Africa Broadband Outlook 2024

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Fixed Broadband Development in Africa

The fixed broadband environment in Africa has been experiencing significant growth, albeit in many countries off a very low base. This growth has been driven by advances in new technologies and their adoption, as well as government efforts to move their countries towards digital societies.

The level of broadband development differs significantly from country to country. Historical infrastructure – national long-haul, metro and access (last mile) – required significant upgrades. This has been achieved to a large degree in the long-haul and metro segments, but considerable investment is still required to bring good quality fixed broadband networks to the people of Africa.

Broadband penetration in Africa continues to be one of the lowest globally. This presents an opportunity, with the potential for immense socio-economic growth.

This Position Paper

The position paper titled “Africa Broadband Outlook 2024” analyses the current situation on the African continent as far as the development of fixed broadband infrastructure, and specifically fibre optic networks, is concerned and assesses the adoption of fixed broadband services.

To make the analysis more focussed, the countries in Africa were segmented into three groups of countries with similar economic and broadband infrastructure characteristics. The groups are: (1) Leading Markets – those that are most advanced; (2) Developing Markets – on their way to Leading Market positions; and (3) Initial Markets – those least developed economically and in terms of broadband development.

The different stages of fixed broadband infrastructure deployment ultimately lead to somewhat different paths towards the development of a policy and regulatory framework which supports more efficient infrastructure development and to various initiatives aimed at stimulating the deployment and the adoption of broadband services. The paper makes recommendations as to the targets for fixed broadband connectivity across different user types by 2030, and actions required to achieve the targets.

The paper also briefly reviews pan-African policies and strategies already in place which can form the basis for greater regional integration and also guide governments in Africa in the development of specific national policies and strategies for ICT development in a manner that will promote regional and continental integration.

The paper considers developments in other countries globally, which have already gone through the process of implementing initiatives to build out fixed broadband infrastructure, in order to identify useful lessons for Africa. This is illustrated through a number of country case studies.

An analysis of the impact of investment in fixed broadband infrastructure illustrates the positive effect such investment has on the economic growth of a country, across all sectors, and consequently on social development. This underscores the criticality of supporting the acceleration of high-quality digital infrastructure build.

We hope that the readers will find this whitepaper useful as an illustration of the importance of greater investment in fixed broadband infrastructure, and fibre optic infrastructure in particular, and a guide for aspirational connectivity objectives and the groundwork required to ensure expeditious achievement of such objectives. We trust that the discussion this paper may stimulate will lead to the development of more extensive digital infrastructure across the African continent for socio-economic upliftment.

We extend our appreciation to the various stakeholders who supported the development of this paper. We also extend our gratitude to our team members who contributed key insights and undertook considerable effort in the creation of this paper.

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1. EXECUTIVE SUMMARY

Africa's fixed broadband market is undergoing a transformative phase, marked by significant growth and technological advancements. Growth is driven by the widespread adoption of fibre and fixed wireless broadband technologies, enhancing connectivity and accessibility across urban and rural areas. However, broadband penetration in Africa remains one of the lowest globally, highlighting both the challenges and opportunities on the continent. The potential for economic upliftment through improved digital access is immense.

Segmentation of Countries in Africa

To accelerate the process of achieving the targets set out in the "Broadband Africa Vision 2030" and to consider disparities between African countries in terms of their fixed broadband development, this review divides the African fixed broadband market into three segments based on broadband penetration and level of economic development. The three country groups are:

1. **Leading Markets**: These markets have a high level of fixed and mobile broadband development and GDP per capita above USD 3 000.
2. **Developing Markets**: These markets have embarked on broadband development journeys and have seen increased investment in fixed broadband infrastructure and improved regulatory policies, but a second wave of initiatives are required on ensure ongoing development and improvements
3. **Initial Markets**: These countries are characterised by a lack of investment in fixed broadband infrastructure and are and the beginning of their broadband development journey.

Although not uniform within each group, countries in these groups exhibit similar characteristics and require similar approaches in terms of the types and extent of intervention measures required to expedite the deployment of fixed broadband infrastructure and uptake of services.

The Impact of Fixed Broadband

The positive socio-economic impact of fixed broadband is extensive and ever-increasing with the advent of new technologies and systems reliant on good quality connectivity. The impact extends through the entire economy and influences all social and industrial sectors.

The multiplier factor of investment in fixed broadband infrastructure is significant. For every dollar invested, the result in total GDP contribution can be more than 120% greater. That is, if USD 200 million is invested, the result in total GDP contribution would be almost USD 446 million in the Leading Markets. The contribution would be lower in the Developing and Initial Markets, due to the lower level of maturity of the ICT sector and its contribution to the country's GDP. Nonetheless, investment in fixed broadband does contribute markedly to stronger GDP growth even in the Initial Markets. The indirect benefits of investment in fixed broadband infrastructure replicate through the entire economy, impacting all sectors and value chains, with some sectors benefiting more than others.

Policies Promoting Broadband Development in Africa

A number of overarching strategies are already in place to provide guidance in the development of ICT infrastructure across the African continent. These can form the basis for greater regional integration and also guide national strategies in the build-out of digital infrastructure. The pan-African policies and strategies are:

- **Agenda 2063** – a 50-year master plan for transforming Africa into the global powerhouse of the future.
- **African Continental Free Trade Agreement** – has the objective of promoting the development of cross-border networks to strengthen land-based infrastructure and diversify connectivity routes.
- **Digital Transformation Strategy for Africa (2020 – 2030)** – seeks to harness digital technologies and innovation to transform African societies.

- **ATU White Paper on Connectivity in Africa and Regional Co-operation Framework for Submarine Cable Accessibility** – stresses the importance of access to affordable international bandwidth and promotes extending subsea cable capacity to landlocked countries.

The above provide a broader framework which can guide individual governments in Africa in the development of specific national policies and strategies for ICT development, and particularly digital infrastructure, in a manner that will promote regional and continental integration.

Recommendations on specific actions which governments should be taking to support and expedite the development of digital infrastructure within countries are provided below.

Proposed Targets and Recommendations

High-level targets have been set for the three different country types for fixed broadband connectivity. These targets are aspirational, in comparison to "business-as-usual" growth forecasts, but they can be achieved over the next several years by promoting policies, regulations and initiatives aimed at quicker digital infrastructure deployment.

Exhibit 1.1: Proposed fixed broadband access targets in Africa by 2030, by country types

Indicator	Leading Markets	Developing Markets	Initial Markets
Households	• FBB penetration: >70% • Connected on fibre: 30% • Urban areas: 200Mbps or higher	• FBB penetration: >40% • Connected on fibre: 20% • Urban areas: 150Mbps or higher	• FBB penetration: >25% • Connected on fibre: 15% • Urban areas: 100Mbps or higher
Institutions of learning	• FBB: 100% • Connected on fibre in urban areas: 100% • >95% with 1Gbps or higher connectivity in urban areas	• FBB: 100% • Connected on fibre in urban areas: >90% • >75% with 1Gbps connectivity in urban areas	• FBB: 100% • Connected on fibre in urban areas: >75% • >50% with 1Gbps connectivity in urban areas
Health facilities	• FBB: 100% • Connected on fibre in urban areas: 100%; >95% at 1Gbps or higher	• FBB: 100% • Connected on fibre in urban areas: >75%; >75% at 1Gbps	• FBB: 100% • Connected on fibre in urban areas: >50%; >50% at 1Gbps
Public sector facilities (government offices)	• FBB: 100% • Connected on fibre in urban areas: 100%; >95% at 1Gbps	• FBB: 100% • Connected on fibre in urban areas: >75%; >50% at 1Gbps	• FBB: 100% • Connected on fibre in urban areas: >50%; >30% at 1Gbps

Notes:
- Fixed broadband (FBB) includes FTTH / FTTB, xDSL, FWA and WTTx.
- FBB and FTTx household penetration consists of both residential and business / other non-residential connectivity.
- The actual FBB (and fibre specifically) connectivity rates would vary from country to country.

Source: Africa Analysis

A number of recommendations are provided below for the achievement of the proposed targets. Some African countries are further ahead in adopting the proposed measures, although most countries even in the Leading Markets group can still realise significant improvements on the current practices.

Exhibit 1.2: Recommendations to achieve fixed broadband connectivity targets

No.	Recommendation	Leading Markets	Developing Markets	Initial Markets
1	Clear national broadband plan with clear objectives			
2	Facilitate rapid deployment through standardisation			
3	Encourage infrastructure sharing			
4	Introduce technology neutrality in awarding of licences			
5	Promote open access network model			
6	Encourage fibre pre-provisioning and FTTR			
7	Establish a mechanism for GIS broadband network mapping / database			
8	Reduce supply-side costs			
9	Reduce demand-side costs			
10	Attract development finance			
11	Implement a 'Digital Infrastructure One Stop Shop"			
12	Develop a Critical Infrastructure Protection Plan			

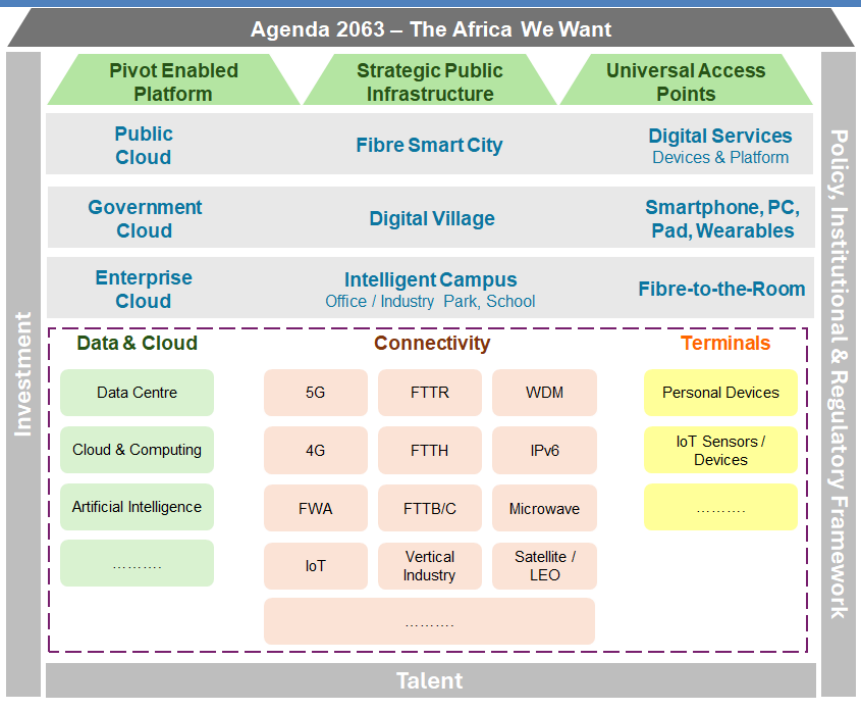
Legend to box colour-coding:

- Green box – recommendations which are either critical or relatively easily implementable
- Orange box – recommendations more complex to implement or to be implemented at a later stage of the process
- White box – does not apply

Source: Africa Analysis

Generating the type of growth of fixed broadband infrastructure required to develop a digital society over the next five years will require a focussed approach and commitment from governments in Africa to drive digital infrastructure development through private sector enablement and greater government involvement.

Exhibit 1.3: The building blocks of a successful African future



Source: Africa Analysis

It will require the right combination of investment, policies, regulation and local talent to realise the objectives of Agenda 2063 and create the Africa we want.

- End Executive Summary -

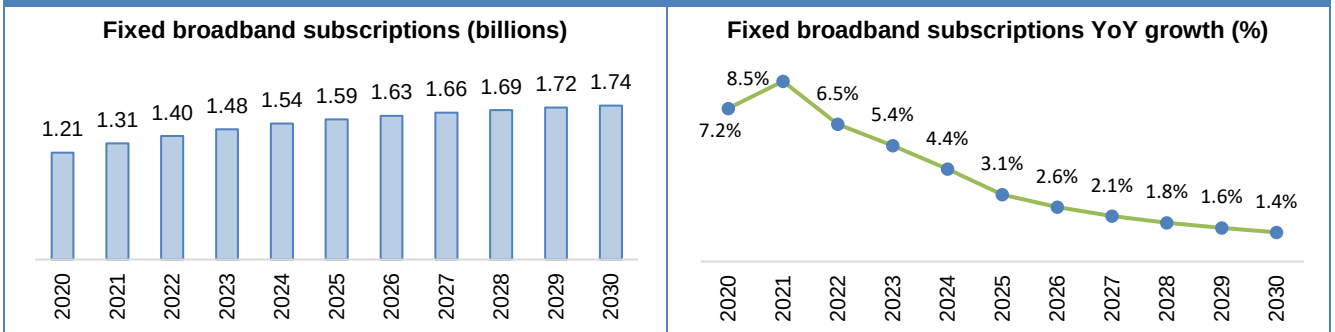
2. GLOBAL BROADBAND MARKET TRENDS

As global broadband connectivity continues to evolve, the trends and dynamics within this space have become a focal point of analysis and strategic planning. This section delves into the current state and future projections of the global broadband market. It examines key factors driving broadband adoption and technology evolution. It also provides a brief overview of broadband development initiatives in various regions globally.

2.1 Global Broadband Market Growth

The global fixed broadband market has experienced significant growth over the past decade, driven by technological advancements and an increasing demand for high-speed internet. The global fixed broadband market is projected to grow from 1.47 billion subscriptions in 2023 to 1.74 billion by 2030 (see exhibit below)[1]. It increased by 5.4% in 2023, with an expected growth of 4.4% in 2024 and 1.4% in 2030, resulting in higher household penetration globally.

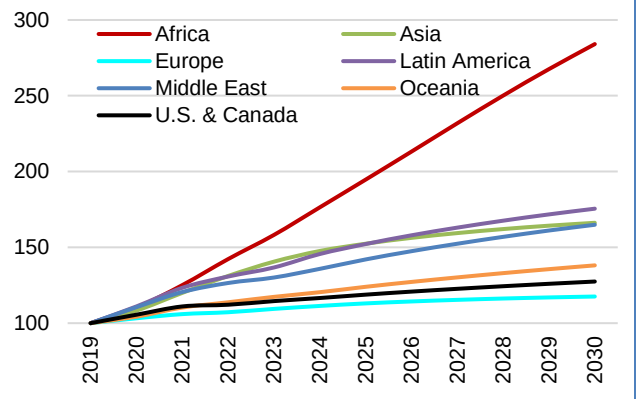
Exhibit 2.1: Global fixed broadband subscriptions and forecast: 2020 – 2030



Source: TeleGeography GlobalComms Forecasts, September 2024

Key growth drivers include accelerated fiber-to-the-home (FTTH) and fixed 5G adoption, and the need to cater for heavy data-consuming applications. Increasing adoption rates in emerging markets are contributing considerably to this growth.

Exhibit 2.2: Growth in global FBB subscriptions by region: 2020 – 2030 (indexed to 2019 = 100)



Source: TeleGeography GlobalComms Forecasts, September 2024, Africa Analysis calculations

For example, in 2023, annual growth rates for fixed broadband subscriptions were highest in Africa (11.2%) and Asia (7.2%), compared to overall global fixed broadband growth of 5.4%.

Africa, the Middle East and Latin America are forecast to record the highest growth by 2030, with growth rates of 6.2%, 2.4% and 2.2% respectively in that year[2].

This contrasts sharply with the overall global growth, which is expected to slow down to 1.4% in 2030. The exhibit on the left illustrates regional growth rates, starting from a base of FBB connections in 2019). The strong growth of fixed broadband connections in Africa vs. other global regions is very apparent, albeit off a much lower base in 2019.

[1] TeleGeography GlobalComms Forecast, September 2024 – Fixed Broadband Subscriptions

[2] TeleGeography GlobalComms Forecast, September 2024 – Fixed Broadband Subscriptions

With worldwide fixed broadband household penetration at 62% in 2023, there remains room for future expansion of broadband services. Fixed broadband penetration continues to grow gradually across all regions. Historical trends indicate that unlike the mobile market, fixed broadband subscriptions are usually limited to a maximum of one per household, and growth rates generally decline significantly once household penetration passes 80%.

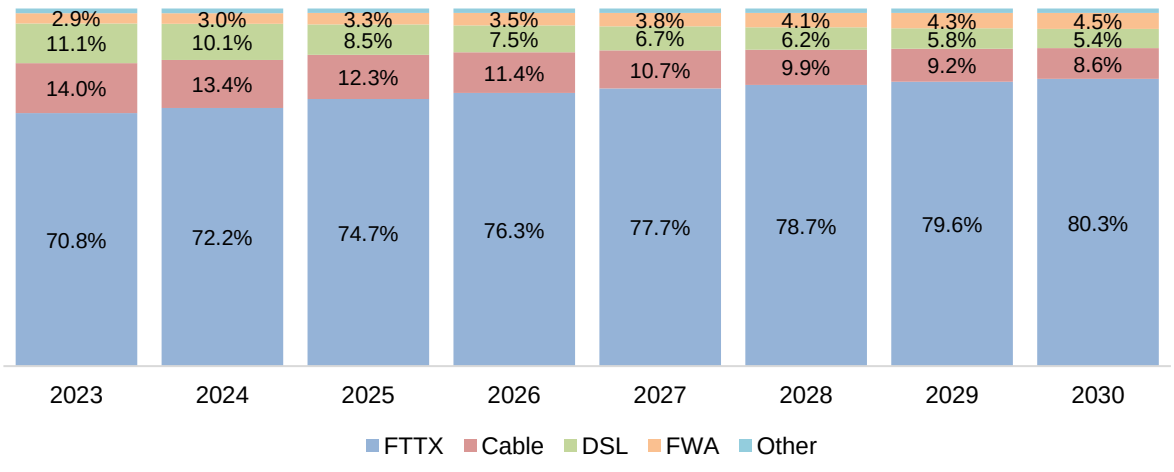
Fixed broadband household penetration in Africa is well behind that of other regions and shows little sign of closing the gap, with mobile services favoured over fixed line services for several reasons. On a continent which is home to 1.4 billion people (300 million households), there were just over 37 million fixed broadband subscriptions by the end of 2023, resulting in a household penetration of 12%. Despite projected strong growth in fixed broadband adoption, household penetration in Africa is expected to reach only 17% by 2030, with penetration levels in all other regions surpassing 50%. Although by 2030, the estimated fixed broadband household penetration will stand at 68%[3], access to advanced gigabit broadband services will be far from equal, and heavily skewed across world regions. While the first digital divide was about basic connectivity, the second digital divide is about access to high-quality fixed broadband connectivity.

2.2 Gigabit Broadband Trends

The demand for better connectivity is growing rapidly as more devices are connected to the internet and applications such as 8K streaming, virtual reality (VR) and the Internet of Things (IoT), are becoming increasingly data intensive. The adoption of extended reality (XR), such as augmented reality (AR) glasses and mixed reality (MR) headsets, will see an even further increase in network demand. It is estimated that these advanced applications could require speeds of 1Gbps to 2Gbps, as well as a maximum and consistent latency of less than 5 milliseconds[4].

The evolution of these internet technologies adds up to exponential growth in data and in increasing reliance on high-speed networks. To meet these demands, service providers worldwide have been investing in fibre connections. By 2030, the global number of fibre connections will make up over 80% of all fixed broadband subscriptions[5]. The exhibit below shows global fixed broadband subscriptions by access technology for the period 2023 to 2030.

Exhibit 2.3: Global fixed broadband subscriptions by access technology type: 2023 – 2030



Source: TeleGeography GlobalComms Forecasts, September 2024 and Africa Analysis calculations

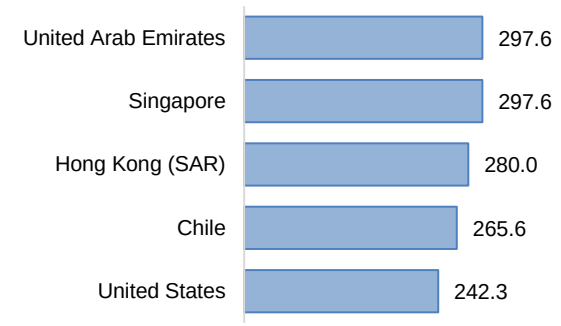
[3] TeleGeography. Global Comms Forecast, September 2024.

[4] Omdia Fibre Development Index Analysis 2024

[5] TeleGeography GlobalComms Forecast, September 2024 – Fixed Broadband Subscriptions

Service providers are also adapting to the demand for faster connections by offering new pricing plans that include speed-based packages. In the Middle East, service providers are addressing indoor performance speed bottlenecks by bundling Wi-Fi 6 compatible customer premises equipment (CPE) and deploying fibre-to-the-room (FTTR) for ubiquitous gigabit access indoors [6]. The percentage of global broadband subscriptions to gigabit or multigigabit broadband services is forecast to increase from 19% in 2023 to 44% by 2028[7].

Exhibit 2.4: Leading five countries by FBB median download speed (Mbps), August 2024

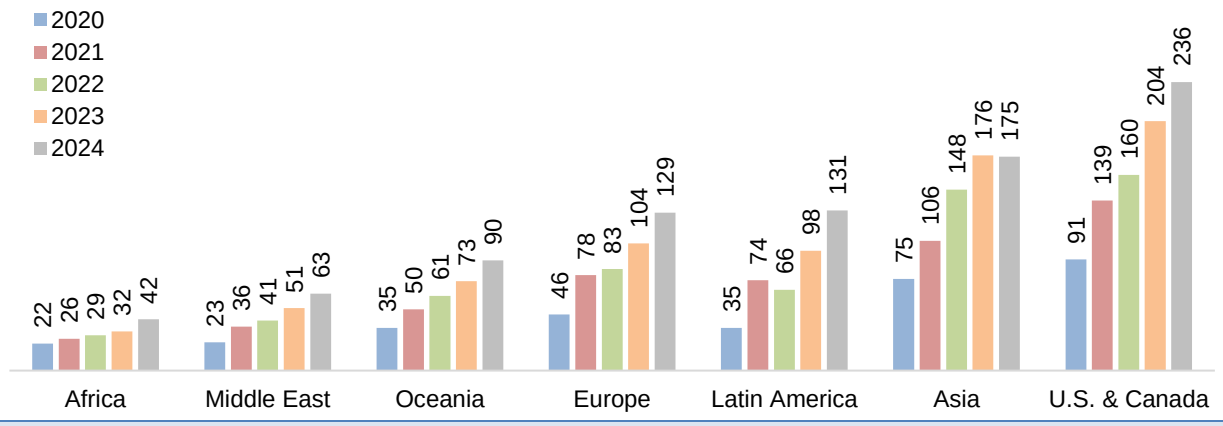


Source: Ookla Speedtest Global Index, August 2024

According to the Ookla's Speedtest Global Index (August 2024), countries in the Middle East and the Asia Pacific regions are at the forefront of available fixed broadband download speeds. The United Arab Emirates (UAE) and Singapore had the fastest median download speeds, reaching 297.6 Mbps[8]. The exhibit on the left shows the top five countries by fixed broadband median download speed in August 2024.

The exhibit below illustrates the significant increase in fixed broadband download speeds by ITU region from 2020 to 2024[9].

Exhibit 2.5: Fixed broadband download speeds by region (Mbps): 2020 – 2024



Source: Ookla Speedtest Global Index 2024, TeleGeography GlobalComms Forecasts and Africa Analysis calculations

The advent of gigabit broadband technology marks a significant leap in internet connectivity, enabling broadband speeds up to 1 Gbps and higher[10]. This advancement in is driven by the growing demand for high-speed internet to support activities such as streaming, online gaming and remote work. Gigabit broadband is primarily delivered through fibre-optic technology, which provides faster and more reliable internet connectivity compared to traditional copper lines. As more internet service providers (ISPs) expand their gigabit offerings, this technology is set to become the standard for households and businesses, ensuring seamless and efficient online experiences.

[6] Ookla. Gigabit Internet is the New Competition Ground for ISPs in the Middle East

[7] Omdia Fibre Development Index Analysis 2024

[8] Ookla. Median Country Speeds Updated August 2024

[9] Fair Internet Report. Internet Speeds by Country, Region, Economy, and Income Group

[10] CNET What is Gigabit Internet and Is It Worth the Money?

10 Gbps Fibre Trials

Gigabit fibre trials around the world are showcasing the incredible potential of next-generation broadband technologies.

China Telecom has been actively involved in 50G PON for many years, viewing optical access as a crucial component of its cloud-network synergy. In 2016, the operator began pre-research on next-generation PON technology, co-initiated the 50G PON standard in ITU-T, and led the G.9804.1 architecture and requirement standard, as well as the G.9805 standard for multi-generation PON coexistence. It also proposed a solution for the coexistence of two to three generations of PONs. In March 2021 and August 2022, China Telecom and Huawei jointly completed 50G PON prototype verification in phases, focusing on key features such as power budget, rate and wavelength[11]. The results demonstrated that Huawei's prototype supports smooth evolution from different PON systems on operators' live networks to 50G PON.

In July 2023, Vumatel (a South African fibre network operator) announced an investment in 50G PON technology through a partnership with Huawei. This will enable significantly higher upload and download speeds compared to the current 2.5 Gbps capabilities. The 50G PON technology will provide ultra-high bandwidth and low latency for applications such as smart homes, online education, gaming, virtual reality and live streaming, improving end user experience for consumers[12].

Telecom Egypt and Huawei successfully completed 50G PON fibre trails in February 2024, the first completed 50G PON trial in Africa[13]. The 50G PON innovation will further accelerate the digital transformation in Egypt and contribute significantly towards the country's digital transformation, in line with the Egypt Vision 2030.

In July 2024, Google Fiber and Nokia tested 50 Gbps broadband speeds over the existing Google fibre network, providing the first live demonstration of 50G PON technology in the U.S. During the testing, Google Fiber was able to simultaneously run 10/25G PON along with 25/50G PON broadband services over the network. The benefit of this is the flexibility and scalability, allowing the operator to keep pace with the future demand for multi-gigabit services[14].

In the Middle East, Saudi Arabia is making progress towards achieving its Vision 2030 goals by developing robust digital infrastructure. The country is focusing on establishing a 10 Gbps Society, characterised by advanced network infrastructure with 10 Gbps peak download speeds, low latency, wide coverage and massive connectivity[15]. This initiative aims to accelerate digital transformation across various sectors, including intelligent education, healthcare, entertainment, cities and manufacturing. The 10 Gbps Society will enable high-quality digital experiences for individuals, homes and enterprises, fostering a thriving digital ecosystem and enhancing national resilience. Major cities, such as Riyadh, are actively exploring the implementation of 10 Gbps infrastructure to drive the growth of the digital economy.

2.3 Next Generation Broadband Standards

The next generation of broadband standards is set to revolutionise internet connectivity by offering ultra-enhanced speeds, reliability and consistency. The European Telecommunications Standards Institute (ETSI) has developed the Future Generation Gigabit Network (F5G) standard, defining the best roadmap-based approach to deploy advanced fixed broadband networks and to develop use cases[16]. F5G is designed to provide higher speeds, better reliability and more efficient network management. The F5G Advanced standard further elevates fixed fibre networks by enabling 10 Gbps speeds to everyone, in alignment with the European Union's

[11] Telecoms.com Time to Build 50G PON as the Foundation for 10Gpbs All-Optical Access

[12] IT Web. Vuma, Huawei trial 50G PON tech for SA

[13] Light Reading. Telecom Egypt and Huawei join forces to complete the first 50G PON trial in Africa

[14] Telecoms.com. Nokia and Google Fiber trial 50G PON in US

[15] Saudi Arabian Ministry of Communications and Information Technology. The 10Gbps Society.

[16] ETSI Fifth Generation Fixed Network (F5G)

(EU) target of providing every EU citizen with at least a 1 Gbps fibre connection by 2030[17]. The evolution from F5G to F5G Advanced is achieved through six dimensions of enabling technologies:

- **Enhanced Fibre Broadband (eFBB):** According to ETSI, application bandwidth has been growing at a rate of about 40% per year, and the trend is expected to continue. Fixed networks need to keep up with this growth and that implies modernisation of transport, aggregation, access and customer premises networks. F5G optical access systems as 10G PON, and upgrades to 50G PON, will ensure increasing bandwidth in access networks. In-premises network bandwidth will be improved by technologies such as Fibre-to-the-Room (FTTR) and upgrades from Wi-Fi 6 to Wi-Fi 7.
- **Real-time Resilient Link (RRL):** The emergence of interactive immersive experience services (such as cloud, VR, AR, XR) and digitisation of the industry, are the major drivers for the dimension of RRL. Through F5G Advanced, fibre networks can provide RRL with PON and Wi-Fi technologies.
- **Guaranteed Reliable Experience (GRE):** To reliably guarantee a high-quality network experience, mechanisms for appropriate resource management, allocation, control and isolation have to be implemented. The implementation of in-network computing abilities through AI, will enhance network services for a better experience.
- **Optical Sensing and Visualisation (OSV):** Multi-modal sensing technologies enabled in optical networks and Wi-Fi can be used to collect environmental data, such as vibration, temperature, pressure, strain and others, that, combined with digital twin technologies, can leverage the new awareness capabilities for networks and services (for residential, enterprise and industrial).
- **Full Fibre Connection (FFC):** In the F5G Advanced framework, both network scope, as well as number of endpoints are expected to increase. More services and a larger coverage with fibre and all-optical technologies are supported. Fibre optics can extend into the home, campuses, and factories. Here, FTTR, Fibre-to-the-desk (FTTD), Fibre-to-the-machine (FTTM) and Fibre-to-the-thing (FTTThing) can be deployed to ensure full fibre connection.
- **Green Agile Optical Network (GAO):** Sustainability remains a global challenge, raising the need for a greener and more agile optical network. In the access networks, the replacement of legacy copper networks (like xDSL and coaxial-based networks) by PON brings significant energy use reduction of over 50%. In transport networks, the adoption of all-optical End-to-End (E2E) networking, with simpler architectures, Optical Cross-Connects (OXC), minimising optical-electrical-optical conversions will allow achieving a greener network infrastructure.

The F5G standard is crucial for supporting emerging technologies and applications that require robust and reliable internet connectivity.

[17] European Commission. Support for Broadband rollout

2.4 The Evolution of the Home Broadband Network

From broadband access to smart home, the home is becoming a multifunctional centre for entertainment, office, education and fitness. Consumer demand for broadband has shifted from pure connectivity to better experience (speed, stability and reliability).

Virtual Reality, Apple Vision and AI-Generated Content

Simultaneous video streaming from different household members drives bandwidth demand and the resolution of such streams will increase over time as different VR applications become more popular. Next-generation applications, such as Apple Vision and AI-Generated Content (AIGC), are revolutionising the digital landscape. Apple Vision Pro introduces the era of spatial computing, seamlessly blending digital content with the physical world by leveraging advanced machine learning algorithms. It offers an infinite canvas for apps, transforming any room into a personal theatre with immersive Spatial Audio and ultra-high-resolution displays[18]. It is becoming a powerful tool for businesses and individuals alike[19].

The use of these technologies in the home will significantly drive bandwidth demand. The forecast for VR hardware total active installed device base is 66.5 million by the end of 2027 (Omdia), up from 24.3 million at the end of 2022. However, these devices will account for only 4% of total global fixed broadband subscriptions in 2027[20].

Through improvements in performance – greater channel bandwidth and more data density – Wi-Fi 7 provides faster wireless speeds, improved network efficiency and reduced interference, enabling seamless connectivity in densely populated areas and supporting the growing number of connected devices. These advancements will not only enhance user experience but also drive innovation across various industries, paving the way for new applications and services that require robust and high-speed internet connections[21].

Wi-Fi 7 represents a significant step up in performance from Wi-Fi 6. It can deliver theoretical peak data rates of 23 Gbps and performance improvement due to greater channel bandwidth (320 MHz, compared to a 160 MHz maximum for Wi-Fi 6) and greater data density (4K quadrature amplitude modulation – QAM). One important feature of Wi-Fi 7 is multilink operation, which means that a single data pipe can be created by using two Wi-Fi radios simultaneously, utilising frequencies in the 5 GHz or 6 GHz bands. This increases the possibility of achieving optimal performance, even in congested areas. Operators will be in a much better position to promise at least gigabit connectivity to every room (using mesh Wi-Fi when necessary).

2.5 From FTTH to FTTR

Fiber-to-the-room (FTTR) is an advanced networking solution that extends optical fibre connections directly to individual rooms within a building. This technology is designed to meet the increasing demand for high-speed, reliable internet connectivity in environments such as houses, offices, hotels and apartments. By using optical fibre, FTTR ensures gigabit-level speeds and low latency, which are essential for activities such as online education, video streaming, VR and smart home applications[22].

One of the key benefits of FTTR is its ability to offer consistent and high-quality Wi-Fi coverage throughout an entire building. Unlike traditional Wi-Fi setups that may suffer from weak signal in certain areas, FTTR delivers stable connections in every room. Additionally, FTTR supports seamless roaming, allowing devices to switch

[18] Apple. Introducing Apple Vision Pro: Apple's first spatial computer

[19] Quick Creator. AI-Generated Content (AIGC): What is and Future Look

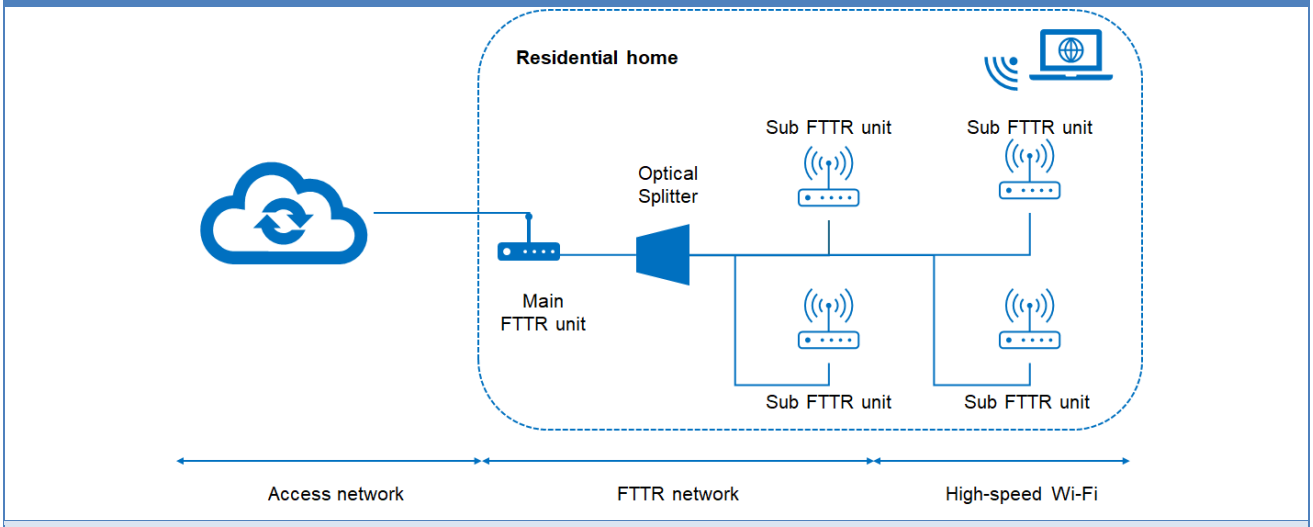
[20] Omdia. Africa Broadband Outlook 2023. (In the US, active VR devices accounted for 4% already in 2019 and will reach 22% in 2027.)

[21] Techradar. Wi-Fi 7: everything you need to know about the new wireless standard.

[22] Ascent Optics. What is Fibre to the room (FTTR)?

between access points without any noticeable interruption (see exhibit below). This is particularly beneficial in larger spaces.

Exhibit 2.6: FTTR network schematic



Source: Derived from Fibre Development Index Analysis, 2024, WBBA and Omdia

Another advantage is that the user can control Wi-Fi usage and test each access point on the home network. Parameters such as quality, speed and content accessed by each device can be checked. For example, parents can check what their children access and for how long. A separate Wi-Fi network for guests can be created if security is a concern. In addition to all the other benefits, FTTR can help reduce power consumption by more than 20% in comparison with traditional Wi-Fi router networks.

Overall, FTTR represents a significant advancement in on-premises networking, addressing the growing need for faster and more reliable internet access.

Fibre operators can use FTTR to pre-position themselves for the delivery of digital services in the future by having a controllable and manageable home network. A key consideration is how to deploy FTTR efficiently and cost-effectively. Installation strategy and pricing are key to creating viable business models and keeping the offer attractive to the customer. FTTR is expected to enjoy robust growth as service providers seek to differentiate around premium-quality broadband services. FTTR share of residential FTTH subscriptions is forecast to be the highest in China, where it will reach 25% in 2030, followed by North America (15%) and Western Europe (12%)[23].

2.6 Global Broadband Development

Broadband development is fundamental to the digital economy, fostering growth and innovation in sectors such as education, healthcare and finance. Governments worldwide, in developed and developing countries, are actively supporting policies and ecological initiatives to advance optical fibre infrastructure. This ensures strong and dependable internet connectivity, crucial for economic development, digital transformation and social inclusion. The following examples from regions across the world highlight broadband infrastructure improvement initiatives.

[23] Omdia. Africa Broadband Outlook 2023.

China's Fibre Deployment Strategy

China, Asia's largest economy, has the largest number of households with access to high-speed broadband and one of the highest fixed broadband penetration rates in the world. This has been largely attributed to the government's aggressive national fibre expansion programme, a key objective in China's national economic strategy. Fibre access for households and businesses is recognised as critical national infrastructure.

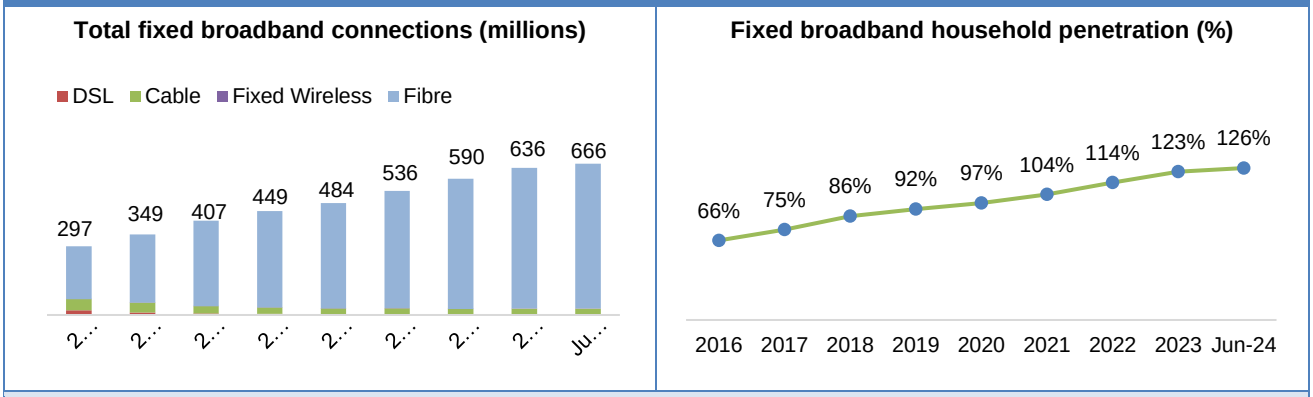
The priority was to accelerate the migration from legacy to next generation networks, and in particular fibre. China's broadband policy was based on three main pillars: (i) public investment and tax incentives, (ii) installation of fibre in civil projects and residential construction ventures, and (iii) promotion of collaborative efforts between operators on network deployment and infrastructure sharing.

This strategy has resulted in the largest mobile broadband and fibre optic networks in the world. The government has provided backing for the establishment of fibre optic networks in 130 000 villages and 4G base stations in 60 000 villages. This has resulted in an increase in rural broadband coverage from less than 70% to 100%.

High-capacity network deployment in remote areas is subsidised from the Telecommunications Universal Service Funds. The state and local municipality can contribute up to 50% of the total network capex and opex.

By 2019, China had reached the 90% household broadband penetration, with over 90% of the connections through fibre. This is illustrated below.

Exhibit 2.7: FBB connections by technology and household penetration in China: 2016 to mid-2024



Source: TeleGeography

Prior to 2019, China focused on the expansion of fibre coverage. Since 2019, the focus has shifted to gigabit infrastructure, with the objective of upgrading the fibre infrastructure to gigabit ready status and increasing the proportion of high-speed connectivity. By the end of 2023, over 200 cities had attained a gigabit city status.

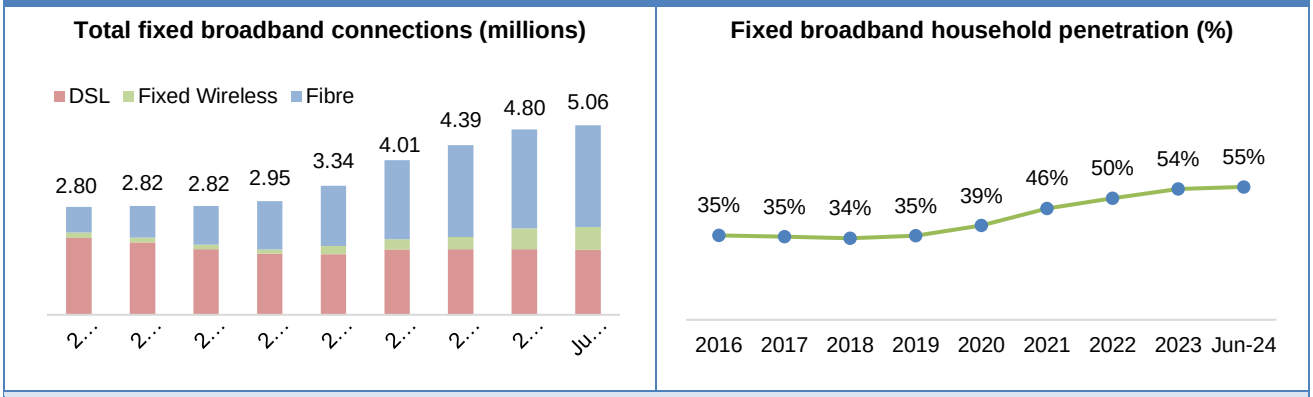
In 2021, the Dual Gigabit Network Co-ordinated Action Plan (2021 – 2023) was launched, involving gigabit fibre and 5G infrastructure to drive high-speed broadband penetration. This strategy combines the characteristics of fibre optic networks with the flexibility, mobility and the ability to support many 5G connections. More than half of the world's 5G base stations are in China, enabled by the national fibre network.

The development of gigabit broadband in China has led to very positive developmental results. Ultimately, the aim is to stimulate the development and adoption of innovative applications and solutions for business and home users through the development of digital infrastructure.

Malaysia's Fibre Deployment Strategy

Malaysia launched the Jalinan Digital Negara (JENDELA) plan in September 2020[24] to provide wider broadband coverage and better-quality experience for users. The initiative targetted 9 million premises being passed by fibre by 2025, up from 4.96 million in September 2020. By June 2023, 7.74 million premises had been passed with gigabit broadband infrastructure. The second phase of the initiative began in 2023, focusing on extending broadband access for the remaining 3% of the population not covered and extending gigabit fixed broadband access to 9 million people. By 2024, Malaysia reached 55% fixed broadband household penetration, with fibre being the main access technology. This is illustrated below.

Exhibit 2.8: FBB connections by technology and household penetration in Malaysia: 2016 to mid-2024



Source: TeleGeography

Malaysian authorities set several initiatives in place to ensure JENDELA's success, including the establishment of a Communications Infrastructure Management System (CIMS). The government also provides subsidies for broadband infrastructure development based on the region. The programme was awarded the ITU's 2023 World Summit on the Information Society (WSIS) prize for Information and Communication Infrastructure.

By enhancing digital infrastructure, Malaysia has enabled better access to online learning resources, especially in rural areas, streamlined digital government services and provided a robust digital platform for businesses to operate online. It has also helped Malaysia evolve into a major fintech market in the ASEAN region, with at least 549 fintech companies[25]. The Malaysian fintech market is forecast to grow to USD 96.1 billion by 2029[26].

France's Fibre Deployment Strategy

In 2013, the French government created a comprehensive national broadband plan to expedite the deployment of fibre – the 'Plan France Très Haut Débit' ('Ultra-Fast Broadband Plan')[27]. The aim is to have 100% broadband coverage on fibre alone by 2025. The broadband plan outlines three zones, characterised by different types of developments and financing, each with a different approach to the construction of broadband infrastructure:

- 'ZTD' ('High-density zones'), where private operators are responsible for deploying their own networks.
- 'AMII Zones' ('Call for Investment' zones), where multiple operators have expressed an interest to jointly deploy and/or finance fibre optic networks. These are medium-density areas and medium-sized cities.
- "RIP Zones" (Public Initiative Network Zones), where local governments use public funds to finance the deployment of fibre infrastructure.

[24] Jendela. Jalinan Digital Negara

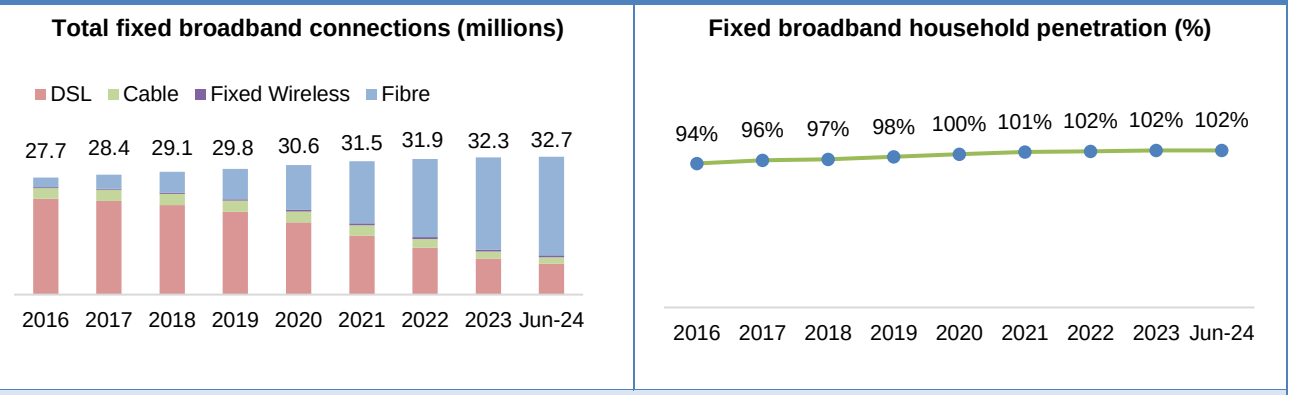
[25] The Fintech Times. Malaysia's Fintech Boom: A growing Force in Southeast Asia.

[26] Mordor Intelligence. Fintech Industry in Malaysia Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029) Source: https://www.mordorintelligence.com/industry-reports/malaysia-fintech-market

[27] Ministry of the Economy, Finance and Industry. Very High-Speed France Plan: deployment of fibre optics throughout France by 2025

Almost 100% of houses in France have fixed broadband access. The copper network switch-off is to be concluded by 2030. Co-investment is one approach that could encourage and enable broadband service providers to migrate their clients to gigabit infrastructures while granting flexibility over retail price-setting for gigabit technologies. The legislative and policy framework encourages infrastructure sharing of fibre networks by competing network operators in buildings. A growing migration to IPTV is a driver of gigabit broadband adoption. The uptake of fibre services is illustrated in the exhibit below.

Exhibit 2.9: FBB connections by technology and household penetration in France: 2016 to mid-2024



Source: TeleGeography

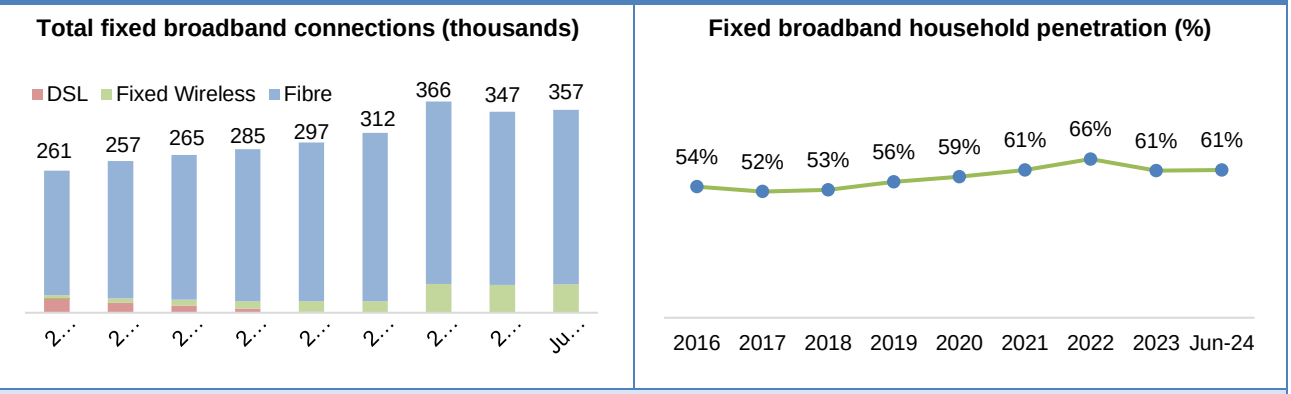
Qatar's Fibre Deployment Strategy

Qatar ranks amongst the most connected countries in the Middle East, with a 99% population fibre coverage and 96% 5G penetration rate. This was enabled by extensive investment in fibre by the Qatar National Broadband Network (Qnbn) to connect the expanding 5G sites. The achievement is founded on Qatar's National ICT Plan 2015: Advancing the Digital Agenda. Flagship 5G initiatives include making Hamad Port the first 5G-enabled seaport in the Middle East and delivering coverage in stadiums for the World Football Cup in 2022.

The government of Qatar established an independent company (Qnbn) to drive the rollout of a national FTTH network and injected USD 550 million into it. Qnbn focuses on the deployment and management of a passive dark fibre network infrastructure, offering equal and open access to telecommunications service providers on a wholesale basis, and owners and operators of private networks on a retail basis.

The goal of Qatar's broadband plan was for 95% of households to have access to affordable, high-quality broadband service with at least 100 Mbps effective download and 50 Mbps effective upload speeds by 2016, and for the entire population to have a minimum of two broadband retail service providers to choose from, regardless of location. The progress in fibre connectivity of households is illustrated below.

Exhibit 2.10: FBB connections by technology and household penetration in Qatar: 2016 to mid-2024



Source: TeleGeography

With its extensive mobile and fibre infrastructure, and data centre investments, Qatar can support the growth of the digital economy. The social goals of Qatar's broadband plan are built on the ictQATAR strategy which includes, inter alia: (1) innovation and capability building, (2) connected citizens, (3) connected business, (4) connected government, (5) e-Education, (6) e-Health, (7) e-Finance, (8) e-Tourism and sports, and (9) ICT in other sectors of the economy.

2.7 Global Broadband Impact

Previous studies have been done on the impact of broadband on economic development. Of note are studies that have been done that have focused on the differences between the impact of broadband in least developed, developing and developed economies. The results of these studies have been summaries in the exhibit below.

Exhibit 2.11: Summary of studies on the impact of broadband

Study	Coverage	Definitions	Findings
ITU (2019) – Fixed Broadband	139 Developed and Developing Countries (including Africa)	• Developed (GDP per capita > USD 22 000 • Developing (USD 12 000 – USD 22 000) • Least Developed (GDP per capita < USD 12 000)	• Developed: 10% FBB penetration = 1.4% GDP increase • Developing: 10% FBB penetration = 0.5% GDP increase • Least Developed: similar to developing, but not statistically significant
ITU (2019) – Mobile Broadband	139 Developed and Developing Countries (including Africa)	• Developed (GDP per capita > USD 22 000 • Developing (USD 12 000 – USD 22 000) • Least Developed (GDP per capita < USD 12 000)	• Developed: No significant impact • Developing: 10% MBB penetration = 1.8% GDP increase • Least Developed: 10% MBB penetration = 2.0% GDP increase

Source: Frost & Sullivan, 2024

The results from the ITU study are relatively accurate as it utilises the most recent data for broadband penetration and the resulting impact on the economy. It also supports the hypothesis that the economic contribution of fixed broadband increases with the level of economic development of the country. This is an important observation and follows as true for the input-output analysis that is followed in this paper. The converse of this is that significant additional technology and growth opportunities are present in developing markets that can use broadband as a platform for fast-tracked development.

O'Connor et al. (2020) found that in South Africa the potential for employment in the areas with broadband increased by 2.2%. This means that for every 1000 people employed in an area, the addition of broadband would induce a further 22 employment opportunities.

3. FIXED BROADBAND MARKET IN AFRICA

Africa's fixed broadband market is undergoing a transformative phase, marked by significant growth and rapid technological advancements. With active fixed broadband connections projected to increase from 36.4 million in 2023 to 65.4 million by 2030[28], the continent is ready to bridge the digital divide and foster economic development. Fixed broadband growth is driven by the widespread adoption of fibre and fixed wireless broadband (FWB) technologies, which are enhancing connectivity and accessibility across urban and rural areas.

Despite recent advancements, Africa's broadband penetration remains one of the lowest globally, highlighting both the challenges and opportunities within the market[29]. The deployment of broadband infrastructure faces hurdles such as unreliable electricity provision and high costs, yet the potential for economic upliftment through improved digital access is immense. This section reviews the current state of the African fixed broadband market.

3.1 Broadband Africa Vision 2030

In a 2022 white paper[30], Omdia proposed a "Broadband Africa Vision 2030", with the overall goal of connecting every African country with broadband to build a stable, united and prosperous digital Africa. To achieve this goal, the paper proposed three sub-goals:

- Increase the adoption of National Broadband Plans (NBPs) or equivalent policies, such as a digital strategy, with a focus on broadband. All key countries should have a NBP or equivalent plan by 2030.
- Raise broadband availability and take-up in Africa. Average household fixed broadband penetration in Africa should be above 20% by 2030, based on Omdia market data.
- African countries to progress in the global broadband ecosystem, compared to peers. Five African countries should be in the top 50 in Omdia's Fiber Development Index (FDI) by 2030.

Africa's Progress Towards Achieving the Broadband Africa Vision 2030

Adoption of National Broadband Plans

Government-led initiatives in policy and regulation have contributed to the improvement of broadband connectivity in Africa. African governments are increasingly implementing policies and strategies to foster broadband development as a catalyst for socioeconomic growth. By mid-2024, 46 out of the 55 African countries and territories (84%) had national digital development strategies in place (including NBPs). Furthermore, numerous countries are updating their NBPs to digital development strategies to address user demands and technological advancements.

Broadband Availability and Uptake

Africa's broadband market continues to evolve at a rapid pace, supported by the increasing consumer demand for high-speed broadband services. According to TeleGeography's market data, fixed broadband subscriptions in Africa grew by 11% year-on-year in 2023, from 32.7 million in 2022 to 36.4 million in 2023 (see exhibit below)[31].

The fixed broadband household penetration rate increased over the same period by 0.9 percentage points to 12% at the end of 2023. Despite the relatively high growth rates, Africa's household broadband penetration rates remain low due to insufficient coverage. High consumer demand for broadband services and the low broadband network coverage offers a huge potential for broadband development in Africa. Fixed broadband

[28] TeleGeography Global Comms Forecast, 2024

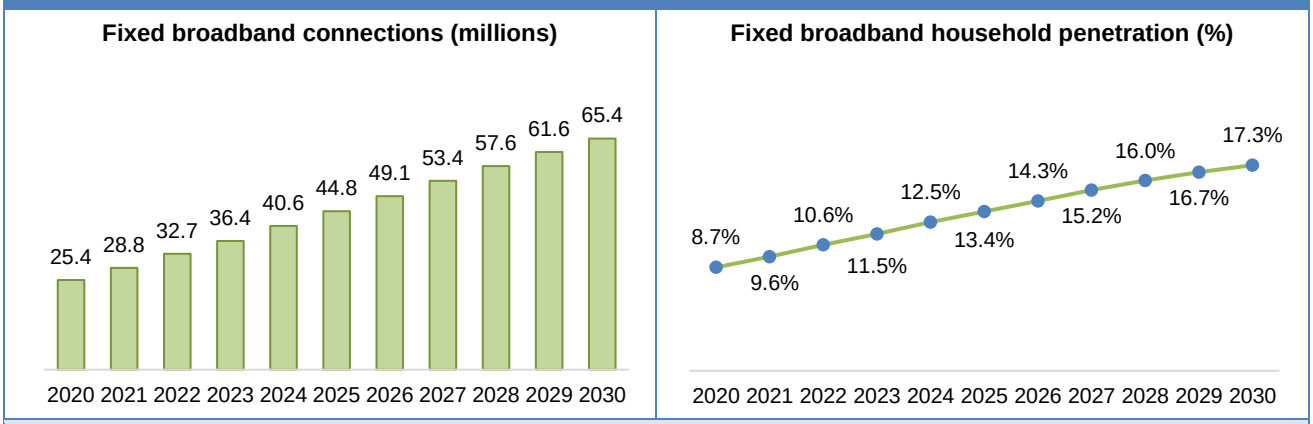
[29] Omdia. Africa Broadband Outlook – 2023.

[30] Omdia. Africa Broadband Outlook 2022.

[31] TeleGeography: Global Comms Database - Global and Regional Totals

subscriptions in Africa are projected to reach 65.4 million and achieve a household penetration rate of 17.3% by end 2030 (see exhibit below)[32].

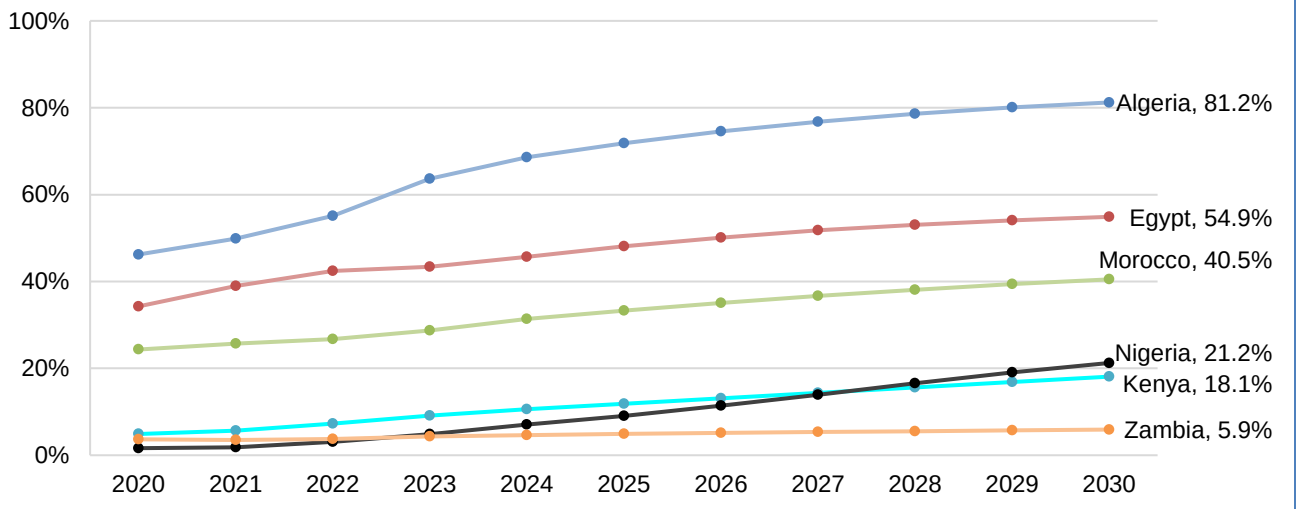
Exhibit 3.1: Africa fixed broadband connections and household penetration rate, 2020 – 2030



Source: TeleGeography Global Comms Database

The exhibit below illustrates fixed broadband penetration rates for selected African countries from 2020 to 2024 and forecast from 2025 to 2030. Given current trends, Algeria is expected to reach fixed household penetration above 80% by 2030, while Egypt is expected to reach 55% by 2030. Although both countries are considered leading African markets in terms of fixed broadband, there are differences between them as far as the mix of access technologies is concerned.

Exhibit 3.2: Fixed broadband penetration rates and forecast for selected African countries, 2020 – 2030

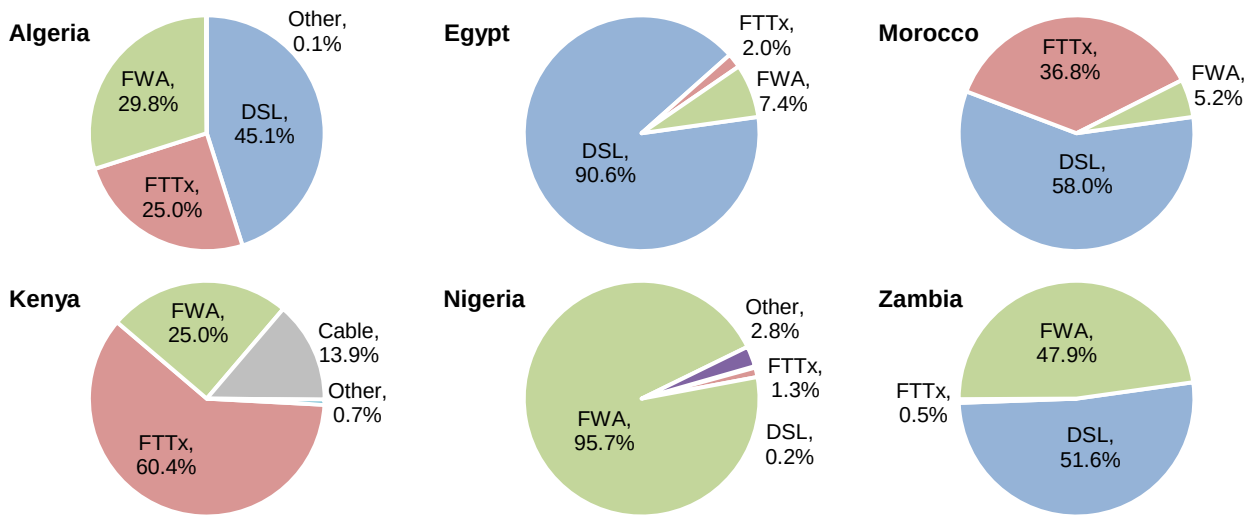


Source: TeleGeography Global Comms Database

[32] TeleGeography: Global Comms Forecast.

A breakdown of fixed broadband connections per access technology for selected African countries is provided below.

Exhibit 3.3: Distribution of fixed broadband access technologies for selected African Countries, mid-2024

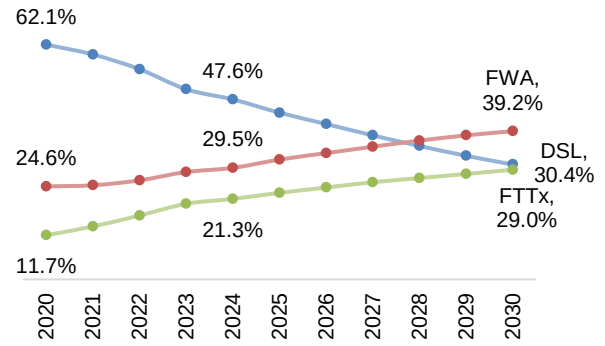


Source: TeleGeography Global Comms Database

FTTx and FWA

The adoption of fibre (FTTx) and fixed wireless access (FWA) technologies continues to increase across Africa, driven by demand for high-bandwidth applications including video calling, UHD/4K-plus video streaming, and real-time gaming. To this end, optical fibre is the most future-proof broadband technology because of its capacity to support high-bandwidth applications and its better energy efficiency and low carbon emissions. FWA is the best complementary access technology for fibre, particularly in areas with limited fibre deployment. In 2023, Africa recorded a significant increase in fibre and FWA adoption, resulting in the number of fibre and FWA connections growing by 29.5% and 21.3% respectively year-on-year. Fibre connections reached 7.1 million and total FWA 10.9 million that year[33]. The estimated share of total fixed broadband connections by major technology type between 2020 to 2030 is shown on the left.

Exhibit 3.4: Share of fixed broadband connections by major access technology, 2020 – 2030



Source: Africa Analysis calculations based on data from TeleGeography's Global Comms Database, 2024

Satellite Communications in Africa

In the global fixed network development, FTTx has surpassed copper and cable technologies, accounting for more than 70% of the market. However, in Africa, the severe shortage of optical fibre assets and the low cost-effectiveness of such services have propelled the rapid development of fixed wireless network technologies. Moreover, satellite communication services have also grown in Africa due to their quick deployment advantage. Satellite In many remote or underdeveloped areas, satellite technology is often the only way to connect to the

[33] TeleGeography: Global Comms Database

internet and other communication networks. In recent years, Africa has seen significant growth in the deployment of low earth orbit (LEO) satellite technology for a range of applications, including internet connectivity, telemedicine, education, agriculture, and disaster management[34].

Several private companies and public initiatives are working to expand LEO satellite coverage across the continent. However, despite progress, there are still some challenges to overcome, such as high costs of terminal devices and a lack of regulatory frameworks that support the deployment of satellite infrastructure. Despite this, with continued investment and innovation, LEO satellite connectivity has the potential to transform connectivity in Africa and support economic growth and development, especially for those living in rural areas.

The rapid growth of LEO satellite and Very High Throughput Satellite (VHTS) across Africa provides massive opportunities for closing the digital divide.

The key features of these services include:

- **Coverage:** As with traditional satellite technologies, LEO satellites have a wide coverage area and a shorter Technology Maturity Model (TMM) than terrestrial network technologies. The ability to connect remote areas and convergence of the mobile and satellite industries makes LEO services an attractive complement to terrestrial networks.
- **Bandwidth:** Currently LEO networks offer a maximum bandwidth of 100 Mbps to 200 Mbps, although typical user experience is 50 Mbps to 100 Mbps. These speeds are lower than offerings based on fibre optic infrastructure globally, but they are equivalent to or better than current fibre offerings in most countries in Africa. Approximately 70% of African users choose 50 Mbps or lower products from their fibre service providers. However, it is unlikely that LEO providers will be able to sustain current delivery due to growth in subscribers and subscriber usage as well as the lack of a unified evolution standard for the LEO industry.
- **Price:** When entering markets in Africa, LEO satellite service providers typically target high-value users with a demand for 100 Mbps connectivity. Prices are generally lower than the prices for comparable products offered by terrestrial network operators. Therefore, high-value users are attracted to the satellite products. However, terrestrial operators in Africa have begun to adjust their offerings as a response to the competition from satellite. Operators in Nigeria, Kenya and Uganda have already taken such action.
- **User experience:** Latency on LEO networks servicing Africa is generally above 100ms due to under-investment in ground stations compared to other regions, and service reliability can be affected by adverse weather conditions. Subscribers requiring low latency and high reliability for using cloud applications or gaming will opt for more robust fixed terrestrial networks where available.
- **Regulation:** Regulation of LEO satellite operators poses a challenge to national regulatory authorities. The extra-territorial nature of LEO services and the ability of LEO subscribers to roam across national borders creates massive regulatory uncertainty in areas such as taxation, licensing, spectrum fees, cybersecurity, online content regulation and cross-border data flows. African countries have adopted different approaches to licensing or permitting LEO services and to the risk of disintermediating national and regional terrestrial network providers.
- At present, with the advantages of wide coverage, high mobility and cost-effectiveness, satellite plays an important role in helping to bridging the digital divide. It will continue to have its place in the portfolio of broadband technologies. However, to support the long-term development of the digital economy, African governments need to support the deployment of domestic communications infrastructure, such as optical fibre networks. Carriers also need to improve the cost-effectiveness of their fixed network products by increasing broadband speeds, providing more affordable products and value-added services (VAS).

[34] Seacom. LEO satellite connectivity within Africa's reach.

Fixed Broadband User Experience

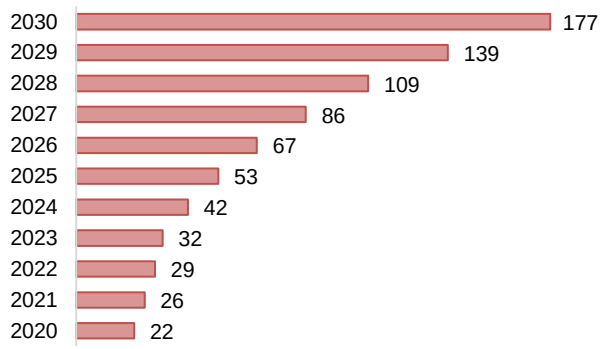
The fixed broadband user experience in Africa has been improving, mainly due to faster download speeds and an expansion of fibre optic networks. In North Africa, countries like Egypt have seen progress in fixed broadband download speeds, with the median fixed broadband download speed reaching 76.5 Mbps in August 2024[35]. Algeria also saw a substantial improvement, with speeds increasing 4.5 times to 14.3 Mbps in August 2024. While countries in Sub-Saharan Africa are slightly behind North Africa in terms of recent fixed broadband speed improvements, there have been notable exceptions. For example, the median download speed for fixed broadband in Zimbabwe increased by 143%, from 9.0 Mbps in August 2023 to 21.8 Mbps in August 2024[36].

Overall, while the median fixed broadband download speed in African countries is improving, the pace of progress varies across the continent, with download speeds in North African countries ahead of the rest of Africa. Continued investment in infrastructure, especially fibre optic networks, supportive policies, and technological advancements will be key to achieving higher speeds and broader access by 2030 across the continent. The derived median download speed for fixed broadband in African countries (including North African countries), is depicted in the exhibit below. The exhibit includes a forecast of the median download speed for fixed broadband up to 2030. The forecast assumes that investment into gigabit broadband networks (for example 50G PON in Egypt and South Africa) will continue and expand across Africa over the forecast period.

Fixed Broadband Pricing

The African fixed broadband market is also being shaped by prices of customer premises equipment as well as tariffs of entry-level packages. Fixed broadband penetration rates tend to be higher in markets where prices of CPE are either waived or subsidized. In South Africa, most internet service providers (ISPs) run a free to use CPE policy. ISPs such as MWEB, Cool Ideas, and MTN SA's Supersonic all offer free-to-use CPEs on their fibre packages. With a free to use policy, the ISP retains ownership of the CPE for the duration of the agreement. At the end of the agreement, the customer has the option to either return the device or purchase it. Although an efficient alternative to attract customers, it is challenging to implement in markets with a lack of know your customer data (KYC) and where bad debt recovery is difficult. In such markets, the upfront purchase of the CPE is required. To counter these challenges, ISPs operating in these markets, increasingly waive the CPE cost if the customers pay upfront for a set number of months. For example, MTN Cameroon waives the cost of CPE if the customer pays two months' subscription upon activation[37].

Exhibit 3.5: Derived median download speed (Mbps) for fixed broadband in Africa, 2020 – 2030



Source: Africa Analysis calculations based on data from Ookla's Speedtest Global Index 2024

[35] Ookla. Speedtest Global Index, August 2024

[36] Ookla. Speedtest Global Index, August 2024

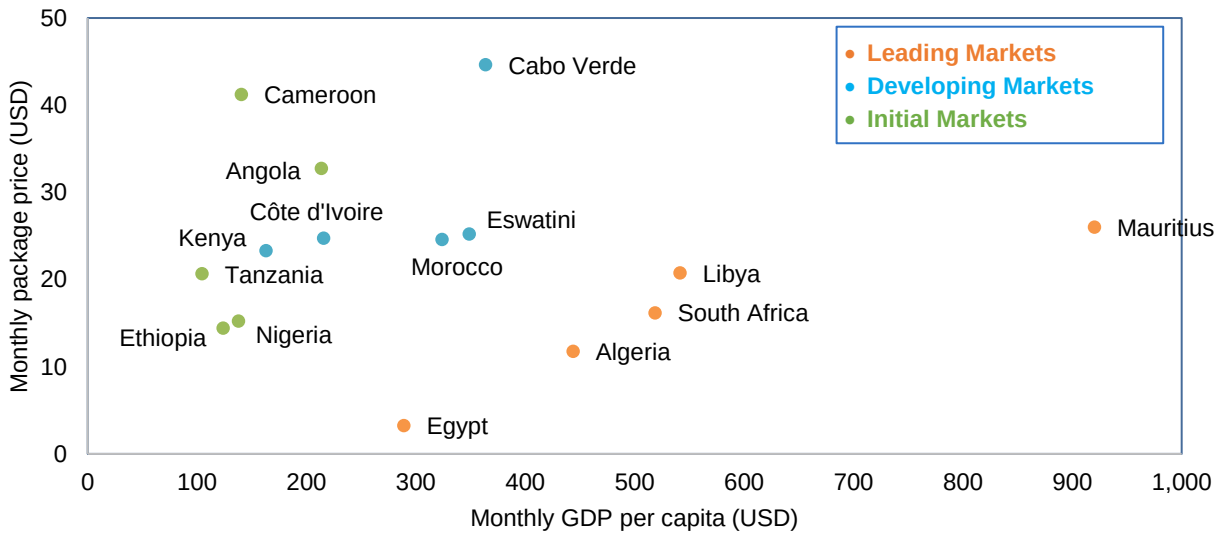
[37] MTN Cameroon. MTN Home Internet

Internet Access Affordability in Africa

Affordability and availability of fixed broadband connectivity remains a key area improvement to ensure the success of digital transformation in Africa. Broadband affordability in Africa remains low because of several factors including high data tariffs, a lack of competition among broadband service providers, and the lack of effective regulatory frameworks around broadband development and fair pricing. High broadband tariffs are detrimental to increased broadband development. Governments should address these factors through successful implementation of policies and regulations.

Entry level FTTH packages were selected from a selection of countries to compare the monthly cost against monthly GDP per capita. GDP per capita was used as a proxy for income. The exhibit below shows a plot of the monthly costs (USD) of entry level FTTH packages for a selection of African countries and their monthly GDP per capita (USD) for 2023. The monthly entry level FTTH package costs for the selection of African countries vary between USD 45 in Cabo Verde and USD 11 in Mauritius. The selection shows that monthly package prices tend to decrease as monthly GDP per capita increases. Mauritius had the lowest monthly FTTH package price but the highest monthly GDP per capita (USD 920). The comparative affordability of a selection of countries is presented below. Countries with the lowest user affordability are in the upper left corner of the graphic.

Exhibit 3.6: Monthly price of entry level FTTH packages vs. monthly GDP per capita for selected countries



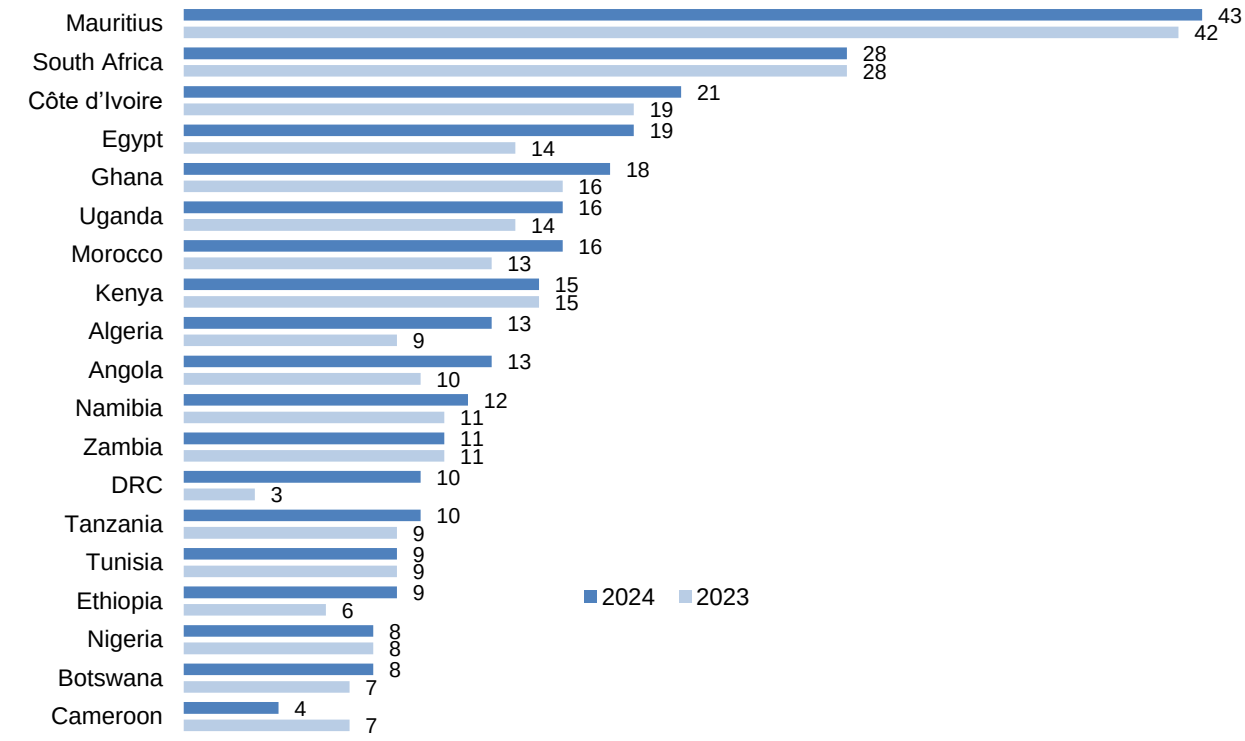
Source: Africa Analysis calculations based on entry level FTTH packages per country. GDP per capita sourced from TeleGeography

Africa's Performance

Based on Omdia's Fiber Development Index (FDI), Africa has made some progress in fibre development[38]. According to the 2023 FDI, nineteen of the 93 countries included in the FDI were from Africa. Mauritius, South Africa, Côte d'Ivoire, Egypt and Ghana are the five highest-ranked African countries. Together with Algeria, Uganda and Morocco, they have high potential to be in the top 50 in Omdia's FDI by 2030. The 2024 FDI ranking of African countries is shown in the exhibit below.

[38] Omdia: Africa Broadband Outlook – 2023.

Exhibit 3.7: Africa Fiber Development Index score, 2023 vs. 2024 (score out of a maximum of 100)



Source: Fibre Development Index Analysis, 2024, WBBA and Omdia

3.2 Segmenting Africa's Fixed Broadband Market

To accelerate the process in achieving the targets set out in the "Broadband Africa Vision 2030" and to consider disparities between Africa countries in terms of their fixed broadband development, this review divides the African fixed broadband market into three segments based on broadband penetration and economic level of development.

African countries are at different stages of economic development, which has an impact on broadband development. The World Bank Group classifies the world's economies into to four income groups namely: low, lower-middle, upper-middle, and high. The classifications are updated each year in July, based on the gross national income (GNI) per capita of the previous calendar year[39]. Based on the World Bank classification, most African countries are classified into the lower-middle-income category. As of July 2024, 42% of African countries were in the lower-middle-income category, 41% were in low-income category, 15% were in upper-middle-income category, and only one country was in the high-income category.

The Seychelles is the only African country classified into the high-income category. Mauritius, South Africa, Algeria, Libya, Namibia, Gabon, Botswana, and Equatorial Guinea are classified as upper-middle-income countries. Mauritius, South Africa and Côte d'Ivoire are the only countries with a score greater than 20 in Omdia's 2024 FDI. Investments infrastructure and broadband have helped to boost these countries' economies. As a result, they record higher GDP per capita.

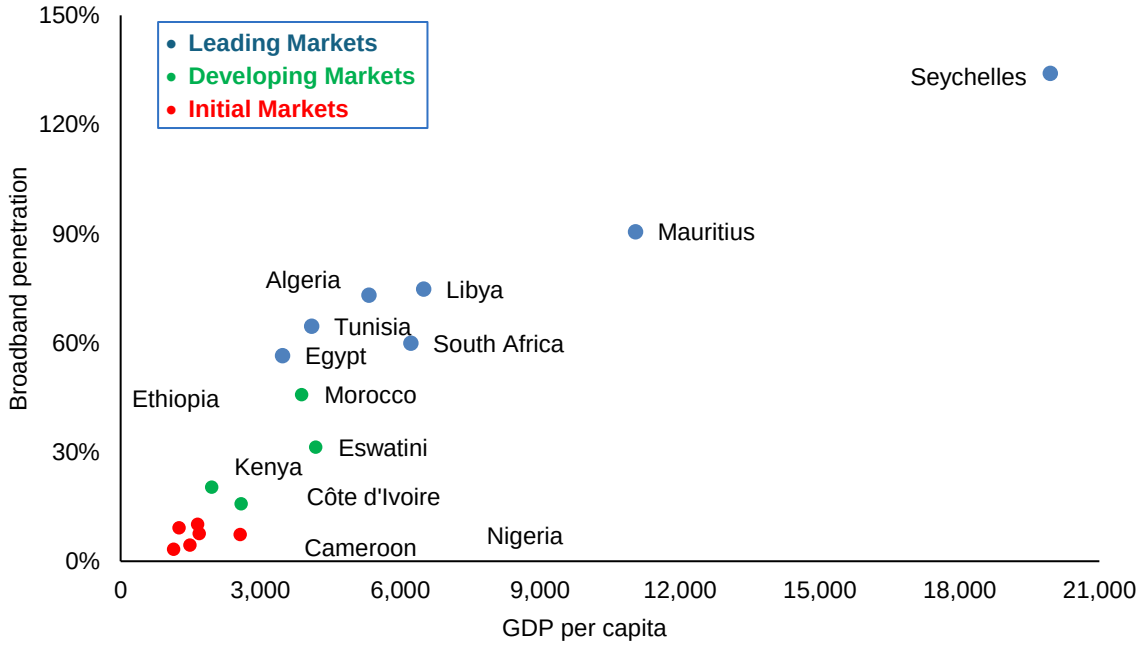
African countries were grouped according to their GDP per capita, fixed and broadband penetration. There market segments were subsequently identified:

[39] World Bank Blogs. World Bank country classifications by income level for 2024-2025

1. **Leading Markets**: These markets have a high level of fixed and mobile broadband development and GDP per capita above USD 3 000.
2. **Developing Markets**: These markets have embarked on broadband development journeys and have seen increased investment in fixed broadband infrastructure and improved regulatory policies, but a second wave of initiatives are required on ensure ongoing development and improvements
3. **Initial Markets**: These countries are characterised by a lack of investment in fixed broadband infrastructure and are and the beginning of their broadband development journey.

Selected countries for each identified market segment are illustrated in the exhibit below. The identified market segments are discussed in more details below.

Exhibit 3.8: GDP per capita vs. broadband penetration for selected African markets, 2023



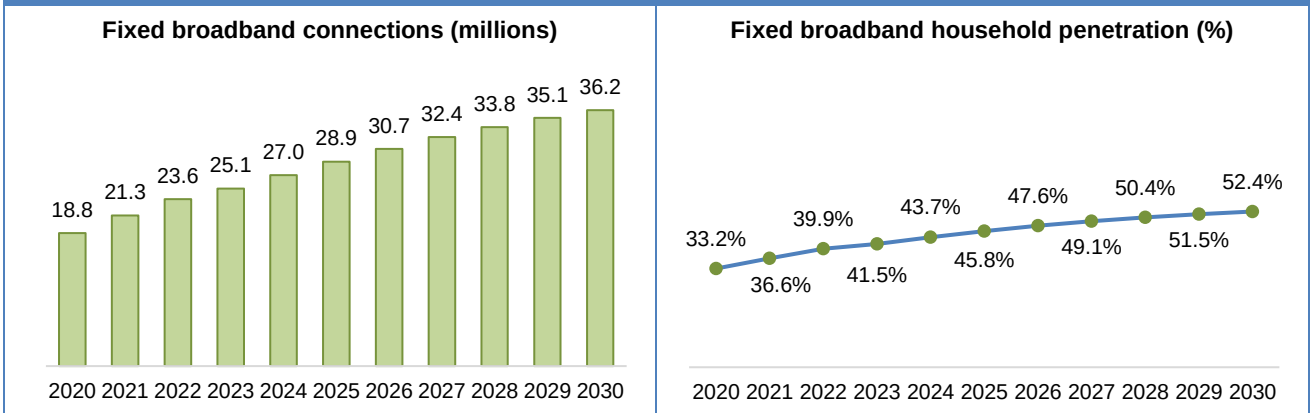
Note: Broadband penetration is a combination of fixed and mobile penetration.

Source: Africa Analysis calculations based on TeleGeography data

3.3 Leading Markets

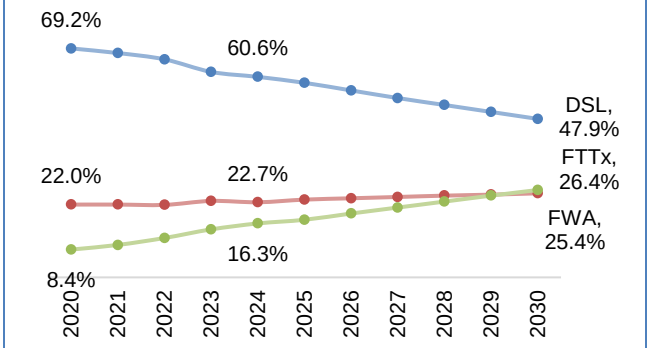
Leading Markets have relatively higher GDP per capita income and have enjoyed significant development in fixed broadband infrastructure. There is also a fair amount of competition in these markets, improving efficiency within the market. This market segment has the largest number of fixed broadband subscriptions in Africa, and the highest household penetration. Household fixed broadband penetration in Leading Markets is expected to increase from 41.5% in 2023 to 52.4% in 2030, a CAGR of 3.4%. Total fixed broadband subscriptions are expected to increase from 24.1 million to 36.2 million in 2030, a CAGR of 5.3%. The growth in fixed broadband subscriptions as well as fixed broadband penetration is expected to slow down between 2023 and 2030. Operators will need to put strategies in place to ensure the growth maintains its pace. Total fixed broadband subscriptions and total fixed broadband household penetration between 2019 to 2030 are illustrated in the exhibit below.

Exhibit 3.9: Leading Markets – fixed broadband connections and household penetration rate, 2020 – 2030



Source: TeleGeography Global Comms Database

Exhibit 3.10: Share of FBB connections by major access technology in Leading Markets, 2020 – 2030



Source: Africa Analysis calculations based on data from TeleGeography's Global Comms Database, 2024

DSL access technologies continue to have a presence in some of the Leading Markets, mainly in Egypt, Algeria, and Tunisia. Fibre is the dominant access technology in Mauritius, while FWA and fibre dominate in South Africa. Mobile broadband penetration is also high in the Leading Markets, with mobile subscriptions exceeding the total population in both the Seychelles and in South Africa. The share of the main fixed broadband access technologies is depicted in the exhibit on the left.

Case Study – Fixed Broadband Development in Algeria

Algeria's fixed broadband market has achieved significant growth over the past five years, with total fixed broadband subscriptions growing from 3.6 million in 2019 to 5.5 million in 2023, a CAGR of 11.5%[40]. This is due to increased demand for high-speed internet access and ongoing government initiatives to improve fixed broadband access in Algeria. Through state-owned operator Algerie Telecom (AT), the Algerian Ministry of Post and Telecommunications (MPT) is committed to achieving two main objectives: (1) increasing the household penetration rate of fixed broadband to two-thirds by the end of 2024, and (2) modernisation of the access network to improve its performance, primarily using fibre optic technology[41]. By June 2024, the household penetration target had been almost achieved[42].

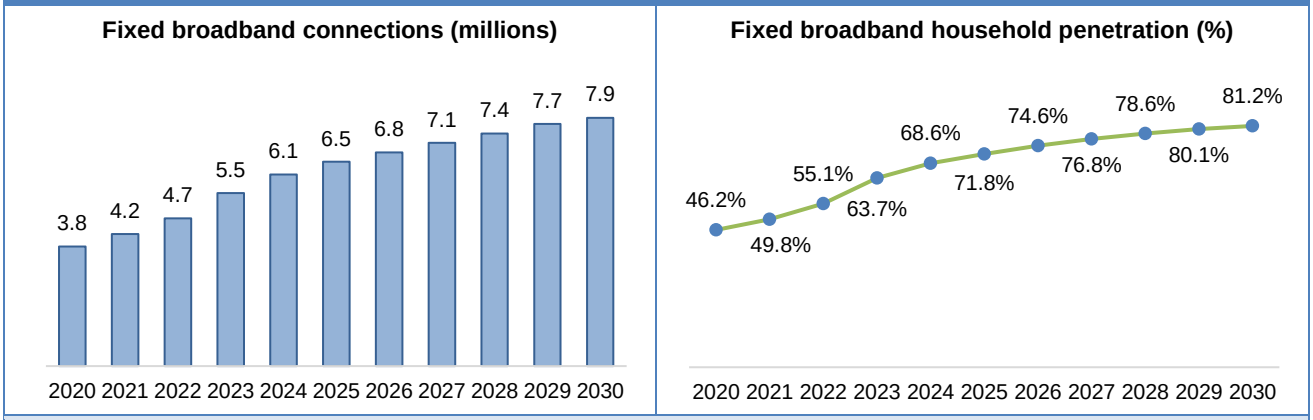
Total fixed broadband household penetration is expected to increase from 63.7% in 2023 to 81.2% in 2030, with connections increasing from 5.5 million to 7.9 million (see exhibit below).

[40] TeleGeography Country Report: Algeria – Fixed Broadband Subscriptions.

[41] Algerian Ministry of Post and Telecommunications – Towards connecting two thirds of households to fixed internet

[42] Algerian Ministry of Post and Telecommunications – Figures and Indicators.

Exhibit 3.11: Algeria – fixed broadband connections and household penetration rate, 2020 – 2030

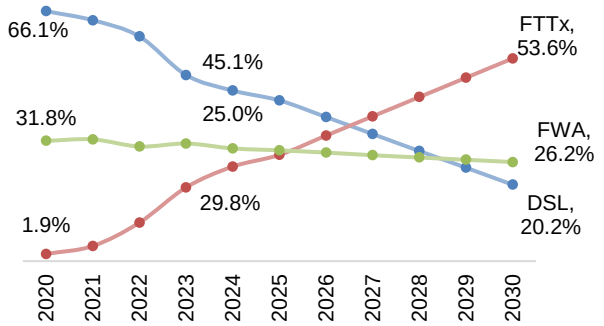


Source: TeleGeography Global Comms Database

Algerie Telecom's FTTH Migration Journey

Algerie Telecom (AT) prioritised the replacement of copper lines with fibre in major cities while maintaining its ADSL services. It also used fixed 4G technology to service areas where wired infrastructure is unavailable or costly to deploy. AT has been rapidly expanding its FTTH/B services since 2018 and in 2023 increased maximum speeds on fibre from 100 Mbps to 1 Gbps for consumers. If Algeria's rapid fibre deployment continues, with corresponding tariff reductions and speed increases, FTTH/B connections could potentially reach 4.1 million by 2030. This is illustrated on the left, along with a breakdown of fixed broadband connections by main access technology.

Exhibit 3.12: Algeria – share of FBB connections by major access technology, 2020 – 2030



Source: TeleGeography's Global Comms Database, 2024

Algerie Telecom's migration plan to FTTH includes a variety of packages designed to meet subscribers' needs. The "Idoom Fibre" offers a range from basic speeds from 10 Mbps to 1 Gbps [43]. Prices are structured to be competitive and accessible, with the 10 Mbps package starting at DZD 1 600 (approximately USD 12) per month and the 1 Gbps package available for DZD 4 200 (approx. USD 31) per month. AT also provides free optical modems and installation for new subscribers, on promotion, to encourage the adoption of FTTH.

To expedite the migration from DSL to FTTx, in October 2024 AT launched an online tool to facilitate such migration. The platform integrates an eligibility checker, enabling business-to-consumer (B2C) and business-to-business (B2B) customers to verify if they can move to a fibre offer and request a subscription[44].

Implementation of Executable Measures for Fibre Deployment

Algerie Telecom and the Ministry of Post and Telecommunications have developed executable measures to ensure ongoing improvement in fibre development in Algeria.

[43] Algerie Telecom. FTTH Packages.

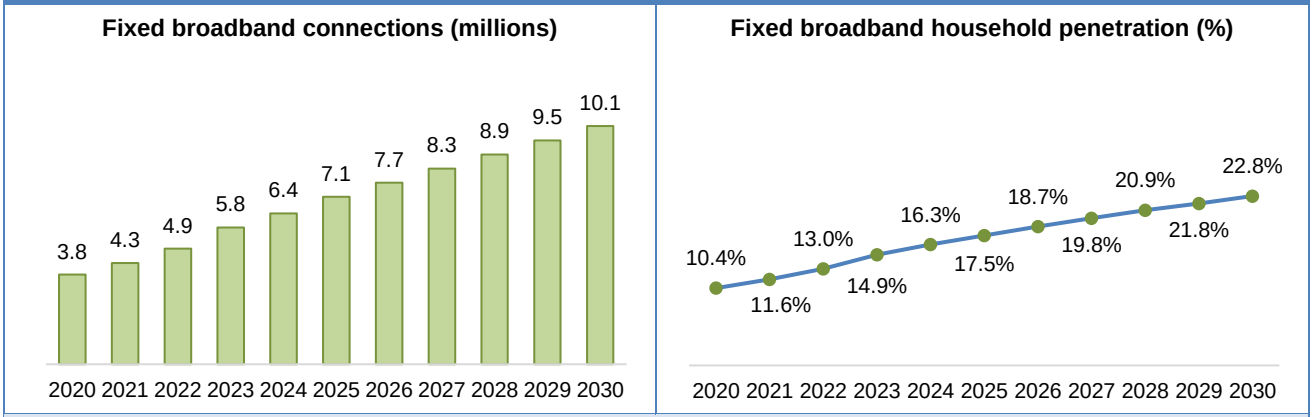
[44] Telecompaper.

- **Fibre pre-deployment**: The implementation of a Memorandum of Understanding (MoU) between AT and the National Agency for Housing Improvement and Development enabled pre-deployment of fibre optic networks in housing developments[45].
- **Fixed broadband speed**: To improve quality of service for customers, AT has introduced a promotion to drive adoption of its Idoom fibre plans, which included a free Wi-Fi 6 router and an upgrade from lower speed plans to 300 Mbps for the first month[46]. The objective is to increase the currently low connectivity speeds in Algeria. In August 2024, the median download speed was 14.3 Mbps (Ookla Speedtest Global Index).
- **Enhancing the fibre backbone and international bandwidth**: Since 2020, Algeria has increased its international bandwidth capacity from 1.5 Tbps to 9.8 Tbps in early 2024[47]. In July 2024, the country has completed a 2 600 km segment of the Trans-Saharan Fiber Optic Backbone project connecting six countries – Algeria, Chad, Mali, Mauritania, Niger and Nigeria. This is an initiative of the African Union's New Partnership for Africa's Development (NEPAD) aimed at continental integration and the development of the digital economy in the region.
- **Keeping Algerian citizens informed on fibre deployment progress**: Algeria's Ministry of Post and Telecommunications (MPT) actively monitors and publicly releases key performance indicators related to broadband development. The MPT publishes monthly updates on its website, including data on FTTH subscriptions[48]. This transparency helps track the progress of broadband initiatives and provides valuable insights into the country's digital infrastructure development.

3.4 Developing Markets

The developing markets segment consists of African countries mainly within the USD 2 000 to USD 4 000 GDP per capita range. Countries in this segment include Morocco, Kenya, Côte d'Ivoire, Senegal, Cabo Verde, and Zimbabwe. These countries are often characterised by high internet penetration through mobile internet access and have initiated fixed broadband development programmes to enhance digital infrastructure through first initiatives. Continued efforts are essential to further enhance fixed broadband connectivity and to support economic development. In general, fixed broadband connections and broadband penetration have increased in these countries since 2019. Further growth can be achieved if second wave programmes and initiatives are implemented and maintained. The exhibit below shows fixed broadband connections and penetration for developing market countries for 2020 to 2024 and a business-as-usual forecast from 2025 to 2030.

Exhibit 3.13: Developing Markets – fixed broadband connections and household penetration rate, 2020 – 2030



Source: Africa Analysis calculations based on data from TeleGeography

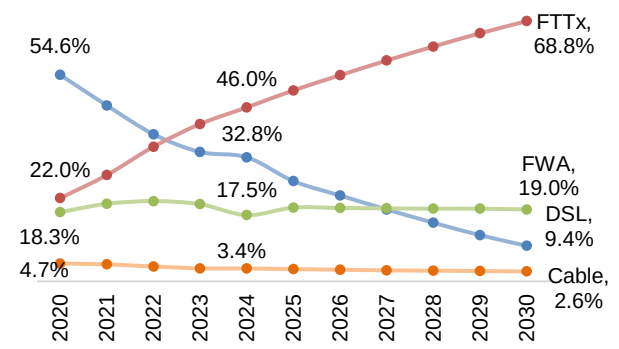
[45] Algeria Eco. Algeria Telecom – AADL: Signing of a framework agreement

[46] Telecompaper. Algerie Telecom offers Wi-Fi 6 modem in 1-month promo for Idoom fibre sign-ups

[47] Waretech.Africa. Algeria Completes 2,600 km of Trans-Saharan Fiber Optic Backbone

[48] Algerian Ministry of Post and Telecommunications. Facts and Figures.

Exhibit 3.14: Share of FBB connections by major access technology in Developing Markets, 2020 – 2030



Source: Africa Analysis calculations based on data from TeleGeography's Global Comms Database, 2024

Renewed investment in fixed broadband infrastructure can result in a high fibre penetration rate in the developing market. A breakdown of fixed broadband connections by access technology type is shown in the exhibit on the left. Fibre access' share of total fixed broadband subscription has the potential to reach 68.8% by 2030. Driving fixed broadband costs down and continued government policy support is needed to ensure that fibre broadband's potential is achieved.

Case Study – Kenya as a Developing Broadband Market Leader

Kenya is being strategically positioned as the leading technological and innovation hub of East Africa and stands at the forefront of mobile broadband connectivity, mobile financial services and a robust ICT infrastructure[49]. It has attracted substantial data centre investments. This could enable Kenya to develop as a regional centre and a testbed for emerging technologies, including cloud computing and AI applications. Global tech companies, such as Amazon Web Services (AWS), have recently selected Kenya for their regional development and edge data centres[50].

Over the past ten years, Kenya has launched a number of initiatives aimed at greater digital development. The key initiatives have been:

- **National Broadband Strategy (NBS) 2013 – 2017** aiming to provide affordable and high-speed broadband to all Kenyans, supporting the country's Vision 2030 goals. Public-private partnerships were crucial in expanding the broadband infrastructure under this NBS.
- **National Broadband Strategy 2018 – 2023** focused on continued fixed broadband expansion, increasing broadband access speeds, and mobile broadband coverage.
- **National Digital Master Plan 2022 – 2032** aiming to leverage and deepen the contribution of ICT to accelerate economic growth, and forming part of the Kenya Vision 2030 plan. One of the plans four pillars was digital infrastructure.
- **Digital superhighway project** (under the digital infrastructure pillar) focused on expanding the fibre optic infrastructure across the country to, inter alia, support the creation of 25 000 public Wi-Fi hotspots and Digital Village Smart Hubs in each of Kenya's 1 450 wards. The expansion of the fibre optic infrastructure is being expedited through the use of the Kenya Power and Lighting Company (KPLC) powerlines to enable the government to build out 100 000 km of fibre optic cables to every part of the country by 2026[51].

Impact of Fixed Broadband

Although not all the initiatives have been completed, they have undoubtedly contributed to the improvement in Kenya's digital infrastructure. This has enabled the Kenyan government to introduce further initiatives, such as

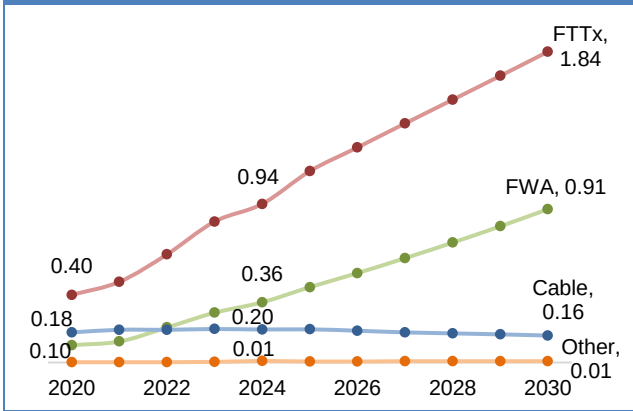
[49] International Trade Administration. Kenya Country Commercial Guide – Information, Communications and Technology (ICT)

[50] Yahoo Finance. Kenya Data Center Market Investment Analysis Report 2024-2029: Nairobi Emerges as Key Hub for Foreign Investments, Global Vendors Dominate Support Infrastructure.

[51] KBC. Kenya Power, ICT Ministry partner to deliver affordable fibre optic network

a digital literacy programme to equip primary school learners with digital skills[52] and the establishment of Haduma Centres for government across the country, all connected to high-speed internet.

Exhibit 3.15: Kenya – FBB connections by major access technology (millions), 2020 – 2030



Source: Africa Analysis calculations based on data from the Communications Authority of Kenya

FTTx connections increased from 268 753 in 2019 to 834 911 in 2023, a CAGR of 32.8%. FWA access connections increased from 70 035 in 2019 to 294 844 in 2023, a CAGR of 43.2%[53]. Fixed broadband household penetration reached around 9% in 2023. FTTx connections could reach 1.84 million and FWA over 908 000 by 2030. The growth of Kenya's fixed broadband connections by access type is illustrated in the exhibit on the left.

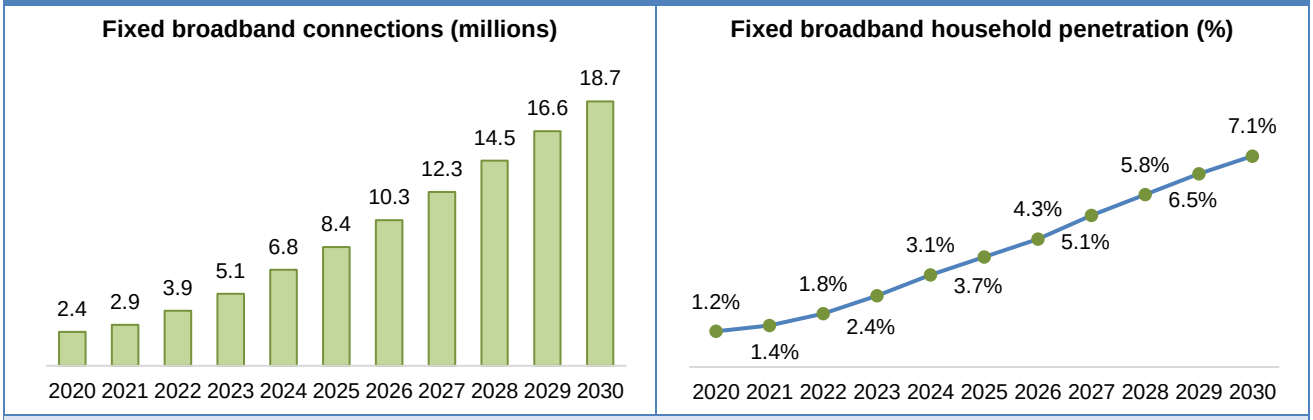
Forty-eight percent of fixed broadband connections had speeds between 2 Mbps and 10 Mbps in 2023 (Communications Authority of Kenya).

In September 2024, Safaricom upgraded its 10 Mbps package to 15 Mbps at KES 3 000 (USD 23) per month, while the 20 Mbps plan was upgraded to 30 Mbps. It also introduced a 1 Gpbs package at KES 20 000 (USD 155) per month.

3.5 Initial Markets

In the Initial Markets of Africa, fixed broadband is still in its emerging stages. Setting up FBB operations and market systems quickly, and triggering early market adoption, presents significant challenges. Most target users are transitioning from mobile broadband, making user experience a critical differentiator. In some cases, the market is highly segmented, with operators facing stiff competition from local ISPs. Despite these challenges, the scale effect has yet to fully demonstrate its potential. The initial setup costs for FBB infrastructure are high, which can often be a barrier to rapid development. The price of FBB packages is usually high and out of reach to the majority of the population.

Exhibit 3.16: Initial Markets – fixed broadband connections and household penetration rate, 2020 – 2030

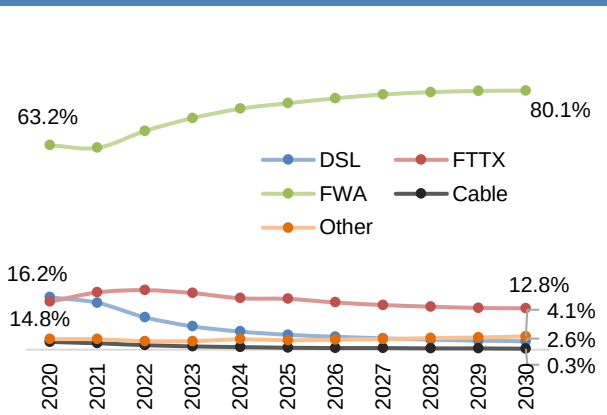


Source: TeleGeography Global Comms Database

[52] ITU. Communications Authority of Kenya National Broadband Strategy

[53] Communications Authority of Kenya. SECOND QUARTER SECTOR STATISTICS REPORT FINANCIAL YEAR 2023/2024

Exhibit 3.17: Share of FBB connections by major access technology in Initial Markets, 2020 – 2030



Source: Africa Analysis calculations based on data from TeleGeography's Global Comms Database, 2024

FBB household penetration in initial markets is low compared to other market segments, with FBB household penetration only at 2.4% in 2023. Total FBB connections in the Initial Markets stood at 5.1 million in 2023, while FWA dominates fixed broadband connections in these markets (see exhibits above and on the left). However, with appropriate government policies and support, and increased infrastructure investment, total FBB subscriptions have the potential to reach 18.7 million in 2030, with a household penetration of 7.1%.

Case Study – Nigeria's Fixed Broadband Market

To alleviate constraints in the national backhaul and last mile infrastructure, limiting access to large bandwidth capacity on subsea cables landing in the country, the Nigerian government has taken various steps to improve the situation.

- National Broadband Plan (2013) aimed to increase penetration of broadband services to 30% and make them more affordable. Various measures included:
  - Policies considering ICT networks and installations as critical national infrastructure.
  - Pricing transparency and reduction of network rollout costs by encouraging infrastructure sharing and interconnection, and introducing price caps where necessary.
  - Regulatory measures to ensure better performance levels in the delivery of broadband services.
  - Facilitation of rapid rollout of mobile and fixed infrastructure, including incentives.
  - Release of more spectrum for broadband services.
- The plan also aimed to foster an attractive investment climate through targeted schemes for stimulating demand and providing targeted concessions, tax incentives, grants or support where needed. While the plan surpassed its connectivity target, most of the subscriptions were mobile 3G and 4G connections.
- National Broadband Plan 2020 – 2025 focusing on increasing broadband penetration to 70% and increasing minimum download speeds to 25 Mbps (urban) and 10 Mbps (rural) by 2025, with data priced at no more than NGN 390 (USD 0.24) per 1 GB.
- National Communications Backbone (NCB) project with the objectives of deploying 120 000 km of fibre across the country, increasing broadband penetration to 70% by 2025, and connecting 60% of communication towers with fibre. A Special Purpose Vehicle (SPV) was established to drive the expansion of the national backbone network at a cost of USD 2 billion[54].
- Project 774 LG Connectivity (February 2024) which will leverage the existing infrastructure of NigComSat and Galaxy Backbone to provide connectivity to all 774 local government secretariats across Nigeria[55].

[54] Nairametrics. FG to launch SPV for delivery of 90 000km of fibre in Nigeria

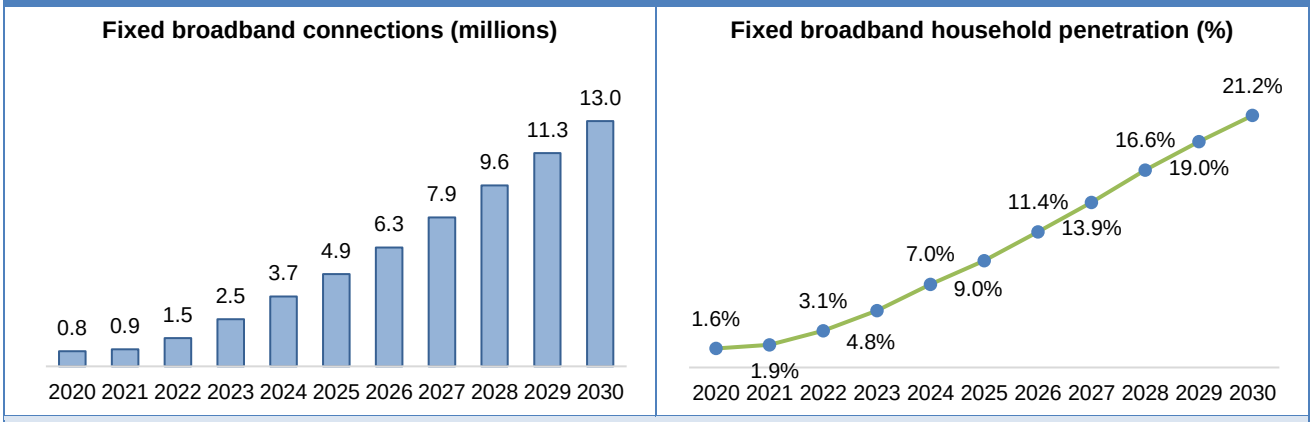
[55] Space In Africa. Project 774 LG Connectivity.

Fixed Broadband Connections

FWA technologies, including fixed 4G and 5G, have seen significant uptake, due to the country's inadequate fixed line infrastructure. By 2023, FWA subscriptions reached 2.2 million, from 525 343 in 2019 (357% increase). Some operators have begun to deploy their own fibre infrastructure to offer more advanced services. FTTH connections reached 32 000 in 2023, from 13 900 in 2019.

The investments committed by the operators and government programmes have improved the outlook for fixed broadband in Nigeria. Total FBB household penetration stood at 4.8% in 2023 (2.5 million connections) and could potentially grow to 21.1% (12 million) by 2030. This is illustrated below.

Exhibit 3.18: Nigeria – fixed broadband connections and household penetration rate, 2020 – 2030



Source: Africa Analysis calculations

3.6 Continental Backbone and International Connectivity

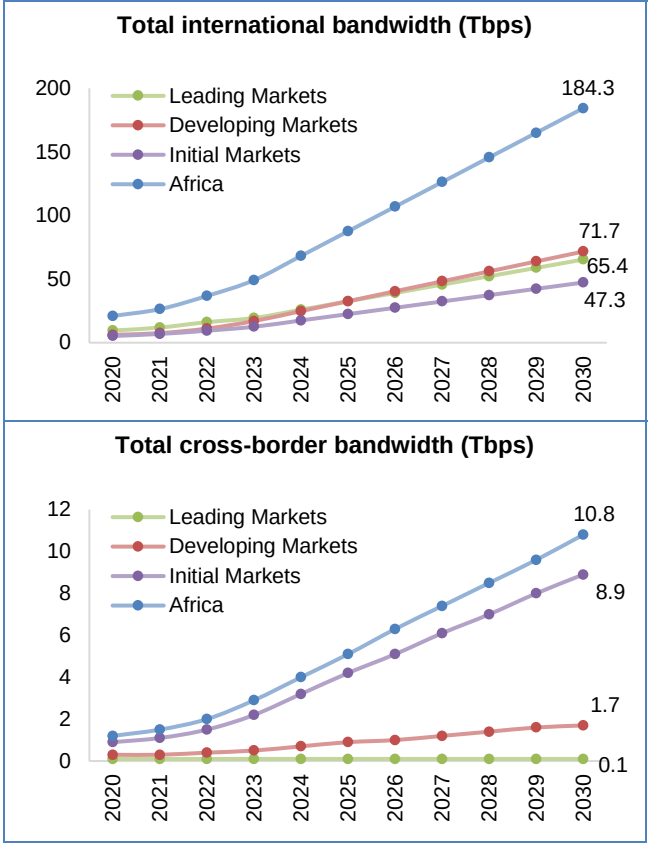
Global international bandwidth usage grew by 22% in 2024 (TeleGeography). Total international bandwidth stood at 1 479 Tbps by October 2024, a four-year CAGR of 25%[56]. Although the pace of international bandwidth growth has been slowing in recent years, it varies across world regions. Africa experienced the most rapid growth of international bandwidth, growing at a compound annual growth rate (CAGR) of 41% between 2020 and 2024. The significant growth is mostly the result of network operators' investments in metro, terrestrial long-haul, and submarine backbone fibre networks during the period. These infrastructure investments have improved internet access for Africa's internet consumers.

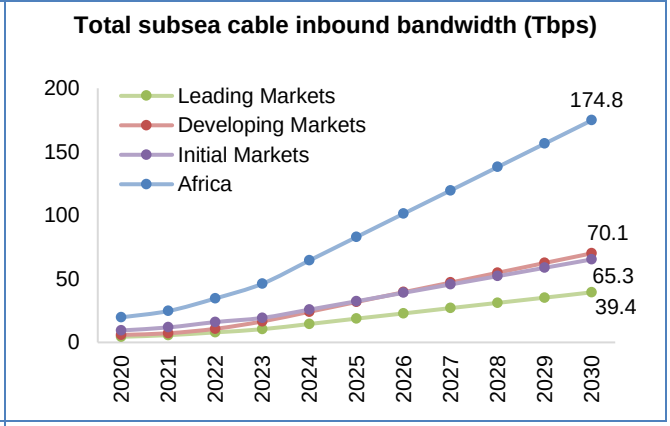
Bandwidth in Africa

Africa's international bandwidth increased substantially between 2020 and 2023. Total international bandwidth in Africa increased from 21.0 Tbps to 49.1 Tbps, a CAGR of 32.7%. Looking across the three broadband segments, the Leading Markets accounted for most of the international bandwidth between 2020 and 2023, increasing from 9.5 Tbps to 19.4 Tbps over the period. The Initial Markets showed a lower growth in total international bandwidth, highlighting the challenges faced in early-stage broadband development, such as infrastructure investment and market readiness. Total bandwidth by market type between 2020 and 2030 is shown in the exhibits below. Note that 2020 to 2023 is historical data, while 2024 to 2030 is a forecast.

[56] TeleGeography. International Internet Bandwidth Connected to Africa has Almost Quadrupled Since 2020.

Exhibit 3.19: Bandwidth by market type 2020 – 2030 Source: Africa Bandwidth Maps, Hamilton Research 2024





The Initial Markets rely more heavily on cross-border international bandwidth, than the Leading and Developing Markets.

The Leading Markets accounted for most of the international bandwidth landing on the shores of Africa via subsea cable systems between 2020 and 2023, indicating the strong demand and investment in high-capacity infrastructure in these markets.

Cost of international bandwidth

International internet bandwidth has an impact on network prices. Globally, network operators' shift to predominantly 100 Gbps internet backbones continues to reduce the average cost of carrying traffic and enables profitability at lower prices. This have resulted in continued price erosion over the last decade. Prices in developing markets that have activated large subsea systems, experienced the greatest change. For example, 100 Gbps wavelength prices between Europe and South Africa declined by 38% post the activation of the Equiano subsea cable, resulting in 10 GigE IP transit prices in South Africa decreasing by 45% in 2023[57]. The example supports the correlation between network scale, competition and price.

Subsea Cable Systems

There are currently 70 active subsea cable systems in the African region, and seven subsea cable systems which are planned or currently under construction[58]. The 2Africa cable is currently the largest cable, spanning 45 000 km, with a capacity of 180 Tbps. It became operational in 2024. The construction of new subsea cable systems is active across Africa, with the aim of improving interconnectivity and intercommunication with other regions.

[57] TeleGeography. International Internet Bandwidth Connected To Africa Has Almost Quadrupled Since 2020.

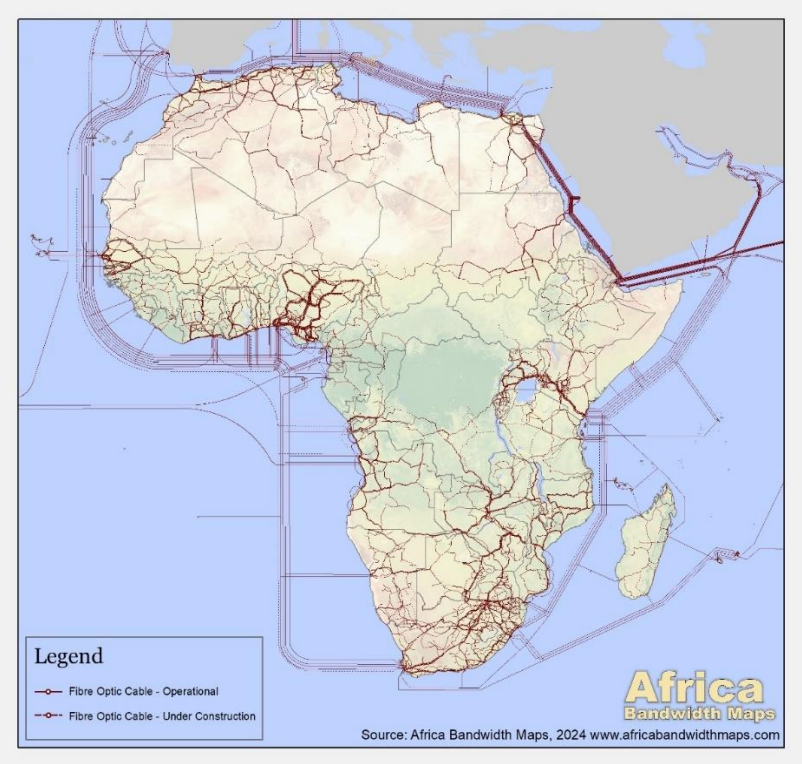
[58] TeleGeography: Submarine Cable Map – Africa

Planned subsea cable systems connecting Africa, include:

- Africa 1, to become operational by the end of 2024
- Coral bridge, operational details to be announced
- India Europe Xpress (IEX), expected to be operational by 2025
- Medusa Submarine Cable System, expected to be operational by 2025
- Raman, expected to be operational by 2025
- SeaMeWe-6, expected to be operational by 2025
- Umoja, operational details to be announced

The increased submarine cable development across Africa will further support growth in the adoption of mobile and fixed broadband services across the region. Subsea cable systems landing in Africa, are illustrated below.

Exhibit 3.20: Subsea cable systems landing in Africa



Source: Africa Bandwidth Maps, 2024

Terrestrial Fibre

A summary of the length of fibre and microwave routes, total and for the three different market segments, is presented below. Africa's total inventory of operational terrestrial fibre optic networks reached 2 139 506 km by June 2024[59]. Total operational fibre across Africa amounted to 1 337 158 km as of June 2024, with 112 373 km under construction, a further 124 179 km planned and 64 671 km proposed. The Leading Markets continue to lead in terms of fibre network extent.

Exhibit 3.21: Regional bandwidth in km by broadband market (June 2024)

Grouping	Developing Markets	Initial Markets	Leading Markets	Africa Total
Total	313 427	1 129 260	686 606	2 130 506
Microwave Operational	17 971	412 164	46 892	477 129
Operational	263 995	920 549	628 529	1 814 287
Microwave Planned	1 607	17 949	0	19 555
Fibre Operational	246 024	508 385	581 637	1 337 158
Fibre Under Construction	12 893	49 076	50 404	112 373
Fibre Planned	30 831	87 682	5 666	124 179
Fibre Proposed	4 101	58 563	2 007	64 671
Total Fibre Inventory	289 401	709 716	622 610	1 622 839

Source: Africa Bandwidth Maps, Hamilton Research, 2024

In May 2024, the Nigerian government announced that it is set to launch a SPV for the delivery of an additional 90 000 km of fibre optic cable to complement existing infrastructure. Upon completion Nigeria's fibre optic cable capacity would increase from 35 000 km to 125 000 km, making it Africa's third-longest terrestrial fibre optic backbone behind South Africa and Egypt[60].

Case Study – Terrestrial Fibre in Africa

Liquid Intelligent Technologies

Liquid Intelligent Technologies' high-speed cross-border network has grown to over 110 000 km of fibre since 2009, offering connectivity to all the main subsea cable systems that link Africa to the rest of the world. Liquid's upgraded regional and national backhaul networks ensure greater service levels for DIA, IPLC and IP Transit services within the region. Liquid offers supplier redundancy as it has access to multiple data centres and multiple cable landing stations. The operator has established three corridors of fibre networks connecting East to West Africa[61].

- The two **central corridors** offer a fully diversified route linking the Indian Ocean cables to the Atlantic Ocean, taking the shortest path. Customers can connect via Mombasa or Dar es Salaam on the east coast and via Muanda or Luanda on the west coast. The route provides onward connectivity to Europe, South America and the USA.
- The **southern corridor** is the most cost-effective route linking the Indian Ocean cables to the Atlantic Ocean. Customers can access all landing stations on both sides of the continent in South Africa.
- The **West Africa network** provides a cost-effective, reliable and secure connectivity solution to all international carriers, multinationals, mobile operators and ISPs.

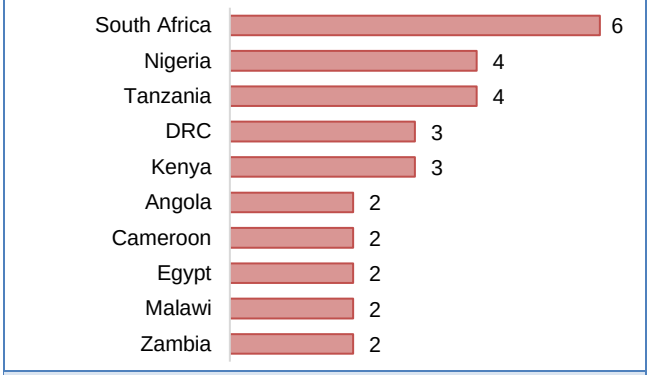
[59] Hamilton Research. Africa Bandwidth Maps, June 2024

[60] IT Web Infrastructure. Nigeria to deploy new 90 000 km terrestrial fibre optic backbone

[61] Liquid Dataport. One Africa Digital Network

Internet Exchange Points

Exhibit 3.22: Top 10 countries in Africa by IXP count



Source: The African IXP Association, 2024

According to the African IXP Association (AFIX), there are currently 56 active IXPs located in 48 cities in 36 countries in Africa [62]. IXPs are core Internet infrastructure services that facilitate large-scale network interconnection and traffic exchange, thereby creating a source of fast, local, cost-effective bandwidth. The top 10 African countries by IXP count is depicted in the exhibit on the left. A complete list of active IXPs in Africa can be found in Annexure A.

Standards on Digital Security for Network Infrastructure and Information Systems for Africa

In 2014, African Union (AU) members adopted the African Union Convention on Cyber Security and Personal Data Protection [63]. To facilitate implementation of the Convention, the African Union Commission (AUC) approached the Internet Society (ISOC) to jointly develop Internet Infrastructure Security Guidelines for Africa [64]. These guidelines were created with contributions from regional and global internet infrastructure security experts, government and Computer Emergency Response Team (CERT) representatives, and network and country code top level domain name system (ccTLD DNS).

The guidelines emphasise the importance of the multistakeholder model and a collaborative security approach in protecting Internet infrastructure. The Guidelines put forward four essential principles of Internet infrastructure security:

- **Awareness:** An understanding of security risks, along with how they can impact others in the Internet infrastructure ecosystem. A preparedness to recognize the risk and manage it and evaluate the impact of actions on oneself and others in the African Internet infrastructure ecosystem.
- **Responsibility:** Taking responsibility for the management of security risks. Due to the fundamental nature of the Internet, one should consider the potential impacts of one's actions, or inactions, on other stakeholders before taking action.
- **Cooperation:** Engage in an ongoing cyber security dialogue that includes actors across borders to effectively counter new and persisting threats. The security of critical Internet infrastructure cannot be achieved alone. There is a need for cooperation and collective responsibility among all stakeholders, not just the government and a selected number of stakeholders.
- **Adherence to Fundamental Rights and Internet Properties:** Actions to manage security risks must adhere to fundamental rights, be transparent, and not infringe upon the fundamental properties of the Internet: voluntary collaboration, open standards, reusable technological building blocks, integrity, permission-free innovation, and global reach.

The guidelines recommend critical actions for various stakeholders to take on internet infrastructure security. These critical actions are tailored to the African cyber security environment's unique features: a shortage of

[62] The African IXP Association: Map of Internet exchange points in Africa

[63] African Union. African Union Convention on Cyber Security and Personal Data Protection.

[64] Internet Society. Internet Infrastructure Security Guidelines for Africa.

skilled human resources; limited resources (including financial) for governments and organisations to allocate for cyber security; limited levels of awareness of cyber security issues among stakeholders; and a general lack of awareness of the risks involved in the use of information and communication technologies (ICTs).

Given the broad nature of Internet infrastructure security, a single framework is not sufficient, and further work is needed to complement the Guidelines with specific recommendations addressing particular issues.

Regional organisations such as the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS) have also implemented policies to strengthen digital security. These policies focus on building robust digital infrastructures, safeguarding critical information systems, and promoting the adoption of best cybersecurity practices.

4. POLICIES PROMOTING BROADBAND DEVELOPMENT IN AFRICA

Robust and resilient national, regional and continental fibre infrastructure is critical to Africa's future and digital transformation. While continued expansion of network coverage is important, some countries (particularly the Leading Markets) have already entered the stage of improving user experience to which the upgrade of existing and deployment of new high-quality broadband networks is vital.

Every African country must have a clear focus on developing and implementing policies promoting broadband infrastructure development. Simultaneously, continental and regional co-operation and harmonisation must be strengthened through implementation of policies that facilitate cross-border traffic and promote the balanced development of communication networks across Africa.

4.1 Pan-African Policies and Strategies

A number of overarching strategies are already in place to provide guidance in the development of ICT infrastructure across the African continent. These can form the basis for greater regional integration and also guide national strategies in the build-out of digital infrastructure.

Agenda 2063 – The Africa We Want

> *By 2063, the necessary infrastructure will be in place to support Africa's accelerated integration and growth, technological transformation, trade and development. This will include high-speed railway networks, roads, shipping lines, sea and air transport, as well as well-developed ICT and the digital economy. A Pan-African High Speed Train Network will connect all the major cities / capitals of the continent, with adjacent highways and pipelines for gas, oil, water, as well as ICT broadband cables and other infrastructure. This will be a catalyst for manufacturing, skills development, technology, research and development, integration and intra-African trade, investments and tourism.*

Agenda 2063[65] is a 50-year master plan for transforming Africa into the global powerhouse of the future. It is the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development.

Communications and infrastructure connectivity is an Agenda 2063 Priority Area, translating the Sustainable Development Goal and Global Digital Compact commitments to build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation into a continental policy instrument.

African Continental Free Trade Agreement (AfCFTA)

The African Continental Free Trade Agreement[66] is a priority programme of Agenda 2063. It has as an objective of promoting the development of cross-border networks in Africa and improving cross-border traffic to strengthen land-based infrastructure and diversify connectivity routes.

The Digital Transformation Strategy for Africa (2020-2030)

The Digital Transformation Strategy for Africa (2020 – 2030)[67] seeks to harness digital technologies and innovation to transform African societies and includes specific objectives linked to broadband infrastructure

[65] Available from https://au.int/en/agenda2063/overview

[66] Available from https://au.int/en/treaties/agreement-establishing-african-continental-free-trade-area

[67] Available from https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf

development. This Strategy builds on existing policies, including AfCTA, the Policy and Regulatory Initiative for Digital Africa (PRIDA)[68], and the Programme for Infrastructure Development in Africa (PIDA)[69].

Broadband infrastructure interventions include:

- By 2030 all African people should be digitally empowered with safe and secure access to at least (6 Mbps) all the time across the continent at an affordable price of no more than (1 cent USD per MB) through a smart device manufactured in the continent at the price of no more than (100 USD). This will allow all to benefit from all basic e-services and content, of which at least 30% is to be developed and hosted in Africa.
- Building a secure Digital Single Market in Africa by 2030 where free movement of persons, services and capital is ensured, and individuals and businesses can seamlessly access and engage in online activities in line with AfCFTA.

ATU White Paper on Connectivity in Africa and Regional Co-operation Framework for Submarine Cable Accessibility

The White Paper on Connectivity in Africa and Regional Co-operation Framework for Submarine Cable Accessibility stresses the importance of access to affordable international bandwidth for all African countries and promotes the idea of virtual landing points to effectively extend submarine cables to landlocked countries.

4.2 What Should Governments Be Doing?

Governments in Africa can implement various measures to enable more efficient development of broadband infrastructure and greater use of broadband services. Six specific measures which can help to achieve the governments' objectives are discussed in this section.

#1: Have a Clear National Broadband Plan

Countries should have a clear national broadband plan which includes credible targets and implementation action steps. The links between implementing a clear national broadband plan or strategy and digitisation are well-established, and the vast majority of African countries have adopted enabling policy for deployment and use of broadband infrastructure.

Keys to the success of these plans / strategies include:

- A primary focus on addressing the digital divide and targeting rural areas.
- Ensuring that targets are credible and progress transparent. Aside from targeting universal access, targets must be regularly reviewed to ensure they are relevant to Gigabit demand in the future.
- Targets should be linked to continental policy frameworks and agreements, as well as international instruments such as the SDGs, the Global Digital Compact (GDC) and the Broadband Commission for Sustainable Development.
- Sources of funding and balanced mechanisms for attracting development finance and frameworks for public / private co-operation.
- Alignment with other government infrastructure policies and strategies, focussing on opportunities for infrastructure sharing across utilities and industries.
- Formulating policies to reduce fibre broadband infrastructure costs, such as fibre pre-deployment and simplified right of way (ROW) process.
- Granular implementation actions required from accountable institutions and entities.
- An all-of-government approach to enable rapid deployment of broadband infrastructure and affordability of broadband services.

[68] Available from https://prida.africa/

[69] Available from https://au.int/en/ie/pida

Example: A Gigabit Optical Broadband Strategy for South Africa

In November 2023 the Minister of Communications and Digital Technologies endorsed a Gigabit Optical Fibre Strategy including a review of existing broadband connectivity targets to future-proof them against anticipated demand.

The exhibit below sets out the detailed targets.

Exhibit 4.1: South Africa updated broadband access targets

Indicator	Baseline (2022)	By 2026	By 2030	By 2035
Infrastructure	• Households passed with fibre: 27% • Fibre to site: 55%	• Households passed with fibre: 55% • Fibre to site: 70%	• Households passed with fibre: 65% • Fibre to site: 90%	• Households passed with fibre: 75% • Fibre to site: 95%
Households	• Approx. 24% of all households (mainly urban), using various fixed technologies • Households connected on fibre: 10%	• Rural: 95% at min. 20Mbps • Urban: 95% at min. 100Mbps • Households connected on fibre: 17%	• Rural: 95% at min. 100Mbps • Urban: 95% at min. 200Mbps • Households connected on fibre: 28%	• Rural: 95% at min. 300Mbps • Urban: 95% at min. 500Mbps • Households connected on fibre: 45%
Institutions of learning	Broadband connection: • Approx. 30% for admin purposes only • Approx. 20% for teachers and learners	• Tertiary level institutions: >95% at gigabit connection	• Primary and secondary level institutions: >95% at gigabit connection	
Health facilities	Broadband connection: • Approx. 5% of public facilities • Over 90% of private facilities	• In urban areas: >95% at gigabit connection	• In rural areas: >95% at gigabit connection	
Public sector facilities (government offices)	• Approx. 2% of public sector facilities	• In urban areas: >95% at gigabit connection	• In rural areas: >95% at gigabit connection	
SMMEs	• Est. 75% use FBB purchased by the organisation			• 80% at gigabit connection

Notes:
- Fixed broadband (FBB) includes xDSL, FWA, FTTH / FTTB, WTTx.
- SMMEs considered are formal (registered) companies only.
- Many micro and some small companies use FTTH (rather than proper FTTB) connectivity, especially if they operate out of a home office.

Source: Africa Analysis

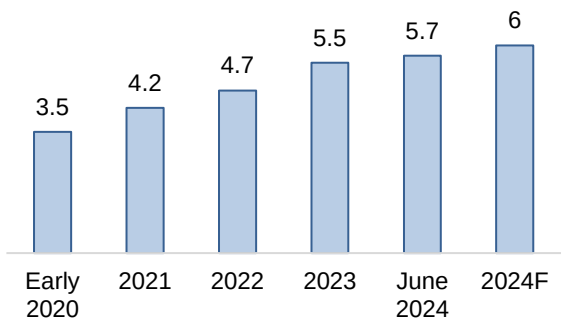
The Gigabit Optical Fibre Strategy outlined practical actions to be taken by the Minister to realise these targets, including:

- Establishing a Digital Infrastructure One Stop Shop (DIOSS) offering an online portal as a single point of entry for applications for wayleaves and other permissions required from government entities. This should be linked to the national broadband infrastructure GIS database and allow tracking of applications against defined periods for processing.
- Reducing and standardising fees charged by government entities for access to the road reserve and other government infrastructure required for broadband infrastructure deployment.
- Pursuing amendments to the National Building Regulations to mandate pre-provisioning of fibre infrastructure.
- Implementing incentives for broadband infrastructure deployment to underserved areas and mandating infrastructure sharing across industries.

Example: Government Support in Algeria

To support ambitious fixed connectivity targets set for the end of 2024, the Algerian government committed to increasing connected households while developing and modernising Algeria's access network, primarily through FTTH deployments.

Exhibit 4.2: Growth in the number of households with a fixed internet connection (in millions)



Source: Ministry of Post and Telecommunications, Algeria, 2024

Specific measures undertaken include:

- Requiring state utilities for electricity, rail and telecommunications to jointly deploy and to share fibre network infrastructure to increase available international bandwidth from 1.5 Tbps (2020) to 9.8 Tbps (2023).
- Requiring fibre pre-provisioning.
- Monitoring progress in deploying connectivity through set Key Performance Indicators (KPIs), with information publicly available on the website of the state telecommunications company.

The success of this strategy and the Algerian government's commitment to a Gigabit broadband

#2: Facilitate Rapid Deployment of Broadband Infrastructure

Inefficiencies at the broadband infrastructure deployment stage introduce delays and inflate pricing throughout the broadband value chain. Creating a continental, regional and national optic fibre fabric, complemented by access fibre and other technologies, is the first key step to a digital future for Africa. Policies should facilitate rapid deployment of broadband infrastructure, including fibre pre-provisioning requirements.

Governments should:

- Simplify and harmonise the broadband network deployment process by adopting policies that eliminate unnecessary administrative requirements and procedures during network deployment.

Standardising Local Government Rules for Deployment

South Africa has passed Standard By-Laws for the Deployment of Electronic Communications Facilities[70] to create a uniform, faster approach by local government to processing ROW applications. The Standard By-Laws are available for adoption by local government.

While this process is at an early stage, there are encouraging signs of local government recognising the value of a standardised approach. The South African government is reinforcing the Standard By-Laws through its broad Operation Vulindlela infrastructure programme[71] and through a specific intervention to provide training to municipal managers and councillors on the benefits of broadband infrastructure for businesses and residents[72].

- Reduce and harmonise tariffs and fees for deployment, which should be based on a cost-recovery model.

[70] Available from https://www.ellipsis.co.za/wp-content/uploads/2023/03/Standard-Bylaws-for-Deployment-of-Electronic-Communications-Facilities-GG-48113.pdf

[71] See https://www.thepresidency.gov.za/node/4892

[72] Online Broadband Fundamentals for Smart Communities Development: Digital Councillor Empowerment Programme, see https://www.dcdt.gov.za/media-statements-releases/519-online-broadband-fundamentals-for-smart-communities-development-digital-councillor-empowerment-programme.html

- Enforce an efficient infrastructure sharing regulatory regime, both between operators and also across different public utilities and infrastructure sectors. Detailed constructions specifications for sharing of poles and pipes must be emplaced to protect against damage and facilitate maintenance by sharing parties.

Rapid Deployment Through Infrastructure Sharing

A key element of the Kenyan Government's Digitalisation Agenda through the Digital Superhighway is the use of Kenya Power Company infrastructure for rapid deployment of middle-mile and last-mile fibre networks, particularly in rural areas. The project will utilise existing electricity infrastructure, as well as seeing fibre networks being rolled out in new electrification projects. As a result, any household with a Kenya Power meter will have access to high-speed fibre internet.

The government of Kenya will realise substantial savings through the agreement entered into between Kenya Power and the Ministry of Information, Communications and the Digital Economy, while a deadline for installing 100 000 km of fibre cabling has been moved forward from 2027 to 2026[73].

- Make government infrastructure available for network deployment and incorporate FTTH infrastructure alongside other bulk infrastructure in new housing developments.

South Africa's National Rapid Deployment Policy

South Africa finalised its National Policy on the Rapid Deployment of Electronic Communications Facilities and Networks[74] in 2023, with the objective of facilitating deployment of broadband infrastructure on public and private land.

The policy has a strong focus on the role of government and intergovernmental co-operation:

> *All spheres of government must enable the rapid deployment of broadband infrastructure to enable universal digital services. Red tape across government spheres must be reduced to eliminate delays in granting approvals and minimise costs for the deployment of broadband infrastructure.*[75]

The government has committed to:

- Recognising that broadband networks are key infrastructure necessary for socio-economic development and attainment of national developmental, social and economic goals and objectives.
- All government entities must give access to servitudes for infrastructure which they control, including roads, power lines, water pipelines, sanitation pipelines and railway lines, for the deployment of digital infrastructure.
- Government entities must further share property and infrastructure such as high sites, pylons, poles, pipes and ducts with operators of electronic communications infrastructure for purposes of broadband deployment.

[73] See https://www.kenyanews.go.ke/fibre-optic-connections-deal-to-save-sh170bn-owalo/

[74] Available from https://www.ellipsis.co.za/wp-content/uploads/2023/04/National-Policy-on-Rapid-Deployment-of-Electronic-communications-Networks-and-Facilities.pdf

[75] National Policy on Rapid Deployment of Electronic Communications Facilities and Networks, para 1.3.

#3: Attract Development Finance

Attaining Agenda 2063 and national broadband infrastructure and connectivity goals will require massive investment across the continent. Creating a favourable environment that attracts private sector investment in infrastructure, such as fibre networks, base stations, satellite gateway earth stations and data centres is important for every African country.

Insufficient focus on establishing a national fibre optic backbone is holding back affordable broadband access: the lowest cost method of delivering high-capacity broadband access is via a national fibre backbone network whose additional cost to connect an ISP approaches zero in the long run. Since the high costs of construction and operation limit private firms' willingness to invest, it becomes the responsibility of the government to either encourage private sector to invest in the national fibre backbone, or itself invest in such infrastructure.

Key steps to be taken include:

- Clearly define the rights and obligations of licensees and deployment and service requirements, facilitating the making of informed investment decisions. Policy and regulatory certainty attract favourable investment decisions.
- Maintain technology-neutral regulatory, licensing and spectrum policy principles to facilitate an appropriate technology mix, particularly for the last mile.
- Regardless of the ownership and operation of backbone infrastructure, regulate it as an Open Access network where all market participants enjoy non-discriminatory access.
- Support competition at all stages of the broadband delivery value chain.
- Provide subsidies from universal service access funds and mechanisms such as tax exemptions and public private partnerships to support broadband infrastructure deployment in rural and low-density areas.
- Consider providing funding to government agencies to construct and operate the national backbone, especially to unserved and underserved areas
- Promote regional harmonisation of licensing and access practices for satellite systems and earth stations.

Example: Subsidising Deployment of Broadband Infrastructure Through a Dedicated Fund

South Africa established a Broadband Access Fund as a component of connecting communities and households under its South Africa Connect National Broadband Policy[76]. The fund is managed by state-owned companies which also provide backhaul and enabling services to participating micro, small and medium enterprises (MSMEs).

The fund provides subsidies to private broadband infrastructure and connectivity providers to expand their networks to eligible low-income areas where affordable broadband solutions do not currently exist. Specific locations – rural and urban – are identified as eligible for funding while private sector entities can also propose their own locations (provided they meet the eligibility criteria).

A build-operate-maintain model is utilised to deploy fibre-based access networks with options for wireless delivery of household connections. Private providers invest their own capital to deploy and maintain networks and remain the owners and operators of these networks. For approved projects, subsidies will be paid to providers on a per home connected basis. The amount of the subsidy depends on the nature of the solution deployed and the number of households to be connected.

Government noted in September 2024 that it had reached an initial target of connecting one million households through the fund.

[76] Available from https://www.ellipsis.co.za/wp-content/uploads/2013/10/NBP-2013.pdf

#4: Fibre Pre-provisioning

A key emerging intervention is for governments to mandate fibre infrastructure deployment for new public and private sector developments and develop appropriate fibre pre-provisioning standards suitable for all new buildings (and renovations).

The benefits at all levels of pre-provisioning are substantial:

- At a country level, pre-provisioning facilitates achieving continental and national policy objectives relating to rapid deployment of broadband infrastructure, universal service and affordability.
- Linking pre-provisioning to affordable housing initiatives ensures that this intervention targets consumers currently without access to good quality broadband connectivity and disadvantaged through the digital divide.
- For consumers, connectivity is instantly available without the need for disruption and potential damage to property.
- Pre-installed connectivity also increases real estate values.
- For infrastructure providers, pre-provisioning allows sharing of infrastructure deployment costs which reduces capital expenditure while simplifying infrastructure provider business models and processes to issue permits for infrastructure deployment.

As a result, more than 20 countries have adopted policy and plans providing for pre-provisioning of fibre networks. In Africa, Algeria, Côte d'Ivoire, Egypt, Kenya and Libya have taken steps towards implementing pre-provisioning requirements.

African governments should take steps to mandate the installation of fibre infrastructure in all new buildings and building upgrades, in compliance with a specified standard.

Case Study: Kenya National Building Code 2024

Kenya's initiative to mandate pre-deployment of fibre infrastructure is a continent-leading intervention.

The National Building Code 2024[77] was launched on 17 July 2024 with explicit support for fibre pre-provisioning as a means to facilitate cheaper rapid deployment of fibre reticulation and FTTR networks. The Code will come into force in March 2025.

> *328(6) The telecommunication installation in a building shall have:*
>
> *(a) at least one network termination point within each dwelling unit with ducting for the network termination point;*
>
> *(b) a telecommunication service duct that is separate from other utility ducts;*
>
> *(c) a cabinet or enclosure for installation of telecommunications equipment; and*
>
> *(d) a common entry duct that is connected from within the building to an access point that is installed beyond the boundary of the construction site.*
>
> *(7) The telecommunication installation in a building shall be designed and installed in accordance to KS 1882-1 (Installation of telecommunication cables – Code of practice - Part I: Fibre optic cable in buildings).*

[77] Available from https://aak.or.ke/download/national-building-code-2024/

#5: Broadband Infrastructure Protection

The growth and security of African countries is increasingly dependent on a modern, resilient broadband network. Broadband infrastructure is, however, susceptible to vandalism, theft and cyberattacks, leading to outages that have a broad economic and social impact. Damage to broadband infrastructure disincentivises investment and drives up costs across the vale chain.

Government should seek to:

- Take steps to classify broadband infrastructure as critical or essential infrastructure and criminalise intentional damage to or interference with this infrastructure. Create sanctions for offences which effectively disincentivise broadband infrastructure theft and vandalism, including cyberattacks.
- Develop a Critical Infrastructure Protection Plan that facilitates collaboration between network providers, regulatory bodies and government (including law enforcement agencies).
- Create and maintain a broadband infrastructure database and mandate additional security measures for important broadband installations.
- Emplace standardised procedures for incident reporting and response by operators and the public.
- Conduct ongoing public awareness and education programmes emphasising the importance of broadband infrastructure and the need to protect it.

Example: Nigeria Designates Broadband Infrastructure as Critical Infrastructure

Over the past two years Nigeria has suffered from several internet outages due to sabotage to fibre optic cables. As a response, the Nigerian government in June 2024 published the "Designation and Protection of Critical National Information Infrastructure Order, 2024"[78] under the Cybercrime: Prohibition, Prevention, Etc Act 2015, as amended[79], in order to provide greater protection for investments in broadband infrastructure and a more robust and resilient national backbone.

The effect of the Order is to designates all telecommunications infrastructure – including fibre optical cables, ducting and associated systems – as Critical National Information Infrastructure (CNII). This means that any intentional damage to or interference with telecommunications infrastructure has been criminalised, with heavy sanctions applicable, including imprisonment without the option of a fine.

#6: Fibre Broadband Experience Supervision

Having a clear, shared and accessible record of existing broadband infrastructure and being able to monitor the performance of this infrastructure is essential to effectively target connectivity gaps and focus strategies to address the digital divide.

Governments should:

- Identify all sources of spatial data relevant to broadband infrastructure deployment (e.g., licensees, local government), standardise the collection of this data and ensure that it is contained in a central database which is regularly maintained.
- Assimilate this data into strategies to address the digital divide and use it to ensure that national broadband connectivity targets remain relevant.

[78] Available from https://cert.gov.ng/ngcert/resources/cnii-gazette.pdf

[79] Available from https://cert.gov.ng/ngcert/resources/CyberCrime__Prohibition_Prevention_etc__Act__2024.pdf

ITU Africa Broadband Maps Project

The AfricaBBMaps Project – launched in July 2024 – aims to produce comprehensive broadband mapping resources and systems in 11 African countries: Benin, Botswana, Burundi, Ethiopia, Côte d'Ivoire, Kenya, Malawi, Nigeria, Uganda, Zambia and Zimbabwe. See https://bbmaps.itu.int/bbmaps/.

Data collected will be used to identify gaps in internet connectivity in the targeted countries. By addressing these gaps, the project aims to support data-driven decision-making for investments in digital infrastructure.

- Make this database generally available, subject to reasonable restrictions – the more open the database, the more its information can be used for planning purposes, infrastructure sharing and avoiding damage to existing infrastructure.

GIGA

GIGA is a UNICEF-ITU global initiative to connect every school to the internet and every young person to information, opportunity, and choice. A key element is Giga Maps, which aims to build a global, dynamic map showcasing the status of school connectivity in the world, including Africa.

GIGA has a number of tools for infrastructure mapping – https://maps.giga.global/map - and governments and internet service providers are encouraged to participate.

- Build a fixed broadband experience supervision platform which allows real-time monitoring of performance across the national backbone and feeder networks.

5. SOCIO-ECONOMIC BENEFITS OF BROADBAND

Key benefits to broadband investment and penetration can be measured by the resulting impact on GDP, employment and general social welfare. It is important to distinguish the difference between fixed and mobile broadband penetration as these have differing impacts on countries, depending on their level of economic development. Generally, least developed countries benefit more proportionally from investment into broadband (especially mobile broadband) than developed economies, as the least developed economies come off a low development base with low broadband penetration and a small proportion of investment will have a significant impact on their relative GDP.

5.1 Implications of Fixed Broadband Investment for African Economies

The socio-economic impact of FBB on economic growth, job creation and social welfare are extensive and are ever-increasing with the advent of new technologies and IoT systems that are reliant on connectivity. These impacts extend through the entire economy through various industries to enhance growth and influence social sectors with education and healthcare.

Technology Enablers

Access to broadband and FBB will allow industry and service sectors in the economy to take advantage of technologies that will enhance the ability of these sectors to generate revenue. The efficiencies and possibilities of new business models enabled by these technologies will filter through the backward and forward linkages in the economy to also allow greater value-added benefits to GDP.

Exhibit 5.1: Examples of technology enablers

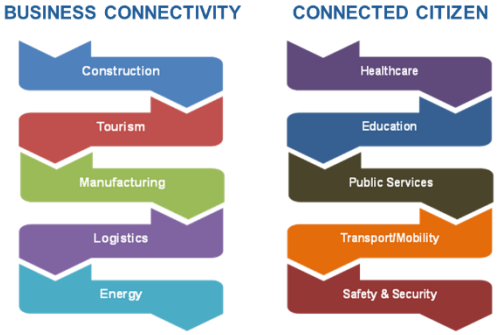
Cloud Computing	Edge Computing	Financial Services / Banking
Artificial Intelligence (AI)	Internet of Things (IoT)	Blockchain

These technologies will impact on the economic sectors to improve efficiencies and revenue generation. Connectivity will also have a direct impact on various segments of the economy due to enabling and improving the ability to share information. For FBB to have its full potential impact on the economy, the enabling technologies, the private sector (business), the government and the private citizens all partake in the creation of additional revenue and socio-economic benefits.

Within the economic sectors, the mechanisms whereby economic benefits are realised, can be described in the exhibit below. Each of these mechanisms allow a socio-economic impact for business or private citizens.

Exhibit 5.2: Impact of technology on business and consumer environments

Impact of technology across different business and consumer spheres



Socio-economic impact mechanisms

Source: Frost & Sullivan, 2024

Business Connectivity

As broadband connectivity is essential for the operations of business, we have grouped certain economic sectors under 'business connectivity' to showcase the ability of broadband investment to enhance business operations and to even allow formation of new business opportunities.

Existing Business

Fast broadband can help small, medium-sized and micro enterprises (SMMEs) work more efficiently, create new products, and develop better service models.

Benefits of Fixed Broadband

- **Real-Time Collaboration**: SMMEs can use software tools and cloud apps for video conferencing, which are often difficult to access on busy mobile networks, which may also lack in quality of service. This allows teams to collaborate easily and make decisions faster.
- **Cost Savings**: FBB can reduce travel costs by enabling effective remote communication.
- **Improved Customer Interaction**: Businesses can enhance how they engage with customers and may even change or expand their services. e-Commerce and online shopping with delivery tracking become more feasible.
- **Supply Chain Efficiency**: FBB helps businesses manage their supply chains better, reducing the need for large stock levels by allowing real-time collaboration and order tracking.
- **Flexible Work Options**: Employees can work productively from home, while traveling, or outside regular business hours. FBB supports bandwidth-heavy services, such as video conferencing, enabling teams to work together seamlessly from different locations.

New Business

The key advantage of FBB investment in an economy is the ability to lower the barriers to entry for startups and new businesses. FBB is combined with cloud computing to allow significant capital savings in starting a business. The speed of FBB connectivity will also then allow any business to scale their operations as required without significant capital expenditure.

Connected Citizen and e-Government Services

Broadband connectivity can greatly improve social welfare for connected citizens by enhancing government services. This not only helps citizens but also reduces costs for the government through increased efficiency and savings.

Benefits of Broadband Connectivity

Numerous social and economic benefits are associated with good quality broadband connectivity.

- **Social and Economic Gains**: While it is difficult to measure all the social benefits, studies show that broadband access leads to cost savings and efficiency improvements. For example, better e-Government services can lead to economic benefits, such as less traffic congestion, which increases employee productivity and lowers transport costs in logistics.
- **Impact on Traffic and Productivity**: Many African countries struggle with heavy traffic. Reducing travel times, along with remote work options enabled by broadband, can enhance productivity and contribute positively to the economy.
- **Education and Healthcare Improvements**: Broadband benefits education and healthcare. It can help improve student performance, lower healthcare costs, and reduce mortality rates. In many African countries, access to schools is limited, but online resources can greatly enhance learning experiences.

Case Study: Rwanda's e-Health Investment

The Rwandan government invested over USD 50 million in e-Health between 2010 and 2020, including e-Health initiatives, ICT infrastructure and internet-enabled health services. By 2015, this investment connected 96% of health facilities to the internet, allowed 27% of hospitals to use telemedicine and helped track 200 000 patients using a mobile solution called RapidsSMS to prevent deaths among mothers and newborns.

The Broadband Socio-Economic Growth Hypothesis

The key factors that are responsible for influencing the level of GDP output derived from FBB investment is summarised by the following points:

- Economic diversification
- Value-chain maturity
- Enabling technologies
- Growth mechanisms

It may not always be possible to influence the structure of an economy or deepen value chains in the short-term, but allowing simultaneous growth of enabling technologies and fostering an ecosystem whereby growth mechanisms can freely operate, will greatly increase the potential impact of FBB investment on GDP output.

5.2 Calculating the Potential Impact of Fixed Broadband Investment

One of the objectives of this study was to understand the potential impact of investment in fixed broadband infrastructure on the economies of countries in Africa. This was done through modelling of the potential positive impact of such investments on a country's gross domestic product (GDP) which allowed for an assessment of direct and indirect contribution of FBB to the economy for the three different country groups – Leading Market, Development Markets and Initial Markets.

Implications and Opportunities in Africa

Our analysis incorporates African economies at various stages of development. These are separated by the qualification of Leading Markets, Developing Markets and Initial Markets. Leading Markets have higher levels of broadband penetration, per capita incomes and economic diversification. This also means that the levels of technology adoption (technology enablers), value-chain depth and socio-economic growth mechanism are more developed.

However, importantly, it needs to be realised that this also means that opportunities in developing and Leading Markets are higher for the establishment of new technologies and adoption of growth mechanisms to take advantage of new or increased FBB. There will also be opportunities for skills development in these markets to implement and utilise the technologies and the growth mechanisms.

Policies and government support will be key factors in enabling countries to take advantage of these opportunities by providing a platform and creating an ecosystem that will foster growth and is supportive to SMMEs and start-ups.

Therefore, FBB investment in Africa can have significant positive opportunities in countries at all levels of economic development, provided that there is private-public participation in the digitalisation process.

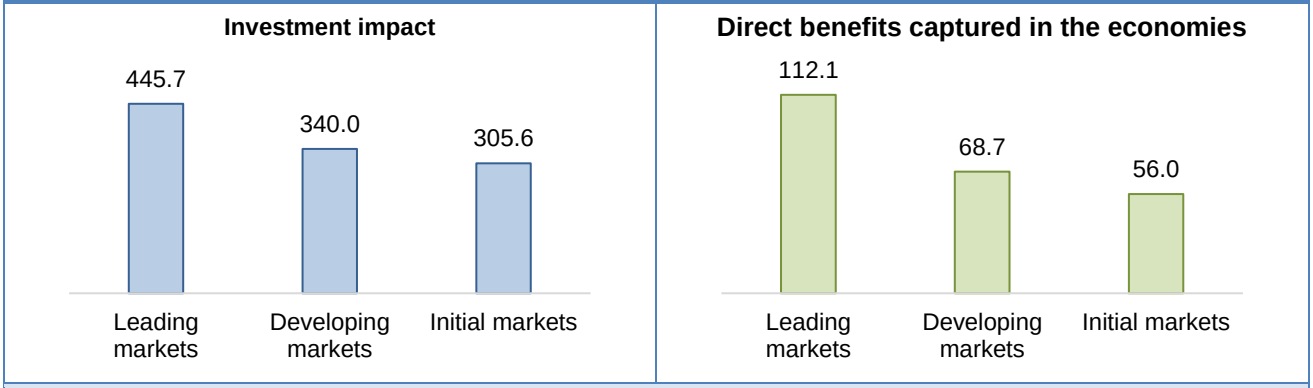
Socio-Economic Impact

The objective of the model that was developed was to estimate the economic multipliers for broadband investment as averaged for the key economy types. The table below indicates the multipliers from fixed broadband investment into the economies.

Economy type	Country examples	GDP multiplier
Leading Markets (Upper-middle-income)	Examples: South Africa, Egypt, Algeria, Libya	GDP Multiplier: 2.23
Developing Markets (Lower-middle income)	Examples: Zimbabwe, Senegal, Kenya, Côte d'Ivoire	GDP Multiplier: 1.70
Initial Markets (Lower and low-income)	Examples: Ethiopia, Mali, Angola, DRC, Nigeria	GDP Multiplier: 1.53

If USD 200 million in FBB infrastructure was invested into a Leading Market it would result in a total GDP contribution of USD 445.7 million. The exhibit below indicates the relative GDP contribution of USD 200.0 million FBB infrastructure investment into the three different economy types. The exhibit also shows direct benefits captured in the economies through this type of infrastructure investment.

Exhibit 5.3: Impact of USD 200 mn investment in FBB infrastructure (in USD mn)



Source: Frost & Sullivan, 2024

It becomes evident that the direct benefits captured are higher in the Leading Markets relative to the direct and indirect benefits. The proportion of direct capture is higher in the Leading Markets due to maturity of the ICT sector and its relative contribution to the country's GDP. The exhibit below presents the indirect benefit of the similar investment and indicates that in the Leading Markets, with greater diversification in the economy and with mature value chains, the indirect benefits of FBB investment are spread to the other economic sectors.

Exhibit 5.4: FBB investment benefits across other vertical sectors of the economy (USD mn)

Vertical sector	Leading Markets	Developing Markets	Initial Markets
Agriculture and Fishing	5.6	3.8	3.3
Industry and Construction	41.4	27.0	18.7
Manufacturing	26.6	14.8	10.7
Services and Trade	45.9	22.0	15.1
Computer and Telecommunications	214.0	203.6	201.7
Total	**333.6**	**271.2**	**249.6**

Source: Frost & Sullivan, 2024

As our key broadband socio-economic growth hypothesis predicts that enabling technologies, value chain linkages, economic diversification and technology growth mechanisms all play a role in increasing positive GDP impacts.

It is important for government and the private sector to focus on implementing the enabling technologies, as well as the technology growth mechanisms across the economy to derive the maximum benefit from FBB investment. Initial markets coming off a lower base of development can capture significant additional investment opportunities over-and-above what their current economic profiles suggest.

Although the initial GDP multiplier benefits from investment in fixed broadband are lower in the Initial Markets than in more developed markets, such investment is necessary to create a platform on which future digital infrastructure and services development can take place. This, in turn, will drive further significant benefits. Investment in fixed broadband infrastructure in the Initial Markets can follow the models of Developing and Leading Markets, and scale gradually, starting in the larger cities, including “fibre city” development.

6. RECOMMENDATIONS

To build a future digital society, leveraging fixed broadband connectivity (and in particular fibre connectivity) for socio-economic advancement, countries in Africa need to focus on expediting fixed broadband infrastructure deployment and the uptake of high-quality broadband services by all sectors of the society and industries. They also need to ensure that all government offices and organisations are connected with high-speed broadband.

This can be achieved over the next several years by promoting policies, regulations and initiatives aimed at quicker digital infrastructure buildout. This section provides recommendations on how this can be achieved in all three types of countries, based on their current level of socio-economic and digital infrastructure development.

6.1 Proposed Targets

The exhibit below provides high level fixed broadband connectivity targets across different user groups for the three types of countries in Africa. Although these targets are aspirational to an extent, they are necessary to create a digital society of the future.

To achieve these targets, the assumption is that countries in Africa will place a strong emphasis on the deployment of fixed broadband infrastructure and adoption of fixed broadband services by users than has been the case to date. Specifically, the deployment of fibre infrastructure would need to be considerably more aggressive in most of the countries. Furthermore, the prices of fibre services would need to continue declining in many markets to achieve greater affordability. The targets are also guided by the assumption that, although xDSL will continue to have a presence in the markets where it exists (particularly in North Africa), its replacement with fibre will be faster than currently expected. This will result in FTTx accounting for a greater share of the overall fixed broadband market than in the case of a "business as usual" growth trajectory.

Exhibit 6.1: Proposed fixed broadband access targets in Africa by 2030, by country types

Indicator	Leading Markets	Developing Markets	Initial Markets
Households	• FBB penetration: >70% • Connected on fibre: 30% • Urban areas: 200Mbps or higher	• FBB penetration: >40% • Connected on fibre: 20% • Urban areas: 150Mbps or higher	• FBB penetration: >25% • Connected on fibre: 15% • Urban areas: 100Mbps or higher
Institutions of learning	• FBB: 100% • Connected on fibre in urban areas: 100% • >95% with 1Gbps or higher connectivity in urban areas	• FBB: 100% • Connected on fibre in urban areas: >90% • >75% with 1Gbps connectivity in urban areas	• FBB: 100% • Connected on fibre in urban areas: >75% • >50% with 1Gbps connectivity in urban areas
Health facilities	• FBB: 100% • Connected on fibre in urban areas: 100%; >95% at 1Gbps or higher	• FBB: 100% • Connected on fibre in urban areas: >75%; >75% at 1Gbps	• FBB: 100% • Connected on fibre in urban areas: >50%; >50% at 1Gbps
Public sector facilities (government offices)	• FBB: 100% • Connected on fibre in urban areas: 100%; >95% at 1Gbps	• FBB: 100% • Connected on fibre in urban areas: >75%; >50% at 1Gbps	• FBB: 100% • Connected on fibre in urban areas: >50%; >30% at 1Gbps

Notes:
- Fixed broadband (FBB) includes FTTH / FTTB, xDSL, FWA and WTTx.
- FBB and FTTx household penetration consists of both residential and business / other non-residential connectivity.
- The actual FBB (and fibre specifically) connectivity rates would vary from country to country. For example, some of the Leading Markets (such as Mauritius, with close to 90%) already have high household connectivity rates on fibre.

Source: Africa Analysis

6.2 Recommendations for Target Achievement

Governments can play a key role in facilitating quicker and more extensive build-out of fixed broadband infrastructure and adoption of fixed broadband services by end-users across all segments of the society and the economy. A number of recommendations are provided below and most are applicable to all three market types. Some of the countries in Africa are more progressed than others in adopting the proposed measures, although most countries even in the Leading Markets group can still realise significant improvements on the current practices.

Not all of the recommendations provided need to be, and indeed would be, implemented simultaneously. Some are essential (such as a clear broadband policy) and more easily attainable (e.g., subsidies / incentives) which could be implemented quicker while other recommendations would be implemented at a later stage. This is colour-coded in the exhibit below (see Legend at the bottom of the exhibit).

Apart from policy and regulatory intervention measures, governments can also apply various supply-side and demand-side support measures to lower the cost of fixed broadband infrastructure deployment on the one hand and encourage the uptake of fixed broadband services on the other hand by making them more affordable.

Exhibit 6.2: Recommendations to achieve fixed broadband connectivity targets

No.	Recommendation	Leading Markets	Developing Markets	Initial Markets
1	Develop a clear national broadband plan with clear objectives and aligned with other government infrastructure policies and strategies.			
2	Facilitate rapid deployment of broadband infrastructure through standardisation of rules and processes across different government organisations (e.g., to simplify and reduce the cost of granting RoW).			
3	Encourage – through policy and regulation – infrastructure sharing between network operators and also operators and utility companies to leverage their passive infrastructure.			
4	Introduce technology neutrality in awarding of licences – operational and spectrum – to enable technology choice for infrastructure deployment, particularly in the access network for quicker and lower cost deployments.			
5	Promote open access network model through regulation to enable greater competition at the retail layer (ISPs) to reduce broadband service fees and improve quality; greater infrastructure sharing among network operators to expedite deployment, improve redundancy and lower capex and opex.			
6	Encourage fibre pre-provisioning through policy and regulation. This could include fibre-to-the-room (FTTR) deployment in new building developments by augmenting national building regulations.			
7	Establish and enforce a mechanism for GIS broadband network mapping / database development and maintenance to more easily identify gaps in digital infrastructure and drive efficiencies in network deployment.			
8	Reduce supply-side costs through measures such as (1) lower or no import duties on imported network equipment and software; (2) regulation of cost of access to government infrastructure to lower the network build capex; (3) subsidise the cost of backhaul for (especially smaller) operators providing service in remote / rural areas; (4) incentives / tax breaks for infrastructure deployment and service provision in high-risk / unprofitable areas; (5) prompt type-approval of network equipment to reduce delays. Some of these measures could be funded out of a universal service fund.			
9	Reduce demand-side costs through measures such as (1) lower or no taxes and import duties on end-user devices / CPE; (2) subsidies for end-user devices / CPE and broadband services for low-income families, institutions of learning, healthcare facilities etc.; (3) incentives to operators and service providers to offer discount on services to public institutions and/or low-income households. A universal service fund could be used for the latter two. The objective would be to encourage greater (sustainable) adoption of broadband services.			
10	Attract development finance through various means, such as: (1) policy and regulatory certainty; (2) promotion of open access infrastructure; (3)			

	provision of incentives to build digital infrastructure in the form of tax breaks or lower import duties on equipment.			
11	Implement a 'Digital Infrastructure One Stop Shop" – a government body / organisation which would co-ordinate responses from various relevant government entities in respect of applications / plans to build digital infrastructure. This would make the administrative process prior to building significantly more efficient, e.g., securing of RoW or electricity supply to key network sites.			
12	Develop a Critical Infrastructure Protection Plan that facilitates collaboration between network operators, regulatory bodies and government (including law enforcement agencies) to discourage and penalise broadband infrastructure theft and vandalism, including cyberattacks.			

Legend to box colour-coding:

- Green box – recommendations which are either critical or relatively easily implementable
- Orange box – recommendations which are more complex to implement or can be implemented at a later stage of the process
- White box – does not apply

Source: Africa Analysis

7. CONCLUSIONS

The countries of Africa are at different stages of development as far as fixed broadband infrastructure is concerned, but they all have the same ultimate objective of achieving ubiquitous high-speed and high-quality broadband connectivity that supports growth across all segments of the society and all sectors of the economy.

To attain the set goal, they will need to implement various intervention measures, the nature of which depends on these countries' current state of development – economic and from a fixed broadband infrastructure build-out perspective – and what they have put in place already. Lessons learnt from more developed countries globally can provide guidance as to prudent approaches to expedite fixed broadband deployment and adoption. Indeed, countries in Africa which are more progressed along this process can also act as models – the Leading Markets countries to the Developing and Initial Markets countries, and the Developing Markets to the Initial Markets. However, the reverse is also true to an extent, in that some of the intervention measures introduced in certain Developing Markets countries are still lacking (but needed) in some of the Leading Markets countries. In this sense, the more developed countries can draw on useful lessons from the less developed countries.

Mostly, to generate the type of growth of fixed broadband infrastructure required to develop a digital society and a digital economy in the next five to ten years, will require a focussed approach and commitment from governments in Africa to drive digital infrastructure development through private sector enablement and greater government involvement.

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9. ANNEXURE A: LIST OF IXPs IN AFRICA

IXP Name	Country	City	Website	Launch Year
Angola-IXP	Angola	Luanda	http://www.angola-ixp.ao/	2006
Angonix	Angola	Luanda	https://www.angonix.net	2015
Benin IX	Benin	Cotonou	http://www.benin-ix.org.bj	2013
Botswana Internet Exchange	Botswana	Gaborone	http://www.binx.org.bw/	2005
Burkina Faso Internet Exchange Point	Burkina Faso	Ouagadougou	http://www.bfix.bf/	2015
Burundi National Internet Exchange Point	Burundi	Bujumbura	http://www.bdixp.bi/	2017
Cameroon Internet Exchange Point	Cameroon	Douala	http://www.camix.cm/	2016
Cameroon Internet Exchange Point	Cameroon	Yaounde	http://www.camix.cm/	2016
Cote d'Ivoire Internet Exchange Point	Cote d'Ivoire	Abidjan	http://www.civix.ci	2013
Goma Internet eXchange Point	Democratic Republic of Congo	Goma	http://www.ispa-drc.cd/index.php?option=com_content&view=article&id=11&Itemid=13	2021
Kinshasa Internet eXchange Point	Democratic Republic of Congo	Kinshasa	http://www.ispa-drc.cd/index.php?option=com_content&view=article&id=10&Itemid=24	2012
Lubumbashi Internet eXchange Point	Democratic Republic of Congo	Lubumbashi	http://www.ispa-drc.cd/index.php?option=com_content&view=article&id=12&Itemid=15	2019
Djibouti Internet Exchange	Djibouti	Djibouti	http://www.djiboutidatacenter.com/en/page/djibouti-ix-djix	2016
Cairo IX	Egypt	Cairo	http://www.caix.net.eg	2002
Egypt-IX	Egypt	Cairo	https://eg-ix.com.eg/	2022
Gabon Internet Exchange Point	Gabon	Libreville	http://www.gabix.ga/	2014
Serekunda Internet	Gambia	Serekunda	http://www.sixp.gm	2014

IXP Name	Country	City	Website	Launch Year
Exchange Point				
Ghana Internet Exchange	Ghana	Accra	http://www.gixa.org.gh	2005
Le Point d'Echange Internet de la Guinee	Guinee	Conakry	https://ixp-guinee.org.gn	2020
Kenya Internet Exchange Point - Mombasa	Kenya	Mombasa	http://www.tespok.co.ke/	2014
Kenya Internet Exchange Point - Nairobi	Kenya	Nairobi	http://www.tespok.co.ke	2002
LINX Nairobi	Kenya	Nairobi	http://www.linx.net	2023
Lesotho Internet Exchange Point	Lesotho	Maseru	http://www.lixp.co.ls	2011
Liberia Internet Exchange Point	Liberia	Monrovia	https://www.lixpa.org.lr/	2015
Madagascar Global Internet eXchange	Madagascar	Antananarivo	http://www.mgix.mg	2016
Malawi Internet Exchange	Malawi	Blantyre	http://www.mispa.org.mw/mix.html	2008
Lilongwe Open Neutral Internet Exchange	Malawi	Lilongwe	https://lionex.org/	2024
Mali IX	Mali	Bamako	https://www.mlix.ml	2018
Mauritius Internet Exchange Point	Mauritius	Ebene	http://www.mixp.org/	2008
Mozambique Internet Exchange	Mozambique	Maputo	http://www.mozix.org.mz	2002
Internet eXchange Point Namibia	Namibia	Windhoek	http://dev.ixp.org.na/about-ixp/	2014
Abuja IX	Nigeria	Abuja	http://ixp.net.ng/	2011
AMS-IX Lagos	Nigeria	Lagos	https://www.ams-ix.net/lag	2023

IXP Name	Country	City	Website	Launch Year
Internet eXchange Point of Nigeria	Nigeria	Lagos	http://ixp.net.ng	2007
Port Harcourt IX	Nigeria	Port Harcourt	http://ixp.net.ng/ixpn-portharcourt/	2012
Congo Internet Exchange	Republic of Congo	Brazzaville	http://www.cgix-congo.cg	2013
Rwanda Internet Exchange	Rwanda	Kigali	http://www.rinex.org.rw	2004
Senegal Internet Exchange	Senegal	Dakar	http://senix.sn/	2017
Somalia Internet Exchange Point	Somalia	Mogadishu	http://soixp.so/	2018
Cape Town Internet Exchange Point	South Africa	Cape Town	https://wiki.inx.net.za/display/pub/CINX+-+Cape+Town+Internet+Exchange	1997
NAPAfrica IX Cape Town	South Africa	Cape Town	https://www.napafrica.net	2012
Durban Internet Exchange Point	South Africa	Durban	https://wiki.inx.net.za/display/pub/DINX+-+Durban+Internet+Exchange	2012
NAPAfrica IX Durban	South Africa	Durban	https://www.napafrica.net	2011
Johannesburg Internet Exchange Point	South Africa	Johannesburg	http://www.inx.net.za	1996
NAPAfrica IX Johannesburg	South Africa	Johannesburg	https://www.napafrica.net	2012
Sudan Internet Exchange Point	Sudan	Khartoum	http://WWW.SIXP.SD	2011
Arusha Internet Exchange Point	Tanzania	Arusha	http://aixp.or.tz	2006
Tanzania Internet Exchange	Tanzania	Dar es Salaam	http://tix.or.tz/	2004
Mwanza Internet Exchange Point	Tanzania	Mwanza	https://www.tix.or.tz/mixp/	2016
Zanzibar Internet	Tanzania	Zanzibar	https://www.tix.or.tz/zixp/	2018

IXP Name	Country	City	Website	Launch Year
Exchange Point				
Togo Internet Exchange Point	Togo	Lome	http://www.tgix.tg/	2017
Tunisia IXP Tunis	Tunisia	Tunis	http://www.ati.tn/en/about-us-0	2011
Uganda Internet eXchange Point	Uganda	Kampala	http://www.uixp.co.ug	2001
Lusaka Internet Exchange Point	Zambia	Lusaka	https://lusakaixp.co.zm/	2022
Zambia Internet Exchange Point	Zambia	Lusaka		2006
Harare Internet Exchange Point	Zimbabwe	Harare	http://www.hix.org.zw/	2017
Source: The African IXP Association				

10. ACRONYMS AND ABBREVIATIONS

4G/5G	4th / 5th Generation mobile technologies
(A)DSL	(Asymmetric) Digital Subscriber Line
AI	Artificial Intelligence
AOI	Automated Optical Quality Inspection
AR	Augmented Reality
ATU	African Telecommunications Union
AU	African Union
BB	Broadband
BRICS	Brazil, Russia, India, China, South Africa et al. – a co-operation grouping of countries
CAGR	Compound Annual Growth Rate
DIOSS	Digital Infrastructure One Stop Shop
DL	Download
EC	European Commission
EOSS	Energy One Stop Shop
FBB	Fixed Broadband
FNO	Fibre Network Operator
FTTH/B/S	Fibre-to-the-Home / Business / Site
FTTP	Fibre-to-the-Premises
FTTR	Fibre-to-the-Room
FWA	Fixed Wireless Access
GB	Gigabyte(s)
Gbps	Gigabit(s) per Second
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GVA	Gross Value Added
GSMA	Global System for Mobile Communications Association
HD	High Definition
HH	Household
ICASA	Independent Communications Authority of South Africa
IMF	International Monetary Fund
IoT	Internet of Things
IT	Information Technology
ITU	International Telecommunications Union
MB	Megabyte(s)
Mbps	Megabit(s) per Second
mmWave	Milimetre Wave
NBR	National Building Regulations
NDP	National Development Plan
NIP	National Infrastructure Plan
ODN	Optical Distribution Network
OTDR	Optical Time-Domain Reflectometer
OTT	Over-the-Top
PoC	Proof-of-Concept
PPP	Purchasing Power Parity
Q.nbn	Qatar National Broadband Network
RDNCC	Rapid Deployment National Co-ordinating Centre
SOC	State-Owned Company
SME(s)	Small and Medium Size Enterprise(s)
UAE	United Arab Emirates
UK	United Kingdom
UL	Upload
USA	United States of America
USD/US$	United States Dollar
VDSL	Very-high-bit-rate Digital Subscriber Line
VR	Virtual Reality
WTTx	Wireless to the X (anything)

11. DISCLAIMER

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