/700 MHz) bands.	The 1-6 GHz mid-range spectrum bands provide a good mix of coverage and capacity. It is expected that most operators will deploy in the wider 3.5 GHz range. This spectrum shows great promise for international harmonisation, and initial deployments of 5G are likely to be in this range.	Spectrum in the mmWave range, 26/28/40/50 GHz, is emerging as key to realising the ultra high speed 5G vision. The 66-71 GHz band is gaining momentum with unlicensed use a particular focus. These spectrum bands are particularly useful for short-range, high-capacity communication.

A combination of all three is needed to deliver services to people and connected devices. Regulators should aim to make available 80-100 MHz of contiguous spectrum per operator in prime mid-bands (e.g. 3.5 GHz) and around 1 GHz per operator in mmWave bands (above 24 GHz). Support for contiguous spectrum is important as it results in improved coverage and more affordable devices. Operators should be permitted to voluntarily share spectrum with each other to support 5G services and more efficient spectrum use.

WRC-19 and the case for mmWave spectrum

mmWave spectrum will play a key role in the most innovative 5G services (such as FWA, industrial automation, intelligent transport systems and VR) across the world. For example, the Sub-Saharan Africa region is expected to deliver $5.2 billion in GDP as a result of mmWave 5G by 2034.[26] Once 5G has taken off in Sub-Saharan Africa, the annual gain from mmWave 5G will grow much faster from 2026, closing the gap between early and late adopters.

Identifying harmonised international mobile spectrum allocations in the mmWave band is on the agenda at the World Radiocommunication Conference in 2019 (WRC-19), where the 26, 40, 50 and 66-71 GHz bands will be the focus of the mobile industry. It is important the identifications come with optimal conditions. There is a risk at WRC-19 that unless this happens, use of the bands in 5G networks will be severely compromised. Government and regulator backing for the mobile industry during this event is essential to make the most of 5G's potential. Outside of WRC-19, 28 GHz will also be a vital band for 5G.

For markets where mmWave 5G services are not planned in the short term, the importance of WRC-19 may not always be obvious. However, given that the process of spectrum identification, allocation and assignment is a long-term effort, spectrum identified at WRC-19 will be in use for decades to come. This underlines the importance of making the case for 5G now, irrespective of when the first commercial 5G service in the band arrives.

Avoiding inflated spectrum prices

A central concern for operators in Africa is that 5G spectrum prices may not be affordable. High spectrum prices are linked to more expensive, slower mobile broadband services with worse coverage.[27] GSMA Intelligence research shows that mobile operators in developing countries already pay three times more for spectrum compared to operators in developed markets once income levels are taken into account. Policies that inflate prices to maximise revenues are a key cause. For example, auction reserve prices in developing countries are five times higher than in developed markets once income differences are considered.

Spectrum pricing best practice includes the following:

• Set modest reserve prices and annual fees, and rely on the market to determine spectrum prices. 5G spectrum in 3.5 GHz and the mmWave bands have inferior coverage capabilities and are likely to be made available in larger quantities. These need to be factored into the price, including any spectrum fee formulae.

• Avoid limiting the supply of spectrum as scarcity can lead to excessive prices. A particular concern is set-asides for verticals or new entrants in core 5G bands (e.g. 3.5 GHz and 26/28 GHz).

• Carefully consider the auction design to avoid unnecessary risks for bidders (e.g. avoiding mismatched lot sizes, which create artificial scarcity, and first-price, sealed bid auctions).

• Develop and publish a spectrum roadmap with input from stakeholders to help operators plan for future availability.

• Consult with stakeholders on the award rules as well as the licence terms and conditions, and take them into account when setting prices.

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[26] Study on Socio-Economic Benefits of 5G Services Provided in mmWave Bands, GSMA, 2018
[27] Spectrum pricing in developing countries, GSMA Intelligence, 2018; Effective Spectrum pricing, NERA, 2017

Implementing effective spectrum management

Effective spectrum management is crucial for universal access to affordable, high-quality next-generation connectivity. For example, mobile operators need assurances that a sufficient amount of affordable spectrum in the right mix of bands will be made available over a long period to give them the certainty needed to make long-term investments in 5G networks. Regulators should publish, and regularly update, a spectrum roadmap for at least the following five years detailing how much is planned to be made available in what bands and when, as well as a clear process for upcoming spectrum renewals.

Tools such as spectrum caps, licence obligations and set-asides should be used with caution. The latter have become a hot topic for the 5G era. While the intention is good, setting aside spectrum can restrict the amount operators can access, which can negatively impact mobile broadband speeds and coverage, and inflate spectrum prices. For example, vertical industries are unlikely to use spectrum in priority 5G bands widely across countries, so national set-asides for vertical industries are likely to go unused in many areas. Mobile operators can provide customised 5G services for verticals, which can then benefit from network slicing, small cells and wider geographical coverage. Auctioning all the available spectrum and then backing voluntary spectrum sharing approaches is best practice. This means all spectrum resources can be used to support all potential 5G users, including verticals. For example, mobile operators can be permitted to lease their spectrum assets so that verticals can build their own private 5G networks.

Technology-neutral spectrum licencing will ensure the best possible experience

To make regulation future proof in an environment characterised by ongoing and rapid technological change, regulation around spectrum licensing should be technology neutral. Mobile technology deployment should be left to market forces, without mandating any particular network standard or restricting the use of a particular technology.

Technology-specific licensing can have negative effects for the industry and consumers. In contrast, technology-neutral regulation allows operators to offer a range of services with their choice of technologies, including using multiple technologies side-by-side. Such approaches have been shown to have better outcomes, including delivering higher mobile broadband adoption.[28]

Technology-neutral spectrum licensing enables 2G or 3G spectrum to be refarmed for 4G as well as 5G, at a pace driven by market demand. To this end, when assigning new spectrum, regulators should do so in a manner that does not restrict the introduction of next-generation technologies, such as 5G. However, some countries in the region have not yet moved to technology-neutral spectrum licences and are still issuing technology-specific licences or have not decoupled spectrum licences from operating licences.[29] Consumers and businesses do not benefit from the best possible mobile broadband experience and can end up paying more for inferior services.

If spectral efficiency is to be maximised, operators need to be free to deploy the latest technology. For example, using 4G rather than 2G, operators can produce much higher levels of throughput for the same cost (a lower cost per bit). This enables mobile operators to offer their customers large data bundles at the same cost.

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[28] FCC, Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services, Ninth Report, 18 FCCR 14783, 14804-875 2003, p. 66
[29] It is best practice to issue spectrum licences separately from operating licences. The operating licence, which may be a unified licence, authorises the operation of a public telecommunications network. A spectrum licence confers the right to use the licensed spectrum.

Figure 21

Average spectral efficiencies
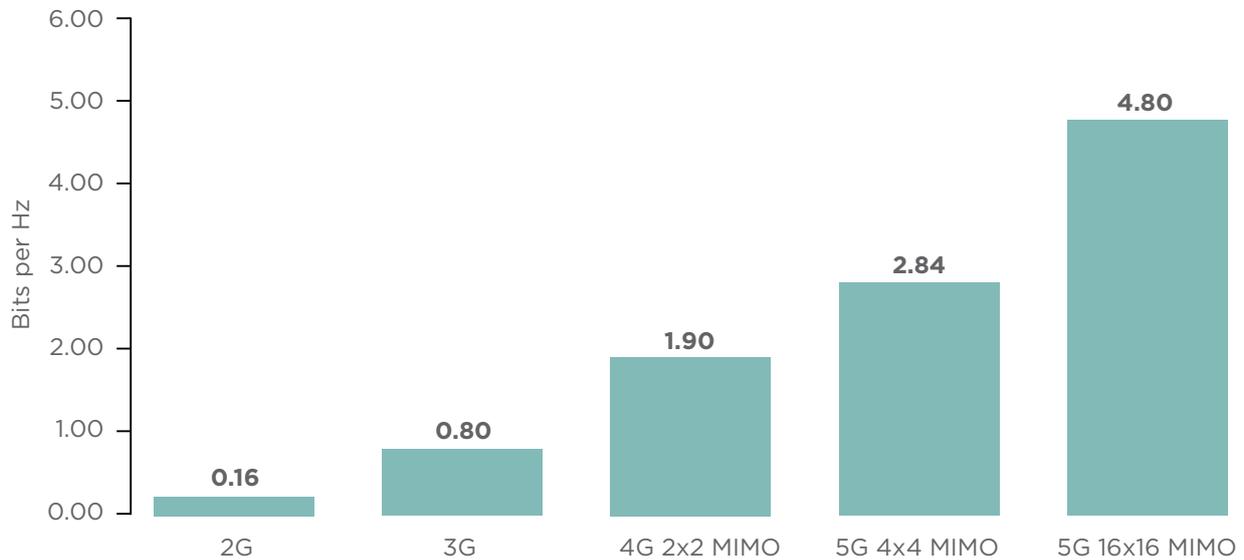
Source: GSMA, Coleago Consulting

4.3 Regulatory flexibility: creating a forward looking and flexible environment

5G networks are distinct from previous generations because of the level of heterogeneity, flexibility and automation inherent in their design. The need to meet the throughput and coverage requirements for 5G era networks would, in theory at least, lead to higher costs. To address this, the industry may need to develop new models for both network management and network ownership, which will in turn require updated, flexible regulations and policy frameworks.

The traditional infrastructure sharing model will continue in the 5G era. Active and passive infrastructure sharing should be allowed under primary legislation and encouraged by regulators on a voluntary basis. There should be no regulatory bias against active sharing; rather, sharing should be subject to safeguards under competition rules supported by evidence-based market assessments. Tower companies have grown significantly in Sub-Saharan Africa over recent years and are likely to play an important role in moves towards network densification and 4G build-out, as well as supporting the early phases of 5G deployments. It is likely that a range of new commercial agreements on active and passive sharing will facilitate 5G deployment.

4.4 Financial demands of 5G: the need for a supportive investment and taxation policy

The financial demands of 5G deployment on mobile operators will be significant, requiring a high level of investment by operators but with uncertain returns. To support their digital policy aspirations, governments across the region should take action to ease the regulatory cost burden faced by the mobile industry in the deployment of next-generation networks in general, and ultimately facilitate the rollout of 5G networks.

Reducing sector-specific taxes

Governments in many countries are increasingly imposing – in addition to general taxes – sector-specific taxes on consumers of mobile services and devices and on mobile operators. This poses a significant risk to the uptake of services among citizens, limiting the widely acknowledged social and economic benefits associated with mobile technology. A recent report by GSMA Intelligence highlighted that on average these taxes on consumers and operators across Sub-Saharan Africa accounted for 26% of sector revenues in 2017.

By directly affecting prices, taxes and fees on revenue tend to distort production and consumption behaviour, which may limit the use of digital services by creating a cost barrier to digital inclusion. Given the high costs of deploying services, governments across the region should take action to reduce the regulatory cost burden faced by operators. A reduction in taxes on the mobile sector would help address broader issues around the connectivity gap in the region and support 5G deployment.[30]

Maximising spectrum efficiency

Policy-makers are encouraged to allow voluntary spectrum pooling between operators to help drive faster services and maximise spectrum efficiency. To deliver affordable, widespread and high-quality mobile broadband services, mobile operators require affordable and predictable access to sufficient radio spectrum. High spectrum prices have been linked to more expensive, lower-quality mobile broadband services and may limit 5G rollout and take-up. Spectrum auctions should allow the market to determine spectrum prices. Governments should prioritise rapid, high-quality 5G service rollouts over revenue maximisation when awarding 5G spectrum.

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[30] Rethinking mobile taxation to improve connectivity, GSMA Intelligence, 2019

Preparing for the 5G era: call to action

Stimulating demand: the importance of deploying e-government services

Governments are often the biggest 'enterprise' vertical for digital services, and particularly so in Sub-Saharan Africa. The development of e-government services in the region as part of a broader digital transformation strategy can provide an enabling environment for the development and adoption of next-generation connectivity. A number of African governments have already taken action to launch e-government services, with several countries scoring well in the UN's 2018 e-Government Development Index, including Ghana, Kenya and South Africa.

However, a number of the existing services in the region are not readily accessible from mobile devices. With growing smartphone adoption and the impending arrival of 5G services, there is a clear opportunity for governments in the region to take a holistic approach to digitising services and make mobile the default access platform. In addition, governments should look to broaden the range of services covered by e-government initiatives, to cover areas such as health services, identity registration and voter registration/digital voting.

Encouraging ecosystem collaboration in the transition to 5G

Ecosystem collaboration on key supply- and demand-side initiatives can facilitate 5G network deployment and stimulate adoption in Sub-Saharan Africa. This may include partnerships to develop use cases in the consumer and enterprise segments, initiatives to bring affordable devices to market, and active network sharing and joint equipment sourcing to drive down deployment costs.

Governments can play an active role in this development, through direct funding support or through expanding collaboration to existing research initiatives. In South Africa, the telecoms regulator, ICASA, has established the 5G Forum, with Working Groups to discuss matters relating to 5G and other relevant standards. Other national governments and regional economic unions should consider similar initiatives, in collaboration with key stakeholders and mobile ecosystem players.

Ecosystem partnerships can help to 'pull through' 5G adoption by delivering a more connected society and new use cases. Pull-through innovations (such as more immersive content and AR/VR entertainment) will play a key role in encouraging customers to upgrade to next-generation connectivity and, ultimately, 5G.

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[31] See https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2018

Appendix
The GSMA BEMECS framework indicators

| BASIC INDICATORS	ECONOMIC INDICATORS	MARKET INDICATORS	ENTERPRISE INDICATORS	CONSUMER INDICATORS	SPECTRUM INDICATORS
Region	GDP (real)	Total Subscribers	IoT Penetration	Affordability ARPU/per capita	<1GHz availability
GSMA Region	GDP Growth Rate (Real)	Average Download Speed (Mbit/s)	Registered Websites per 1000 people	Affordability: Device ASP/GDP per capita	1-6GHz availability
Population	GDP Growth Rate (Constant)	Number of Operators	Published Apps per 1000 people	Literacy Rates	>6GHz availability
Population Density	GDP Growth Rate (PPP)	4G Penetration	Population with Tertiary Education	Mobile Social Media Accounts	
Urbanisation	GDP (real) Per Capita	Mobile Connections Penetration	Ease of Doing Business	Personal Computer Penetration	
		Smartphone Penetration	Published Apps in National Language	FWA Opportunity	
		Unique Subscribers Penetration	E-Government Availability		
		Fixed Broadband Penetration			
		Average ARPU (2017-2018)			
		FTTx Penetration			
		ARPU Growth (2018-2023)			
		Internet Backbone Penetration			
		Mobile Revenue Growth/GDP Growth			
		Electricity Availability			

Sources: GSMA Intelligence, GSMA, ITU, SE4ALL, UN, ZookNIC, AppFigures, Ethnologue, World Bank, Tarifica, We Are Social

Sub-Saharan African countries in the BEMECS framework

Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Chad, Congo, Cote d'Ivoire, DRC, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe
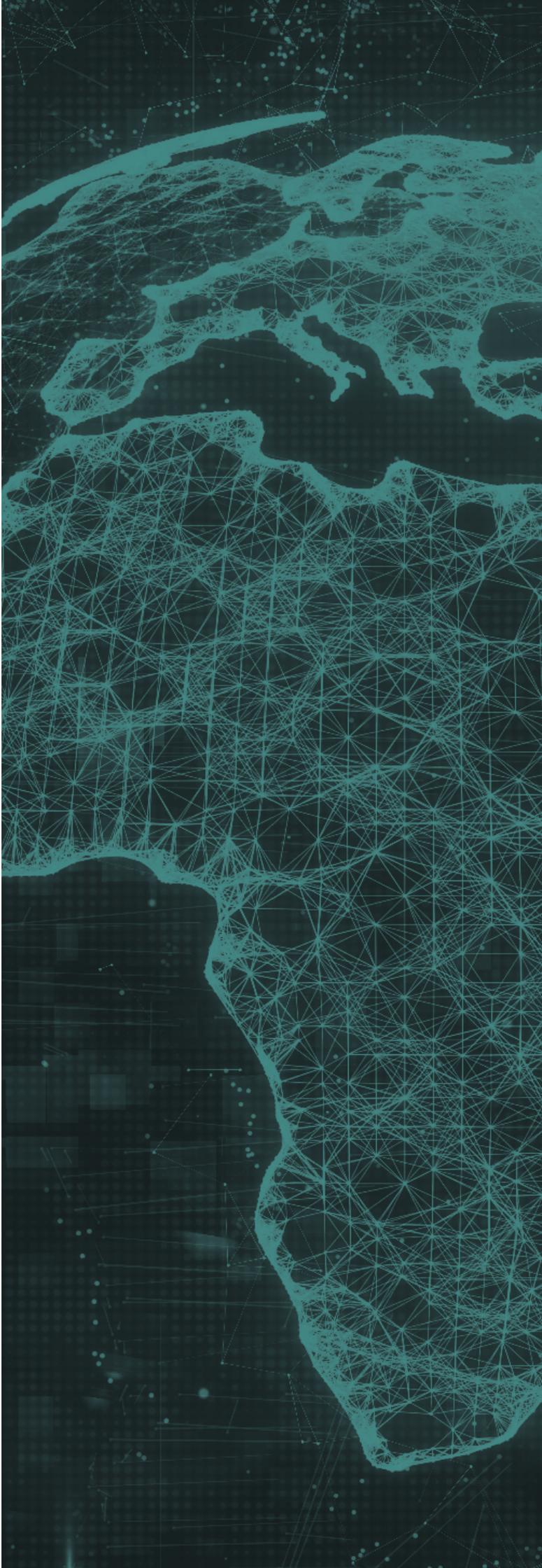
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