GSMA

Technology Neutrality and Legacy Network Sunsets

The Evolution of Connectivity in Africa

December 2023

GSMA

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The crucial role of technology-neutral spectrum licensing

Spectrum is a scarce resource, so its use needs to be optimised. This means that as mobile operators adopt newer technologies, they often need to rely on existing spectrum resources. The need for additional spectrum to meet the coverage and capacity expectations for 4G and 5G services is driving the refarming of spectrum from legacy technologies. Technology-neutral spectrum licensing (also referred to as technology neutrality) is crucial to allow mobile operators to refarm spectrum used for legacy networks (2G and 3G) for 4G and 5G services, at a pace driven by market demand.

The initial rollout of 4G in many pioneer markets was based on technology neutrality and spectrum refarming. Technology neutrality is also enabling mobile operators to use spectrum refarming in legacy bands to support 5G deployments. Refarming exercises have involved the following:

- 850 and 900 MHz from 2G to 4G
- 900 MHz from 2G to 3G
- 1800 MHz and 1900 MHz from 2G to 4G
- 2100 MHz from 3G to 4G
- all of the above to 5G.

Technology neutrality looks to maximise the efficient use of scarce spectrum resources (enabling the delivery of more data per MHz). This objective is shared by regulators and mobile operators. Optimum use of spectrum generates the greatest societal impact from mobile broadband services and accommodates more traffic per licensed spectrum band. Users benefit from better mobile broadband coverage, higher data speeds and lower mobile data prices than would otherwise be the case. GSMA Intelligence estimates that connecting all of Africa to 4G by 2030 would add $75 billion in economic value, adding 5.5% to projected growth.

Technology-neutral licensing is an important enabler of legacy network sunsets. Between 2015 and mid-August 2023, a total of 91 networks were shut down, of which 43 were 2G networks and 48 were 3G networks. At least 148 networks will be shut down between Q4 2023 and 2030, based on announced plans from operators. The rationale for legacy network sunsets varies, with factors including refarming spectrum for 4G/5G services, optimising network operations (with potential capex and opex savings), rationalising device portfolios and mitigating the risks associated with the slowing improvements to and maintenance of legacy equipment.

Africa looks to a smooth transition of networks

In Africa, it is still early days for legacy network sunsets, reflecting the state of its connectivity landscape compared to other regions. The early stages present an opportunity to prepare for the transition from legacy networks in a manner that is efficient and causes the least amount of disruption.

Importantly, the process should be driven by market conditions, rather than mandated. This calls for collaboration among stakeholders, including regulators, mobile operators and other ecosystem players, to identify and implement the enablers of a smooth phasing out of legacy networks in the region.

01.
The benefits of technology-neutral licences

1.1 Defining technology-neutral licensing

In the evolution of mobile networks over the past three decades, most of the existing spectrum has been used for 2G and 3G services. Typically, 800/900 MHz and 1800 MHz were assigned for 2G, while 3G has been mostly deployed in the 1900/2100 MHz range. However, the need for additional spectrum to meet the coverage and capacity expectations for 4G and 5G services is driving the refarming of spectrum from legacy technologies.

Technology-neutral spectrum licensing (technology neutrality) is crucial to allow mobile operators to refarm spectrum used for legacy networks (2G and 3G) for 4G and 5G services, at a pace driven by market demand. In simple terms, spectrum refarming refers to the repurposing of spectrum bands to more efficient technologies. For example, a mobile operator using 1800 MHz to provide 2G services may opt to free a portion of this range for 4G or 5G services to meet growing demand for data services.

Technology neutrality does not mean mobile operators can do anything they choose within a frequency band; regulations govern the deployment of radio communications networks including, for example, those designed to protect other spectrum users and ensure that transmission power and radiation limits are not breached. Technology neutrality empowers operators to replace older equipment in a frequency band with equipment of a newer standard to upgrade from legacy network services to 4G or 5G as demand develops.

Service neutrality: a key complement to technology neutrality

Technology-neutral licensing refers to spectrum licences that allow the deployment of any standards-based technology that complies with regulations in the licensed frequency band. However, it must be based on the premise of service neutrality, which enables operators with spectrum licences to offer any type of mobile service to end-users in the spectrum they hold, including (for example) mobile broadband and FWA.

This complement eliminates limitations on the range of mobile services that operators can provide and the necessity to secure a licence or permit to introduce a new mobile service – for instance, where operators authorised to provide 2G, 3G and 4G services need an additional permit to offer fixed wireless and 5G services. Such a setup is inefficient and hinders the adaptability of network expansion and spectrum utilisation in line with market requirements, even when technology-neutral spectrum licensing is in place.

Around the world, there is a growing shift away from service-specific mobile licences and towards the adoption of service-neutral mobile licences and/or unified licensing frameworks that allow operators to offer a range of mobile telecoms services on a single licence. For example, the Unified Access Service License (UASL) in Nigeria[1] and the Facilities Based Unified License (FBUL) in Saudi Arabia[2] are single licences that allow qualifying operators to offer mobile-based services, including FWA, using any type of communications infrastructure and technology capable of delivering the desired mobile service.

There are several benefits to technology-neutral spectrum licensing and service-neutral licensing, notably: the opportunity to encourage growth of new applications and services based on advanced technologies; the simplification of the licensing procedure; ensuring flexibility and the efficient utilisation of resources, including spectrum; and the potential to enable smaller operators to cover niche areas, such as rural and remote regions, with the most efficient technology.

Importantly, service neutrality is necessary to unlock the potential of technology-neutral licensing. Where the latter exists but not the former, operators are still restricted in their ability to refarm their spectrum holdings for newer technologies and other types of service in a way that maximises the efficient use of spectrum and meets market demand for new services.

Furthermore, a single service-neutral mobile licence not only simplifies the regulatory framework; it also allows the focus of management to be on spectrum resources. Best practice shows that service-neutral mobile licences can be perpetual and free, while fees, commitments and expiration dates are attached to spectrum licences.

1 Licensing Framework for Unified Access Service in Nigeria, Nigerian Communications Commission
2 Regulatory Framework on License Classification, Communications and Information Technology Commission

1.2 The rationale for technology-neutral spectrum licences

The ability to refarm spectrum bands so they are used simultaneously for several technologies, including 4G and 5G, is the basis for technology neutrality. The initial rollout of 4G in many pioneer markets was based on technology neutrality and spectrum refarming. As of the middle of the last decade, nearly half of 4G deployments globally were running on refarmed 2G and 3G spectrum.

In many cases, refarming exercises have involved the following:

- 850 and 900 MHz from 2G to 4G
- 900 MHz from 2G to 3G
- 1800 and 1900 MHz from 2G to 4G
- 2100 MHz from 3G to 4G
- all of the above to 5G.

Table 1: Examples of 4G and 5G launches using refarmed spectrum

Democratic Republic of Congo (DRC)	Vodacom launched 4G by refarming spectrum used for 2G and 3G.[3]
Malaysia	The Malaysia government's Jendela initiative, targeting universal 4G coverage, has benefitted from technology neutrality. As of June 2023, 37,997 2G and 3G base stations have been upgraded to 4G[4] using refarmed spectrum in the 900, 1800 and 2100 MHz bands.
Singapore	StarHub started refarming its 1800 MHz spectrum from 2G for 4G services in 2012 to provide a better mobile broadband experience for customers.[5]
South Africa	Vodacom's 4G network went live in 2012, initially using refarmed 1800 MHz spectrum. It subsequently refarmed 2100 MHz and 900 MHz spectrum.[6]
Thailand	Mobile operators in Thailand introduced 4G in 2013 by using part of the 2100 MHz band, which was previously used for 3G. They later added 4G in the 1800 and 900 MHz bands.[7]
UK	EE started refarming spectrum in the 2100 MHz band from 3G to 4G services to support carrier aggregation (the combination of different bands to improve data speeds).[8]
US	AT&T introduced 5G in existing 850 MHz spectrum holdings using dynamic spectrum sharing (DSS).[9]

Source: GSMA Intelligence

3 "Vodacom Is 5G-Ready but Still Focusing on 4G", Connecting Africa, November 2019
4 "JENDELA Phase 1: Here's how much Malaysia improved its 4G and fibre broadband access in the last two years", SoyaCincau, June 2023
5 "StarHub refarming 2G spectrum for LTE", ZDNet, April 2012
6 About the Vodacom Network, at r-spectrum.com.au
7 Socio-economic impact of mobile broadband in Thailand and contribution to the digital economy, GSMA, 2015
8 "EE turns 3G into 4G to boost smartphone speeds and lay foundation for 5G launch in 2019", EE, September 2018
9 "AT&T to launch 5G for consumers using low-band 850 MHz spectrum", Fierce Wireless, November 2022

With its performance capabilities, 5G has brought a new dimension to the spectrum refarming space. While the majority of 5G deployments to date have been in new mobile broadband frequency bands, notably 3.5 GHz, it is essential operators have the ability to refarm existing spectrum assignments, particularly to meet the requirements of the 5G coverage layer, which benefits from the propagation capabilities of sub-1 GHz spectrum (700, 800, 850 and 900 MHz). Some spectrum in these bands has been licensed as 2G, 3G or 4G technology-specific spectrum but will be useful as a 5G coverage layer.

As new 5G spectrum has yet to be assigned in many markets, operators are using spectrum refarming in certain legacy bands to support 5G deployments. Spectrum migration is mainly seen in the 1800, 2100 and 2600 MHz bands. The 2600 MHz band is increasingly being tested and deployed for 5G, reflecting its relative availability and widespread use in 3G and 4G networks. For example, AIS in Thailand has successfully tested carrier aggregation (CA) using 100 MHz in the 2600 MHz band and 1200 MHz in the 26 GHz band. The ability to refarm existing 3G spectrum on these frequencies to 5G networks is an important part of the transition to 5G.

Technology neutrality is also necessary for dynamic spectrum sharing (DSS), which allows operators to use the same spectrum band for different radio access technologies such as 4G and 5G, to combat the absence of new 5G spectrum. It works by allocating spectrum to different technologies in real time, based on demand. As of June 2023, DSS had been deployed for 5G networks by 49 operators in 34 countries. In Africa, MTN has deployed the technology in South Africa, in partnership with Huawei, using DSS on the 2.1 GHz frequency band to upgrade 4G base stations to 5G without changing antennas or radio units.

Operators in different markets can have different technology roadmaps for meeting changing consumer demand. Below we highlight three underlying factors for spectrum refarming and, by extension, the key rationale for technology neutrality

Delivering high spectral efficiency

Technology neutrality looks to maximise the efficient use of scarce spectrum resources (enabling the delivery of more data per MHz). This objective is shared by regulators and mobile operators. Optimum use of spectrum generates the most societal impact from mobile broadband services and accommodates more traffic per licensed spectrum band. Users benefit from better mobile broadband coverage, higher data speeds and lower mobile data prices than would otherwise be the case.

Significant spectral efficiency has been achieved through better frequency modulation techniques. As the 3GPP roadmap has evolved from 3G to 4G and 5G with multiple input, multiple output (MIMO) techniques, operators are now able to improve throughput significantly by upgrading to the next available generation of technology. Greater spectral efficiency also improves capacity available for voice communications, which has been rising steadily over the years, despite the growth in data traffic.

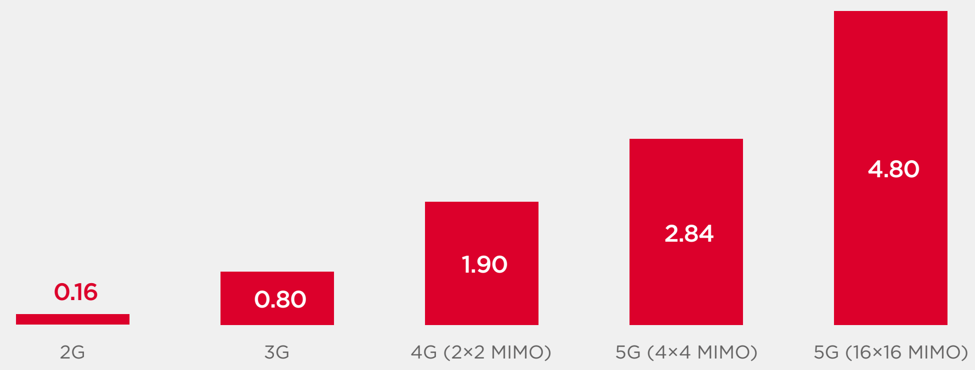
Most 2G networks use the 850, 900, 1800 or 1900 MHz frequency bands. Additionally, countries such as Cameroon, DRC, Indonesia and Nigeria previously awarded the 850 MHz bands for CDMA 2000 technology. In Nigeria, MTN acquired the assets of CDMA operator Visafone in 2016 and was able to refarm the defunct operator's 800 MHz spectrum to launch 4G services.[10] In Indonesia, Smartfren has shut down its CDMA network and refarmed spectrum in the low-frequency 850 MHz band for 4G services, allowing it to improve mobile broadband coverage and capacity and, by extension, customer experience.[11]

As spectrum below 2 GHz is particularly scarce, reuse of these frequency bands for new and more efficient technologies is essential to maximise the benefits from available spectrum. For example, the spectral efficiency of 4G coupled with MIMO is such that refarming 850 or 900 MHz spectrum from 2G to 4G with 2×2 MIMO delivers a 12-fold increase in mobile data capacity. For 1800 and 1900 MHz spectrum, where higher orders of MIMO can be deployed, moving from 2G to 4G delivers a bits/Hz improvement of up to 26 times (see Figure 1).

10 "NCC officially ends CDMA in Nigeria", SpaceWatch Africa, June 2019
11 "Smartfren: Going 4G LTE Only", ZTE, February 2018

Figure 1: New technology delivers higher spectral efficiency

Bits/Hz



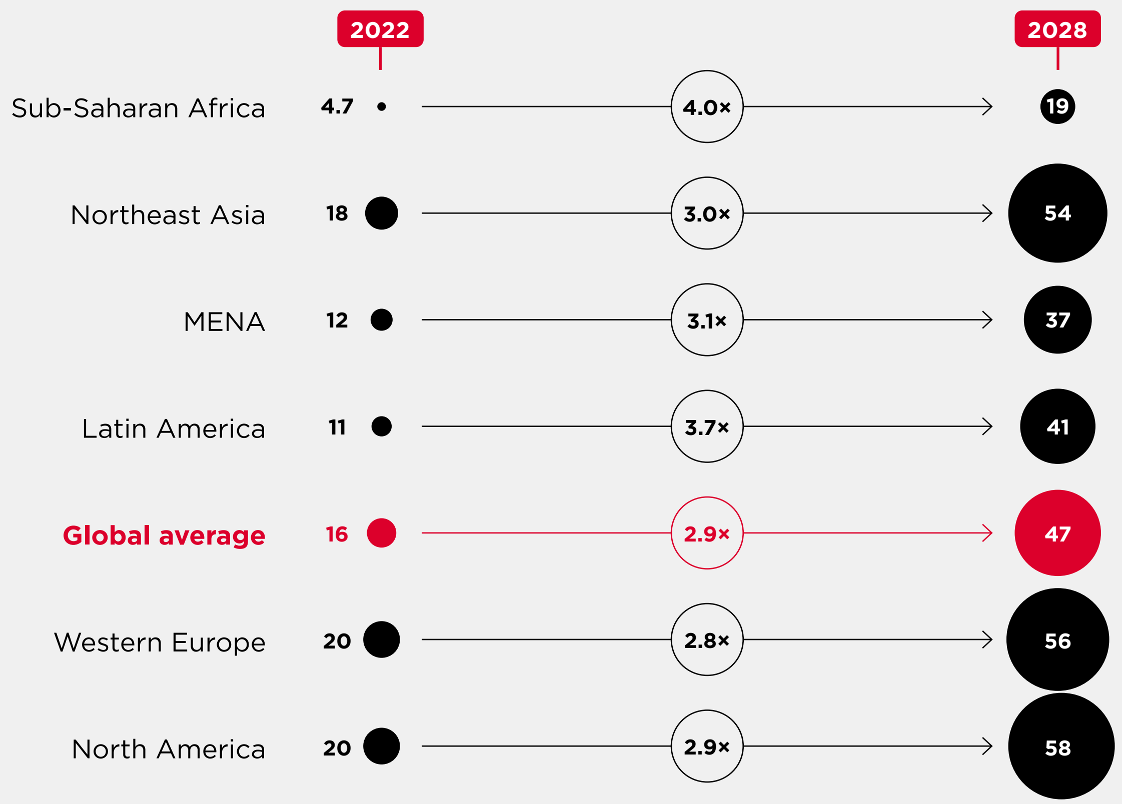
Source: Coleago Consulting

Increasing capacity to cope with growing demand for mobile data

Data traffic continues to grow rapidly as more people get online and increasingly make use of bandwidth-heavy applications, such as video conferencing and streaming services.

Figure 2: Mobile data traffic per smartphone

GB per month



Source: GSMA Intelligence, based on Ericsson Mobility Report, 2023

In countries where most users rely on wireless broadband solutions, notably enhanced mobile broadband (eMBB) and fixed wireless access (FWA), technology neutrality is essential to enable the efficient and timely introduction of new technology in existing frequency bands to support rising demand for broadband services.

This situation was particularly evident during the Covid-19 pandemic when mobile networks had to deal with more consumers using devices for video conferencing, online education and streaming services. Operators took steps to increase capacity and optimise their networks in response to new usage patterns. Of particular note was the upgrading of networks to 4G and 5G to cope with the surge in data traffic. Some governments[12] provided vital support to manage increased demand on network resources, by assigning additional temporary spectrum (e.g. in Ghana, Oman, South Africa and the US) or suspending regulatory fees (e.g. in Colombia and the Philippines).

The existence of technology neutrality in many countries was instrumental in enabling spectrum refarming, particularly in the 2100 and 2600 MHz bands, for 4G/5G upgrades to alleviate capacity constraints. In recognition of the importance of technology neutrality, some countries took steps during the pandemic period to make existing spectrum technology neutral (e.g. in Tunisia, albeit it on a temporary basis).[13] There is an important lesson here for countries where technology neutrality is still not allowed or implemented partially, to ensure they are prepared for future emergencies and requirements to close the digital divide.

Enabling advanced IoT solutions for verticals

Technical developments that enable low-power, wide area IoT as well as massive machine-type communications are important components of the development of the digital economy. For example, 5G has been designed not only for mobile broadband but also mMTC. Two 3GPP standards LTE-M (also known as eMTC, LTE Cat-M1) and NB-IoT (also known as LTE Cat-NB1) are expected to be central to delivering on the vast potential of IoT by offering major advantages over legacy alternatives. Building new NB-IoT and LTE-M networks is an important first step in moving M2M customers away from ageing 2G networks.

Technology-neutral spectrum licences are required to allow operators to deploy dedicated networks optimised for IoT. Meanwhile, migrating legacy M2M customers from 2G or 3G to new technologies requires the refarming of spectrum from legacy networks to 4G and 5G services. This reinforces the need for existing mobile licences to be technology neutral to support ambitious government programmes around the fourth industrial revolution. Regulatory restrictions on the technology to be deployed with specific spectrum bands would be particularly harmful in this fast-growing market, stifling innovation and the adoption of modern technology among verticals.

1.3 The global status of technology-neutral licensing

Figure 3 identifies the countries that have technology-neutral spectrum assignments. Outside of Africa, the majority have at least one spectrum band that is technology neutral. However, there remains a lack of technology neutrality within the continent, notably in West Africa, and parts of Central and Southern Africa. By contrast, technology neutrality has been adopted more widely in Eastern Africa. Meanwhile, Table 2 compares mobile market outcomes between countries with technology neutrality and those without.

12 How networks stayed the course as everyone stayed at home, GSMA Intelligence, 2021
13 "Keeping everyone and everything connected: How temporary access to spectrum can ease congestion during the COVID-19 crisis", GSMA, August 2021

Figure 3: Global state of technology-neutral spectrum licensing

Source: GSMA Intelligence, based on data available. Includes countries that have at least one spectrum band that is technology neutral, permitting the use of more than one spectrum technology.

Some countries have fully implemented the principle of technology neutrality. For example, in the US, mobile operators can deploy any IMT technology within all bands. In some countries, technology has been partially implemented. Examples include where neutrality is only permitted for a subset of technologies, such as up to 4G (e.g. in Malaysia) or where the regulator has imposed certain conditions or obligations on operators to deploy new technologies, including additional costs. Egypt, Morocco and Tunisia are examples of African countries where, even though some technology neutrality is permitted, it remains partial as specific authorisation is required for each band.

Table 2: Comparison of mobile market outcomes in African countries with and without technology neutrality (2022)

	4G network coverage	Mobile internet penetration	4G/5G connections penetration	Download speeds (Mbps)
Countries with	74%	30%	32%	13.7
Countries without	57%	24%	17%	9.9

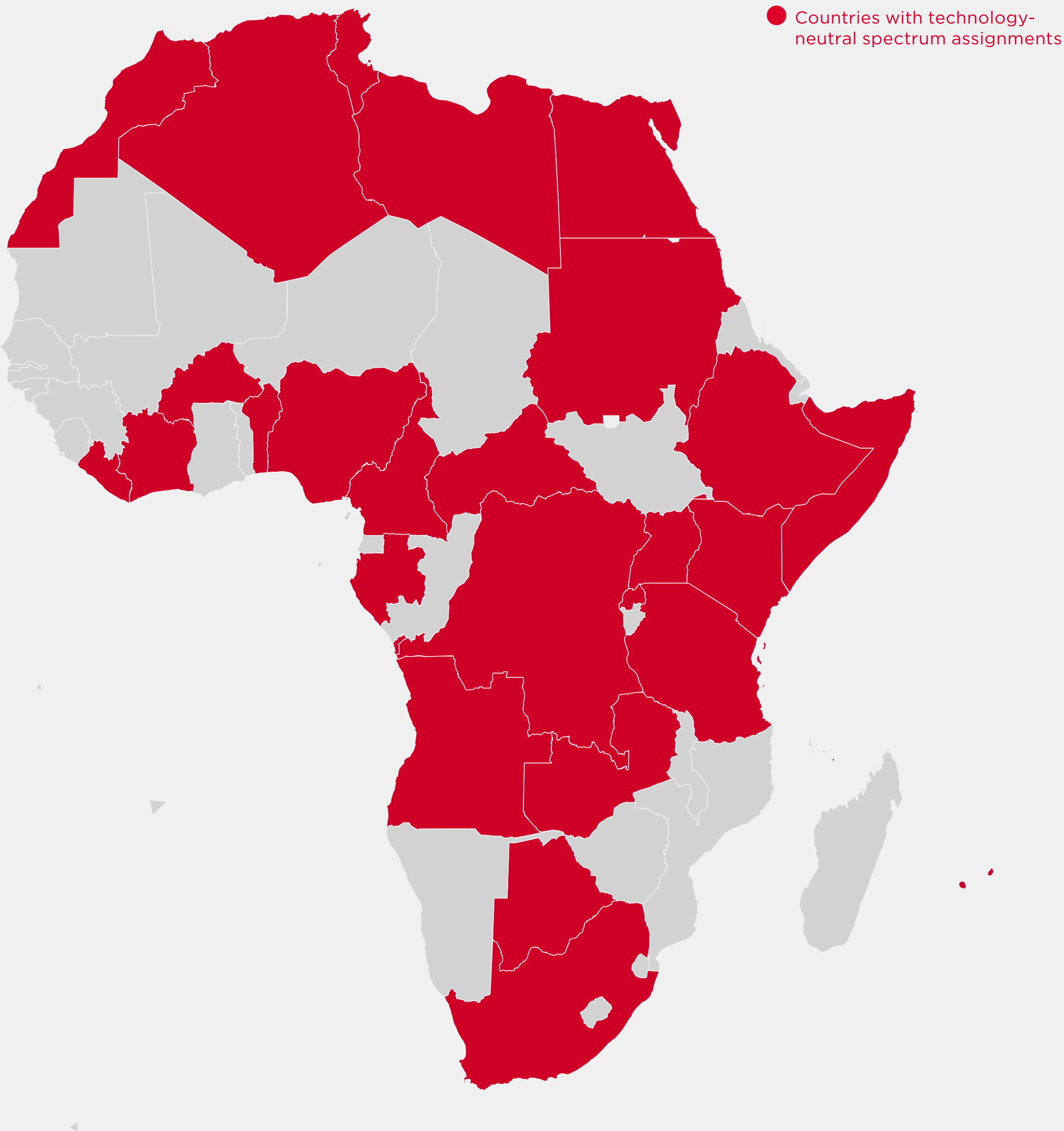
Source: GSMA Intelligence

Table 3: Examples of African countries that have adopted technology-neutral licensing

Côte d'Ivoire	The principle of technological neutrality is applied to all compatible bands, according to Ordonnance 2012-293 and its various specifications. Mobile operators are allowed to switch technologies at no extra cost, subject to necessary planning to ensure compatibility and an obligation to notify the Ivory Coast Telecommunications Regulatory Authority (ARTCI) to avoid harmful interference.
South Africa	The Independent Communications Authority of South Africa published three final Radio Frequency Spectrum Assignment Plans (RFSAPs) for International Mobile Telecommunications (IMT) Systems in April 2023. The three bands addressed in the RFSAPS – 450–470 (IMT-450), 825–830 and 870–875 MHz (IMT850), and 1427–1518 MHz – were earmarked to be auctioned on a technology-neutral basis, building on an existing technology-neutral licensing framework, to enable the rollout and uptake of 4G and 5G services across South Africa.
Tunisia	Spectrum was assigned on a technology-neutral basis to improve mobile broadband connectivity during the Covid-19 pandemic. However, this has still not been legislated. Consequently, while operators can request to refarm spectrum for a technology upgrade on an ad-hoc basis, the process to gain a formal authorisation and sign an addendum takes up to six months.
Uganda	The National Spectrum policy developed a guide for the management of spectrum in Uganda, with technology neutrality a guiding principle. It recognises the role of technology neutrality and flexible spectrum use in ensuring the efficient use of spectrum, stimulating competition among different technologies and encouraging competition among service providers.

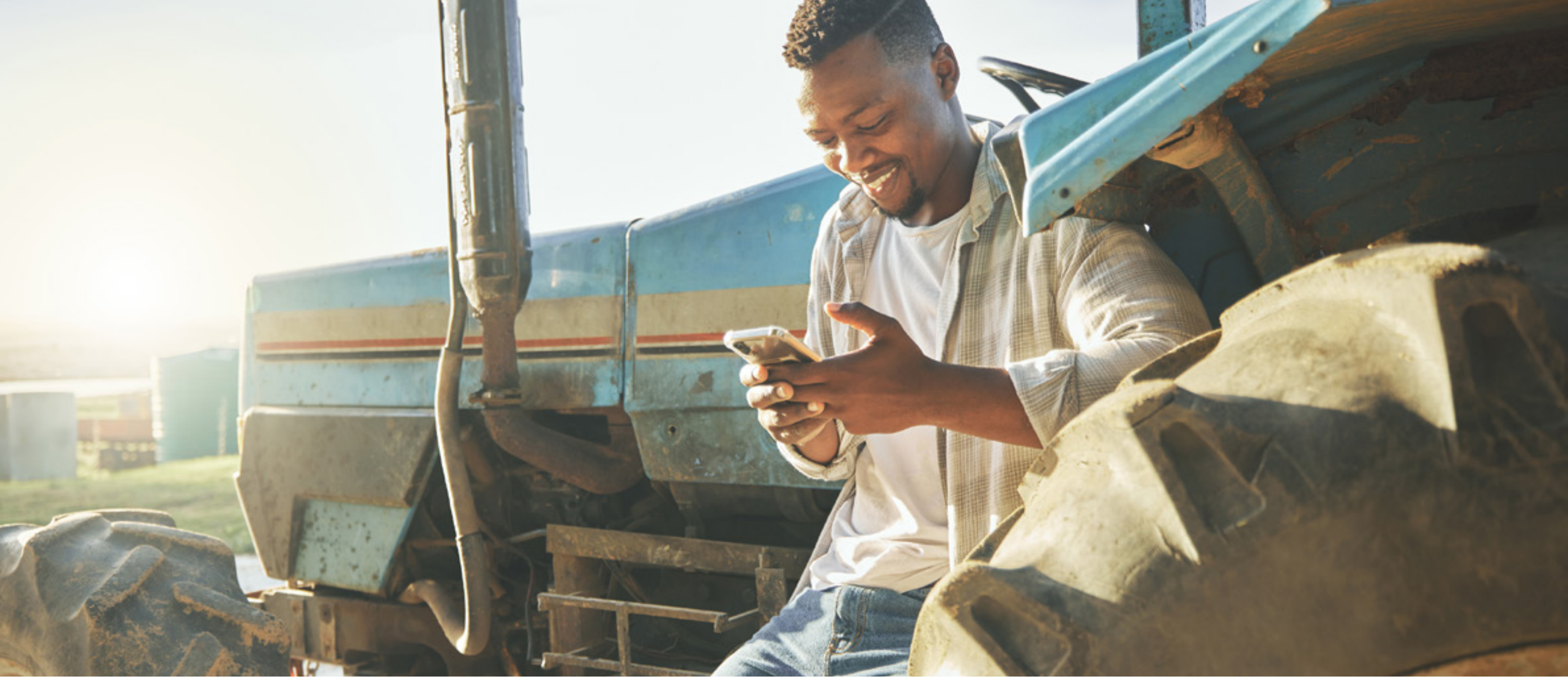
Source: GSMA Intelligence

Figure 4: Technology-neutral spectrum licensing in Africa



Source: GSMA Intelligence, based on data available. Includes countries that have at least one spectrum band that is technology neutral and those where technology-neutral spectrum licensing has only been partially implemented.

Several countries in Africa still have technology-specific or restrictive licensing regimes that have resulted in low speeds, delays in the introduction of new technologies, and other unintended consequences, often to the detriment of mobile users and the efficient use of spectrum.



The impact of technology-specific licensing on Ghana's mobile market

In Ghana, a focus on maximising revenue from the sale of spectrum licences meant that those licences were neither technology nor service neutral. In 2011, the government sold 2600 MHz spectrum licences to local ISPs, allowing them to introduce 4G fixed wireless access but not mobile services. In 2015, Ghana auctioned 800 MHz spectrum for the introduction of 4G in mobile networks. However, the high reserve price meant only one operator, MTN, acquired 800 MHz spectrum. MTN became the only operator to offer 4G mobile services.

The lack of technology- and service-neutral spectrum licences caused a competitive disequilibrium. ISPs that had previously acquired 2600 MHz spectrum found there was no business case after MTN launched 4G. Essentially, the 2600 MHz band ended up not being used, while other mobile operators in the market were unable to refarm existing spectrum to roll out 4G services.

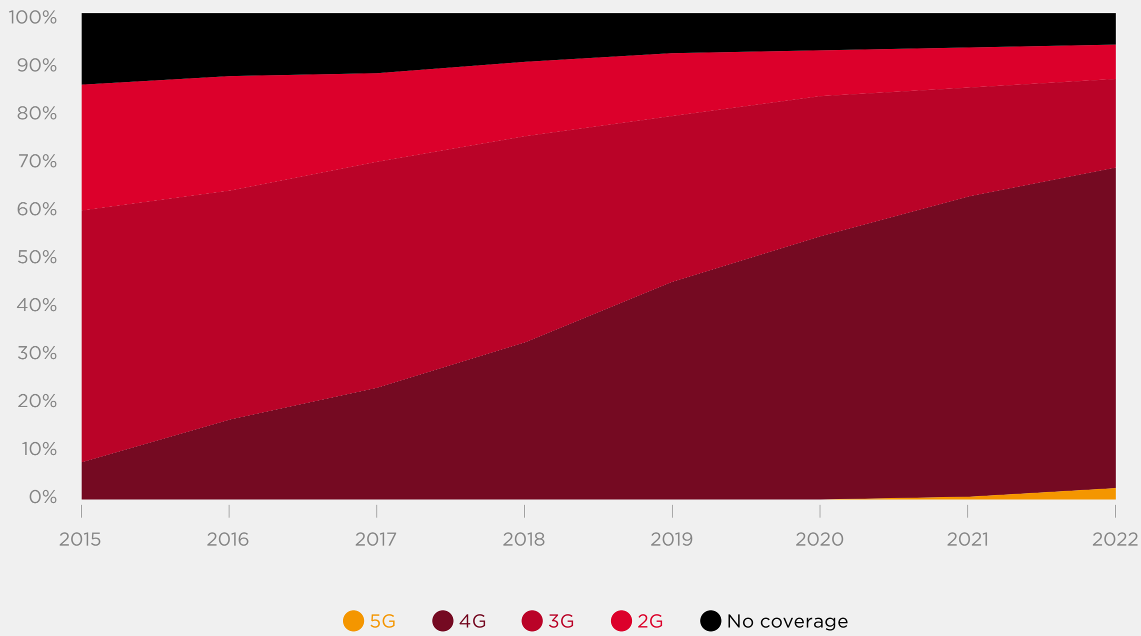
In June 2020, the National Communication Authority classified MTN as a dominant player with significant market power (SMP), and in July 2023 implemented technology neutrality for 'non-dominant' players. As a result, Vodafone Ghana (now part of the Telecel Group) and AT (formerly AirtelTigo) were permitted to pay an annual premium to refarm their spectrum holdings in the 900, 1800 and 2100 MHz bands for 4G use. MTN Ghana was excluded from the application of the new technology-neutral framework based on the SMP declaration.[14] This move aims to correct market imbalances resulting from the initial approach to spectrum licensing, but it risks creating unintended consequences, including stifling innovation and investment, and impacting the mobile broadband experience for consumers.

1.4 The role of technology neutrality in closing the connectivity gap in Africa

The uptake of voice, SMS and (in some countries) mobile money was enabled by widespread expansion of 2G coverage, which now reaches 94% of the population in Africa. Since 2015, there has been a significant increase in mobile broadband coverage. 3G coverage increased from 54% to 87%, while 4G coverage has accelerated from 7% to 68% over the same period. However, there remains a significant mobile broadband coverage gap, particularly for 4G (see Figure 5). The usage gap is even more substantial. As of December 2022, more than 800 million people, equivalent to three in five, lived in areas covered by a mobile broadband network but did not subscribe to mobile internet services.

14 "Public Information: Declaration of SMP and What it Means", NCA, June 2023

Figure 5: Mobile technology coverage in Africa



Source: GSMA Intelligence

Technology neutrality is an important enabler of the evolution from legacy networks to 4G and 5G, and can play a vital role in efforts to bridge the connectivity (coverage and usage) gap in Africa. Technology neutrality enables mobile operators to use the spectrum efficiently, instead of depending on declining technologies and services. It allows consumers to access more effective and spectrum-efficient technologies. Removing artificial roadblocks to efficient usage, such as technology-specific licensing, is a major step towards allowing operators to evaluate, plan for and deploy the most efficient technologies, including for 4G coverage expansion, using spectrum holdings available.

Most of the expansion in 3G and 4G over the past few years has been driven by upgrading existing sites, rather than greenfield deployments. At present, 7% of the population in Africa lives in an area with 2G but not 3G network coverage (compared to 16% five years ago), while 25% has 2G but not 4G coverage. The most effective way to close the coverage gap further is to upgrade 2G sites. Technology neutrality provides an important enabler, particularly in the sub-1 GHz bands.

In many African countries, mobile operators have been able to expand mobile broadband coverage significantly in recent years by using refarmed 900 MHz spectrum. In Nigeria, for example, the technology-neutral use of the 900 MHz band was a key factor enabling mobile operators to expand mobile broadband coverage to 83% at the end of 2022. GSMA Intelligence coverage gap analysis showed that using sub-1 GHz spectrum to deploy 4G in four of the countries studied (Sierra Leone, Ghana, Nigeria and Tanzania) would enable rural 4G coverage to increase by 4–11 percentage points (depending on the country) compared to deployment in the 1800 MHz band.[15]

Meanwhile, affordability remains an underlying factor in the usage gap in Africa. The ITU has set an aspirational target of ensuring that an entry-level broadband subscription costs less than 2% of income per capita, as well as 2% of average income of the bottom 40% of the population. Considering a monthly basket of 1 GB of data, Sub-Saharan Africa is the only region where more than half the countries are above the ITU's 2% threshold, with the median affordability level at 3.5% in 2022. Meanwhile, the median affordability is almost 10% of monthly income for the poorest 20% of the population in the region.

Reducing the cost of 4G deployment by refarming legacy network spectrum for 4G upgrades has the potential to benefit consumers in the form of lower prices. This, in turn, would improve affordability and increase demand for mobile broadband services, helping close the usage gap (at 58%) in Africa.

15 Using Geospatial Analysis to Overhaul Connectivity Policies, GSMA Intelligence, 2022

1.5 The economic impact of higher mobile broadband speeds

By allowing mobile operators to upgrade their legacy networks to 4G and 5G, technology neutrality is an important enabler of higher mobile broadband speeds. There is considerable empirical literature indicating that upgrades to information and communication technologies contribute to economic growth, productivity and employment. In particular, GSMA Intelligence research[16] finds the following:

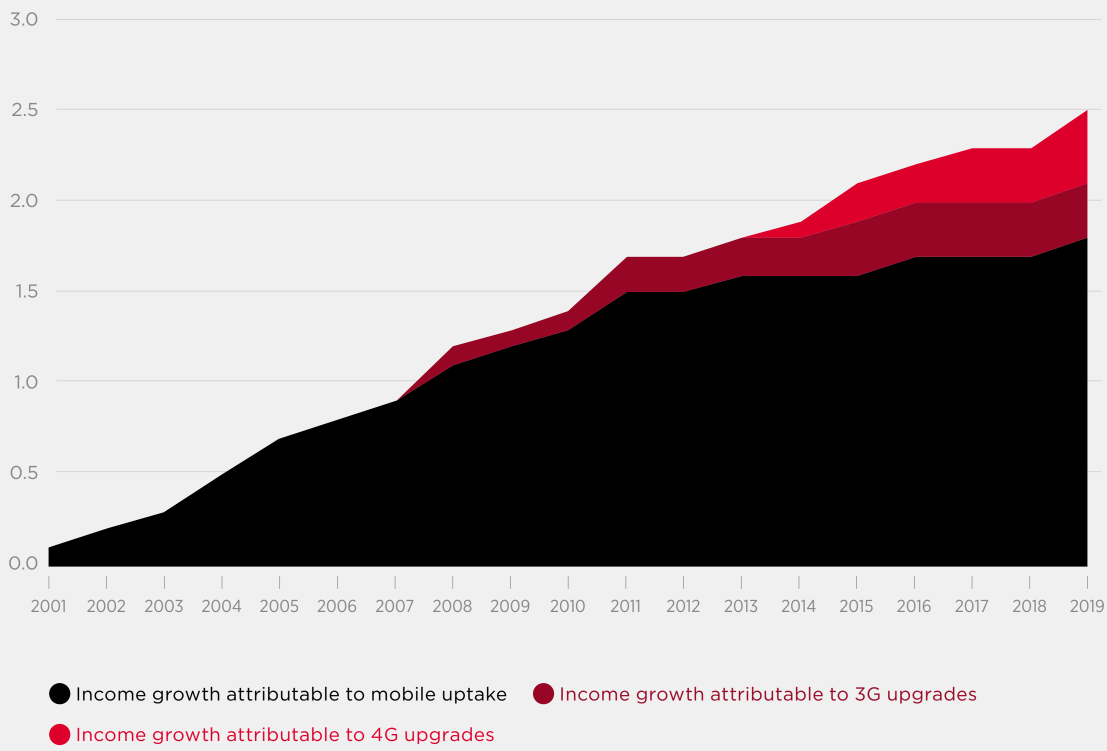
— Over the period 2000–2017, on average a 10% increase in mobile adoption increased GDP by 1%.

— The economic impact of mobile increases by approximately 15% when connections are upgraded from one mobile network technology to another (from 2G to 3G and from 3G to 4G).

— By 2019, the benefits from the additional services and functionalities enabled by 4G upgrades contributed almost $390 billion (or 1% of income growth) to the $2.5 trillion of economic activity enabled by mobile technology (see Figure 6).

Figure 6: Global GDP growth driven by mobile technology

Cumulative, $ trillion



Source: GSMA Intelligence

This has important implications for the potential benefits of new generations of mobile technology such as 4G and 5G, and highlights how technology-neutral spectrum licences not only enable efficient management of spectrum by mobile operators but also help unlock significant economic growth. For example, connecting all of Africa to 4G by 2030 would add $75 billion in economic value, adding 5.5% to projected growth.

16 Mobile technology: two decades driving economic growth, Working Paper, GSMA Intelligence, 2020

02. Legacy network sunsets in Africa: status and outlook

With 4G and 5G deployment growing steadily, the process of sunsetting 2G and 3G networks is well underway in several countries. The sunsetting of legacy networks describes the gradual phasing out of mobile infrastructure that supports devices running on older technologies, such as 2G and 3G. While the pace and approach to legacy network sunsets differs significantly, increasing numbers of 2G and 3G sunset dates are being published.

The rationale behind legacy network sunsets

— Refarm spectrum for 4G and 5G upgrades, and in the process increase the efficient use of spectrum resources to meet growing demand for mobile broadband.

— Optimise network operations, with potential opex savings from fewer network maintenance contracts with network vendors.

— Improve energy efficiency in the network (legacy networks are less energy efficient on a per-gigabyte basis) amid rising energy costs.

— Realise capex savings from retiring 2G and 3G networks, which are nearing end of life and require a capex refresh.

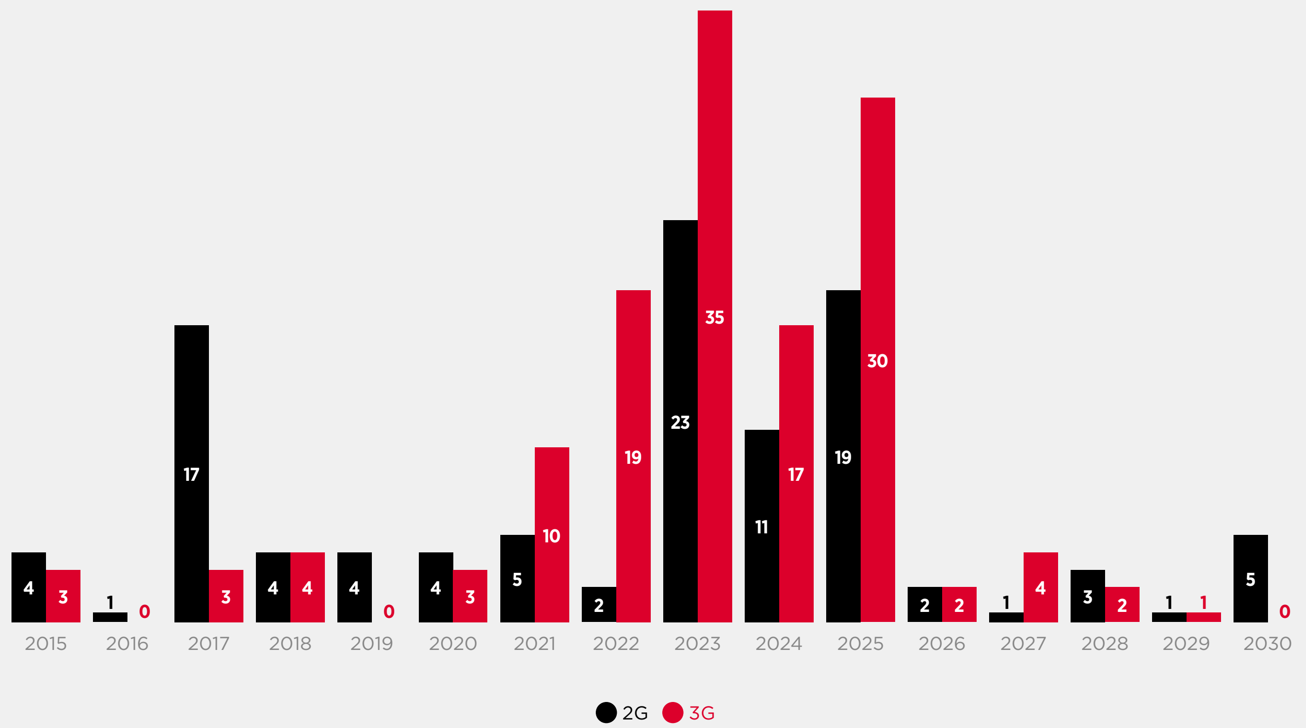
— Rationalise device portfolios and simplify tariff structures.

— Minimise risks associated with the slowing improvements to and maintenance of legacy equipment, some of which is due to lose support within a few years.

2.1 Sunsets in numbers

Between 2015 and mid-August 2023, a total of 91 networks were shut down, of which 43 were 2G networks and 48 were 3G networks. The pace of sunsets is accelerating. Based on announced plans from operators, at least 148 networks will be shut down between Q4 2023 and 2030. Of these, 63 will be 2G networks and 85 will be 3G. According to announced plans, 2023 is expected to record the highest number of sunsets (58), with Asia Pacific accounting for more than 40% of these (see Figure 7).

Figure 7: 2G and 3G network sunsets



Note: Legacy network sunsets as opposed to technology migration within the same generation of technologies. WiMAX network sunsets not included. Data for 2023–2030 is estimated based on operators' announced plans for sunsets. Data correct as of 14 August 2023.

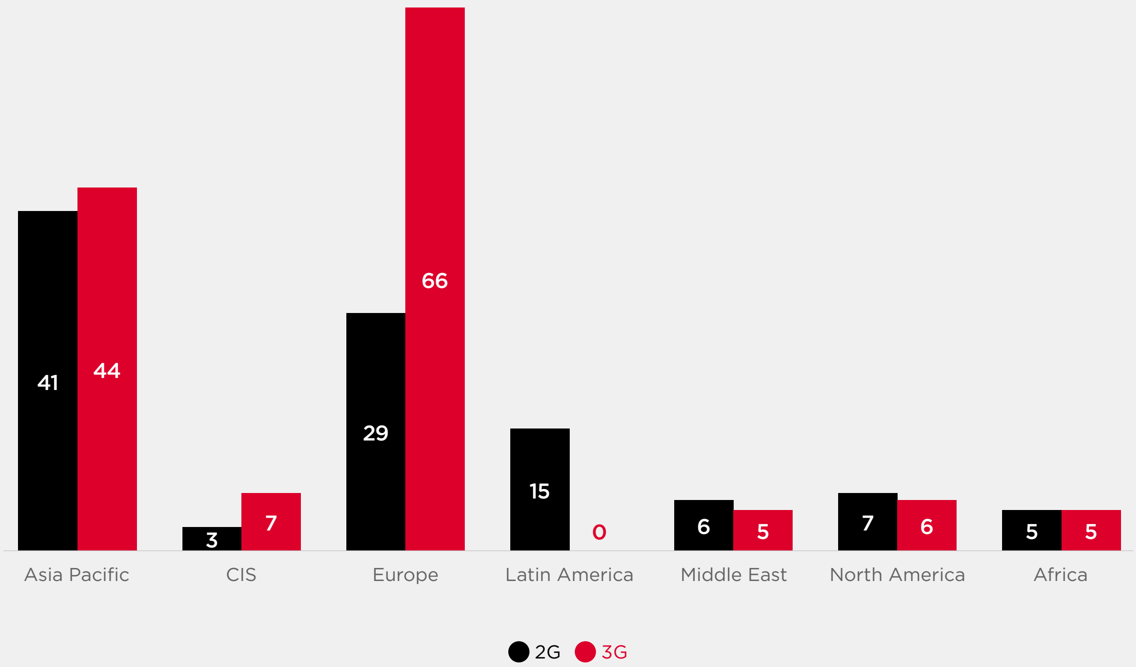
Source: GSMA Intelligence

An important factor influencing legacy network sunset decisions is the scheduled expiry of spectrum licences. 3G networks were typically launched between 2000 and 2005 in major markets, with licence durations of around 20 years to allow operators to amortise network investment in spectrum at the relatively high frequencies around 2 GHz. As operating permits expire, regulators are re-auctioning the spectrum, usually with neutral policies, paving the way for 4G and 5G.

2.2 Global trends and drivers

The approach, pace and underlying factors of legacy network sunsets vary by region. Figure 8 shows a regional breakdown of legacy network sunsets between 2015 and 2030.

Figure 8: Completed and planned legacy network sunsets, by region (2015–2030)



Note: Data for 2023–2030 is estimated based on operators' announced plans for sunsets. Data correct as of 14 August 2023

Source: GSMA Intelligence

Table 4 highlights the notable trends and regional nuances in legacy network sunsets.

Table 4: Legacy network sunsets: regional trends

Asia Pacific	— The phasing out of 2G networks is the preferred option in Asia Pacific. The opportunity to leverage the propagation capabilities of sub-1 GHz spectrum for 4G and 5G coverage expansion is a key driver. — Japan was the first market in the world to shut down 2G networks (SoftBank in 2010, and KDDI and NTT DoCoMo in 2012). — Between 2015 and 2025, more 2G networks (38) than 3G networks (30) will be shut down in Asia Pacific. — In many cases (e.g. in Australia and New Zealand), the shutting down of 2G and 3G networks is being driven entirely by operators, rather than mandated by regulators.
Europe	— Most European mobile operators are retiring 3G before 2G services (e.g. Vodafone has completed its 3G sunset in Germany and Italy, maintaining 2G, and plans to do the same in the UK). Deutsche Telekom, EE, Elisa and Telefonica are taking a similar approach. — Long-term contracts with enterprises such as utility providers, automotive OEMs and multinational companies are the main reason why 2G networks need to be maintained. — Conventional 2G networks are used for low-power M2M/IoT applications such as smart metering and eCall (emergency call) services in vehicles. These need to be maintained until transitioned to LTE variants. The cost and practicality of replacing the equipment for these applications is high, reinforcing the decision to retire 3G networks before 2G. — By 2025, at least 42 3G networks in Europe will have been shut down, compared to just 13 2G networks.
Latin America	— After an initial flurry of activity in the latter part of the last decade, the pace of legacy network sunsets has slowed in Latin America. By 2025, 13 2G and 2 3G networks will have been shut down in Latin America. — This could change as the deployment of 5G begins to gain traction in the region, and operators seek new efficiencies within their operations. — However, in many countries, a partial sunset is already happening, with operators refarming 2G and 3G spectrum for 4G services in certain locations but not discontinuing the legacy network entirely. — Technology neutrality is an important enabler of partial sunsets, allowing operators to support a small but significant 2G customer base, while using the majority of spectrum for 4G/5G.
Middle East	— Rising 4G adoption and the rollout of 5G networks has led operators in the Middle East, particularly in the GCC states, to step up plans to shut down legacy networks and refarm 2G and 3G spectrum for 4G and 5G services. — In the UAE, 2G services will be discontinued completely by the end of 2023 by mobile operators e& and Du. — Outside the GCC states, only Israel and Jordan have announced plans to shut down legacy networks. — By the end of 2025, at least five 2G and three 3G networks across the region will have been completely shut down.
North America	— Verizon officially decommissioned its CDMA networks at the end of 2022, becoming the last major US operator to do so. — 2G has already been discontinued by the major US operators. AT&T ended support for its 2G network in 2017, Verizon's 2G network was phased out in 2020, and T-Mobile started its 2G sunset in December 2022. — 2G/3G sunsetting removes the availability of circuit-switched emergency calling (the technology typically used for emergency calling in markets where VoLTE has been deployed). Following concerns regarding the availability and interoperability of VoLTE emergency calls in both the US and Europe, the GSMA and its members have come together to update and align technical specifications (see Addressing VoLTE emergency call issues). — By 2025, most of the major mobile operators in the US and Canada will have shut down all legacy network services.

Source: GSMA Intelligence

Addressing VoLTE emergency call issues

The GSMA board approved the creation of a new VoLTE Emergency Task Force to address concerns around the impact of 2G/3G sunsetting on the availability of circuit-switched emergency calling. The VoLTE Emergency Task Force comprises senior representatives from leading mobile operators covering all regions and collaborates with relevant GSMA Network and Terminal Steering Working Groups.

The task force, which began sitting in September 2022, has agreed on requirements and success criteria for emergency calling, VoLTE interoperability and VoLTE roaming. Currently, the GSMA Network and Terminal Steering Working Groups are updating the technical specifications that will ensure VoLTE emergency calls are handled correctly in both devices and networks, enabling a smooth transition from circuit-switched to packet-switch-based emergency call support.

2.3 Key considerations

It is still early days for legacy network sunsets in Africa, reflecting the connectivity landscape compared to other regions. Plans for the shutting down of legacy networks have been announced in only a handful of countries in the region, including the following:

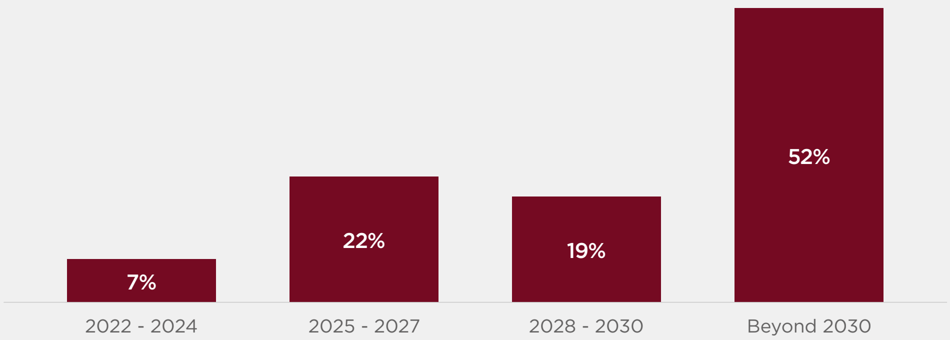
— South Africa: Telkom South Africa retired its 2G network in 2020 and had shut down 80% of its 3G network as of January 2022, with plans to complete the process by 2025. In September 2022, the government proposed an ambitious timeline for retiring the legacy network technologies, including a ban on the import and distribution of 2G devices by the end of February 2023 and a shutting down of 2G and 3G services by 2025.

— Tunisia: State-owned operator Tunisie Telecom was reported to be planning to shut down its 3G network to increase its focus on 4G, though no timeline was provided.[17]

In 2022, GSMA Intelligence surveyed stakeholders from the telecoms ecosystem, including policymakers and mobile operators, on the outlook for 5G in the region. Insights from the survey show that more than half of respondents expect legacy networks to still be operational in their markets beyond 2030 (see Figure 9). Consequently, vendors are providing multigenerational RAN solutions, which allow operators to run 2G, 3G, 4G and 5G on the same radio.

Figure 9: Anticipated timeline for the shutting down of legacy networks

In your opinion, what is the realistic timeline for shutting down legacy networks in your market? Percentage of respondents



Source: GSMA Africa Survey

17 "TT planning to shut down 3G network", Comms Update, June 2022

The transition from legacy networks in Africa needs to take place in a manner that is efficient and causes the least amount of disruption. This should mitigate the potential challenges that could arise as the process gathers momentum, such as reduced 2G/3G device and network equipment support; diminished user experience with global content that is increasingly optimised for 4G and 5G networks; and difficulties when roaming in countries that have completed their 2G/3G network sunsets.

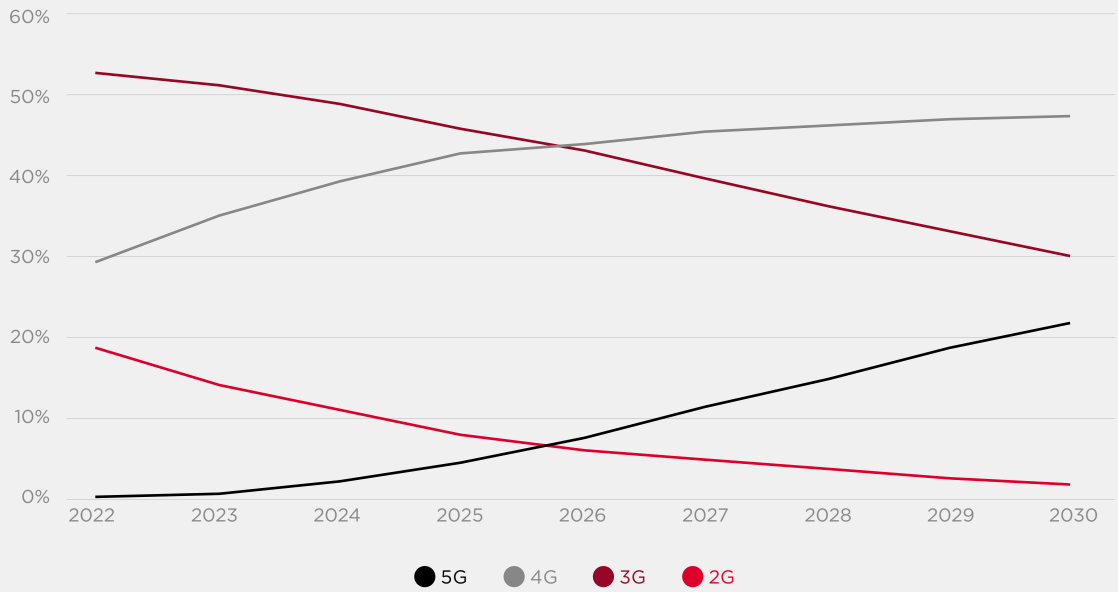
Importantly, the process should be driven by market conditions, rather than mandated. This calls for collaboration among stakeholders, including regulators, mobile operators and other mobile ecosystem players, to identify and implement the necessary enablers of a smooth phasing out of legacy networks in the region. The below highlights the main considerations if stakeholders are to strike the right balance in the transition from legacy networks in Africa.

Customers on legacy networks

On average, as of September 2023, 2G and 3G accounted for 15% and 51% of mobile connections, respectively, making their closure more of a long-term prospect. Although 4G and 5G adoption are expected to rise sharply in the coming years, legacy networks will still account for nearly a third of mobile connections in the region in 2030. Shutting down legacy networks with that many subscribers still connected to them risks exacerbating the already significant digital divide in the region.

Figure 10: Africa: mobile adoption by technology

Percentage of total connections



Source: GSMA Intelligence

4G coverage

4G coverage has now reached 68% of Africa's population. While this represents a significant improvement in recent years, it means around a third of the population, equivalent to more than 460 million people, still live in areas without a 4G signal. Ensuring universal 4G/5G coverage is an important prerequisite for legacy network sunsets. Technology neutrality will play a critical role here, as it enables operators to upgrade existing 2G and 3G sites to 4G and 5G in a timely and efficient manner. Where there are restrictions or onerous conditions for refarming current spectrum resources, delays in expanding 4G coverage are inevitable.

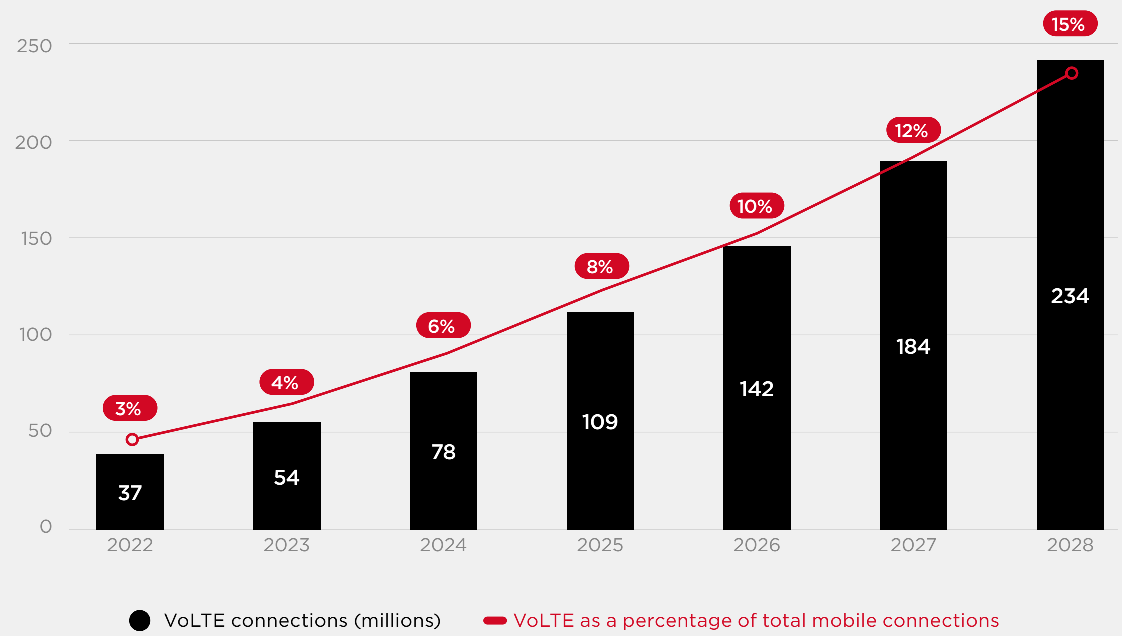
Voice communications

A significant concern around the shutting down of legacy networks is how to deliver voice services, which remain fundamental to communications service portfolios despite the shift to data. Legacy networks, particularly 2G, were primarily designed for voice services and still account for the majority of voice traffic in the region.

However, a new era of voice communication has emerged, as legacy networks are phased out. First is voice over LTE (VoLTE), which enables operators to migrate their circuit-switched infrastructure to a fully IP-centric network. More recently, 5G voice over new radio (5G VoNR) has emerged with the deployment of 5G standalone networks, allowing 5G voice calls to be implemented as end-to-end VoIP connections managed by the IMS core. In the 5G era of all-IP wireless communications, VoLTE represents greater efficiency and better quality of service.

As of September 2023, there were 291 VoLTE networks in 120 markets globally. These accounted for nearly 4.2 billion VoLTE and 5G VoNR connections, equivalent to just under half of total mobile connections. There were 27 VoLTE operators in 16 African markets, with 44.7 million connections or 3.5% of total mobile connections. By 2028, there will be 234 million VoLTE connections in Africa, representing 14.5% of total mobile connections. While VoLTE deployment and adoption are moving in the right direction in the region, the scale of deployment and pace of adoption will be key considerations for legacy network sunsets.

Figure 11: VoLTE connections and adoption in Africa



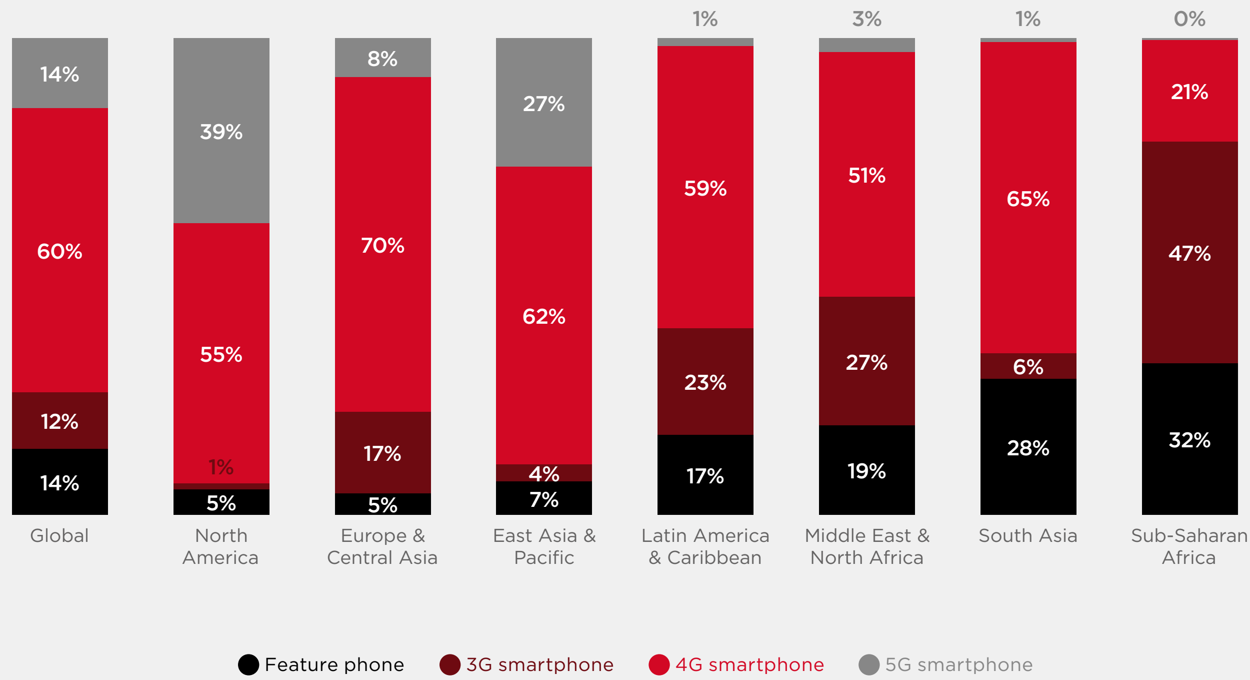
Source: GSMA Intelligence

Devices

Connectivity over 4G networks, for voice and data, requires the right devices. For consumers in Africa, the availability and affordability of these 4G- and VoLTE-enabled devices is challenging. The majority of consumers in the region are still using a 3G smartphone or a feature phone. Furthermore, one in six people in Sub-Saharan Africa are voice/SMS/mobile money users only (they do not use mobile internet), meaning there is also a large base of 2G customers.

A key barrier for stakeholders to address is device affordability, particularly considering the low purchasing power of most consumers in the region, as reflected by low ARPU rates. ARPU in Africa averages just over $3, compared to a global average of $8. Analysis in the GSMA report *The State of Mobile Internet Connectivity 2023* shows that median affordability of an entry-level internet device in Sub-Saharan Africa is 30% of monthly income (almost twice the global median). For the poorest 40%, it is almost 70% of monthly income. Until 4G- and VoLTE-enabled devices become widely accessible, efforts to shut down legacy networks will be hamstrung.

Figure 12: Device ownership of mobile internet users, by technology, 2022



Source: GSMA Intelligence

IoT

Cellular M2M has helped address region-wide challenges by improving resource efficiency in key sectors such as energy, water, agriculture, transportation, manufacturing and healthcare. For example, M2M solutions play an important role in enhancing the delivery of essential utilities, raising agricultural productivity and reducing average delivery times for customers. While cellular M2M will continue to support IoT devices that require mobility and higher data transfer speeds, licensed LPWA solutions (LTE-M and NB-IoT) will experience much stronger growth over the next decade as they support new use cases as well as IoT devices previously served by legacy networks (2G/3G).

As of the end of 2022, NB-IoT had been deployed in fewer than 10 countries in Africa, while LTE-M is not yet available in the region. There is limited public data on NB-IoT and LTE-M population coverage. However, Vodacom South Africa reports 80% population coverage, which is slightly lower than its 4G population coverage.[18] Overall, operators in Africa have been slower to roll out and commercialise LPWA services than those in high-income markets because they were later to deploy 4G services. With LPWA networks designed with spectral efficiency in mind, it is essential that mobile operators can use spectrum resources flexibly to meet market demand. Use of assigned spectrum should be left as technology neutral so LTE-M and NB-IoT can be deployed across any of the resources operators have.

2G versus 3G sunsets

The approach to legacy network sunsets varies across regions. For example, 2G has seen the most sunsets to date in Asia Pacific, while 3G has seen the most in Europe. Based on insights from the GSMA Intelligence survey of regulators and mobile operators, there is a stronger appetite in Africa for 3G services to be shut down first. This is supported by the following reasons:

- Overall traffic is decreasing much faster on 3G than 2G networks, as 3G users are generally more likely to upgrade to 4G than 2G users.
- 3G users are more likely to appreciate the benefits of more advanced technology as they are confirmed data users.
- The spectrum used for 3G can be refarmed for 5G, particularly in the 2100 MHz band.
- M2M/IoT services are predominantly based on 2G networks and will require long-term support.
- 2G devices have longer battery lives, which is necessary for rural areas with unreliable or unavailable electricity.

The choice of which legacy network to shut down first ultimately depends on local market realities. However, the decision should be guided by the overarching principles of inclusion and minimising service disruption for consumers and businesses. Furthermore, stakeholder engagement is essential to ensure that different perspectives have been taken into consideration, and (where necessary) mitigation plans have been formulated to support vulnerable users and communities.

18 "How NB-IoT will drive a new generation of low-power IoT devices", TechCentral, June 2022

03. Preparing for future networks: a call to action

The connectivity landscape in Africa over the next decade will be shaped by efforts to close the digital divide. This will involve measures to ensure consumers and businesses have continuous access to fast, reliable and affordable mobile broadband services. Technology neutrality is an important first step to achieving this goal by allowing the introduction of new technologies in line with increasing mobile broadband demand, while at the same time supporting legacy users.

Mobile operators must have the ability to refarm frequency bands for 4G and 5G upgrades, rather than being tied to declining technologies and services, if regulators are to achieve the twin goals of maximising the efficient use of spectrum and the societal benefits of mobile broadband for users. Technology neutrality is also a vital prerequisite for operators to sunset legacy networks in a smooth way, when market conditions allow it, without leaving any user behind.

Calls to action for regulators and authorities

- Implement a service-neutral or unified licensing framework that allows operators to utilise technology-neutral spectrum licences to offer different mobile-based services, including FWA, using the most efficient networks and technologies. This means removing restrictions or requirements for a new licence, usually at an additional cost, and undue red tape, which can delay the introduction of new mobile services in response to market demand.
- Implement technology neutrality for all mobile operators, where it does not yet exist, and avoid holding up the refarming of spectrum through technology-specific licensing or other forms of restrictions. It is also important for spectrum to be contiguous to enable operators to use it optimally when refarming from legacy networks to 4G and 5G services.
- Avoid introducing charges for changes of spectrum use and cut the red tape associated with this process. It discourages more efficient use of spectrum, reduces the funds available to invest in 4G and 5G services, and ultimately delays the delivery of the benefits of those technologies for users.
- Utilise the opportunity of licence renewal to re-issue spectrum licences on a technology-neutral basis. However, regulators should not tie the introduction of technology neutrality to the licence renewal process, as this could delay the transition to 4G and 5G, especially where the expiry dates of existing licences are not imminent.
  - For example, in Rwanda, the implementation of technology neutrality outside the licence renewal cycle enabled operators to introduce 4G services in July 2023 (the spectrum licence of one of the operators was not due for another eight years at the time technology neutrality was implemented).
  - In Nigeria, the NCC introduced a licensing framework for universal access services in 2005, which included the immediate amendment of all active licences, making them technology neutral even though expiration dates were in the future.
- Avoid mandating the shutting down of legacy networks. Rather, allow the process to be dictated by market conditions.
- Use policy levers to improve the outlook for key considerations around legacy network sunsets. Examples include eliminating taxes on 4G and VoLTE-enabled devices to drive uptake among consumers. This is especially important considering the low and, in some cases, worsening purchasing power of large swathes of the population.
- Engage with operators with a view to providing the necessary regulatory support, and address any transitional issues that may arise with legacy network sunsets when the process eventually begins in their market.
- Support efforts to create awareness among consumers and businesses around the opportunity to upgrade to newer technologies and thus accelerate the migration from legacy networks.
- Create a conducive environment to support investment in 4G and 5G networks to enable the transition. Examples include implementing full technology neutrality where it does not yet exist and using fiscal incentives to stimulate spectrum refarming for 4G and 5G services.

Learning lessons from other regions

For operators in Africa, there is an opportunity to learn lessons from the experience of other regions on technology upgrades and planning for the retirement of legacy networks. These include the following:

- On average, it takes 2–4 years between sunset announcement and actual network switch-off. Mobile operators should formulate their network sunset plans with this timescale in mind to ensure a smooth migration of customers.
- Decide which technology to retire based on specific market circumstances, potential obligations (for example, M2M commitments) and the risk of exclusion for any residual customers on a given network.
- Develop a roadmap for essential network preparation requirements, including 4G coverage expansion, VoLTE deployment and roaming agreements. This should align with local market realities and serve as a guide for the timescale of the legacy network sunset.
- Define and communicate plans to support users who may be affected by technology upgrades and legacy network sunsets.
- Keep track of adoption and usage trends for legacy network devices, as part of strategies to migrate customers in particular segments and locations to newer technologies.
- Consider both push and pull incentives for service upgrades for the most reluctant customers – for example, legacy device trade-in offers and seamless 4G SIM swap arrangements.

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