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Requirements for Networks in Africa

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Forward

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Requirements for Networks in Africa

Introduction

The general status of the African Networks

The state of the telecommunication networks infrastructure in Africa, on average, is very different from the state of telecommunication networks in on other continents. In Africa the telecommunication networks are generally outdated, have small coverage and very costly, while on other continents, telecommunication networks are modern, have wide coverage and costs are low.

However within Africa, the state of the telecommunication infrastructure is similar in most countries. Surprisingly it is also similar with other infrastructures such as roads, electricity etc.

Therefore by all measures and from all sides, it can easily be established that infrastructure development in Africa lags behind the developments in other continents. By all indicators used to measure information society.

The International Telecommunication Union (ITU), in its Measuring the Information Society Report 2015, published in November 2015, indicates that access to fixed telephony, mobile telephony, internet, broadband, smart phones etc., is lowest in Africa. Given the fact that telecommunication access is closely related to the network availability, it means that Africa's telecommunication networks (infrastructures) lag behind all other continents.

It is almost true in all cases that high availability of networks means high levels of access, although there are cases where the network utilization is very low compared to the network capacities availed. Therefore when the ITU's report indicates that access in Africa is lowest compared to that of all other continents, it almost means that the networks that support those services are also not that much available.

The variance in the networks in Africa

It is important to understand that there is variance in the level of availability of telecommunication networks with Africa. All countries are at varying levels of telecommunication networks. There are countries in Africa which have similar availability of networks like other countries on other continents. For example, South Africa's networks compares well with other networks in some countries on other continents, and in many instances, it is much better than some countries found in on some continents. However on average, the networks in Africa are the worst as Africa has some of the countries with the worst telecommunication networks in the whole world.

Within Africa, there is variance from one country to another, and within the country there is also variance between urban and rural. These are most pronounced in Africa, compared to countries on other continents. The general trend is that there are good networks within the cities and big towns of Africa but as soon as you get out, the situation quickly turns to absence of networks.

The commonest measurements of the state of the telecommunication networks is in terms of capacity, and modernity (ability to support modern services). However in Africa's case, it is important to consider another closely related measurement of network reach, which points to how far out the networks reaches. This is not as important for other continents as for most of them, the variance between urban and rural is not that big.

Current growth statistics indicate that Africa has the highest growth of almost everything but most certainly has the highest growth of mobile telecommunication users in the whole world. This indeed says a lot about the rapid changes that are taking place in the growth of telecommunication

networks in Africa. However due to the gap that has existed for a long time, between mobile usage in Africa and other continents, the fact still remains, the networks of Africa still lag behind.

Lagging behind but with still impressive networks would not be such a bad thing but lagging behind and having insufficient networks is certainly bad. African networks are not only lagging behind, but they are not sufficient to serve the needs of the population in Africa.

The importance of the African Networks

Surprisingly African telecommunication networks are among the key infrastructures that have seen a lot of attention, by way of policy and regulatory interventions, financial investments and technological advancement. The main reason for this is the now established understanding that telecommunication infrastructure is used by most of all others to jumpstart their development. Therefore in Africa, it is expected that once the telecommunication infrastructure is fixed or improved, then the others will quickly follow suite in the path of development. This points to the importance of quickly fixing the telecommunication networks in Africa for other developments to also take off in a meaningful way. There are other sectors almost depend on the dependability of the telecommunication networks to thrive. It has been noted that for Africa, it is the developments in the infrastructures (networks) that have contributed greatest to the growth currently being experienced. This, points to the fact that growth in infrastructure will spur the growth of Africa.

Efforts to address the African Network challenges

There have been many interventions that have been put in place to address the challenges facing African networks' inability to deliver as expected. Many organizations have been truly concerned and many have made efforts. Some of the interventions have been in areas of analysing the challenges and providing possible solutions, others have been in areas of funding for actual network replacement, installation and improvements. Others have been in the areas of capacity building.

The ITU has mainly been in the main areas of studying and advising on possible solutions through its Bureau of Telecommunication Development (BDT) and development of Recommendation and standardization applicable for adoption of technological advancement and applications through its Telecommunication Standardization Bureau (TSB).

The World Bank, the African Development Bank, and several other local and international banks have invested heavily in telecommunication networks. By and large and in all honesty, there are great improvements in African networks. Over the years, and day by day more countries are implementing new and appropriate networks, although there are still remains issues of coverage. More and more African countries are being encouraged to identify the critical issues to be addressed when developing new technologies in order to simplify adoption, although there is still a challenge of how much influence is being made. And more and more users from Africa are actually using new applications and now technology, although there is a challenge of how many compared to the other users.

Some reasons for the disparity

Despite all the efforts, investments, policy interventions to date, African networks still lag behind other continents' in almost all aspects. Most certainly the majorities of networks in Africa do not have the required capacities to meet the current needs. They also do not yet have the capability of applying new technological advancements in their networks. They are not able to deliver the new services and applications which are cost effective, secure. Most African networks do not have sufficient coverage of the population.

There are many reasons as to why this may be so. Most common ones relate to:

- Lack of financing
- Lack of human capacity
- Being left behind with old technology networks

- Demography and geographical challenges of many countries in Africa
- Cultural
- And many others.

In some quarters, this situation is called the “Digital Divide”.

It is crucial that African networks are able to deliver the new services, apply new technological advancement, deliver new applications and provide enough capacities, because these are more cost effective, they are more secure, they are faster, they are also cheaper as well as enhance global competitiveness.

This technical paper, examines issues of the current status of the African telecommunication networks and the possible future requirements to enable them be able to meet the needs of the African population.

Scope

This Technical Paper is focusing on analysing the current status of African telecommunication networks in order to be able to make statements on the following aspects:

- The current status of networks in Africa
- The adaptability of the African Networks to new technologies advancements
- The suitability of African networks to deliver new services and new applications
- The success stories on setting up the new/enhanced networks in Africa in accordance with the African continent requirements and network elements;
- The challenges faced while installing/transiting/migrating to the new network;
- The forecast and remarkable tendencies for future needs for African countries in terms of networks requirements and their impact on the everyday lives at the continent
- The possible roles of ITU

Whereas there are several aspects of the telecommunication networks that can be looked at, this paper will focus only on mainly the technological aspects and essentially from the angle of standardization requirements and abilities of African Networks.

The networks analysis will be restricted to the period from the year 2000 to date and will only look at networks in Africa.

This paper could be used to inform SG 13 about the standardization requirements for African networks and to inform developing countries in Africa on how to best prepare themselves to become involved in ITU-T SG 13 standardization work as well help WTSA-16 consider improvements.

1 Definitions

Most of the terms and definitions being used in the document those already defined by the ITU. The other definitions will be appropriately referenced.

Terms defined elsewhere

This Technical Paper uses the following terms defined elsewhere:

- 1.1.1 **evolution towards IMT-2000** [ITU R M.1308]: A process of change and development of a mobile radio system towards the capabilities and functionalities of IMT-2000.
- 1.1.2 **integrated services digital network** [ITU-T I.112]: An integrated services network that provides digital connections between user-network interfaces.
- 1.1.3 **IP-based networks** [ITU-T Y.1401]: A network in which IP is used as one of the Layer 3 protocols.
- 1.1.4 **migration to IMT-2000** [ITU R M.1308]: Movement of users and/or service delivery from existing telecommunication network to IMT-2000.
- 1.1.5 **public switched telephone network** [ITU-T Q.1290]: A telecommunications network established to perform telephone services for the public subscribers.
- 1.1.6 **ubiquitous networking** [ITU-T Y.2002]: The ability for persons and/or devices to access services and communicate while minimizing technical restrictions regarding where, when and how these services are accessed, in the context of the service(s) subscribed to.

2 Abbreviations

This Supplement uses the following abbreviations and acronyms:

1G	First Generation Network
2.5G	2.5 Generation Networks
2G	Second Generation Network
3G	Third Generation Network
4G	Fourth Generation Network
ARPU	Average Revenue Per User
CC	Cloud Computing
CDMA	Code Division Multiple Access
COMESA	Common Market for Eastern and Southern Africa
DSL	Digital subscriber lines
EAC	East African Cooperation
ECOWAS	Economic Community of West African States
GSM	Global System for Mobile communications
ICT	Information and Communication Technologies
IGAD	Inter-governmental Authority on Development
IMS	IP Multimedia Subsystem
IMT	International Mobile Telecommunications
IN	Intelligent Network
IoT	Internet of Things
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet Service Providers
LTE	Long Term Evolution
NBI	National Backbone Infrastructure
NGN	Next Generation Network
OSI	Open System Interconnection
PANAFTTEL	Pan African Telecommunications
PSTN	Public Switched Telephone Network
QoE	Quality of Experience
QoS	Quality of Service
RASCOM	Regional African Satellite Communication Organization
SG	Study Group
TSB	Telecommunication Standardization Bureau
Wi-Fi	Wireless Local Area Network
WiMAX	Worldwide Interoperability for Microwave Access

WTSA	World Telecommunication Standardization Assembly
BDT	Bureau for Development of Telecommunications
ICT	Information and Communication Technology
IMT 2020	International Mobile Telecommunications 2020
ITU	International Telecommunications Union
ITU-T	International Telecommunications Union-Telecommunications
SADC	Southern Africa Development Community
SG 13	Study Group 13

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4 Review of the current status of African Telecommunication Networks

4.1 The historical trend of the development of the telecommunication networks in Africa

The introduction of telecommunications networks in Africa was done by the colonialists around the 1870s. The colonialists brought with them more modern forms of communications in Africa essentially replacing the traditional means which included human beings trekking long distances to carry messages, use of drums to convey messages over a distance. At the start it was the telegraphy was quickly introduced in Africa. These were introduced in towns and along railway lines for signalling. Communication was not for the ordinary person, it was for the administrators and government business. This has remained to date with government in Africa still having a big say in the way telecommunication developed and evolved and how it was managed. This has had both positive and negative influence on the state of the African Telecommunication networks.

In Africa, unlike in other continents, telecommunication networks change, develop or evolve mostly after the government has taken steps for the change to happen. The non government society (business community and others) have always had little or no influence on the direction of telecommunication networks in most African countries. For example, even up to now, it is governments which first push for change of technology, say from 1G to 2G to 3G. The positive of this is that government usually comes up with the required resources for the change to happen but the negative is that governments are not good at keeping pace with technological changes and as a result most African telecommunications networks have remained either basic or a little more than basic. This observation is reinforced by the fact that in most countries where networks are rapidly changing or with keeping pace with technological changes, there is a high degree of liberalization. The private sector is driving that change.

Interestingly even today, most developments in telecommunication networks in Africa are driven by governments. This means any interventions to develop telecommunication in Africa have to take into account this fact and be ready to work with governments to implement effective changes.

4.2 The characteristics of African Telecommunication networks

It is interesting to observe that African networks have developed in a predictable way, with similar characteristics. These can help understand the issues with African networks and how they can be used for the better.

African networks have the following common characteristics;

I Resourced by Governments

Most of them are resourced by governments. A big number of them have resulted from bilateral agreements with other developing partners or banks. There are several which have been directly funded by governments. There are many which have resulted from the action of governments to liberalize the telecommunication sector.

II Have limited reach

Owing from the resourcing by government, governments have a big say where the networks reach. As a result Africans networks have a limited reach to only cover government administrative, political and business interest places and big towns and cities. African countries have most of their population in rural places which are often of no immediately interest for governments.

III Technologically inferior

As a result of mostly being resourced by governments, African telecommunication networks mostly remain technologically inferior. They do not keep up with current technological changes. This is because governments have little interest in doing more than basic and since most networks still serve, even with outdated technology, they serve the purpose.

IV Regional networks

Africa unlike other continents, Africa has had many attempts at developing regional networks. This is because most networks in African countries are influenced by governments, and secondly it makes financing sense, since most of the financing is done by banks.

Governments in Africa find it reasonable to work together in building regional networks. Much as this makes a lot of business sense for African countries, there are few success stories of truly African networks.

Examples of regional networks include;

- The East African Telecommunication and Posts Corporation (EAP&TC).
- Pan African Telecommunication network (PANAFTEL)
- Submarine cables Landing to the eastern African coast, West African coast, Southern African coast and Northern African coast.

V National Backbone Infrastructure (NBI)

Most, if not all African countries have embraced and have completed installation of or are in the process of installing a national backbone networks. This normally forms a ring around the country and cities and towns connect to it.

Most African networks follow these characteristics with very few exceptions.

4.3 The Telecommunication Networks in Africa

As mentioned earlier, the African Telecommunications networks have maintained its characteristics even over the years. They are mostly fully or partially owned by governments or governments have a stake in the ownership. They are still using a lot of outdated technologies. Their reach is limited and there is a lot of efforts to create regional networks and national backbones are a big part of the networks in many countries.

A number of countries in Africa have some specific data networks but these are few. Most use ISP for data or use mobile data.

Almost all coastal countries in Africa have a submarine cable landing on their costs, a few inland cables are used to distribute it to the landlocked countries. Technology deployed in Africa include mostly fixed, GSM (1G, 2G, 2,5G, 3G, CDMA, WiMAX and Wi-Fi). These technologies and their deployment frequency are illustrated in Figure 1.

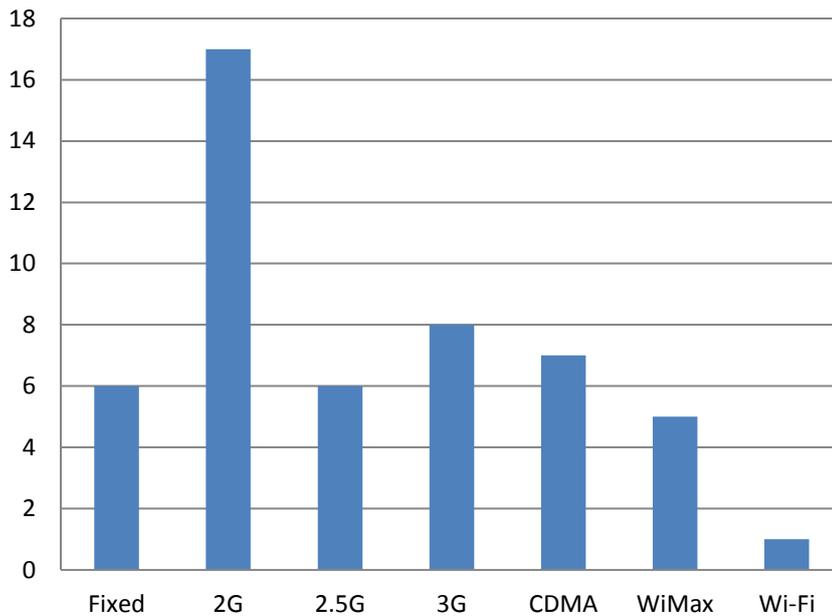


Figure 1 – Technology deployed in Africa

I Basic public switched telephone networks (PSTN)

Most African countries have maintained their Public Switched Telephone Networks (PSTN) otherwise commonly known as fixed telephony networks despite the continued operational difficulties with fixed networks. A number of countries have tried to upgrade the capabilities of fixed networks by putting in digital subscriber lines (DSL) others have also installed intelligent networks (IN) all in the effort of improving the capabilities of fixed networks, to have bigger capacities as well as increase the speeds, required by newer applications and services.

The greatest challenge in Africa for PSTN is its volume, availability, and quality. South Africa has the largest telephone network on the continent, accounting for 72% of 5.3M lines on the continent but the problem of coverage is serious. The fact that close to 80% of the population in most African countries live in the rural areas where only 20% of the phones are installed illustrates just how seriously the telecommunication services are lacking for the rural majority of people in the region.

Most African countries have seen quicker and more effective coverage through use of wireless technologies. However unlike PSTN where the terminal device does not require electricity, wireless terminal necessarily require electricity. There is almost no electricity coverage in the rural places where 80% of the population is. This is a slow down to an otherwise very rapidly rolling out technology.

II Wireless Network coverage in Africa.

All African countries have deployed wireless technologies. Mobile telephony is well spread in Africa just like in the Western World. While in Europe and North America there is a trend towards an average of two cell phones (or two SIM cards) per person, more and more Africans own at least 2 cell phones per person. The percentage keeps increasing year after year. Furthermore, the African mobile telephony market has been growing at a fast rate since between 2004 and 2007; for example, this growth has been three times the world's average.

Table 1: African mobile subscriber growth and penetration – 1998 - 2010

Year	Subscribers (million)	Annual growth	Penetration	As percentage of total telephone subscribers
1998	3.38	133%	0.5%	17%
1999	7.66	126%	1.0%	29%
2000	11.3	48%	1.5%	36%
2001	23.8	111%	2.9%	53%
2002	35.3	48%	4.6%	62%
2003	52.1	48%	6.1%	65%
2004	81.0	53%	9.2%	76%
2005	134	65%	15%	82%
2006	196	46%	21%	88%
2007	279	42%	30%	91%
2008	379	35%	38%	92%
2009 (e)	463	22%	46%	93%
2010 (e)	540	17%	54%	93%

(SOURCE: BUDECOMM BASED ON ITU, GLOBAL MOBILE AND INDUSTRY DATA)

The most popular standard for mobile phones in Africa is GSM with 2G being predominant. However there is rapid roll out of both 3G and 4G so as to be able to provide data services beyond voice. There are already countries which have installed LTE in Africa. CDMA and WiMAX are stunted wherever they have been in Africa.

ITU statistics show that by 2005 mobile subscription had surpassed fixed telephony subscriptions. The main reason for this phenomenal growth is that mobile networks are much more cost effective to deploy beyond the major cities and towns deep in the rural places where more than 80% of African population stays. The other reason is that most technological developments have been targeting mobile networks and as such they are better suited to handle new services and applications. Beyond that they are truly mobile an attraction worldwide.

However there are still a few places here and there in Africa where networks have not yet reached and people there have no access. This is largely due to inaccessibility, remoteness and the sparse population in such areas or dire poverty and thus unattractive to operators. Some countries in Africa still have Code Division Multiple Access (CDMA) and WiMAX technologies. These however never became as popular as GSM. The information available about deployed mobile networks in the 53 African countries show that availability of the oldest and latest wireless technologies being deployed in Africa. Figure 3 summarizes information collected on the current status of mobile networks in African countries as of May 2014. The availability of 2G, 3G and 4G LTE networks in African countries is rapidly changing.

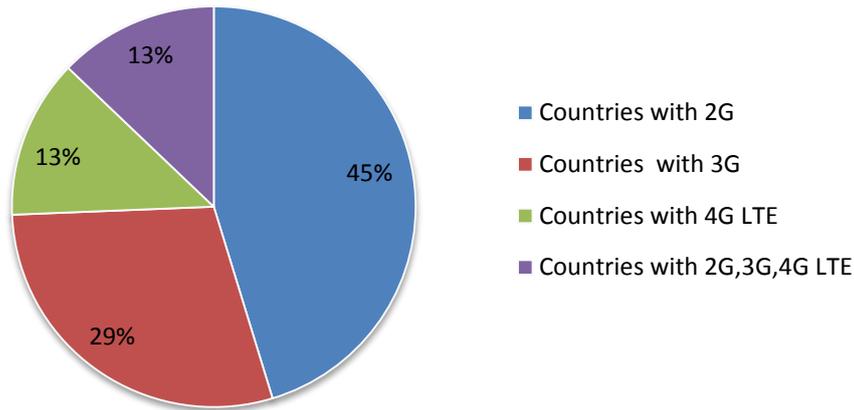


Figure 2 – Current deployment of mobile networks in 53 African countries

I Regional infrastructures

A Terrestrial

In the late 70s and early 80s, a continental, analogue, microwave network called PANAFTTEL began to connect all countries in Africa in hopes of reducing the need to transit intra-continental telephone calls outside the continent a situation now estimated to cost African countries over US\$900 Million annually. Despite the admirable vision, a number of countries have not connected their portion. For the countries that have fulfilled national commitments, the network is in use. Yet, old technology, inadequate capacity, and coordination among countries are a major challenge.

New, technologically advanced, regional networks are now under serious consideration along with various levels of development for the Southern Africa Development Community (SADC), Common Market for Eastern and Southern Africa (COMESA), East African Cooperation (EAC), and ECOWAS and the Inter-governmental Authority on Development. These future networks will be digital and offer higher capacity.

II Satellite

RASCOM, a continent wide satellite project, intends to consolidate African intra-continental traffic from the present six satellites to one satellite, to reduce hopping outside Africa and, as noted earlier, reduce transit fees. The rationalized traffic would form a basis for the acquisition of a dedicated satellite for Africa. Presently, most of the traffic is carried by Intelsat satellites, although the Panamsat system is playing an increasing role as liberalization gathers momentum. With large parts of the region far from getting simple telephony, Very Small Aperture Terminals (VSAT) will play an increasing role in providing telephony and data services to the remotest parts of the region. The Inmarsat system offers data connectivity from remote sites to head offices.

III Submarine cable

A submarine cable, known as Africa ONE, was planned to link all coastal countries and inland countries, providing immense capacity. Financing and support caused tremendous delay and changes in the project implementation. However this idea prompted other cable networks to plan and actually implement their networks. Already, a number of cables

have already commenced providing services to the East Africa coast. The other coasts, Southern, Westerns, and Northern already have cables landing on their coasts.

These cables employ the latest technological advances and therefore are capable of supporting all new services and application, plus affording very high capacities with great reliability. The current challenge to extending the capabilities of the cables to the landlocked countries, beyond the coastal countries where they land. Figure Technology deployed in Africa

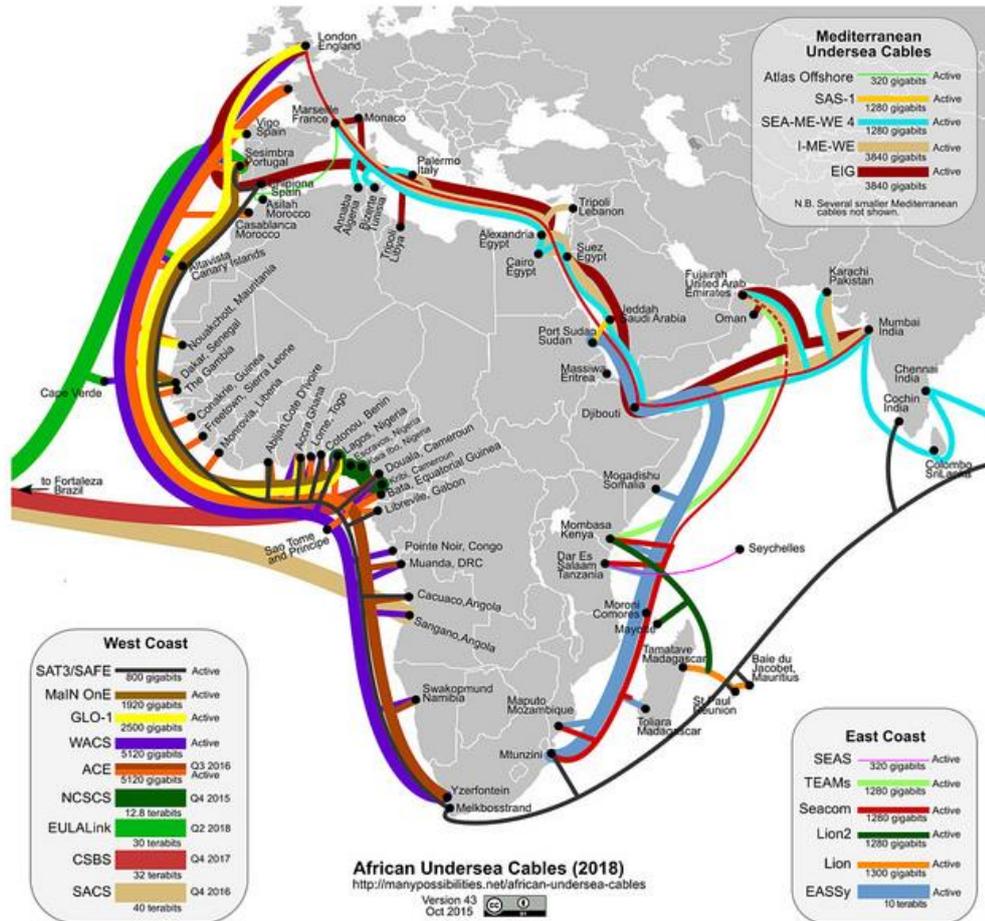


Figure 3 – African Submarine Cables

As a result of the landing of the submarine cables, large parts of Africa have gained access to international fiber bandwidth via submarine cables for the first time in recent years. In other parts of the continent, additional fiber systems have brought competition to a previously monopolized market. This has led to massive investments into terrestrial fiber backbone infrastructure to take the new bandwidth to population centres in the interior and across borders into landlocked countries.

Africa’s Internet and broadband sector is set to benefit the most from these developments.

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. 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 DSL 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 mobile data and third-generation (3G) broadband services is changing this, with the mobile networks bringing Internet access to many areas outside of the main cities for the first time.

Many fixed-line incumbents have reacted by rolling out fixed-wireless access networks to expand their geographical reach. The technology of choice has been CDMA-2000 which supports broadband data rates with an upgrade to EV-DO standard. WiMAX technology, however, offers higher data rates and has gained ground in Africa with well over 100 networks already in operation. And also traditional copper fixed lines and DSL have seen a renaissance in some markets on the back of an increasing demand for broadband access.

Table 2 below shows some figures to show how the internet penetration is growing in Africa as a result of submarine cables.

Table 2: Top ten African Internet market penetration rates – early-2012

Country	Market penetration
Morocco	51%
Seychelles	43%
Tunisia	39%
Egypt	36%
Mauritius	35%
Cape Verde	32%
Nigeria	28%
Kenya	28%
South Africa	21%
Sao Tome and Principe	20%

(SOURCE: BUDECOMM BASED ON ITU DATA)

I Data networks

The region has invested poorly in dedicated data networks. While basic data transmission can be accomplished through leased lines on the public switched telephone network, advanced services need dedicated high-speed networks. Outside South Africa, which has a wide range of services for data transmission and database access, only six countries have invested in dedicated data networks all with packet switched networks, accessed at various speeds ranging from 2, 400 to 6 400 bps. Kenya has built a 64/128 Kbps infrastructure distributed to key towns and linked to major international destinations. Regarding ISDN, few countries have it as a priority or have the resources to build such a network. Only two countries have Integrated Services Digital Network (ISDN). Those countries that have ISDN use it for both voice and data in the same network. The demands for data beyond the data being provided through ISDN

Unlike cellular, where the private sector has played a major role in its development, data networks have yet to catch the eye of the private sector, with exception of Tanzania where three companies are providing data infrastructures. With shrinking opportunities for investment and increasing policy reform, the private sector will soon be eyeing this area and similar fast growth will be seen as in cellular.

II Internet

Four years ago, the Internet was virtually unknown in Africa, but today all capitals in the region, apart from Comoros and Somalia (which, incidentally, do not have plans for deployment in the near future) have Internet services. Both telecom companies and Internet Service Providers (ISP) are involved in this. As expected, internet rides on the

back of other networks therefore where the other networks do not reach internet is unlikely to be there unless it is being provided via satellite, which is not the case in majority of African countries. Countries where there is mining, are the ones which have private access to telecommunications services via mostly satellite.

The needs for internet in most of the African countries are being met via ISPs who are using mostly existing wireless networks. Also the telecoms who provide voice telephony, fixed and mobile are also in the mix of providing internet on their networks.

The biggest problem for internet access in Africa is coverage, speeds and Quality of Service (QoS).

III National Backbone Networks

A new trend that is sweeping across almost all African countries is the installation of an Optical Fibre Cable across the country to build the National Data Transmission Backbone. It is high capacity and all other users wishing to expand their networks beyond can use it. The investments are mainly by governments. In Eastern Africa, Uganda, Kenya, Tanzania and Kenya have already completed a number of Phases of such networks. These have modern technologies therefore capable of supporting new services and applications at various speeds and bandwidth.

Current drawbacks mostly relate to high costs of installation, but there is momentum and interest in these infrastructures.

The Uganda National Backbone Infrastructure (NBI) is projected to be 1536.39Kms of Optical Fibre Cable across the country.

IV Broadband infrastructure improvements enable advanced services and applications

The use of digital media is still in its infancy in Africa but growing fast. This is being driven by the availability of low priced gadgets on the market like smart phones. In the meanwhile suitable broadband infrastructure on the continent is also evolving. However, significant improvements in national and international fibre infrastructure and the emergence of wireless broadband access and third-generation (3G) mobile systems in recent years are now bringing the Internet to a wider part of the continent's close to many in African countries. This is opening the way to advanced online applications and services and a convergence of telecommunications with digital media.

Requiring relatively little bandwidth, VoIP Internet telephony was the first application in this converging environment. Beginning in 2004, its use has been liberalized in many key markets in Africa but remains restricted in others.

Besides communication, information and entertainment, the Internet also holds the potential to bring vast improvements in other key areas where Africa lags behind most of the rest of the world: governance, trade, health and access to education. South Africa is the leading market on the continent where digital media have reached a level of development to foster an associated advertising and marketing industry. However many countries in Africa are making a significant contribution globally towards the growth of social networking portals. Table 3 below gives an indication of internet penetration among top ten countries in Africa.

Table 3: Top ten African Internet user communities – early-2010

Country	Internet users (million)	Market penetration
Nigeria	44.0	28%
Egypt	16.6	20%
Morocco	10.3	32%
Algeria	4.7	14%
South Africa	4.4	9%
Sudan	4.2	10%
Kenya	4.0	10%
Tunisia	3.5	34%
Uganda	3.2	10%
Zimbabwe	1.4	11%

(SOURCE: BUDECOMM BASED ON ITU DATA)

4.4 Expected benefits of new technology networks: A case of IMT and IMS

4.4.1 Benefits of IMT

IMT access technologies enable mobile networks to have new capabilities that provide access to a wide range of telecommunication services including advanced mobile services supported by mobile and fixed networks (e.g., PSTN/ISDN/IP) as well as access to other services which are specific to mobile users. Most networks are increasingly packet-based. IMT systems support low to high mobility applications and a wide range of data rates in accordance with user and service demands in multiple user environments.

Deployment of IMT systems started in the year 2000 following the introduction of ITU approved Recommendation ITU-R M.1457, which contains specifications for radio interfaces of IMT-2000. It was at this point that IMT was renamed IMT-2000. IMT-2000 is a third generation network (3G) mobile cellular technology and provides access by means of radio links.

All networks which do not have IMT capabilities are referred to as pre-IMT-2000 and ITU and other standardization bodies have made recommendations on the most feasible ways to evolve and migrate from pre-IMT-2000 to IMT-2000.

The implementation of IMT has many benefits including:

- mobility;
- a high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of IMT services with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability;

- enhanced peak data rates to support advanced services and applications (100 Mbit/s for high mobility and 1 Giga bit per second for low mobility).

4.4.2 Specific benefits from the implementation of IMT

Specific benefits resulting from the implementation of IMT are described below:

i) Capabilities and services

IMT access technologies like LTE provide higher bandwidth for mobile networks for launching newer services such as multimedia services. IMT access technology further supports effective spectrum utilization which results in increased cost effectiveness.

Developing countries should thus be desirous to improve and modernize their telecommunication infrastructures which are largely based on telephone oriented services, such as PSTN/ISDN services.

ii) Operational features

Key features of IMT are described in [ITU-R M.1645], [ITU-R M.1822] and IMT-Adv/2Rev.1 and include the following:

- less capital intensive compared to fixed networks;
- easier to manage (day to day);
- improved reliability;
- a lot of commonly available support (similar systems);
- high degree of commonality of design worldwide;
- compatibility of services within IMT-2000 and with the fixed networks;
- high quality;
- small terminal for worldwide use;
- worldwide roaming capability;
- capability for multimedia applications and a wide range of services and terminals;
- better average revenue per user (ARPU).

iii) Catching up with modern trends (Technological and otherwise)

In developing countries, the task of bridging the digital divide arrived at a juncture where most of the countries were still grappling with the problem of providing voice access. Large-scale computerization and the growth of e-services require higher bandwidth availability on the local access network. In these developing countries, most of the access networks are likely to be implemented using wireless technology and therefore IMT systems have a unique advantage in these markets.

iv) Resource management

Developing countries have a responsibility to manage resources well. These days, developing countries are very concerned about whether the new technologies, innovations and systems utilize resources efficiently.

v) Electricity requirements

In keeping with the desire of developing countries to ensure efficient resource management the reduced electricity requirements of IMT systems are important. In many developing countries, electricity is expensive and only available in cities and major towns, leaving most rural areas without commercial mains supply electricity. These rural areas can only be serviced using alternative power sources such as solar and wind power. Electricity consumption is therefore a key factor in deciding on the type of communications systems to be adopted.

vi) **Health and the environment**

Many developing countries are now cautious about technologies and their effects on health. Developing countries are keen to be satisfied that new systems and technologies do not pose environmental or health risks.

vii) **Consumer issues**

On behalf of the consumer, governments in African countries are usually concerned about:

- end user terminal size and cost;
- availability of end user terminal and after-sales services;
- service costs;
- QoS;
- QoE;
- availability;
- suitability for rural utilization;
- environmental and health issues;
- ease to use.

4.4.3 IMS

The IP multimedia subsystem (IMS) is defined in [ETSI TS 123 228] and in [TIA-873.002] as a collection of core network functional entities for the support of session initiation Protocol (SIP) - based services. The Third Generation Partnership Project (3GPP) defines IMS as a generic architecture for offering multimedia and voice over IP services. In more general terms, IMS is a standardized IP-based architecture that supports multiple network types and multimedia applications.

4.4.4 Specific benefits from implementing IMS

Capabilities and services supported by IMS are numerous and include:

- combining voice, text, pictures and video in seamless call sessions;
- defining a number of network reference points to support operator-provided services and other security arrangements;
- offering significant ease-of-use to subscribers and allowing service providers to drive branding through a common interface while substantially reducing costs;
- supporting defined reference points within the underlying transport infrastructure for the enforcement of QoS negotiated by session signalling and for flow gating;
- supporting authentication as part of registration;
- supporting defined reference points for the collection of accounting data in support of charging and billing operations. These reference points also support the exchange of information in support of correlation of charging between IMS and the underlying transport;
- supporting multiple access operations and interworking with a variety of external networks (such as GSM, CDMA 2000) via defined reference points;
- supporting the registration of the user and the terminal device at a particular location in the network.

IMS assumes IP networks and is essentially used to enable and enhance capabilities for providing and managing new applications over networks. The implementation of IMS is mostly a choice by an operator as a way to improve revenues and operations.

IMS is a sign that a network is modern. Outdated networks cannot support IMS, therefore IMS can safely be used as a measure of the modernity of a network, especially in Africa.

4.5 Ability to adapt to new technologies

There is a worldwide explosion in demand for increased bandwidth, mobility, multiple new applications, games, better quality of service and instant access to information. These demands are being driven by higher incomes and increased levels of computer literacy. While the explosion is most significant in developed countries, recent statistics show a growing demand among developing countries in Asia and in Africa.

The most recent access technologies providing increased bandwidth for mobile networks related to international mobile telecommunications (IMT) are long term evolution (LTE) access technologies. In order to enable session based services such as voice over LTE (VoLTE) with a high level of quality, the IP multimedia subsystem (IMS) has gained significant relevancy in mobile telecommunication networks.

Many operators in developed countries have implemented these technologies, however in African countries these technologies have already been implemented by some mobile networks while others are in the process of implementing them; however the majority of African countries are yet to commence implementation. Main reasons for this relate to lack of appropriate infrastructure (networks), lack of commercially optimum demand for the services, and in some cases lack of awareness and lack of technical capacity.

Some countries are still deploying legacy networks with architecture based on the seven layers of open system interconnection (OSI), while others have deployed state of the art networks based on next generation networks (NGN) with a simplified architecture of only two layers, the service layer and the transport layer. Reasons for slow implementation mostly relate to financing (initial capital investment) and economics (doubt as to whether the market will take up the services and recoup the investment). There is also reluctance due to insufficient understanding of the benefits of IMT and IMS.

Despite these drawbacks, it is the desire of many developing countries to evolve their networks and migrate their users enabling them to take advantage of the many services being provided by modern networks. Thus IMT and IMS systems are important to developing countries.

In the ITU Supplement T-REC Q.Sup66-2014, there was a survey carried out relating to migration to IMT and IMS among developing countries. This survey was carried out in some developing countries concerning the status of IMT and IMS indicated that 76% of respondents were willing to migrate to IMT while 81% are planning to migrate to IMS. Over 64% of countries surveyed from Africa have implemented mobile networks capable of IMT and the rest are planning to implement IMT and IMS capable networks within two to five years. . The survey found fourteen countries in Africa which had implemented IMS in their mobile networks. Those countries were South Africa, Uganda, Morocco, Algeria, Namibia, Liberia, Angola, Cameroon, Ghana, Botswana, Côte d'Ivoire, Gambia, Nigeria and Rwanda. However a number of countries in Africa were in advanced stages of negotiation with vendors while others were in the testing stage.

The 2014 statistics on IMS in developing countries especially in Africa are incomplete, however, going purely by availability of IP networks as a basic requirement for IMS, 64% of countries in Africa are capable of implementing IMS and it is therefore just a question of making the decision to implement.

4.6 Ability to provide new services and applications

Most current telecommunications networks in Africa are not yet providing users with the worldwide expected experience they would wish to have or they should expect. Much as this is very subjective and too much generalization, but on average in most African countries, telecommunications

services are rather slow, poor quality, absent in some places, and use old technology as well as being very expensive. This is against the measurement that newer services are faster, versatile, high quality of service, cheap and accessible as well as available.

In a nutshell most African networks need upgrading, revamping and installation of new technology networks, modernization and or expansion.

Upgrading:

There are a number of countries which have already installed technology which has evolved with time. For example, those with GSM, CDMA, WiMAX and ISDN, all have latest versions which are capable of supporting providing new services and applications. This could be done by simply by newer components which can be added on to the existing networks to make it able to provide new services and applications.

Revamping and installation of new technology networks.

Some African countries have networks which cannot be helped in anyway. They are very old, small in coverage and the best way out is to revamp and install new networks altogether. Such countries, though minority, have an opportunity to draw a new networks plan based on the most efficient technology.

Expansion

Most networks in Africa need expansion. Most networks in Africa so far cover less than 40% of the population. This is against the background that most 80% of the African population is found in rural places and yet telecommunication services are usually covering only the 20% in the urban places.

Modernization.

All over the world, IP, IMT and IMS have become the basic tenets of acceptable networks to support new and emerging technologies services and applications. The networks have to be IP based, they must have IMT capabilities and must be able to support IMS. Africa still has many countries with no IP networks, do not have IMT capabilities and certainly have not migrated to IMS.

Hypothetically, if IMT and IMS are used as a sign of modern networks, the following figures give interesting insights in the situation of the African Telecommunication Networks.

The figures arise from a very simple survey on the issues relating to migrating to IMT and IMS in networks of developing countries.

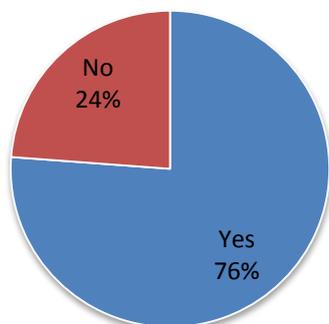


Figure 4 – Plan to migrate to IMT

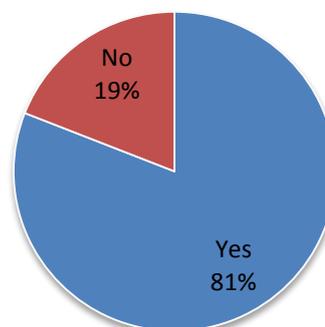


Figure 5 – Plan to migrate to IMS

The regulators (representatives of government) from African countries who responded show a strong support for migration to IMT and IMS. Figure 4 shows that the percentage of those planning to migrate to IMT is 76%, while Figure 5 shows that the percentage representing those planning to

migrate to IMS is 81%. It is very possible that those who remain undecided may just not be aware, otherwise there would a 100% willingness to have the latest technology in telecommunication.

This simply shows that there is knowledge about these new technologies, there is also willingness to migrate to these new technologies but evidently there is a very big gap between what is known to be good and what actually get implemented in as far as the African Telecommunications networks is concerned.

Technically speaking all networks from 3G and above have IMT capabilities. Figure 6 below shows that by May 2014, 61% of the African countries had networks which have IMT capabilities. 39% of the African countries were ready to implement IMS but only 13% have implemented IMS. This is interesting that for IMT, by default as long as they have 3G and above networkers they have IMT, they do not have to add on any other technology or capability, and actually most African networks are projected to have 100% presence of IMT networks before 2020, as there is a strong drive in Africa to license 3G network providers in almost all African countries. The irony is that while this is being done, there is little awareness of the capabilities availed to the countries through having IMT networks. This means the utilization and demand for new services in most cases does not match the availability, which discourages operators and investors.

On the side IMS, another indicator of modern networks, 39% of African countries had networks able to support IMS but only 13% of those were providing IMS supported services. Meaning they are not yet willing to support these modern services much as they have networks capable of supporting them.

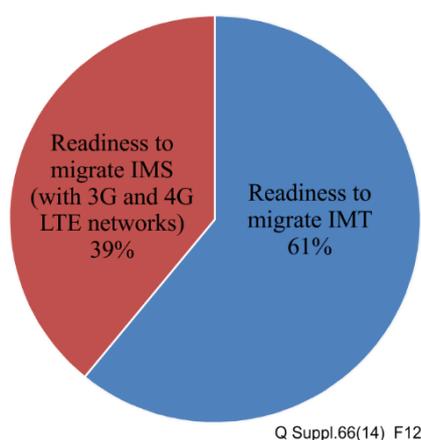


Figure 6 – 3G and 4G LTE mobile networks with IMT capabilities

5 Challenges faced by Telecommunications Networks in Africa

African infrastructure faces many challenges and these evolve with years but in general some of the reasons for not installing some of these new technologies are listed and ranked in Figure 7 below:

- Cost relating to acquiring IP based networks (which support modern services)
- Low demand for services being supported by new technologies
- Lack of adequate awareness of critical stakeholders such as regulators, operators and policy makers;
- Complicated processes involved in migration;
- Interconnection with fiber-optic cable;
- Lack of skilled technical and managerial skills.

Figure 6 summarizes and ranks the challenges faced by African countries in implementing new technology networks.

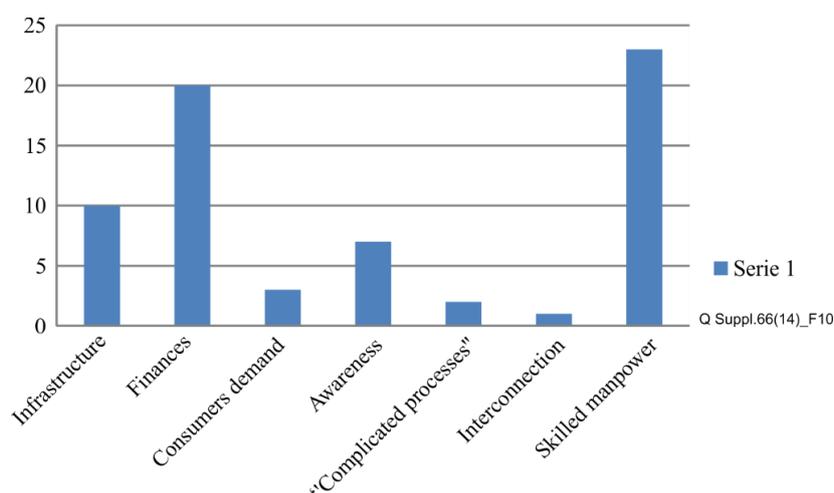


Figure 7 – Ranking of the challenges to implementing modern telecommunication networks in Africa

However the basic ones remain as;

I Inability to attract financial investments for African Telecommunication networks

Most African countries face serious financing for most of their infrastructure. This is worse for African Telecommunication networks where most financing organization believe that there are enough financial resource to finance telecommunication infrastructure development in the private sector. This was the case from 1986 to about mid 1990s but this interest has disappeared not from telecommunication but from Africa. Such financing has a lot of competition. Africa faces serious competition for finances from Asia and emerging European markets. Since it is private, it always ends up where greater returns are expected, and unfortunately Africa's conditions of expansive investment climate, unstable political environment do score Africa negatively.

II Lack of human capacity

It has been documented by many scholars that there is a serious lack of human capacity to keep up with technological advancement. There is also serious lack in the maintenance, planning, optimizing, projecting and scaling new technology for maximum benefits. This makes it inhibitive for Africa to keep resourcing expertise from abroad to carry out such activities in Africa.

III Demography and geographical challenges of many countries in Africa

Africa's terrain is very difficult to plan for especially wireless networks of high capacity which require short spans. It is very hilly, very a lot of vegetation and many inaccessible spots. In addition, Africa has 80% of its population living in rural areas which unfortunately are not usually economically viable. Furthermore in most rural places, the African population in rural places live very far apart villages with few people (sparsely populated) thus making it very difficult to properly sort out Africa infrastructure needs.

IV Culture of Push of services rather than Pull of services by African Consumers

Most operators in Africa avail "Push" services to the African market without much demand "Pull". There is very little or no Pull for services in Africa. This makes it difficult for investors to invest with confidence in the African new infrastructure.

5.1 Challenges of installing new networks

Most African countries have some old networks, fixed or mobile. Most of these are acquired through very expensive financing which has to be paid back over a period of time. Therefore most African networks do not fill it worthwhile or even prudent to replace equipment which has not yet

served its life time let alone brought returns to finance the loans. This is why some African countries are slow to replace their current networks in favour of newer networks.

5.2 Challenges of transitioning/Migrating to new technologies in existing networks

Challenges of transitioning /migration mostly relate to lack of technical skills and capacity to optimize networks by most African technical personnel. Transitioning and migration or almost require re engineering but starting from an existing platform rather than a clean slate this requires good knowledge and awareness of what is available, good knowledge of applicable standards and of course availability of fund to buy the new components. Sadly there challenge of insufficient capacities of old networks which makes transitioning and migration to newer technologies, which usually require higher speeds and high capacities difficult.

5.3 Challenges of applying new technologies on existing networks

These challenges usually are complicated by lack of awareness of what is available in terms of applications on the side of African technical experts. This is because most networkers in African of foreign owned and the foreign owners are not keen to invest in training the African technical exporters in new technologies and applications.

African consumers are usually depends on operators and marketers to inform them about the existence and availability of new technologies and application before they can turn into buyers. This is interpreted in lack of interest in new applications.

6 Success stories in Africa of implementing new telecommunication networks and technologies.

Only in the late 1980s, the information and telecommunication technology (ICT) sector in Africa was trivial and stagnant. Very few people had access to a telephone, and even fewer had access to computers. The idea of an ICT revolution in Africa was beyond the dreams of most people.

In the 1990s, the global shift to wireless telecommunications created a technology that was ideally suited to Africa. Governments across Sub-Saharan Africa began changing the way that they manage the sector, shifting from a model of state-owned monopoly operators to competition between privately-owned companies. Between 1998 and 2008, more than \$36 billion was invested in telecommunications networks in Africa, mostly by the private sector.

Efforts by Sub-Saharan African governments succeeded in expanding network coverage of the population from around 10 percent to over 60 percent between 1998 and 2008 while the number of mobile subscribers in the region increased exponentially, from 4 million to approximately 259 million. Simultaneously, prices fell two-thirds, from an average of \$0.30 per minute to \$0.10 per minute, and are continuing to drop, bringing telecommunication services within the economic reach of most Africans. In addition to allowing people to communicate more easily and inexpensively, the ICT revolution has created jobs, boosted investment and the sector is now in the top three sources of government revenues in many African countries.

It has also had a profound impact on the way Africa does business and the way governments operate, driving innovation and entrepreneurship in the creation and delivery of both public and private services. For example, in Ghana, the customs clearances went from 2-3 weeks to 1-2 days with a 50% increase in revenue 18 months after introduction of the IT systems and business re-engineering.

The first lesson of Sub-Saharan Africa's ICT experience relates directly to the telecommunication industry, showing that the sector has investors who are willing to take risks and invest very large sums in the region. The key is having the right business model, the correct policies, and a regulatory environment that is conducive to doing business. This still continues to be true for Africa.

The second lesson concerns innovation and entrepreneurs in Africa. The connectivity revolution has shown that, with the help of ICT, ITU, standardizations, groups etc., African entrepreneurs will establish new businesses and generate new areas of economic activity.

6.1 Installations of new networks success stories

Despite the almost gloomy story for Africa in as far installation adoption and migration to modern networks is concerned, there some countries which are doing extremely well.

The table below shows the state of networks in 53 African countries by May 2014. This situation is certainly much better by this date.

Table 4: Status of mobile networks in African countries as of May 2014

	Country	2G	3G	4G LTE	IMT	IMS
1	Algeria	Yes	Yes	Yes	Yes	Yes
2	Angola	Yes	Yes	Yes	Yes	Yes
3	Benin (Republic of)	Yes	Yes	No	No	No
4	Botswana (Republic of)	Yes	Yes	Yes	Yes	Yes
5	Burkina Faso	Yes	No	No	No	No
6	Burundi (Republic of)	Yes	Yes	No	No	No
7	Cabo Verde (Republic of)	Yes	No	No	No	No
8	Cameroon (Republic of)	Yes	No	Yes	Yes	Yes
9	Central African Republic	Yes	No	No	No	No
10	Chad (Republic of)	Yes	No	No	No	No
11	Comoros (Union of the)	Yes	No	No	No	No
12	Congo (Republic of the)	Yes	Yes	No	Yes	No
13	Côte d'Ivoire (Republic of)	Yes	Yes	Yes	Yes	Yes
14	Democratic Republic of the Congo	Yes	Yes	No	Yes	No
15	Djibouti (Republic of)	Yes	No	No	No	No
16	Egypt (Arab Republic of)	Yes	Yes	No	Yes	No
17	Equatorial Guinea (Republic of)	Yes	No	No	Yes	No
18	Eritrea	Yes	No	No	No	No
19	Ethiopia	Yes	Yes	No	Yes	No
20	Gabonese Republic	Yes	No	No	No	No
21	Gambia (Republic of the)	Yes	Yes	Yes	Yes	Yes
22	Ghana	Yes	Yes	Yes	Yes	Yes
23	Guinea (Republic of)	Yes	No	No	No	No
24	Guinea-Bissau (Republic of)	Yes	No	No	No	No
25	Kenya (Republic of)	Yes	Yes	No	Yes	No
26	Lesotho (Kingdom of)	Yes	Yes	No	Yes	No
27	Liberia (Republic of)	Yes	No	Yes	Yes	Yes
28	Libya	Yes	Yes	No	Yes	No
29	Madagascar (Republic of)	Yes	Yes	No	Yes	No
30	Malawi	Yes	Yes	No	Yes	No
31	Mali (Republic of)	Yes	Yes	No	Yes	No

Table 4: Status of mobile networks in African countries as of May 2014

	Country	2G	3G	4G LTE	IMT	IMS
32	Mauritania (Islamic Republic of)	Yes	Yes	No	Yes	No
33	Mauritius (Republic of)	Yes	Yes	No	Yes	No
34	Morocco (Kingdom of)	Yes	Yes	Yes	Yes	Yes
35	Mozambique (Republic of)	Yes	Yes	No	Yes	No
36	Namibia (Republic of)	Yes	Yes	Yes	Yes	Yes
37	Niger (Republic of the)	Yes	No	No	No	No
38	Nigeria (Federal Republic of)	Yes	Yes	Yes	Yes	Yes
39	Rwanda (Republic of)	Yes	Yes	Yes	Yes	Yes
40	Senegal (Republic of)	Yes	Yes	No	Yes	No
41	Seychelles (Republic of)	Yes	Yes	No	Yes	No
42	Sierra Leone	Yes	No	No	No	No
43	Somalia (Federal Republic of)	Yes	Yes	No	Yes	No
44	South Africa (Republic of)	Yes	Yes	Yes	Yes	Yes
45	South Sudan (Republic of)	Yes	Yes	No	Yes	No
46	Sudan (Republic of the)	Yes	Yes	No	Yes	No
47	Swaziland (Kingdom of)	Yes	Yes	No	Yes	No
48	Tanzania (United Republic of)	Yes	Yes	No	Yes	No
49	Togolese Republic	Yes	No	No	No	No
50	Tunisia	Yes	Yes	No	Yes	No
51	Uganda (Republic of)	Yes	Yes	Yes	Yes	Yes
52	Zambia (Republic of)	Yes	Yes	Yes	Yes	No
53	Zimbabwe (Republic of)	Yes	Yes	No	Yes	No

In Table 4 above it is clear that all African countries are following almost a similar trend in as far as adopting GSM is concerned. All countries have 2G by 2015. By 2015 only 20% of African countries have only 2G networks which are not considered modern. Otherwise 80% of African countries have 3G and upwards, which are considered modern networks.

A number of countries have gone ahead with issuing 3G licenses. There are 69.8% of the African countries with 3G networks. 3G is IP, IMT and is capable of supporting IMS.

A small number, 13% has even gone higher by issuing licenses for 4G LTE which are IP, IMT and automatically IMS.

The Figure below shows the percentages of those countries.

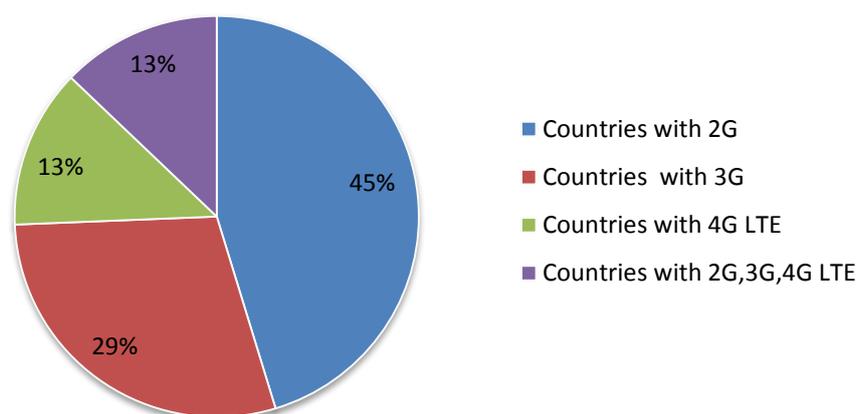


Figure 8 – Current deployment of mobile networks in 53 African countries

The 13% of the countries are the ones which have endeavoured or gone against the common tide to keep up with the trends in telecommunication technology.

6.2 Factors influencing success stories in Africa

There are a number of factors that have been observed here to have strong influence on success stories in African Telecommunication networks. The most obvious ones include;

6.2.1 Strong Government intervention in ICT

There are countries who are been successful and have been observed to strong government involvement. Government sets targets for the sector, government is involved in looking for the finance, government is involved in the governance in the sector. Some of those countries include; Rwanda, Botswana, Tanzania, Zambia, Morocco, Mali, Burkina Faso, Cote d'Ivoire Ghana. These countries have got very successful stories of liberalization in the ICT sector and they are very active in ITU activities under ITU-T, ITU-R and ITU-D.

6.2.2 Strong demand by consumers

There are countries, few in Africa, whose ICT sector is driven by a strong demand by consumers. They have big industries which rely on ICTs like mineral exploration, mining, manufacturing, education, health, tourism etc. Such countries include; South Africa, Nigeria, Ghana, Algeria, Morocco, Kenya Sudan and Egypt.

6.2.3 High calibre of operators

There is another category of success drivers. These are countries in Africa which by some design, succeeded in attracting very high calibre operators who are of international reputation and their operations are at international level. The developments therefore are mainly driven by these strong operators. Such operators are like, Airtel, Orange, Vodafone. MTN, etc. These include countries like, Uganda, Nigeria, Tanzania, Rwanda, Algeria, Cameroun, Tunisia, Uganda, Kenya and Egypt. The operators are developing a strong group of private sector that drives the developments in the sector.

6.2.4 Participation in ITU activities

One common factor in all the four categories of success drives in active participation ITU activities. It is observed that countries in Africa which are developing their networks in the positive direction

are countries which are active in ITU activities. All the countries mentioned above are very active in one of or all of the ITU main bureaus of ITU-D, ITU-T, and ITU-D.

7 Present Needs for African Telecommunication Networks

Even as any countries would look to the future in as far technology is concerned, it would have to be mindful of the technologies that are already on the horizon, hence not too distant future. These include Internet of Things (IoT), Cloud Computing (CC), Big Data, and now IMT 2020. Discussion and possibly the shape is already known, in fact it is difficult to think outside these technologies being discussed. However there are key things African countries would like to see in the future technologies and networks. These include, high degree of adaptability, low power, adaptable quality offerings.

There is all the evidence that the next ten years will bring further exciting developments to the increasingly vital telecommunications industry worldwide. The foundations for change are already well in motion and the continuing deployment of high-speed broadband and 4G technology will provide the infrastructure to ignite the new innovations and revolutions of the future.

There are a number of key trends which have emerged in recent years and will be real-game changers. Internet of Things (IoT) is one such trend that promises to transform every single sector of society and the economy. This will have big impact on new networks outlooks, especially in Africa.

The large amounts of data generated by IoT developments as well as the increase in user generated communications via social networks and will likely contribute to towards Big Data progress. Organizations are beginning to recognize the importance of storing and processing the huge amounts of data they retain and also mining this data for commercial benefit. In turn, this is leading to a growth in data centers, due to the increasing data storage demands and pressure on companies to appear environmentally pro-active by consolidating and outsourcing their data management requirements.

Cloud Computing deployment and development is gaining momentum around the world as the true potential of this technology reveals itself. It has become one of the fastest growing areas for the IT sector and cloud computing solutions are being adopted by enterprises; government and consumers alike.

It is evident that Wi-Fi will play a key role in the telecoms environment of the future. The use of Wi-Fi hotspots continues to rise due to increasing popularity from smart phone and mobile device users. The status of Wi-Fi technology is continuing to improve; creating a whole new range of opportunities in the Wi-Fi market. Smartphone users want faster, more ubiquitous and reliable connectivity, while operators are looking to squeeze every last bit of capacity out of their cellular networks. As a result, smarter Wi-Fi is needed so that it can take on a more strategic role as part of the overall mobile network infrastructure. Ultimately users simply want the fastest and most reliable wireless connection they can get.

More spectrum is always going to be required worldwide, if we want to make the most of all the new opportunities that mobile and wireless broadband technology have to offer our society and our economy. With the voice market saturated, the telecommunication operators' attention is focused on mobile broadband which requires additional spectrum. Governments around the world are beginning to view the sale of spectrum as a viable revenue raising opportunity in a fragile economy. Increased interest in the re-use of white spaces is growing.

7.1 Technical Requirement

Africa's general telecommunication networks deficiencies are based on;

- Lack of modern technologies in the networks

- Lack of sufficient capacities in networks
- Lack of coverage beyond big towns and cities
- High costs of services
- One size fits types of networks

These issues draw the outline of the needs for African telecommunication networks. In terms of the technical requirements, most African countries currently need to modernize their telecommunication networks to be able to reap the benefits of new technologies and to compete better.

Modernization of networks will address:

- backward compatibility with existing networks;
- efficient utilization of electricity;
- meeting the need for affordable and economical solutions for rural communication needs;
- billing accuracy;
- addressing convergence between mobile and fixed services;
- QoE;
- QoS;
- security;
- spectrum efficiency for wireless technologies;
- support of modern services (data and multimedia) while maintaining voice services;
- increasing revenue streams from mobile operations.

The issue of expansion beyond the big towns and cities is driven by commercial value by operators. This is being addressed by some sort of subsidies arrangements which vary from country to country. Even then, the most efficient networks need to be installed.

The issues of “one size fits all” refer to having the ability to optimize the network to fit the unique needs of African countries. Such a network should be able to provide service to fewer individuals in some places while being able to be adjusted to provide services to bigger populations. In Africa even quality can be adjusted, It has been proven that some individuals do not mind poor quality service if they are paying relatively. Hence a predetermined setting for size, speed and quality is not right for African countries.

7.2 Financial Requirements

The issue of financing African networks is unfortunately becoming more complicated. More and more financing organizations are becoming less interested in financing African Telecommunication Networks. This is because of the competition from other places on the continent where it makes better sense to finance than in Africa. Nevertheless it is a critical need to examine as it is key to fund modernization of networks, in the face of recent investments. Most successful stories like in Rwanda and Ghana have governments strongly getting involved in ensuring this financing, through bilateral agreements at a government level. Otherwise innovation in licensing will have to be used to overcome scarcity of financing.

7.3 Human Resource capacity Requirements

The issue of capacity development is critical. It is critical in being able to articulate the kind of network solutions specific Africa countries need, it is critical in being able to negotiate the right terms and conditions for acquisition, it is critical in being able to install, critical in being able to maintain.

There is the issue of brain drain which is facing African countries. Once the capacity is built, the individual opt for greener pastures or better earning conditions elsewhere.

ITU had done a lot in addressing capacity building in African countries but the critical numbers are yet to be achieved.

7.4 Future Telecommunication Networks of Africa.

Technology is forever changing, changing very fast and this is a really problem for African countries who are usually not at the heart of the changes. The planning becomes very difficult and certainly keeping up becomes a daunting job. However looking to the future there are certain key features of networks Africa will need, to at least address it unique situations.

7.5 High capacity and modern connectivity to the rest of the world.

By default only two technologies are poised for this. These are satellite technology and fiber cable (surface or submarine). Suitability will vary from place to place and situation to situation but they both work well as back up and primary.

Fortunately it can be confirmed that all African coasts now have submarine cables landing on them. The challenge remains competition for access prices and connectivity for inland countries.

7.6 Adaptability of networks

Africa's future networks have to have a very high degree of ability to adaptability to especially different needs of locality to locality. This is in respect to;

- Quality of service offerings
- Environmental Climate change
- Power requirements
- Traffic loading
- Etc.

It is very important for the future networks to be able to adjust appropriately to the local requirements and conditions.

7.7 Scalability of networks

Telecommunication networks which will serve Africa better in future need to be able to be incrementally adjusted, in case of expansion, it should be able to do that by simply adding another module likewise in case of reducing the opposite happens. The reasons for this are that Africa population distribution is still changing even within countries. The rater of urbanization is great and towns and cities are just beginning to grow. One place which did not have settlement today may be a high demand place just in under a year.

The maximum utilization in Africa has not been reached so network requirements change very often in as far as capacities and application are concerned, so in order not to buy new replacement all the time scaling up would make better sense.

7.8 Low power networks

Africa still has challenges of accessing enough power to run equipment for domestic use. Africa needs networks of the future to require very little power for consumption as there is not enough. This is to user terminals and system equipment.

7.9 Environmental Sensitivity

Africa joins the other parts of the world to be sensitive to environmental changes. It is imperative that new technology networks have to be environmental sensitive. This takes into account some adverse weather condition some African countries experience. Networks should be able to adjust to keep providing services with optimal power consumption.

7.10 Shared Resources

Africa has developed a mechanism that allows sharing of resources in order to cut costs of networks and duplicity. This is already working well with physical sites, base station towers, cables, and power equipment. There is need for new networks to be able to allow sharing of even other more critical components of the networks, such as switching, billing and other intra network components. This will reduce costs for each individual and it will easier for interveners to do it for many operators within a single order. In return the movement towards new networks will increase.

7.11 Backward Compatibility and Interconnectivity with other types of networks

The African future networks should be able to handle interconnectivity with other, most often older existing networks. This is because, experience has shown that African countries do not abandon working networks for new ones. The usual progression is interconnectivity first with older network and then total migration to new network.

Unfortunately new technologies have often required total abandon of older networks or running two networks at the same time. African has a challenge of abandoning older networks because most of them have been acquired through expensive loans and they have hardly reached their lifetime hence they have not brought in returns. Abandoning them means acquiring another one, most likely on loan

The figure below illustrates this point.

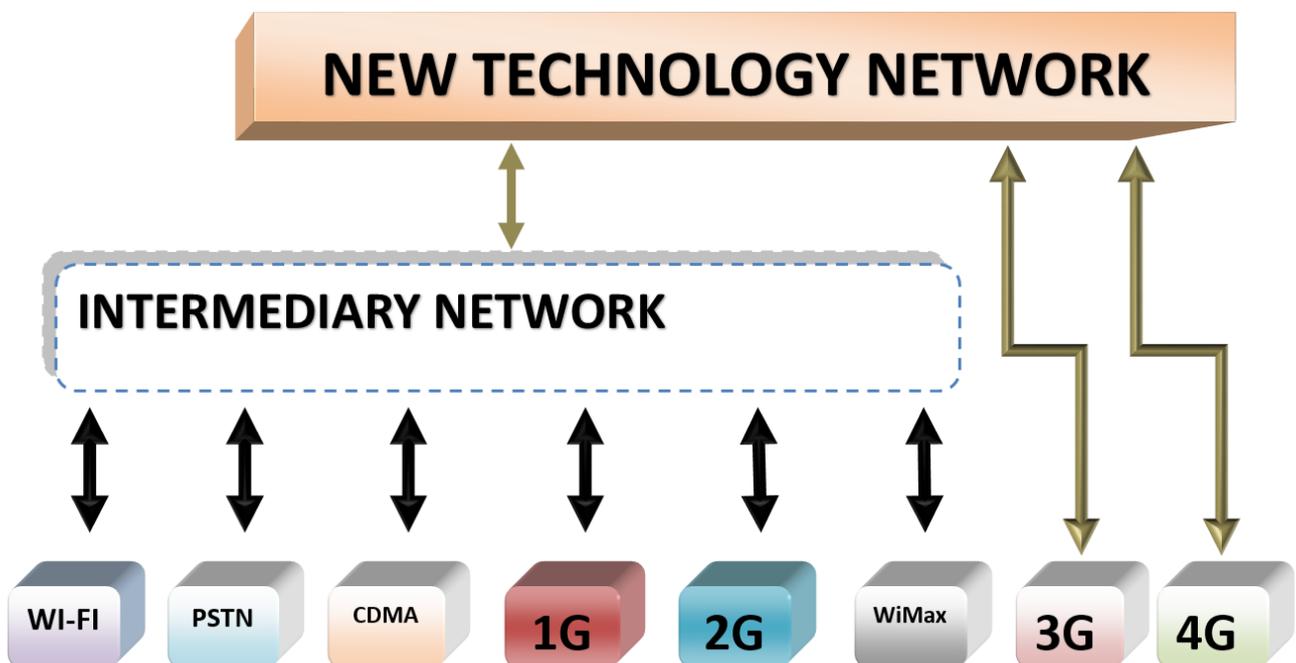


Figure 9 – The New Technology Network Requirement for Africa

7.12 Achieving the dream of future networks for Africa

Despite less than optimal network conditions across Africa, countries there have made considerable progress over the last four years toward acquiring modern networks and technologies. There things they have done which could be used as lessons for others to jump start similar developments in their countries.

A Liberalizing

A number of countries which are success stories have somehow undertaken reforms in their ICT sectors. Mores especially they have liberalized their ICT sector to allow in private sector. Private sector brings in the much more needed and scarce financing of telecommunication networks.

There have even been moves toward more advanced privatization, such as the sale of shares of state-run telephone operators to the public sector, as is the case in Zambia.

In an effort to be more competitive, African governments are allowing private sector participation through joint ventures and subcontracting of installation and maintenance service with the aim to improve network conditions. Telecommunications policy reforms have taken place in Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Gambia, Ghana, Ivory Coast, Mali, Niger, Nigeria, Senegal, Tanzania, Togo and Zambia. Reform is also expected in Angola, Rwanda, and Sudan.

The participation of the private sector in the provisioning of telecommunications and the entry of foreign suppliers has realigned priorities toward promoting economic, trade and industrial development.

B Increased participation in ITU Activities

Most of all the countries which are at the forefront of telecommunication infrastructure development in Africa happen to be the ones which are very active in ITU and other standardization activities. What is clear is that when a country is active in for a where ICT developments are being crafted, discussed, and explained, things like acceptability, adaption and implementations become easier. Therefore one of the steps of improving the state of affairs in African ICT infrastructure is to encourage African countries to be active where developmental issues are being discussed.

C Shared solutions

One of the biggest hurdles in modernizing ICT networks in Africa is huge costs of doing so. Some African countries have developed a relative new initiative within Africa's ICT infrastructure development is sharing of infrastructure. For example all NBIs are on the basis of sharing.

This approach solves many things;

- Guaranteeing is required, the numerous participating operators provide it easily
- Government can easily provide financing and easier financing terms to such a group than to an individual operator
- The cost to each operators is much lower than it would have been

8 Possible next steps

This paper has highlighted a number of issues relating to the needs of the African Telecommunication networks. It is intended to be studied further by all those wishing to help the situation in Africa. More so for African countries who are in this pit. As next steps, there are proposal for local things to be done and also international ones, in order to start on the path to modernizing African networks.

8.1 Local

- Locally most critical issue is for all stakeholders to accept that there is a deficiency problem.
- Locally it is important that Government can allow the private sector to drive the change as they have the capacity and ability to make more informed decisions
- Locally government should encourage network developments along sharing basis
- Locally government should encourage stakeholders to go where discussion are taking place.
- Locally government should be ready to come to the fore front to ease as required licensing conditions and government should be ready to help out with financing.

8.2 International

- Internationally the developed world has to accept the African ICT problems as global problems otherwise the world will not be a truly global village.
- Internationally global solutions have to be discussed and developed.
- Internationally, the voice of Africa needs to be heard and understood.

9 Conclusion

Modernization of the African telecommunication networks is a critical necessity in the global economy. Transactions critical communications, security are all being affected because of this problem. Genuine discussion and solution can possibly be found. As discussions of new networks are hitting pitch fever high, it is necessary for the developed world not to leave Africa behind.

Fortunately the ITU and its groups have picked up this issue with all seriousness, it is hoped that the next opportunity of WTSA-16 will see resolutions and recommendation which are aimed at addressing these identified critical issues.

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