

Development Tendency of Contemporary Telecommunication Systems and Networks in Africa

Dimov Stojce Ilcev

University of Johannesburg (UJ), Johannesburg, South Africa.

Abstract: In this paper is discussed the development tendency of different telecommunication systems and networks in Africa as a primary means of economical and social growth during recent years. The African Cellular and Internet infrastructures have taken significant strides forward over the past decade, thanks to the massive investments telecommunications operators have made in new terrestrial and submarine fibre cables. However, there is still a lot of hard work to be done before Internet services are accessible and affordable to every person and location on the African Continent. This paper examines the impact of telecommunications development and liberalization in Africa on both sectoral performance and economic growth. Actual regulatory quality plays a major role in bringing down prices and in improving access to telecommunication services in African countries. Existing competition, especially in the Internet and Cellular telephony segments, also improves the performance of the sector. Increasing access to mobile networks by 1% means an increase of 0.5% of real Gross Domestic Product (GDP) per capita. In addition, Growth of Fixed and Mobile Networks driven by Broadband Demands, Development of Fibre Optic Networks in Africa, Mobile Broadband Drive Data Growth in Africa, and Internet Usage Statistics for Africa are also discussed.

Keywords: GDP, AU, DTS, CAGR, ITU, FTTP, FTTH, IP, DSL, ROW, DVB-RCS, HAP, CDMA, EV-DO, WiMAX, SIM, LHS, RHS, PoF, NEPAD, ADSL, ISP, IXP

1. Introduction

The development and implementation of digital transformation is the driving force for innovative, inclusive and sustainable growth in any African country. Thus, to achieve technological transfer and innovation in Africa, it is necessary to carry out a digital transition of all sectors, governments and enterprises conducted by the power of innovative techniques, solutions and contemporary projects. African countries, in an effort to further exploit the advantages that accompany digital transformation, are taking major steps towards prioritizing and accelerating meaningful digitization. The strategy builds upon existing initiatives and frameworks in Africa and bring together key players in the ICT sector across Africa to achieve its objectives.

In order to carry out an overview of the general development of African countries in the function of improving telecommunication systems and networks, it is necessary to explain and determine the growth of their GDP and generally in Africa. Average growth in real GDP decelerated to an estimated 3.1% in 2023, which real GDP growth, by world region, 2020 - 2025 is presented in **Figure 1**.

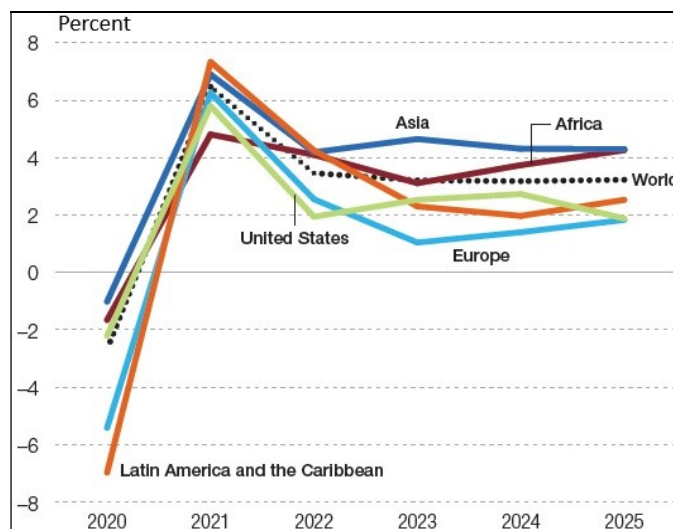


Figure 1. Real GDP growth, by world region, 2020-25

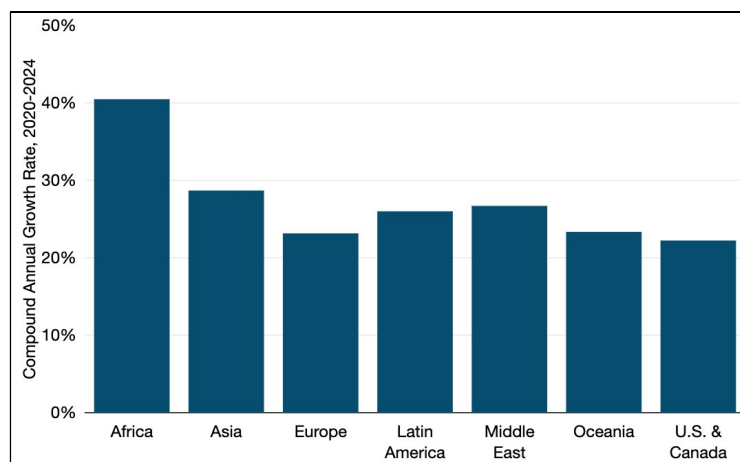


Figure 2. International used Bandwidth Growth by Region

Therefore, it is on this basis that the African Union (AU) has developed the Digital Transformation Strategy (DTS) for African Continent to not only provide a common and coordinated guide to enable African leaders to reap the benefits of digital transformation, but to also help mitigate the risks that might accompany these developments. In **Figure 2** is illustrated the international used bandwidth growth by regions, where it can be concluded that the Africa provides the greatest bandwidth growth. On a regional level, most parts of the world have seen very comparable growth at about 35-40% Compound Annual Growth Rate (CAGR) since 2019. The role of Content Providers, such as Google, Meta, Microsoft, and Amazon are firmly entrenched as the biggest users of network capacity globally. As recently as 2016, internet backbone providers accounted for the majority of demand. Not anymore. As of 2023, content and cloud networks accounted for more than 70% of all bandwidth usage. The markets that stand out are Africa, where capacity growth is still surging at a nearly 50% CAGR, and the U.S. & Canada, where market maturity has slowed demand to around 30% CAGR.

As of 2023, the GDP of Africa was estimated at roughly 3.1 trillion US \$. This was the highest value since 2010 when the continent's GDP amounted to approximately 2.1 trillion US \$. In fact, Africa's growth performance remains volatile, with entrenched structural challenges and susceptibility to shocks. This rate is a deceleration of 1.0% point from 4.1% recorded in 2022. It reflects persistently high food and energy prices on the back of sustained impact of Ukrainian Civil War in 2014, weak global demand weighing down on exports performance, the impact of climate change and extreme weather events on agricultural productivity and electricity generation, and pockets of political instability and conflicts in some African countries. The slowdown was compounded by monetary policy tightening aimed at bringing inflation down amid depreciation pressures on exchange rates in several countries.

Despite the slowdown in Africa's estimated average growth rate in 2023, the continent is still ranked the second fastest growing region after Asia. The growth projections for 2024-25 also indicate that the continent will retain this position. With Africa consistently recording the second fastest growth rate in the world for the past four decades, several African countries have been ranked among the top 20 fastest growing economies in the world. However average growth on the continent is still too low and insufficient to trigger a faster economic transformation and convergence with higher-income regions, as Asia experienced from 1970 to 2016, when thanks to China's growth, its share of world industrial production increased tenfold from 4% to 40%. Looking ahead, economic performance in Africa is poised for gradual improvement.

Real GDP growth is projected to increase to 3.7% in 2024 and firm up at 4.3% in 2025, as most of the effects of the risks that caused the deceleration in 2023 begin to subside. The projected stronger growth in 2024 and 2025 reflects expansions in East Africa (by 3.4 percentage points), Southern Africa (by 0.6% point), and West Africa (by 0.6% point), and in 40 countries. However, 17 countries are expected to post growth rates higher than 5 percent in 2024, up from 15 in 2023, and the number could rise to 24 the following year. In 12 countries, the projected output expansion in 2024 will be below 1 percentage point than in 2023, meaning a slowing pace of growth in these economies.

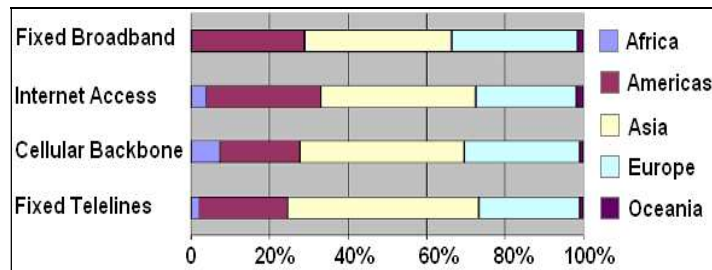


Figure 3. Comparison of Telecommunication Growth by Continent

2. Development of Telecommunication Systems and Networks in Africa

The International Telecommunication Union (ITU) brings together governments, private companies, and industry to develop and coordinate the operation of global telecommunication networks and services. It has coordinated shared use of the frequency spectrum, promoted international cooperation and standards and improved telecommunication infrastructure worldwide, which growth in Africa and other continents is shown in **Figure 3**.

With billions of US \$ of international investment flowing in, and significant subscriber numbers rising across the Continent, Africa’s communications marketplace has now passed the tipping point from high potential to high growth. Unburdened by a legacy of installed telecommunication infrastructure, African Continent has leapfrogged the fixed-line phase of development to go straight to mass-market fibre-optic, satellite broadcast and novel Cellular networks and services. Even as Africa’s total cellular subscriptions soar past 500 million, a huge, untapped market is still up for grabs by a wide range of local, regional and global players. In addition to being one of the world’s most dynamic telecommunication markets, African Continent is also among the most innovative, a global testing lab and a leader in digital and cellular-enabled applications in areas like payments, commerce, health and education.

Large parts of Africa gained access to international fibre bandwidth for the first time via submarine cables in 2009 and 2010. In **Figure 4** is shown the domination of African countries in development of Fibre To The Premises (FTTP), where South Africa dominates in Fibre to the Home (FTTH) networks, but also a mature market and low growth rate. Therefore, most countries growing at least 50% such as Kenya, Angola, Senegal, Libya and Ghana, while many growing at above 100%, such as Cote d’Ivoire, Gabon and Togo. In other parts of the continent, additional fibre-optic infrastructures have brought significant competition to a previously monopolized market. More cables are expected to go online in the following years. This has led to massive investments into terrestrial fibre backbone infrastructure to take the new bandwidth to population centers in the interior and across borders into landlocked countries.

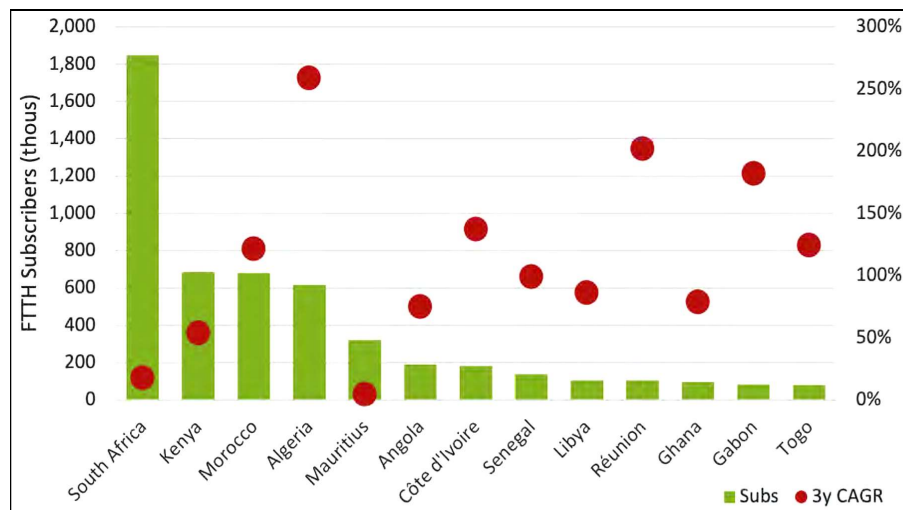


Figure 4. Fibre To The Premises (FTTP) Growth by Country

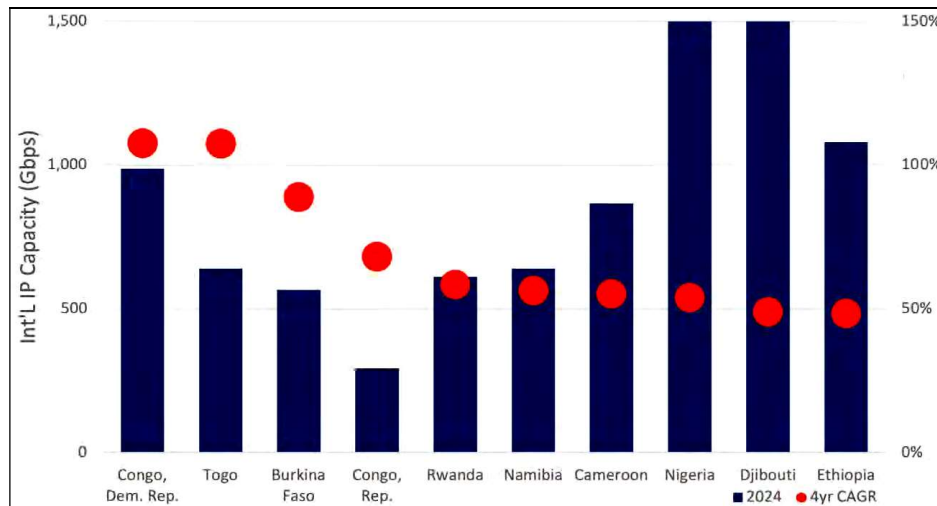


Figure 5. International IP Capacity growth of African Countries

The Internet and broadband sectors in Africa are set to benefit the most from these developments. In such a way, wholesale prices for Internet bandwidth have come down by as much as 90% from previous levels based on satellite access, and the cost savings are slowly being passed on to the retail level as well. In **Figure 5** is illustrated the international Internet Protocol (IP) capacity growth of African countries, which DRC (Congo) and Togo are experiencing more than 4y CAGR of 100%. Broadband is rapidly replacing dial-up as the preferred access method and this process is already virtually completed in the continent's more developed markets. Most African countries now have commercial Digital Subscriber Line (DSL) services, but their growth is limited by the very poor geographical reach of the fixed-line networks. Improvements in Internet access have therefore been mostly confined to the capital cities so far.

The rapid spread of cellular networks via cellular data and third 3G, 4G or recent fourth generation 5G broadband services is changing this, with the cellular networks bringing Internet access to many areas outside of the main cities for the first time. In **Figure 6** is shown the top 10 African 4G and 5G markets subscribers, of which, only 31% of all Cellular subscribers in Africa are 4G with Rights of Way (ROW) around 60%. Largest most mature 4G markets have slowest growth. North African countries and South Africa have largest subscriber bases but lower growth. Thus, DRC stands out with over 200% Kenya, Tanzania, Cote d'Ivoire and Ghana have between 50-100% growths.

In addition, to improve Internet access in rural and remote areas with low density of population some African countries are implementing satellite Digital Video Broadcasting-Return Channel via Satellite (DVB-RCS) and broadcasting via High Altitude Platforms (HAP) located in stratosphere.

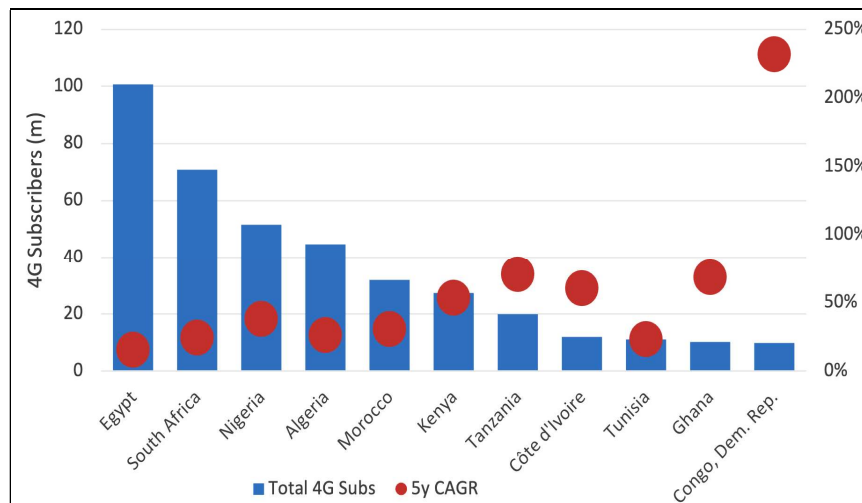


Figure 6. Top 10 African 4G Markets Subscribers

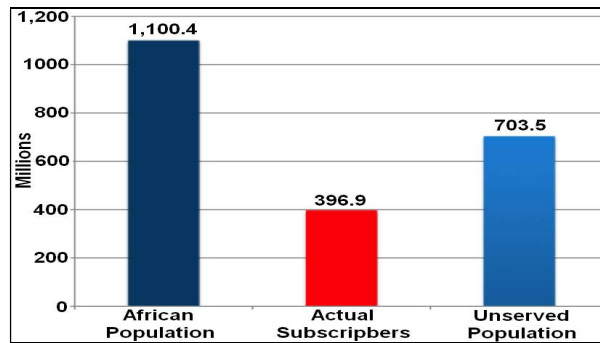


Figure 7. Actual Cellular Served/Unserved Population in Africa

Many fixed-line incumbents have reacted by rolling out fixed-wireless access networks to expand their geographical reach. The technology of choice has been Code Division Multiple Access-2000 (CDMA-2000) which supports broadband data rates with an upgrade to Evolution Data Optimized or Evolution Data Only (EV-DO) standard. The local Worldwide Interoperability for Microwave Access (WiMAX) technology, however, offers higher data rates and has gained ground in Africa with well over 100 networks already in operation.

3. Growth of Fixed and Mobile Networks driven by Broadband Demands

While being the world's most rapidly growing market for Cellular telephony, Africa is also home to the fastest growing fixed-line markets in the world. However, more than a third of all countries on the African Continent saw double or triple digit growth rates in the fixed-line sector in 2010, a total of 30 markets had positive growth. The difficulties of rolling out fixed-line networks across its vast land mass have meant that in mid-2011 cellular users constituted around 90% of all African telephone subscribers, which statistics scheme in 2013 shows total growth of cellular subscribers and unserved population in Africa.

The African continent currently supports a population of about 1.1 billion people, which usage of cellular system is shown in **Figure 7**. Cellular adoption penetration rates for the countries on the continent are commonly thought to be between 50% to almost 80%, but these adoption rates are misleading due to the unique nature of the African cellular telecommunications market. Although Africa boasts a number of fast-growing economies, many inhabitants still live below globally recognized poverty lines. As such, cellular users in Africa are highly sensitive to costs and have adopted cellular phone usage strategies to minimize these costs. These strategies include the use of multiple Subscriber Identification Module (SIM) cards in their phones and the extensive sharing of phones between users or families. Given this use of multiple SIM cards, Manifest Mind estimates that cellular phone penetration rates for unique subscribers are well below other popular market estimates. This exposes a cellular telecommunications market of more than 700 million people who have yet to own their own phone, which diagram is shown in **Figure 8**.

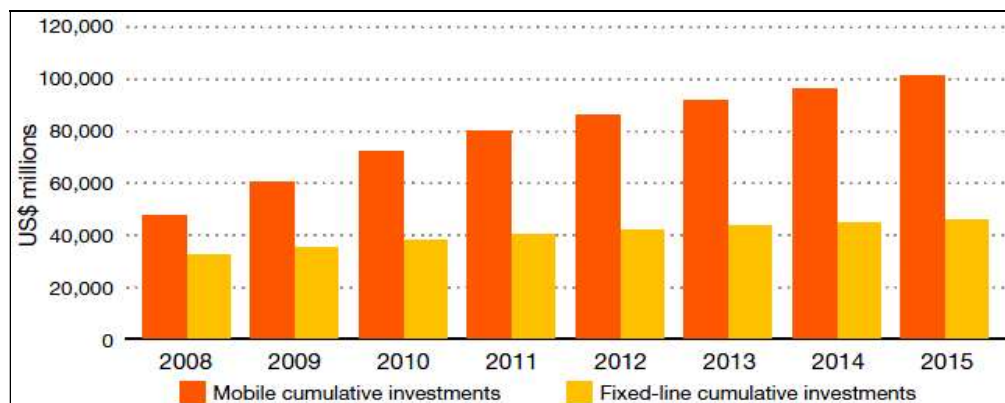


Figure 8. Fixed-line versus Cellular as Cumulative Investments in African Telecommunications

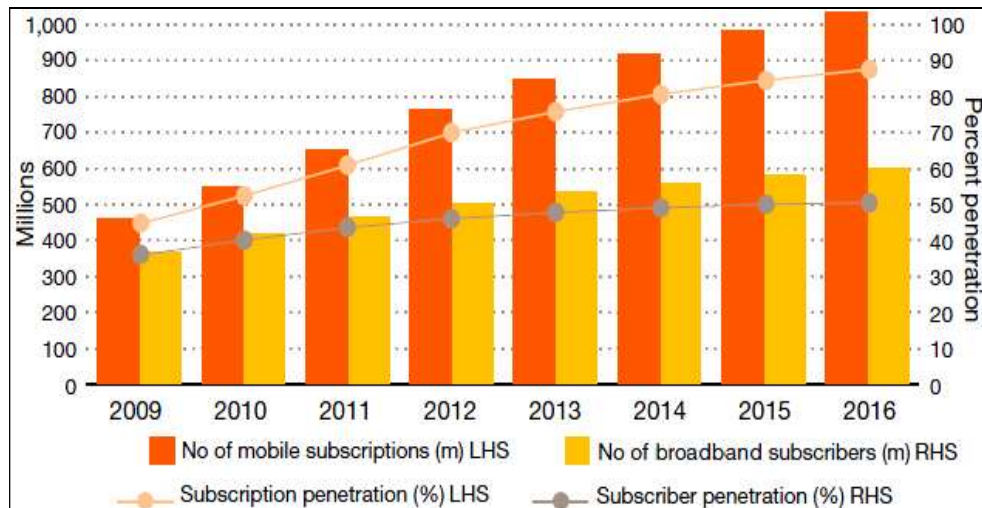


Figure 9. Estimated Cellular (LHS) and Broadband (RHS) Subscriptions in Africa from 2009 to 2016

The cellular telecommunications market in Africa is developing in such a manner that is unique to the African continent. With its lack of a landline-based infrastructure, Africa has leapfrogged what many consider to be the standard evolutionary adoption path of telecommunications technology. For many Africans, the cellular phone is the first form of telecommunication (versus a landline telephone) and the first computing device they own (versus a PC or laptop), which mobile and fixed growth supported by rising investment is illustrated in **Figure 8**. Thus, this rising tide of investments is undergoing an accelerating shift away from investment in fixed-line services and infrastructure, and towards cellular networks. Because of this, cellular phones have become one of the most valued possessions for many Africans, not only enabling increased communications between family members but also opening new possibilities and opportunities for their futures.

The continued interest in Africa confirms that, despite the rapid growth to date, the biggest opportunities are still to come, as a result of the remaining massive potential for mobile and broadband subscriptions to grow, which estimated subscription rates in the period from 2009 to 2016 for cellular Left Hand Rate (LHS) and broadband Right Hand Rate (RHS) are shown in **Figure 9**. The real growth opportunity is even bigger than it appears at first sight, because of the high level of multi-SIM behaviors by African consumers. Thus, as with consumers in other lower-income, price-sensitive markets with healthy competition among providers, many subscribers in Africa look to optimize their costs by mixing and matching their use of various networks. And they are doing this by buying and using handsets that enable them to subscribe to multiple operators through multiple SIM cards. With recent forecasting that almost half of Africa's population still won't be connected to cellular services in 2016, it's evident that the market's potential is largely untapped.

4. Developments of Fibre Optic Networks in Africa

The development of fibre-optic networks is significantly sustaining growth in Africa's Internet and broadband sector during past decades. Large parts of Africa have gained access to international fibre bandwidth via submarine cables for the first time in recent years. In other parts of the Continent, additional fibre systems have brought competition to a previously monopolized market. This has led to massive investments into terrestrial fibre backbone infrastructure to take the new bandwidth to population centers in the interior and across borders into landlocked countries.

An optical fibre is a flexible, transparent fibre made of high quality extruded glass (silica) or plastic, slightly thicker than a human hair. It can function as a waveguide, or "light pipe" to transmit light between the two ends of the fibre, which cabling pipes (Left) and silicon fibre (Right) are shown in **Figure 10**. The field of applied science and engineering concerned with the design and application of optical fibre is known as fibre optics. Otherwise, Power over Fibre (PoF) optic cables can also work to deliver an electric current for low-power electric devices.



Figure 10. Cabling Pipe Lines (Left) and Silicon Fibres (Right)

One of the most likely reactions one gets when discussing fibre optic networks in Africa is “why not satellite technology?” Satellite communications has been around for a while and has provided telecommunications links between Africa and the rest of the world, which Cabling Pipe Lines (Left) and Silicon Fibres (Right) is shown in **Figure 10**. However, a comparison between fibre-optic and satellite technologies reveals that although satellite systems are the most efficient solutions for TV broadcast, for access to remote locations, and essentially, for wireless access to the local loop and the network backbone, fibre-optic undersea or underground networks are more suited for high bandwidth transmission between countries and continents though core networks (or backbones) and submarine links respectively.

For a history of African regional undersea fibre cable network, have a look of two current and one proposed undersea fibre-optic network shown in **Figure 11**, which particulars are as follows:

1. South East Asia (SEA), Middle East (ME) and Western Europe-3 (WE-3). Some North African countries such as Egypt, Tunisia and Algeria are connected by SEA/ME/WE-3, one of the longest undersea fibre-optic cable, which includes 39 landing points in 33 countries and 4 continents from Western Europe (including Germany, England and France) to the Far East (including China, Japan and Singapore) and to Australia. Maximum capacity of this two fibre pair cable is 505 GB/s.
2. South Africa Trans Atlantic (SAT-3), West Africa Submarine Cable (WASC) and South Africa Far East (SAFE). This is perhaps the most successful attempt at an African fibre-optic submarine network so far. The SAT-3/WASC network continues from South Africa to Portugal and Spain in Europe with landings at a number of west and southern African countries. The funding agreement for the project was signed in 1999 and President Wade, one of the founding members of New Partnership for Africa's Development (NEPAD), officially launched the networks in Dakar in May 2002. The original capacity was 20 GB/s and is upgradeable to 120 GB/s. The submarine cables span a total of 28,000 km and connect Portugal, Spain (Canary Islands), Senegal, Ghana, Benin, Cote D'Ivoire, Nigeria, Cameroon, Gabon, Angola, South Africa, France (Reunion), Mauritius, India and Malaysia.
3. The submarine cable network in development phase is East African Cable Submarine Cable System (EASSY) proposed by Herakles Telecom LLC Company.

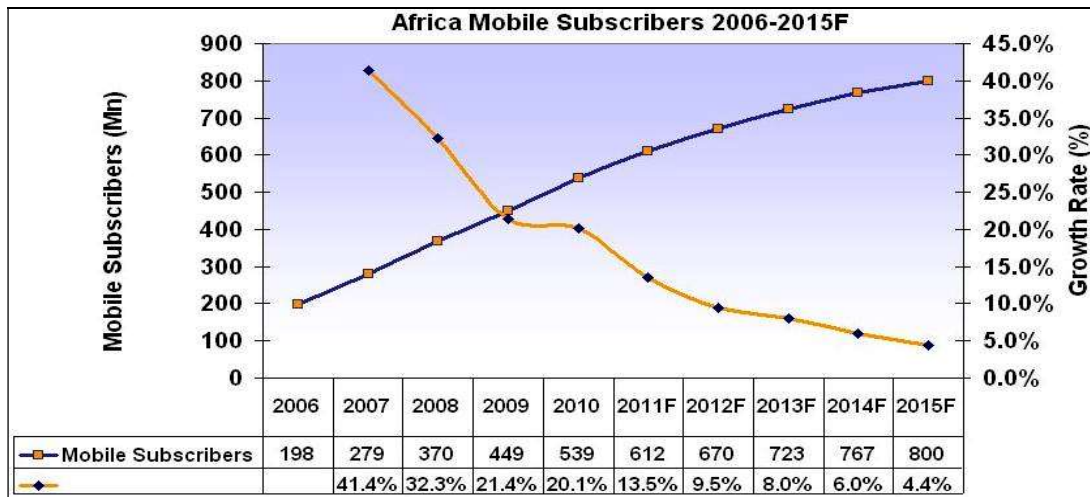


Figure 11. Total Cellular Subscribers in Africa is forecasted to Reach 800 Million by the end of 2015

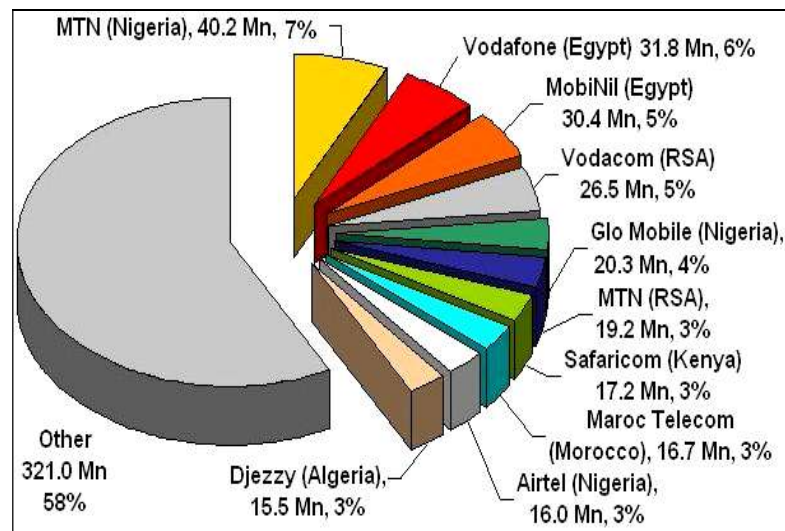


Figure 12. Top 10 Cellular Operators in Africa

Therefore, Africa's Internet and broadband sector is set to benefit the most from developments of fibre networks, so at this point wholesale prices for Internet bandwidth have come down by as much as 90% from previous levels based on satellite access, and the cost savings are also slowly being passed on to the retail level. The broadband network is rapidly replacing dial-up as the preferred access method and this process is already virtually completed in the Continent's more developed markets. Most African countries now have commercial Asynchronous DSL (ADSL) services, but their growth is limited by the poor geographical reach of the fixed-line networks. Improvements in Internet access have therefore been mostly confined to the capital cities so far. However, the rapid spread of cellular data and 3G/4G/5G broadband services is changing this, with the cellular networks bringing Internet access to many areas outside of the main cities for the first time.

5. Mobile Broadband Drive Data Growth in Africa

The use of mobile broadband data services is growing strongly in Africa, along with data revenues, fueled by factors such as the continent's improved international connectivity, the rollout of mobile broadband networks and the increasing availability of low-cost smartphones. Thus, the growth in data revenues in Africa is being driven by factors including the continent's new submarine and terrestrial cables, the rollout of mobile broadband networks, the increasing affordability of data devices; and economic growth. Of course, despite Africa's generally good macroeconomic outlook, there are still substantial problems on the continent, including some political instability, often-poor infrastructure and the fact that many people have very low incomes. However, regulatory matters, such as logjams around spectrum for mobile broadband, also need to be addressed in a number of markets.

The tendency of present Africa's telecommunication market continues to be about growth, which figures of cellular subscribers and growth is shown in **Figure 12**. There were 723 million cellular subscriptions in Africa at end of 2013 and the continent's cellular subscription count will reach 800 billion during 2015 and 1.2 billion by end-2018. Cellular voice revenues in Africa are forecast to continue growing over the next few years, whereas voice revenues in many other major regions are either already declining or expected to decline before long. The significance of Nigeria as Africa's most vibrant cellular market is clear, which figures are illustrated in **Figure 12**. With 3 of the Top 10 cellular operators by subscriber numbers being based there: MTN, Glo Mobile and Airtel. MTN's dominance is also clear: not only is its Nigerian operation the largest on the continent, but its operation in South Africa is ranked sixth.

Cellular data usage and revenues are growing strongly in Africa, and at a significantly faster rate than voice revenues, albeit from a fairly low base. Annual cellular data revenues on the continent are expected to rise from US\$ 8.53 billion in 2012 to US\$ 23.16 billion in 2018. Thus, data accounted for 14.3 % of cellular service revenues in Africa in 2012 but will account for 26.8 % in 2018.

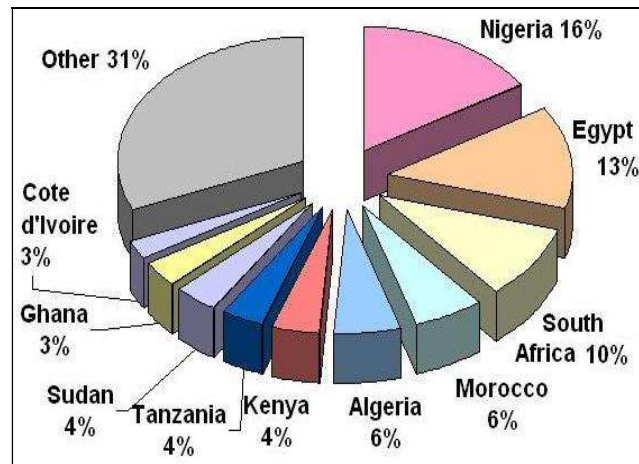


Figure 13. Top 10 States by Mobile Subscribers in Africa

The number of mobile broadband subscriptions on the continent is growing strongly, reflecting the growing number of cellular broadband network deployments and the increasing availability of affordable data devices. The growing availability of cellular broadband networks in Africa, combined with the take-up of advanced devices such as smart-phones and tablets, is fuelling a rise in the use of digital media such as gaming, music, social-networking and video.

The number of cellular broadband subscribers by each country is dramatically changing in last several years. Namely, just a few years ago South Africa was the dominant cellular market in Africa, by now Nigeria is the dominant nation with 16 % of the African market, followed by Egypt with 13 %. In **Figure 13** is shown top 10 African states by percentage of cellular subscribers.

Nigeria is about to gently nudge South Africa into second place as the African state with the largest number of cellular subscribers. In fact, South Africa suffered during the year when Vodacom restated its subscriber numbers, with the removal of inactive accounts, although this was countered by Cell-C who attracted higher levels of new users in the final quarter. This is not to say that Nigeria has not also had its problems, with the regulator first instructing operators not to sign new clients, and then more recently fining operators for poor service.

6. Internet Usage Statistics for Africa

The Internet in Africa is limited by a lower penetration rate when compared to the rest of the world. Thus, measurable parameters such as the number of Internet Service Provider (ISP) subscriptions, overall number of hosts, Internet Exchange Point (IXP) traffic and overall available bandwidth all indicate that Africa is way behind the “digital divide”.

Moreover, African continent itself exhibits an inner digital divide, with most Internet activities and infrastructures concentrated in South Africa, Morocco, Egypt, Nigeria, Kenya, Algeria, Mauritius and Seychelles, etc. In **Figure 14** is illustrated estimated Internet usage and penetration rate in percentage in Africa compared with the world average rate and rest of the world.

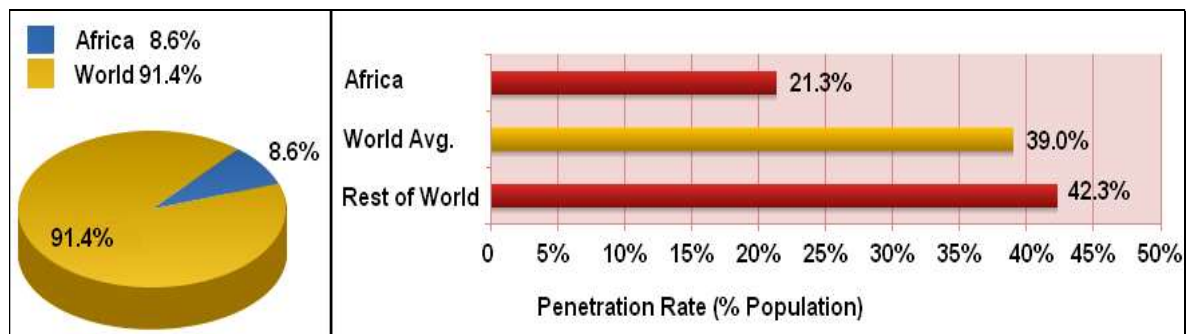


Figure 14. Estimated Internet usage and penetration of Population in Africa for December 2013

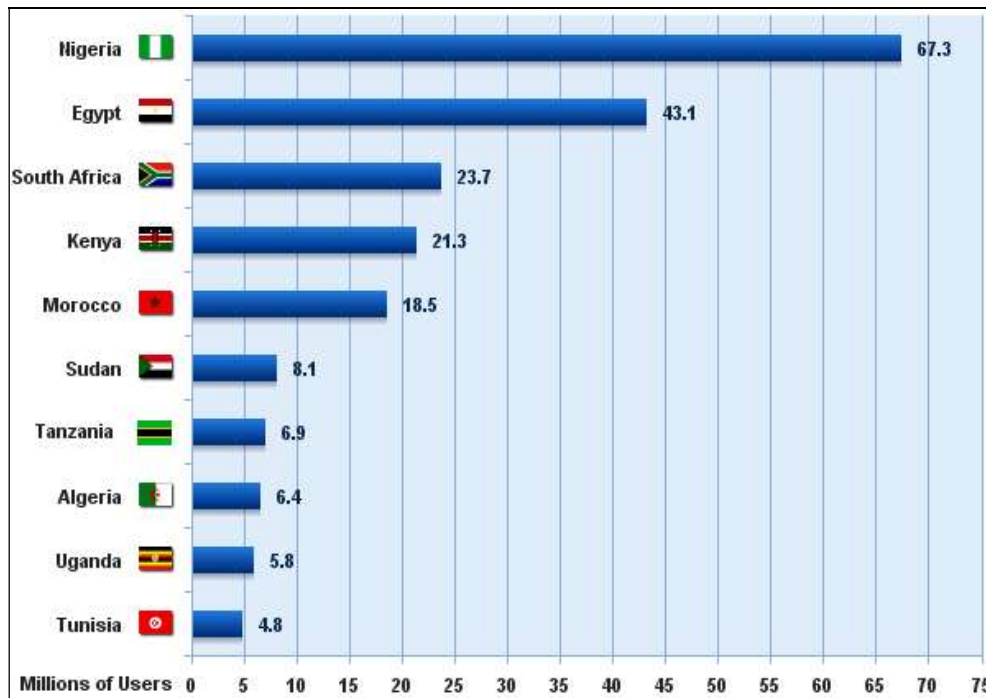


Figure 15. African Top 10 Internet Countries in 2013

The African region is witnessing one of the strongest increases in cellular data use in the world. Forecasts suggest that mobile Internet traffic across Africa will double between 2014 and 2015, and will see a 20-fold increase by the end of the decade. Get all the facts here, in Figure 15 is illustrated comparison of African top 10 Internet countries.

A major driver behind the rise in the use of Internet access and data services in Africa is the strong growth in international connectivity to the Continent over the past few years through space Video Broadcasting-Return Channel via Satellite (DVB-RCS) using GEO satellites and High Altitude Platforms (HAP) or/and Stratospheric Platform Systems (SPS) shown in Figure 16. The activation of submarine cables on Africa’s East and West coast has hugely increased the international data capacity available to the Continent.

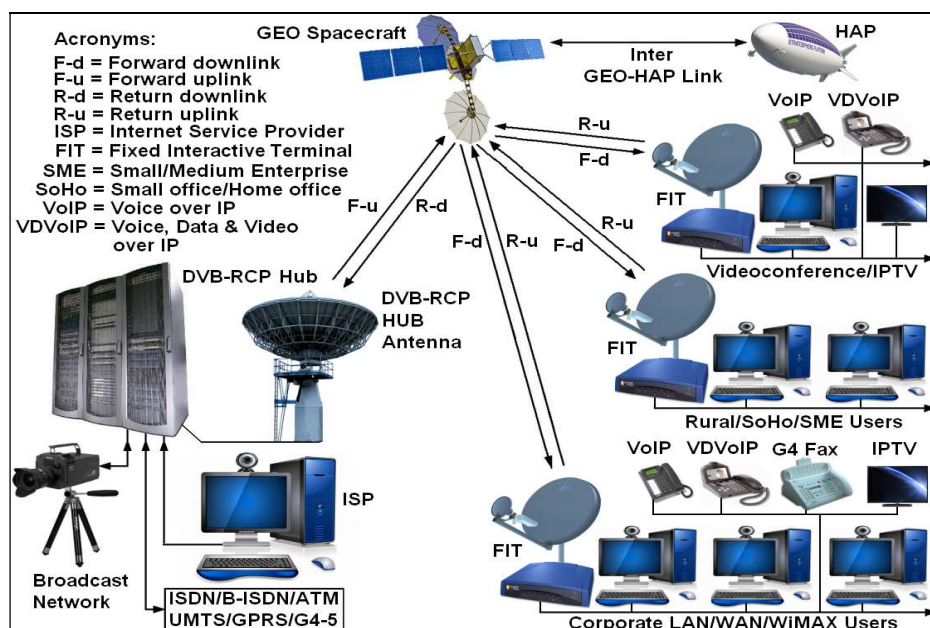


Figure 16. African Top 10 Internet Countries in 2013

In addition, in some African more developed countries is implemented satellite broadband backbone, such as Digital Video Broadcasting-Return Channel via Satellite (DVB-RCS) standards. Thus, the DVB-RCS network is able to provide backbone to mobile and landline telecommunication roaming including Internet access in rural and remote areas.

Finally, the new significant development in telecommunication systems for Internet and Cellular networks is modern design and implementation of High Altitude Platforms (HAP) stations for local coverage of suburban and rural environments, which as more cost effective solutions will provide bridges for high speed Internet and G5 cellular networks everywhere.

7. Conclusions

Space backhaul via Geostationary Earth Orbit (GEO) and non-GEO satellites and/or High Amplitude Platform (HAP) or Stratospheric Platform Systems (SPS) stations is widely used today to support the efforts of Internet and cellular operators to expand their network coverage in fixed, cellular and mobile environments.

In general, the development trend of modern telecommunication systems and networks in Africa will provide improved service in urban and semi-urban areas to enjoy congestion reduction and seamless connectivity using satellite and HAP backhaul, but rural and remote coverage around the world is still poor due to needs for more reliable satellite transmission via the DVB-RCS standard and deployment integrated HUP stations.

Given the technological, technical and business options available for using satellite integrated with HAP stations backhaul and recent technological transfer and innovations such as GEO and non-GEO High Throughput Satellite (HTS) constellation networks, there is good reason for Internet and cellular operators to implement satellite and HAP backhaul service. In addition to the socio-economic impact, Internet access and cellular backhaul through satellite and HAP networks significantly increases the subscriber base and allows them to guarantee full reach in rural, remote and mobile environments.

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BIOGRAPHY OF AUTHOR



Prof. Dimov Stojce Ilcev is a senior research professor at University of Johannesburg (UJ). He has three BSc degrees in Radio Engineering, Nautical Science and Maritime Electronics and Communications. He got MSc and PhD in Mobile Satellite Communications and Navigation as well. Prof. Ilcev also holds the certificates for Radio operator 1st class (Morse), for GMDSS 1st class Radio Electronic Operator and Maintainer and for Master Mariner without Limitations. He is the author of 9 books and over 330 papers in mobile Radio and Satellite CNS, DVB-RCS, Satellite Asset Tracking (SAT), Stratospheric Platform Systems (SPS) for maritime, land (road and railways), and aeronautical applications.