The Programme for Infrastructure Development in Africa:
Transforming Africa through Modern Infrastructure

Programme for Infrastructure Development in Africa

Interconnecting, integrating and transforming a continent

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Africa Information and Communications Technology Sector Outlook 2030

Africa ICT Sector Outlook - 2030

ACKNOWLEDGEMENTS

The completion of the Information and Communications Technology (ICT) Sector Report and the ICT Outlook Report 2030 as part of the Programme for Infrastructure Development in Africa (PIDA) was a major milestone in defining Africa's performance and prospects in the ICT sector. This helped to inform on the priority ICT projects which are now an integral part of the project investment portfolio of the PIDA Priority Action Plan (PIDA-PAP) for the period up to 2020.

The support and collaboration of the Regional Economic Communities (RECs) and the Member States led not only to the success of PIDA, but also to ensuring that the ownership of PIDA rests with the RECs and Member States who are, ultimately, the drivers of PIDA as well as the beneficiaries.

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TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

AfDB	African Development Bank
AICD	African Infrastructure Country Diagnostic
AU	African Union
AUC	African Union Commission
CAB	Central African Backbone
CEN-SAD	Community of Sahel-Saharan States
CM	Common Market
COMESA	Common Market for Eastern and Southern Africa
CR	Criticality Ratio
EAC	East African Community
EASSy	Eastern African Submarine Cable System
ECA	Economic Commission for Africa
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EU	European Union
HIPPSA	Harmonization of ICT Policies in Sub-Saharan Africa
ICT	Information and Communication Technology
IGAD	Intergovernmental Authority on Development
INX	Internet Node Exchange
IP	Internet Protocol
IPTV	Internet Protocol Television
ISP	Internet Service Provider
ITU	International Telecommunications Union
IXPs	Internet Exchange Points
MM	Man Months
NEPAD	New Partnership for Africa's Development
NPCA	NEPAD Planning and Coordinating Agency
NRA	National Regulatory Authorities
OF	Optical Fiber
PAP	Priority Action Plan
PCT	PIDA Consulting Team
PIDA	Programme for Infrastructure Development in Africa

PPP	Public Private Partnership
REC	Regional Economic Communities
RIO:	Reference Interconnection Offer
SADC	Southern Africa Development Community
SANE	South Africa, Algeria, Nigeria and Egypt
SATA	Sub-Saharan Africa Basic Network-Terrestrial Link
SMP	Significant Market Power
TEAMS	The East African Marine System
UMA	Arab Maghreb Union
UN	United Nations
UNECA	United Nations Economic Commission for Africa
WACS	West African Cable System
WAPP	West African Power Pool
WB	World Bank

1. INTRODUCTION

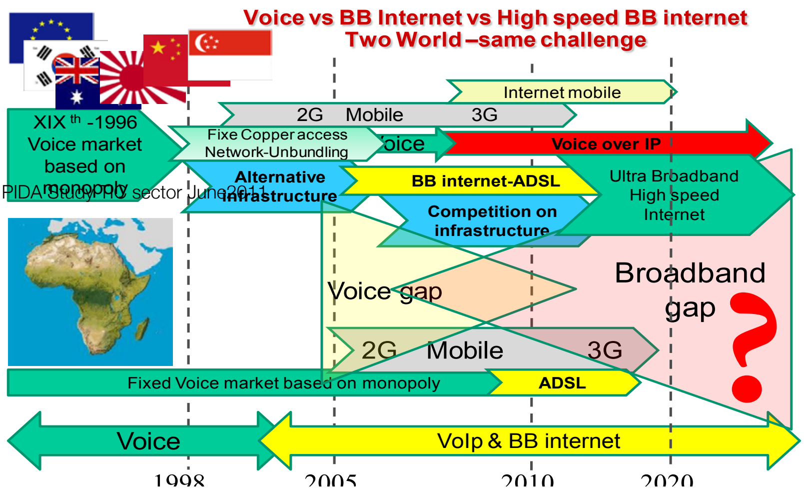
In few years, ***the African continent caught up widely with the delay in voice services thanks to the liberalization of its mobile services market***. It is also due to the fact that investments have been carried out widely by private operators. Operators in the landline services sector have invested very little and most of them today are no more capable of playing a significant role because they are financially and technically weak. However, some countries (Morocco, Tunisia, Senegal, Mauritius, to a lesser extent South Africa and some other countries) have invested in land-based infrastructure which are likely to meet the broadband requirements.

This lack of land-based infrastructure on all the segments (national, backhaul and access) along with a mobile services sector focused on voice offer and which rarely had the possibility[1] to invest in land-based infrastructure and the lack of international bandwidth are the reasons why Africa is considerably lagging behind the rest of the world.

Even if some countries like Uganda and Rwanda have opted for an information society development policy, another gap is widening day after day separating Africa from the rest of the world. In fact, the developed countries have embarked on the race for ***high speed broadband***[2] while accelerating their migration to digital society. The information technologies in the world have made great leaps thanks to IP and the development of digital society.

Today, these most developed countries' objective is no more access[3] to broadband but high speed access in order to offer access to broadband with a speed of 30 to 100 Mbps[4] nationwide. This objective can be realized by deploying new access infrastructure, in particular, the FTTH technology to compensate the non adaptation to the speed targeted by existing technologies such as ADSL, Cablemodem, Wimax… and by creating new infrastructure capable of carrying the growing data flow generated by numerous applications used by internet surfers.

Figure 1: The challenge of very high speed



Africa may decide to try to catch up with its delay without taking into consideration the radical technological and economic changes that affect the ICT sector globally but can also try to skip a step and set itself the goal of developing a digital society based on the developed countries[5] model and to put in place a suitable digital policy which would allow the continent to largely fill, by 2020-2030, the gap in broadband use.

The challenge in terms of infrastructure in the ICT sector is totally different from other sectors such as transport and energy.

[1] non enabling legal and regulatory framework

[2] Expected to replace high speed broadband by 2018-2030

[3] Which is widely common

[4] Not to confuse online speed with bandwidth needed for access. One relates to transmission speed and the other to the average volume required to fulfill the first

[5] Europe with its program "Digital Agenda for Europe-2020", Australia with its program RNHD, USA, Korea, Japan, Singapore have all embarked on this high speed with perspective dates varying from 2020 to 2030.

The liberalization of the market and the introduction of private operators have paved the way for the development of ICT on the African continent. Today, tomorrow (2018) and shortly later (2025-2030), Africa will always need new ICT infrastructure to meet a major challenge which is the migration to an information society and an e-economy. A very large part of these investments will be carried out, as is the case today, by the private sector.

In addition, the first task of the African decision makers is to undertake policy, legal and regulatory reform to allow such investments. The delay of Africa in the ICT sector is probably an opportunity if the continent is able to analyze the mistakes made elsewhere (overinvestment) and choose the right technological solutions. This requires a radical questioning of the role of institutions and governments to foster such development.

As a first step, an important legal and regulatory reform must be undertaken in a large number of African countries in order to enable and make easier the use of existing infrastructure.

Interconnection between countries and the implementation of trans-border infrastructure must be facilitated by the liberalization of processes and an agreement between all the African countries. The implementation process must be reviewed by all the countries in order for them to report to the relevant regulation authorities.

Free access to submarine cable landing stations must be guaranteed and non discriminatory for all the players; the coastal countries must enable access to landlocked neighboring countries

Competition in services must be strengthened but also in land-based infrastructure

Institutions, governments, regulators must focus again on the role of supervising the sector rather than managing it. Among other things, they must work on land-use planning, intervene to end the isolation of non profitable areas and to ensure legal and regulatory reform which must follow the evolutions of the market in order to remain efficient and drive rather than hinder development.

2. DEMAND FORECAST - OVERVIEW 2030

2.1 Technological changes

2.1.1 Context

The telecommunication sector in Africa has been undergoing tremendous change for many years now. In less than 10 years, the sector has been shaken by major technological revolutions and Africa's capacity to transpose practices and technologies in order to benefit from them.

Voice services

The emergence of GSM technologies associated with market liberalization has enabled Africa to rapidly bridge the gap. Today, with a density of 40%[6] and coverage of 80%, the voice services sector is mature and meets comfortably consumers' expectations.

The sector is largely dominated by private players/ investors and continues to consolidate itself with the extension of coverage and high pressure on prices as well as an important decrease in APRU which is the double consequence of "the price war between operators" (result of competition) and the "densification" which reaches population with the lowest purchasing power.

International calls cheaper than local calls[7]

If prices dropped by 40% for internet for the past years, they still remain very high. In some parts of the world, the cost of access to the internet represents 0.3% of the average monthly income. In Africa, it is sometimes 100% of the income. As far as the mobile phone is concerned, prices have dropped but it is often the local prices that do not decrease. ***It sometimes happens that an international call is cheaper than a local call. This means that interconnection rates within countries are not properly negotiated and are excessively high.***

Hamadoun Touré

Secretary General of the International Telecommunications Union (ITU), 2010

A retroactive analysis of the GSM development highlights three main issues:

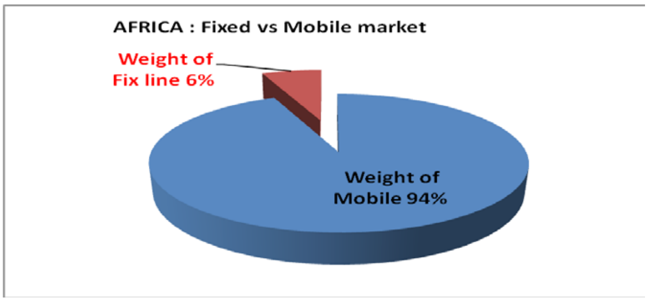
1. ***Consumer expectations*** because within a few years, the voice services density has gone up from 3% (before the 2000s) to about 40% with a few differences between countries depending on the level of economic development and/or the political and regulatory framework.
2. **Investments required** to establish GSM infrastructure are generally carried out by the private sector (> 90%).
3. **Transposition of technology** use: In developed countries, landline services and their related infrastructure have continued to develop in parallel with the development of the infrastructure related to GSM while in Africa, the development of mobile phone services has totally marginalized the landline services sector and over 95% of the African consumers use the mobile voice services (voice transposition) and remedy to the lack of landline access infrastructure through applications developed around SMS based services (transposition of applications).

In terms of numbers of subscribers, landline services represent on average on the continent less than 5% of the consumers while 95% use mobile voice services.

[6] Percentage corrected because consumers may own many SIM cards.

[7] Telecom: The 3G Race- Hamadoun Touré : "There is a need for an African regulation at a higher level " - Jeuneafrique.com

Figure 2: Africa: Fixed vs Mobile market



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In terms of players (operators) at the continental level, there is an important disparity between the number of operators licensed to operate land-based infrastructure and offer services and those licensed for mobile operation. In most African countries, the landline services market is still under the responsibility of incumbent operators, privatized for the majority of them. In the mobile phone sector, the majority of licenses were awarded to private operators with the presence of international companies/groups such as Barthi, MTN, and Orange…

Table 1: Landline services market vs Mobile phone sector

Type	Status	Number
Mobile	Private operators	144
	Operators, branch of incumbent operator	37
Landline + Infrastructure	Non privatized incumbent operator	26
	Partially privatized incumbent operator	26
	Alternative operators (infrastructure)	20
	Total	253

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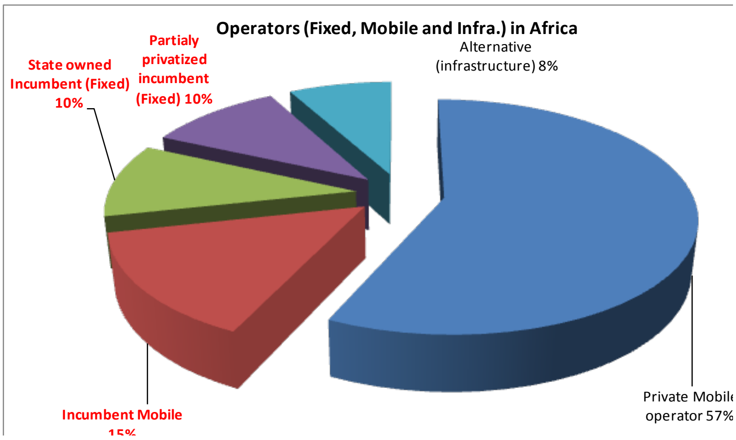
Figure 3: Breakdown of operators in Africa



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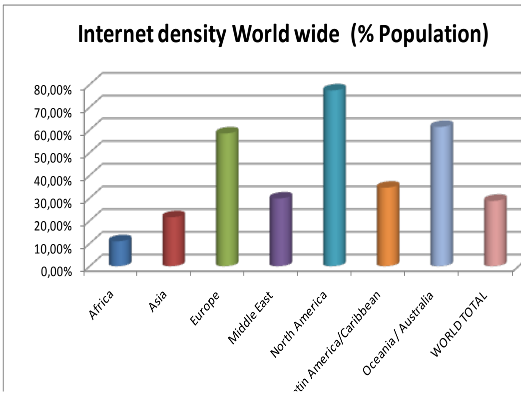
Similarly, the analysis[8] shows that the mobile services market has reached maturity and that Africa is at the end of the growth cycle in the market for the development of GSM for voice services and for the consolidation of operators.

Densification will continue at a slower pace and the sector will have to find a new impetus for development by turning to the internet and related service offers meeting consumer expectations (electronic payment...).

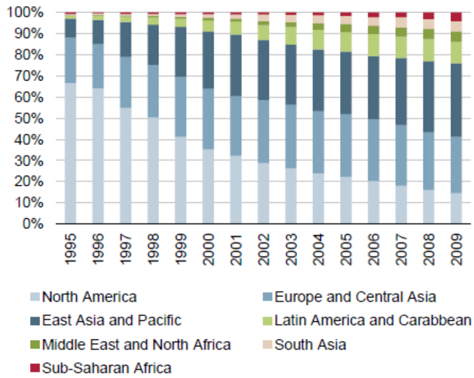
Internet services

We may argue that the gap between Africa and the rest of the world in terms of voice services has been widely closed in most countries. However, the **internet digital divide** between Africa and the rest of the world is huge and is **widening day by day** with in addition an **intra-African digital divide** between countries with "comfortable access to international bandwidth" and countries which remain landlocked[9] or those which have not yet set up a "digital" policy.

Figure 4: Internet density worldwide (% population and between 1995 and 2009)

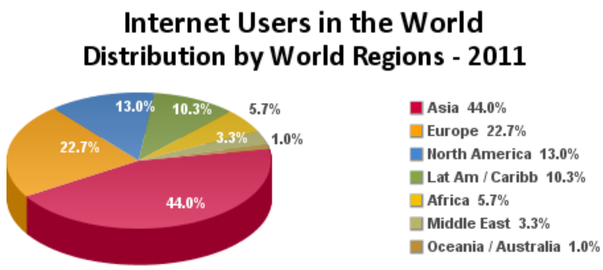


Source: PIDA Study ICT sector 2010



Source ITU 2010

Figure 5: Internet density worldwide (% population and between 1995 and 2009)

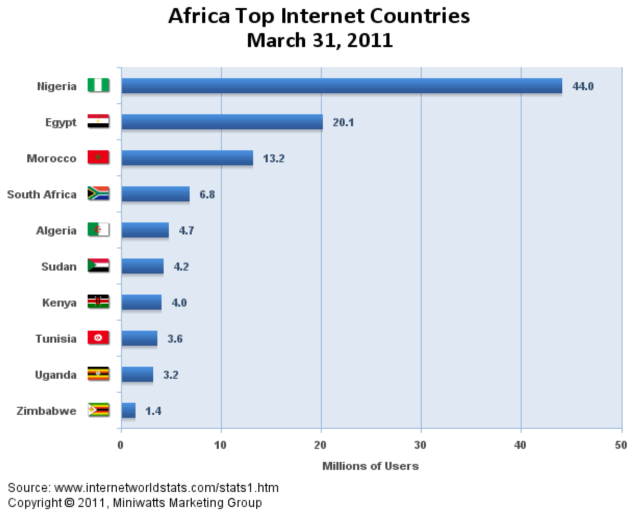


Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 2,095,006,005 Internet users on March 31, 2011
Copyright © 2011, Miniwatts Marketing Group

8 Note IFRI Bearing Point Afrique-telecoms 2010, the financial challenges of the telecom explosion in Sub-Saharan Africa

9 Chad, CAR, Burundi

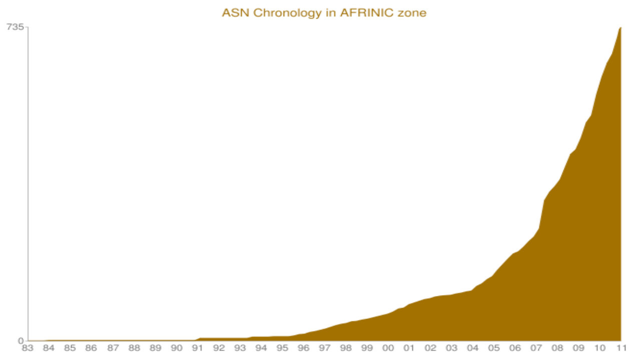
Figure 6: Breakdown of operators in Africa



Development of the « IP World »»

The development of the "IP World" in Africa is lagging behind the rest of the world and is unevenly distributed in the various African countries. However, Figure 7 below highlights the dynamism and the growth of ASNs (virtual infrastructure) in Africa which confirms the market's expectations and which is also a necessary point of passage to enter the "broadband" world.

Figure 7: Evolution of the number of ASNs in the African countries



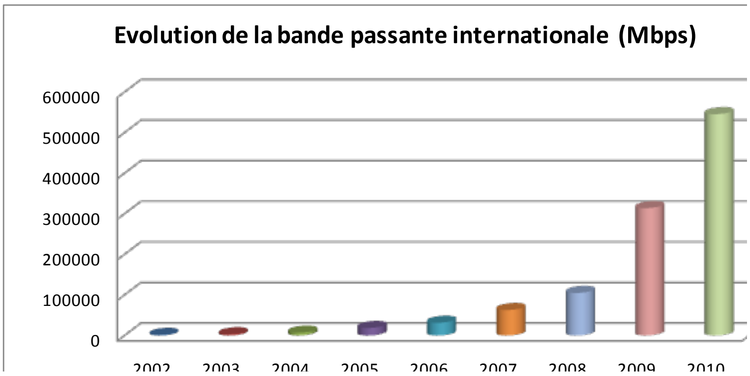
RIR_Delegations/AFRINIC/ASN-ByNb

International bandwidth

Used Bandwidth

The history of international bandwidth used in Africa shows an important growth since 2005 thanks to the internet "take off".

Figure 8: Evolution of international bandwidth (Mbps)



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The analysis of IP international Broadband "used" between 2009 and 2010 in Africa shows an increase of 78% to reach 520 Gpbs which remains far below other continents (Europe 20 Tbps, Asia 5 Tbps…). This growth is shared by North Africa which reached 312 Gbps totaling a growth of 56% and Sub-Saharan Africa which reached 208 Gbps marking a growth of 125%[10]. This shows a significant digital divide between countries turned to Europe and the rest of Africa.

Evolution of IP Bandwidth

- In fact, this is not a new phenomenon. The emergence of the internet as an alternative means is with no doubt the basis of a significant growth in the volume of traffic across networks. But what we see is more the continuity of the historical growth pace on the internet (about 50% per year) rather than uncontrolled sudden explosion. Furthermore, different reports (including the Cisco Visual Network Index quoted by the Authority, or Telegeography/Global Internet Geography) confirm that this growth is more important in developing countries or regions (Asia as a whole, Eastern Europe, South America,, Africa) than in developed countries (North America, Western Europe and some parts of Asia such as Japan and South Korea). Thus, the pace of internet traffic growth is paradoxically lower in the countries where "the burst of volume" is widely publicized than in those countries where such debates have no market.
- First of all, the need to invest in the development of network capacity is not a topic for discussion but is applicable to both access networks of the FAI and international networks and transit operators'. However, increasing international network capacity is carried out based on the most advanced technologies called Next Generation, notably IP on Ethernet, WDM on optical fiber), and therefore under optimal and economic efficient conditions. This efficiency in implementation, combined with that of an open and fully competitive market, has widely contributed to the decrease in internet transit prices, thus allowing this extraordinary internet boom and its major impact on the world economic growth.

Public consultation of ARCEP on the neutrality of internet and networks. Comments submitted by Cogent Communications (http://www.scribd.com/doc/47009853/Cogent-contribution-Arcep-Neutralite-13-juillet-2010)

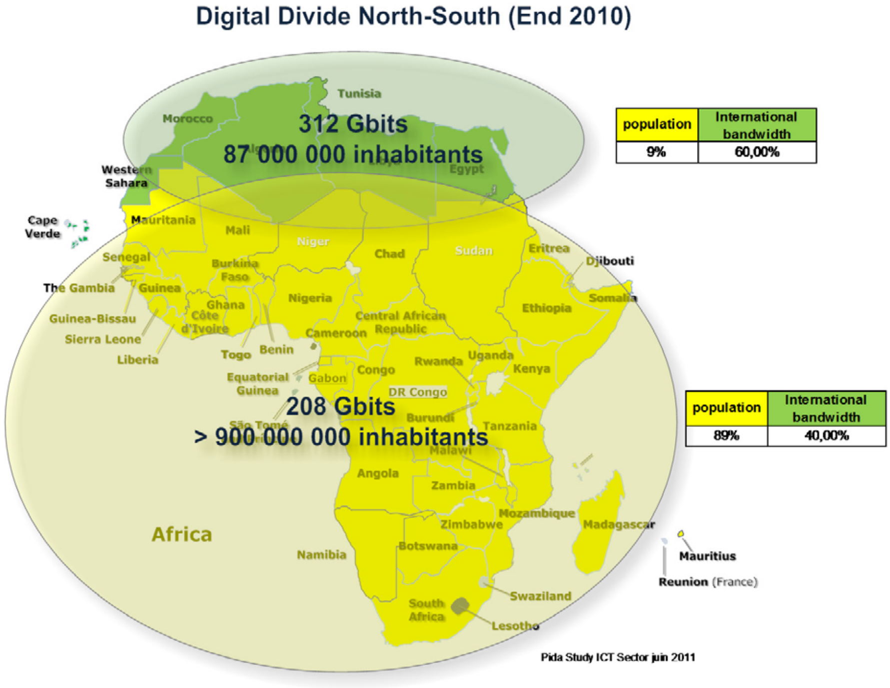
The Cisco VNI Forecast Projects International [11] - IP Traffic to Increase By More Than Four times by 2014

The Cisco VNI forecast has projected that the International Internet traffic will increase by more than four times to 767 exabytes or by more than a three fourth of a Zettabyte, by the year 2014. This increase is about 100 exabytes greater than the level for 2013, or it can be said that the increase is equivalent to 10 times of all the traffic crossing Internet Protocol networks in the year 2008.

[10] See www.africabandwidthmaps.com, May 2011

[11] http://voip-phone-systems.tmcnet.com/topics/voip-phone-systems/articles/87369-cisco-vni-forecast-projects-international-ip-traffic-increase.htm

Figure 9: Digital divide North-South (End 2010)



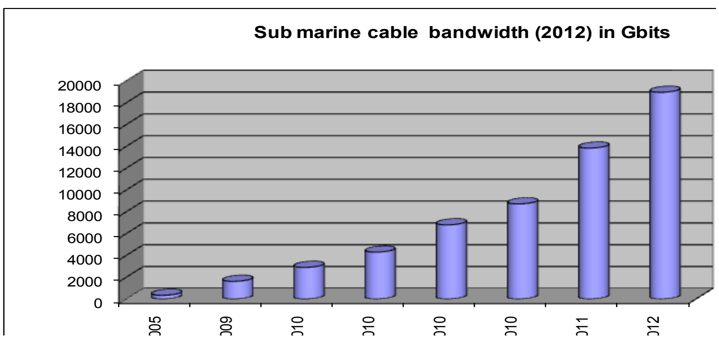
PIDA Study ICT Sector June 2011

Available bandwidth[12] *by end of 2012*

Deprived of landing submarine cables for a long time, the situation in Africa (mid 2011) and in the short term (2012) is completely different from that of 2009.

The landing of many submarine cables on the various coasts, at a continental level, leads Africa to soon have a great share of available intercontinental broadband as well as competition between players.

Figure 10 : Submarine cable bandwidth (2012) in Gbits



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This bandwidth dedicated to Sub-Saharan Africa will be relatively very well distributed between the Eastern and Western coasts with some "privileged" countries (hubs) such as Nigeria, Senegal, Ghana, Angola, South Africa and Djibouti.

12 See www.africabandwidthmaps.com, May 2011

What some analysts say[13]:

The transformation of the offer for international bandwidth in Africa 2010-2012: From Scarcity to a bandwidth Tsunami

2.1.2 High speed internet and use characteristics

In order to develop forecasts of the future traffic related to the development of internet in Africa, one must take into consideration the results and perspectives of the developed countries and the particularities of Africa

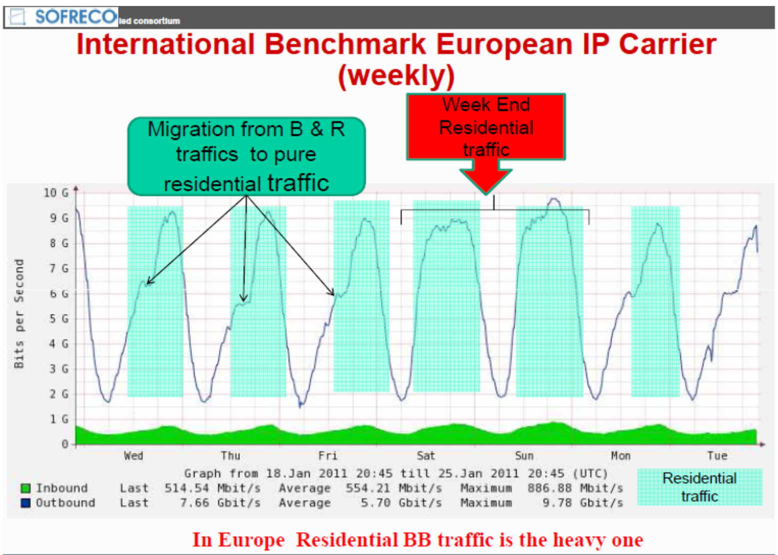
Data from[14] industrialized countries

The major lessons of 10 years of internet development and use in the industrialized countries are:

- Voice-related traffic (based on commuted networks) becomes insignificant compared to IP traffic whether it is data, video or voice[15].
- The generated bandwidths are calculated in Gigabps and are growing each year ; only adequate infrastructure can carry them
- The traffic peak is generated by residential traffic showing that internet use is part of consumers' lives.
- The economic model changed from a consumption-based model on to a package-based model (minute vs. broadband)
- The onNet[16] traffic is 1.5 to 3 times the international Offnet traffic.
- The major access technologies are land-based ones : ADSL, Cablemodem and migration to the FTTH is underway (High speed Internet)
- The IP traffic generated by "smartphone" terminals is less important compared to the traffic generated by other means (computers, pads...)

Figure 11[17] below highlights the predominance of residential traffic over the "business" traffic.

Figure 11: International Benchmark European IP Carrier



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[13] International Bandwidth Economics, Bottlenecks and Business Models http://www.telecomsmarketresearch.com

[14] Benchmark by operators carried out by the Consultant, but subject to confidentiality conditions

[15] IP Voice as a substitute to « traditional » voice is today around 40% of the voice traffic and VoIP with a growth of more than 10% annually.

[16] Due to double play offers (Internet and voice) and triple play (Internet, voice et TV) and the presence of peer to peer or IXP.

[17] International IP Traffic of one European operator (Consultant's Note)

Fixed Internet vs. 3G/LTE Internet

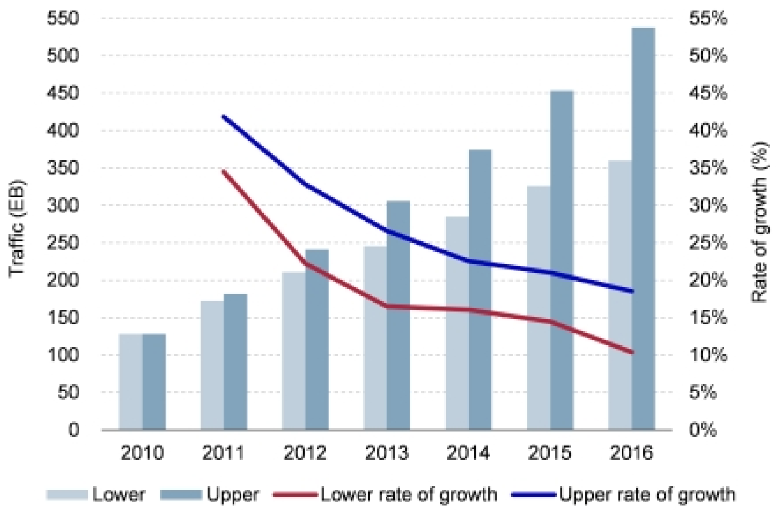
In the developed countries, high speed connections are for the majority supplied through fixed access. Today, xDSL and Cablemodem technologies, often associated with double or triple play offers and the use of personal computers, are big consumers of bandwidth for domestic use. The emergence of terminals like smartphones and cache techniques set up by operators will tend to slow down bandwidth exponential growth On and OffNet.

The first feedbacks on the impact of FTTH technologies show that the deployment has a very limited impact on downstream bandwidth but strongly impact upstream bandwidth.

Increasing the use of smaller-screen devices could reduce the overall growth rate

Many published internet traffic point forecasts show continued annual growth worldwide of 30–40% for the foreseeable future. After all, this sort of growth rate has been achieved for the past decade or so, and demand has consistently outstripped the constantly evolving methods of increasing network efficiency.

Figure 12: Internet traffic and growth rates, upper and lower limit, worldwide, 2010–2016



Source: Analysis

Devices, neither the services nor the networks, drive consumer data usage trends. Smaller portable devices actually engage end users for an increasing proportion of hours in the day and at home, compared to PCs and connected TVs. These smaller devices typically require lower bandwidths and consume less data, a trend reinforced by new compression standards. This substitution would result in a reduced rate of data traffic growth, although in the longer term the effect would be offset by the multiplication and personalization of devices.

One of the interesting effects of high availability of ultra-fast broadband (>100Mbps) is that while it does not always drive greatly increased downstream usage, it does tend to drive upstream usage. Japanese broadband subscribers typically have far more access bandwidth than their European or American counterparts, but their downstream usage is not significantly different. However, broadband subscribers in Japan, and even those on European FTTH networks, show much higher upstream-to-downstream Internet traffic ratios. Peer-to-peer services drive upstream usage because high upstream bandwidth availability tends to mean users become content delivery nodes. But there are other possible causes: increased consumer usage of basic cloud-computing services and increased usage of advanced video communication. Both extend broadband beyond simple media delivery.

http://www.analysysmason.com

Broadband growth in African countries, due to the lack of fixed access network, will happen (happens) through the substitution of Fixed-3G/LTE. In this case, bandwidth growth (downstream) will be linked to 3G/LTE[18] broadband access growth and the use of personal computers.

Data issued by African countries

In order to better understand the potential evolution of IP traffic on the African continent, the approach was carried out by collecting and analyzing data from operators on the African continent.

It is worth noting that the use by domestic consumers is not homogenous amongst African countries. Figure 13 and 14 below show that in South Africa and Uganda, two countries with the same internet user density, the use of internet by consumers is different and ***highly depends on operators' offers and the ownership of a personal computer.***

Figure 13 : JIXP (South Africa) (2011)

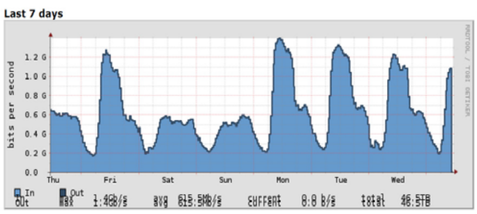
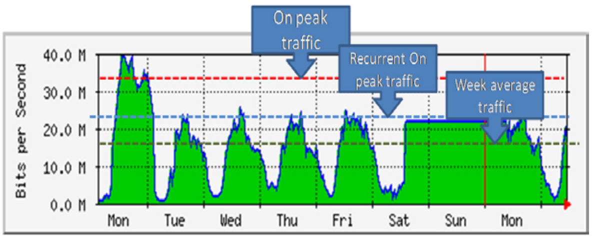


Figure 14 : UIXP (Uganda) (2011)



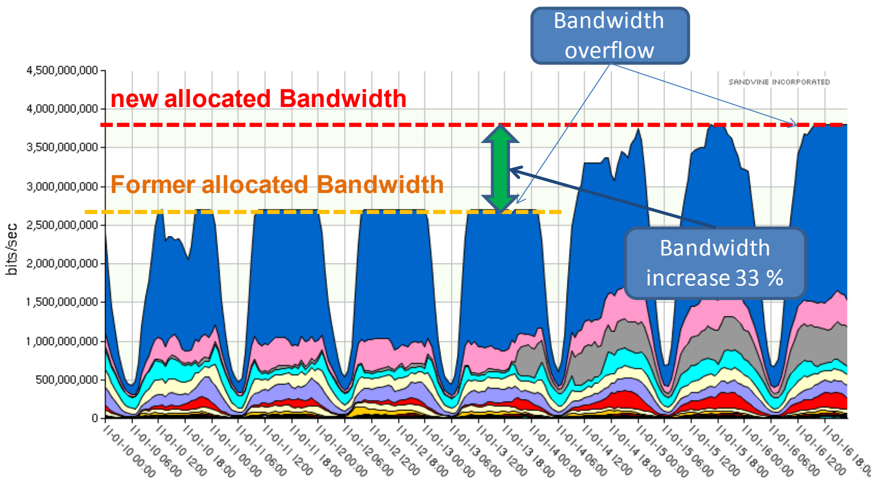
In South Africa, residential traffic is not dominant which is very visible with bandwidth hollowness on weekends and at the end of the day while it is the opposite in Uganda with saturation on weekends.

An analysis of the Ugandan market shows that this use can be explained by the simple fact that certain ISPs offer a laptop as part of the "3G Internet" access package deals[19].

An analysis of the case of the operator Orange in Tunisia, which developed a package deal based on double play "Fixed 3G Internet"[20] or "3G Data Internet" in competition with ADSL offers, which are geographically limited because of the lack of quality copper access network, confirms that:

- Domestic traffic is dominant if consumers have private high speed access
- The "Fixed 3G Internet"[21] is a substitute for the lack of ADSL Offer

Figure 15: January 2011-IP Broadband on 3G offer (Tunisia)



[18] This is not the same as fixed–mobile substitution. In fact, even with LTE in place, it would be the opposite. Although, smartphones and tablets are wireless, they have an increasingly fixed-line component to them. In developed economies, we forecast 73% of devices associated with a SIM will be fixed-network compatible by 2016. http://www.analysysmason.com

[19] With the specific key

[20] Internet and VoIP

[21] Key and box with 3G access connected to a PC

Key lessons on the development and use of internet in African countries are:

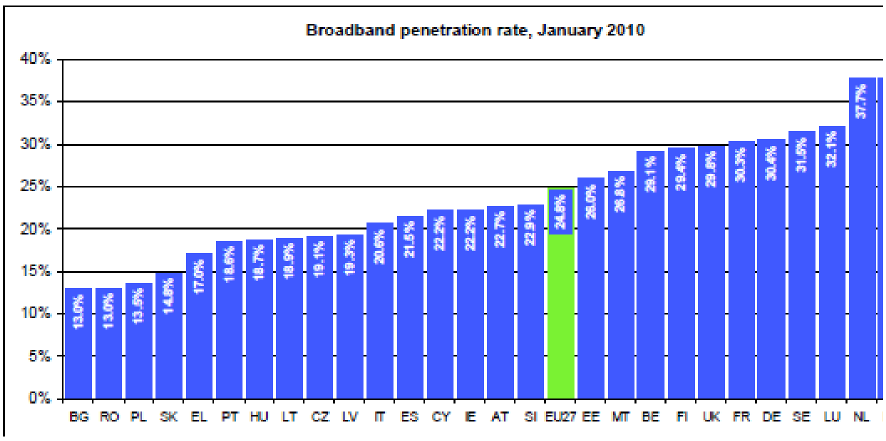
- Consumers are very sensitive to operator commercial offers
- Domestic traffic becomes very important in terms of instant[22] volume in countries where operators have "high speed internet access" offers covering residential areas
- The traffic peak is generated by domestic traffic showing that the use of internet is part of the consumers' life
- In African countries[23] with the best high speed internet access rate[24], bandwidth reserved by access by operators is very similar to that of industrialized countries
- The «3G high speed internet » offer is entirely de-correlated[25] from the « 3G smartphone[26] offer »
- The double play « 3G High Speed Internet Box Offer » providing access to VoIP and the key offer (single play) are substitutes for similar offers in industrialized countries made by xDSL or Cablemodem technologies and show similar characteristics in terms of usage. However, their commercial success and implementation is much faster under the pressure of demand.

2.1.3 Internet: the challenge of the 21st century for Africa

The 21st century will be globally marked by the development of an information society based essentially on e-economy. Information technologies have changed the world today. Infrastructure along with IP world (submarine cables, optical fiber land-based infrastructure, ADSL high speed access networks) allow huge progress.

The objective of the industrialized countries as well as some of the emerging countries (India, China…), is not broadband access only but also high speed access. They seek to acquire 21st century infrastructure in order to offer nationwide broadband access with high speed of 30 to 100 Mbps and set up trans-border networks allowing free movement of data.

Figure 16 : Broadband penetration in Europe



Progress report on the single European electronic communications market (15th report)

Africa, in this new world, must find a place and make use of its delay in developing 20th century equipments. A voluntary and future-oriented policy will allow a technological breakthrough as is the case for the mobile phone. Just 20 years ago, the internet was a research tool for academics. Since, it has become the key to economic development changing forever the way the business world operates, the way teachers teach, the way students study, the way governments and citizens discuss

[22] Broadband peak is the value taken into consideration in gauging active equipments by operators and which can be invoiced (vs. volume invoicing)

[23] Benchmark by many African and European operators in 2010-2011

[24] ADSL2+, VDSL, Box 3G, Clé 3G –Morocco Tunisia, Senegal

[25] Different SIM card and rates (commercial offer benchmark)

[26] Traffic curve similar to voice and low consumption of offNet broadband as its is essentially mail

matters and the way the people communicate with one another. Without a strong and reliable internet service, the world of finance and business will slow down, trade with others may disappear and integration between the people will no longer be possible. Today, it is the tool of all the challenges and has shown its power in developing democracy.

2.2 Methodology

2.2.1 Challenges of bandwidth forecasts

Forecasting short to medium term bandwidth future needs will require a pragmatic approach in order to take into consideration the 3 major parameters[27] which impact the development of bandwidth in Africa.

Market lessons

These lessons are presented here below:

- A boom of the offer through submarine cables which on the mid-term (2015-2018) will provide Sub-Saharan operators and consumers with more than 17 Tbps while the offer in 2008 was limited to 380 Gbps[28].
- A very high pressure of African consumers' demand whose use is similar to that of the developed countries as soon as the offer is made available.
- A total de-correlation of the "mobile high speed internet" offer with the 3G voice or 3G Smartphone offers because it is a substitute for wired access.
- A great similitude between bandwidth consumed by "mobile high speed internet" broadband access in Africa and that of xDSL access in the most advanced countries.
- An abundant international bandwidth offer, at an affordable price, as it represents 20 to 30% of the broadband access price in countries which do not have data centers and therefore require connections to servers outside the continent
- An effective broadband access, providing 40 to 80 kbits[29] of international broadband and 2 to 3 times more in onNet, in particular when it is doubled with a VoIP and TV offer.

Broadband per inhabitant vs. high speed access

The two approaches are quite similar and for them to be a development indicator of the use of internet in a country will require knowledge of two parameters which are generally collected by the regulator.

- **Number of « high speed subscribers »: it is the total of all types of "high speed" access offered by the operators and ISPs (XDSL, cablemodem, Wimax, FTTH). It is an indicator[30] retained by the ITU.**
- **International bandwidth : It is the total of international capacities acquired by all the operators in a country**

In this case, these 2 indicators are :

International IP *bandwidth per inhabitant* = ∑*(Operators' international bandwidth/ Population of the country*

International IP bandwidth per High Speed Access[31] = ∑ *operators' international bandwidth/∑ high speed access (xDSL, cablemodem, FTTH, Wimax)*

In developed countries, the first indicator is more significant, because usually, there are many users per high speed access due to the multiplicity of personal computers per household. In addition, more than 30% of high speed subscription density corresponds to 90% of the population having personal usage of high speed access (Note of the Consultant)

[27] It is well known that the GDP has only a limited impact on development or at least as long as density between 15 and 20% is not reached. This is equally true for the mobile sector development in 2004 and 2007

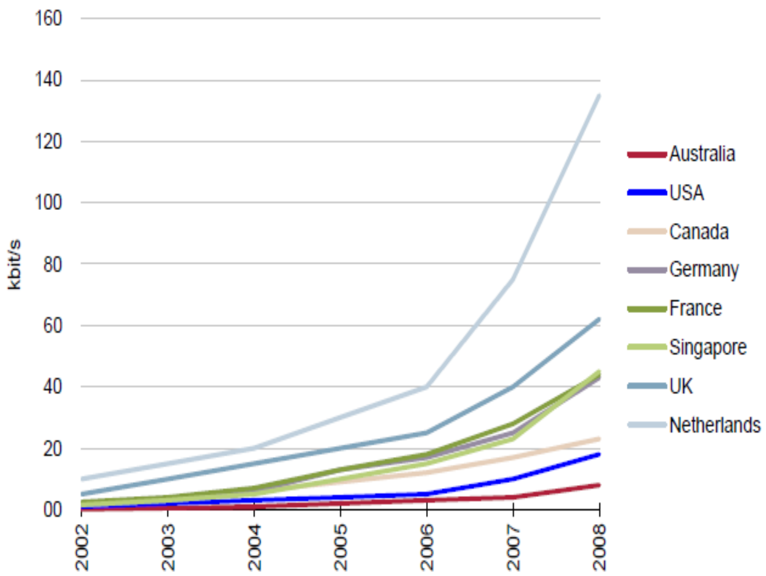
[28] SAT3 for Sub-Saharan countries

[29] Benchmark European and African operators

[30] Not available for African countries because of the lack of data collection and publication by regulators

[31] Mobile high speed internet access is not calculated in these countries because they are reserved for mobility and because consumed broadband is trivial compared to fixed accesses

Figure 17 : Growth [32] of International IP Broadband per inhabitant[33]



Source: Telegeography, ITU, Euromonitor, company data]

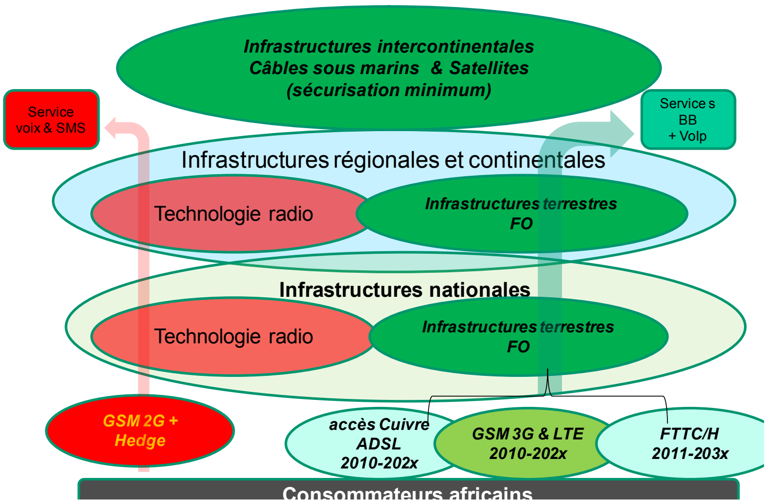
Technological factors related to the development of broadband in Africa

The development of broadband requires:

- Ad hoc access infrastructure knowing that in the short and medium terms, access offer will be carried out in majority by 3G technology (and/or LTA) and to a lesser extent by xDSL technology because of the low deployment of wired access networks in African countries
- Optical infrastructure covering the whole territory in order to connect 3G/LTE transmitters through technologies providing important capacity (M/Gbps). Land-based radio technologies (capacity limited to a few Mbits over a few kilometers) and even more satellite links, due to the transponders' limited bandwidth, are not suitable for broadband transmission for the areas with the highest density of high speed connection.
- Accessibility to an international bandwidth in terms of quantity and quality and at an affordable price.

Development can only be achieved if such conditions are fulfilled:

Figure 18 : Broadband technologies[34] and infrastructure



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[32] Analysis Mason: Overview of the IP interconnection ecosystem (2011)

[33] The density of high speed access in these countries being higher than 30% and each access uses many personal computers; broadband by access is therefore higher than that per inhabitant

[34] In red, technologies which are not adapted and in green the required technologies and infrastructure

Exogenous factors linked to the development of broadband in Africa

If technical conditions are endogenous factors to the development of broadband, its availability is exogenous at all levels.

Access networks: The use of 3G technologies (today) and LTE (in the medium term) is related to the award of licenses by governments and to the availability[35] of the required frequencies at an affordable price[36].

Figure 19 : 3G Licenses (T3 2010)

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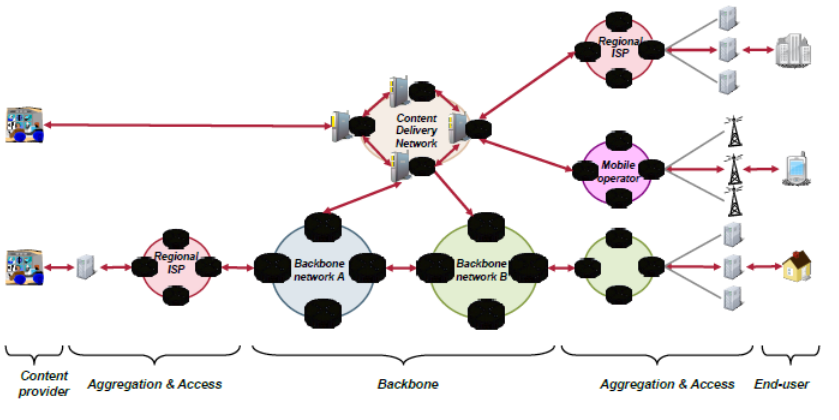
Optical backbone and backhaul networks: The use of 3G/LTE as bandwidth access technology requires the connection of radio transmitters using bandwidth infrastructure. The availability of such infrastructure on the continent is very heterogeneous mainly for political, legal and regulatory reasons. The countries[37] with an enabling regulatory framework already own part of the required infrastructure but in the countries[38] where this framework is not adequate, national infrastructure is generally under-gauged and cannot meet broadband challenges.

Figure 20: Structure of a content delivery network



Source: Analysys Mason

35 LTE requires re-management in allocating part of the commercial sector

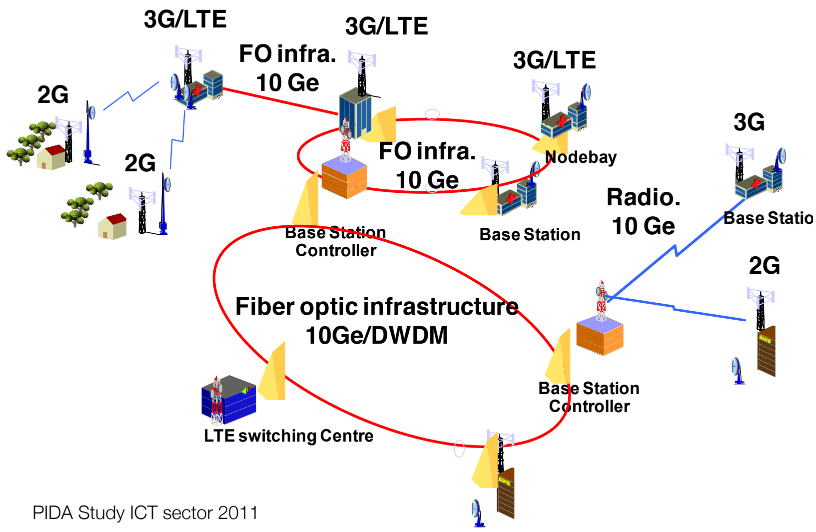
36 Specter prices are managed by governments

37 Nigeria, Morocco, Tunisia, Uganda, Kenya to name but a few

38 Cameroon, Togo, Democratic Republic of Congo, Gabon, to name but a few

Moreover, the use of existing optical infrastructure by private players which are, for the majority, operated by incumbent operators, is rarely offered at an affordable price because of the lack of tariff regulation on wholesale offers.

Figure 21: 3G mobile Internet" Infrastructure



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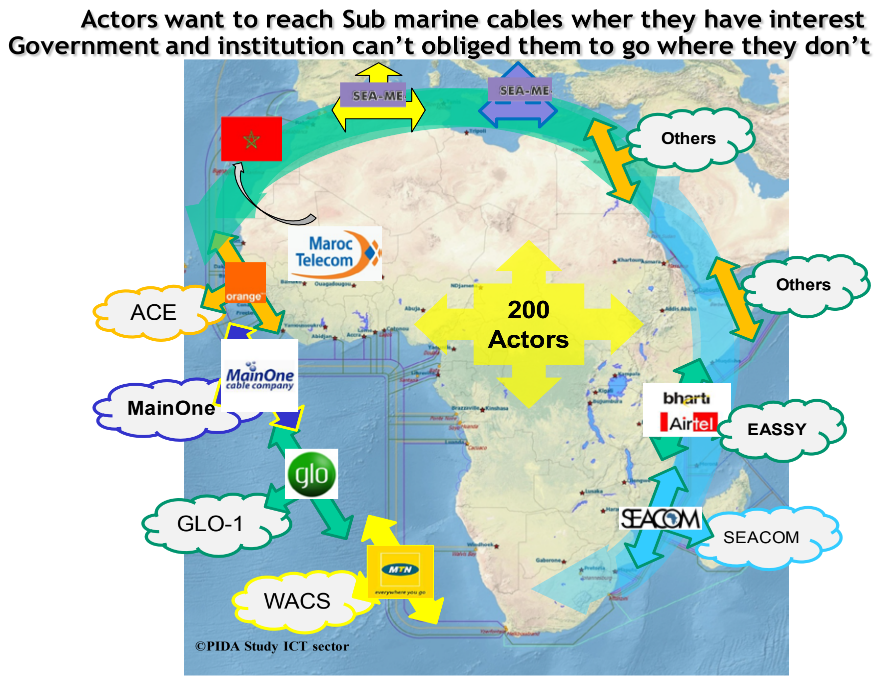
International gateways: Accessibility to such gateways for all the players of one country at an affordable price is sometimes hindered by legal or de facto monopolies established and maintained by the legal and regulatory framework. In landlocked countries, or countries with one single submarine cable landing station, access to international gateways is often linked to bilateral political agreements. In such cases, interconnection between the infrastructure of two countries requires the signature of a Memorandum of Understanding by the ministers of these two countries.

Operators' commercial offer: If the possibility of using 3G technologies is in the governments' hands, the implementation of a mobile high speed internet offer capable of meeting technically and economically consumers' expectations is the operators' responsibility.

Routing traffic to submarine stations: Routing IP traffics to submarine stations is *exclusively* linked to strategic and commercial interests of the operators and is based on the principle whereby "each operator will rout its traffic according to its own interests".

Figure 22: IP traffics, submarine stations and operators' interest



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Two other important factors are:

- Availability of energy
- The development and use of laptops

2.2.2 Selected parameters to meet the challenges of bandwidth forecasts

Parameters

In order to develop a bandwidth modeling, the Consultant in contact with a number of European and African players, has selected the following parameters as entry values for the Model:

- International IP bandwidth per high speed access
- Number of « high speed » subscribers as a percentage of the population

They correspond to the usual international indicators and particularly those of the ITU.

Technological hypotheses

International bandwidth is available in quantity for all countries at a competitive price. Since 2012, it is available for all coastal countries. Only the competitiveness of offers will need to be established. An analysis of the elasticity of international bandwidth cost will be carried out according to the bandwidths required by the continent.

Land-based backbone and backhaul infrastructure is available; they are capable of carrying national and international bandwidth, both in quantity and quality, at affordable prices.

Access infrastructure and particularly 3G/LTE infrastructure is available in the most populated areas (capitals, big cities) and the related commercial offers[39] are economically reasonable

Exogenous hypotheses

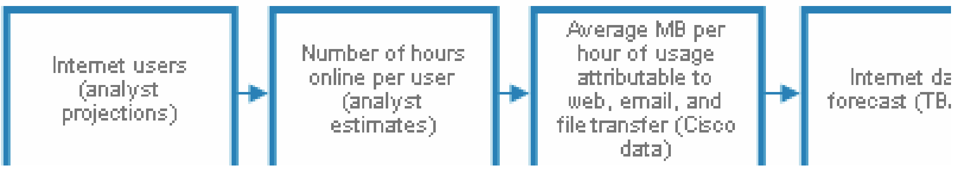
A large number of exogenous factors directly impact the development of services and do not allow the provision of an annual growth per country:

- Award of 3G/LTE licenses
- Technical and commercial offers made by operators
- Availability of energy
- The use of individual computers

Modeling methodology

In order to assess the IP traffic generated by the various African countries, the forecasting methodology implemented by the ICT sector of the PIDA Study is based on the same approach as major consultancy firms such as IDC, OVUM, Gartner or Pyramid...

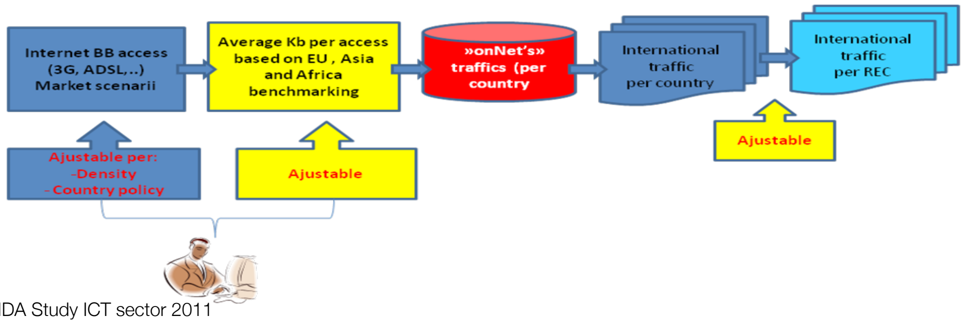
Figure 23: Methodology for Consumer Web, E-mail, and File Transfer Traffic Forecast



http://www.hbtf.org/files/cisco_IPforecast.pdf

In order to refine the volume per access, the Consultant carried out with the operators[40] a benchmarking on volumes and forms of IP traffic.

Figure 24: Methodology for Consumer Web, E-mail, and File Transfer Traffic Forecast



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39 their price is related to the license, usage and frequency costs

40 Confidential for a large number

Quantification of national and international IP traffic

In the context of PIDA (continental and regional infrastructure), only international IP traffics are to be taken into consideration. However, at this stage, it seems important that the Consultant forecasts not only international traffics (regional) (off country) but also national (on country) in order to enlighten African decision makers on the national and regional infrastructure needs that will have to be implemented to ensure digital migration of Africa. The "voice" traffic, being today less than 15% compared to internet traffic and becoming more and more marginal[41], international forecasts only take into consideration IP traffic.

2.3 Short Term Hypothesis (2012-2018)[42]

This median hypothesis is a realistic goal that African leaders should try to achieve by 2012-2014 at least for the most advanced or proactive countries. Countries having more progress to make in terms of legal and regulatory reform or in terms of development of national backbone/backhaul infrastructure could try to achieve their goals by 2015-2018.

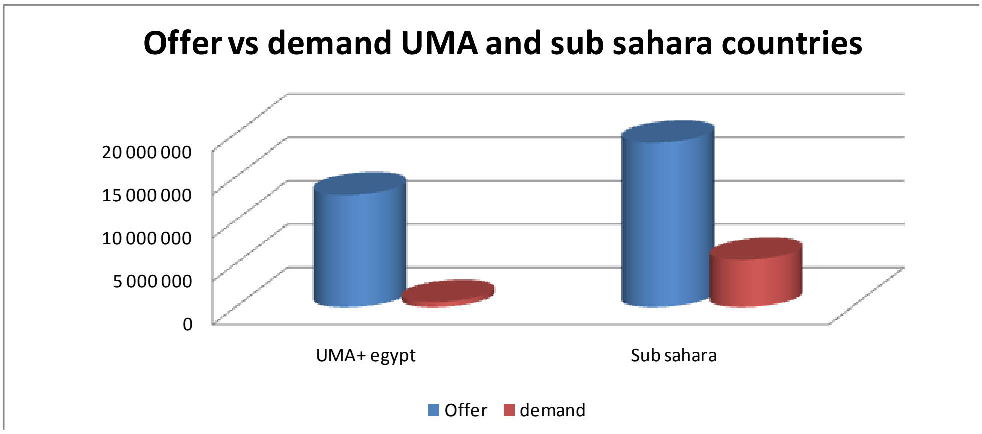
These hypotheses[43] are:

- 10% of the population has high speed access (that is 20 to 30% of the population that has access to internet in a comfortable way)
- 60 kbps of international bandwidth available per access[44]
- 120 kbps of OnNet bandwidth (including 60 kbps for international bandwidth) available per access

2.3.1 Bandwidth: Continental offer/demand

Continental bandwidth is provided just for information. It is modeled by demand and compared to the offer. The figures simply highlight the "possible" potential for broadband development in Africa whose fate essentially depends on each government which will take more or less efficient measures for the development in its country.

Figure 25 : Offer vs demand in UMA and Sub-Saharan countries



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The figures show that Africa mainly has international bandwidth issues and therefore highlight that its development is essentially in its own hands. The main points which Africa may, or must, act upon are:

- The national development of infrastructure which is the responsibility of governments
- Regional development which essentially depends on the will to integrate and regional solidarity.

[41] international Benchmark and Report of the UMA BB except for national traffic (outside PIDA)

[42] Hypothesis corresponding to the situation in Bulgaria (2010), the least advanced country of the European Union

[43] Other hypotheses may be generated using the « PIDA ICT IP traffic model »

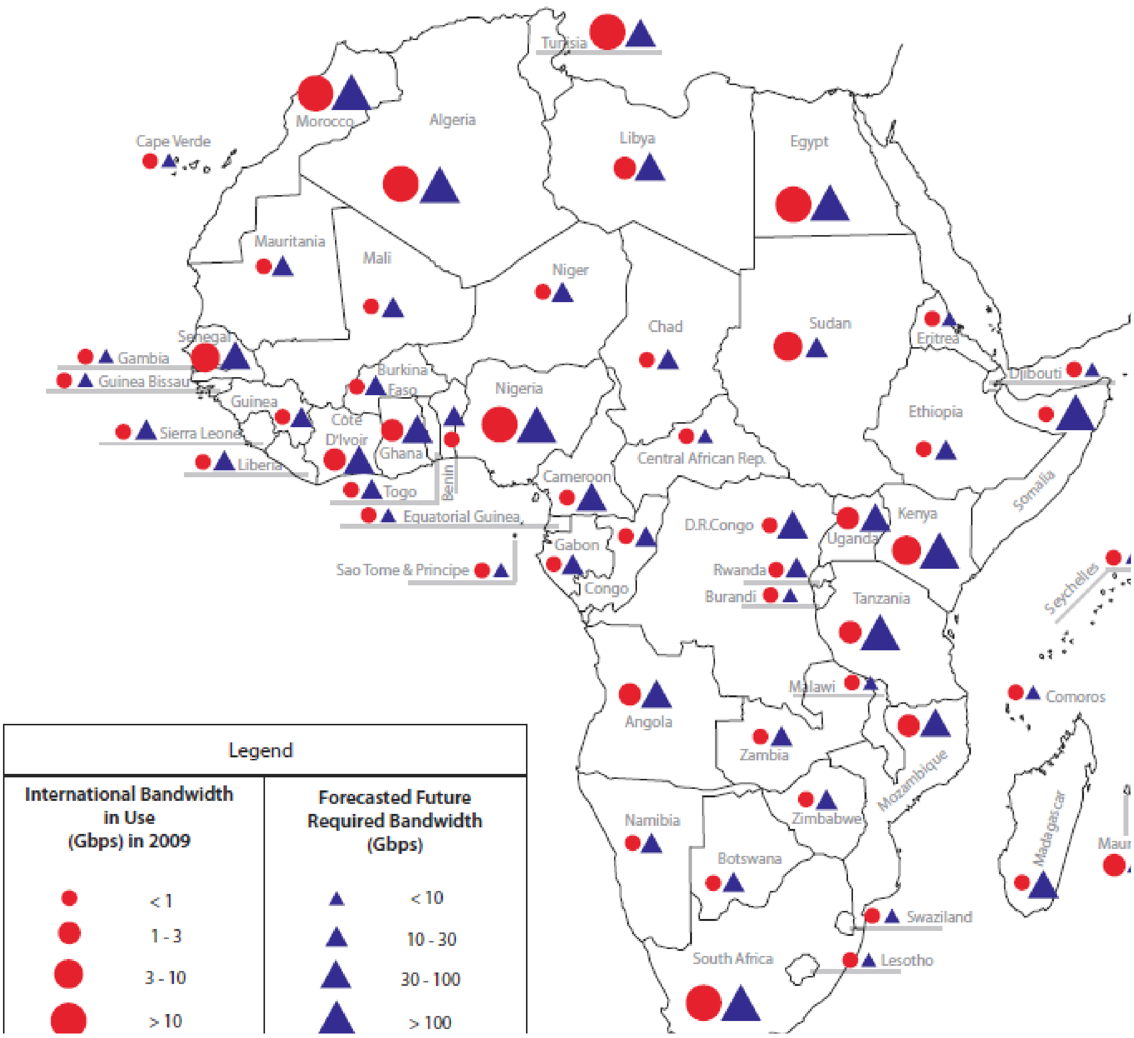
[44] International and operators Benchmark

Harbingers of a bandwidth boom abound

Broadband connectivity uptake and traffic are on the rise, following on a path trodden by mobile voice services. Over the next five years –and based on a variety of supply and demand assumptions- connectivity numbers should rise to approximately 30 million from only approximately 6.5 million in 2010, primarily thanks to the proliferation of mobile broadband. The numbers of internet users are higher, with more than 120m users projected for sub-Saharan Africa by 2015.

©International Bandwidth Economics, Bottlenecks and Business Models (2011)

Figure 26: **International bandwidth usage by country, 2009 and projected bandwidth usage (2018)**



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2.3.2 International bandwidth forecasts for the RECs

The main results are summarized in Table 2 below.

Table 2: International bandwidth (Gbps)

International bandwidth (Gbps)										
Bandwidth in Gbps	COMESA	SADC	EAC	ECOWAS	ECCAS	UMA	LLC	IGAD	Africa Bandwidth	Bandwidth in reserve on SMC
Bandwidth in 2009	125	42	15	26	4	118	6	20	308	19 000
Projection of International Bandwidth	3 000	2 000	800	2 000	800	500	1 500	500	6 000	13 000
Gap (%)	2 400%	5 000%	5 000%	8 000%	20 000%	400%	25 000%	2 500%	2 000%	

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This table highlights:

- The confirmation of the digital divide Maghreb + Egypt – Sub-Saharan countries
- The divide landlocked countries and ECCAS – rest of the continent

Figure 27: International IP traffic (2009) and forecast

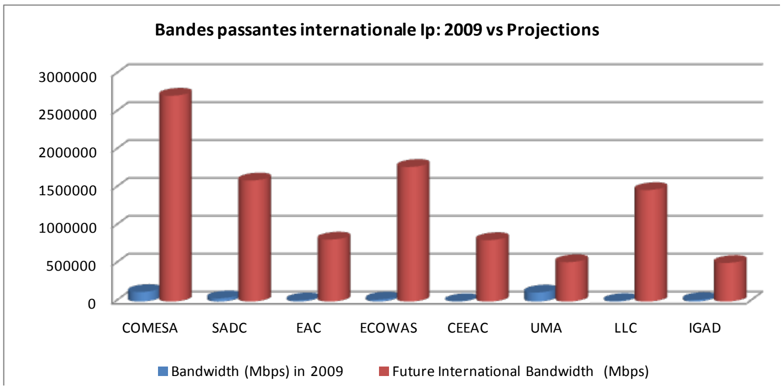

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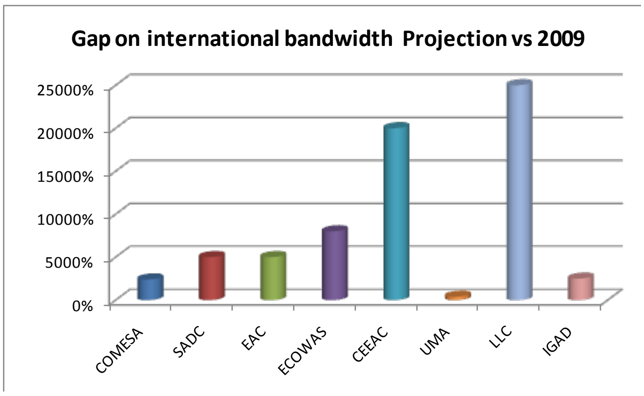
Figure 28: International IP traffic (2009) and forecast, Gaps per CER



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International bandwidth deficit (outside the Maghreb) can be explained by:

- The lack of international bandwidth provided by submarine cables until 2010 whose demand in terms of volume and prices could not be met with satellite offers.
- The lack of "high speed internet" access infrastructure as both xDSL and mobile internet offers show a very important deficit in the majority of countries.
- ECCAS is lagging behind because of the delay in reforming the legal and regulatory framework and the "monopoly held by the majority of countries on SAT3"
- IGAD has a less important deficit due to the international hub of Djibouti and reforms of the Kenyan legal framework.

Figure 29: **Global overview per REC**

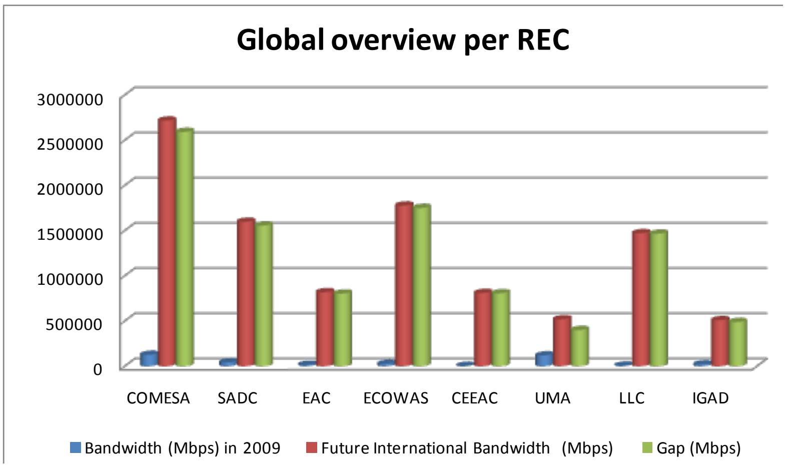

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Figure 29 above shows that a lot remains to be done in the area of broadband development in Africa and highlights the exception of UMA which, thanks to both reforms and the availability of submarine cables, is already well ahead of the rest of the continent.

2.3.3 International bandwidth forecasts[45] per REC and per country

The key figures per REC are provided below.

- Total of figures per country
  - National bandwidth (OnNet)
  - International bandwidth in 2009
  - Forecast bandwidth
- The graphic providing the international bandwidth figures for 2009 and the forecast
- The graphic providing bandwidth deficit in percentage (Forecast/2009)

The main comments are provided in the Phase I Reports (REC analysis and annexes "Market study")

Table 3: **International bandwidth for COMESA**

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Sudan	503 762	251 881	7 500	24 4381
Swaziland	16 249	8 124	85	8 039
Uganda	400 784	200 392	1 200	19 9192
Zambia	144 683	72 342	255	72 087
Zimbabwe	139 822	69 911	600	69 311

45 The forecast figures are those provided by the modeling, they must be taken as size order and not as absolute value.

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Sudan	503 762	251 881	7 500	24 4381
Swaziland	16 249	8 124	85	8 039
Uganda	400 784	200 392	1 200	19 9192
Zambia	144 683	72 342	255	72 087
Zimbabwe	139 822	69 911	600	69 311

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Figure 30: International bandwidth forecasts for COMESA

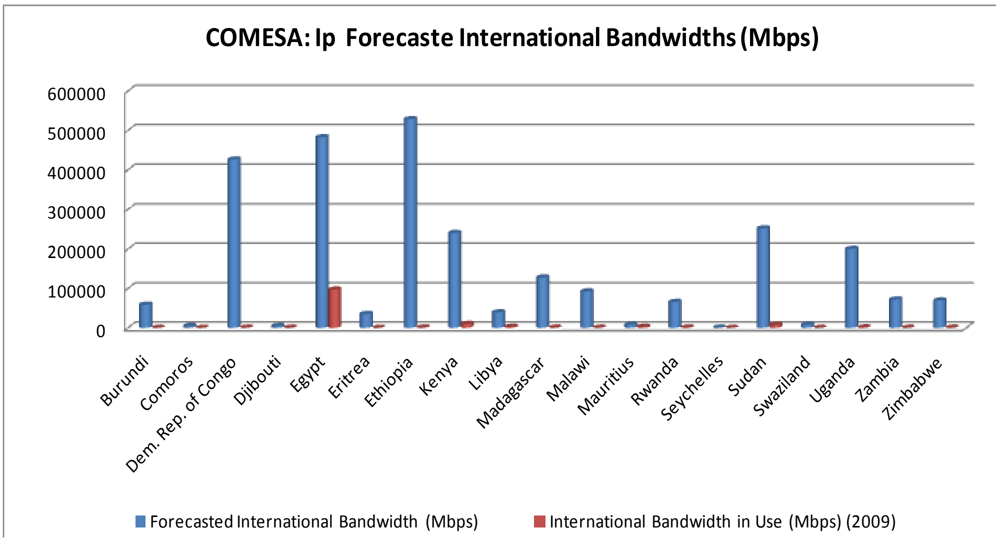

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Figure 31: International bandwidth gap in % for COMESA

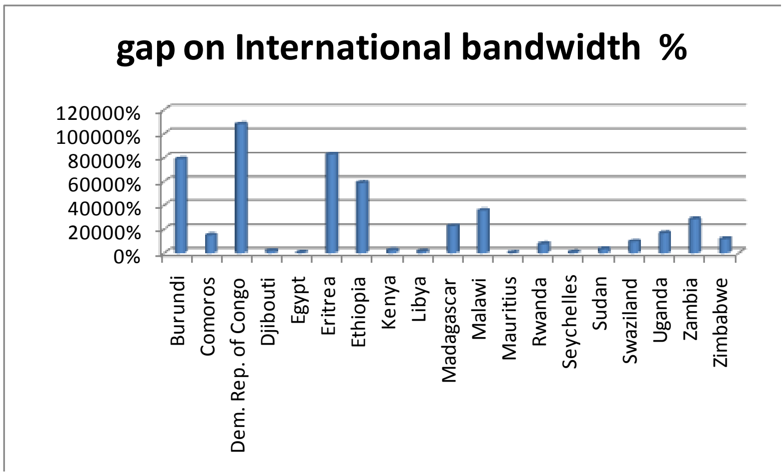

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Table 4: International bandwidth for SADC

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Angola	156 818	78 409	1 800	76 609
Botswana	24 352	12 176	500	11 676
Dem. Rep. of Congo	850 997	425 499	225	425 274
Lesotho	23 035	11 517	106	11 411
Madagascar	255 382	127 691	566	127 125
Malawi	185 370	92 685	260	92 425
Mauritius	15 529	7 765	2 650	5 115
Mozambique	264 737	132 369	1500	130 869
Namibia	25 542	12 771	655	12 116
South Africa	589 309	294 655	30 000	264 655
Swaziland	16 249	8 124	85	8 039
Tanzania	502 715	251 357	3 000	248 357
Zambia	144 683	72 342	255	72 087
Zimbabwe	139 822	69 911	600	69 311

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Figure 32: International bandwidth forecasts for SADC

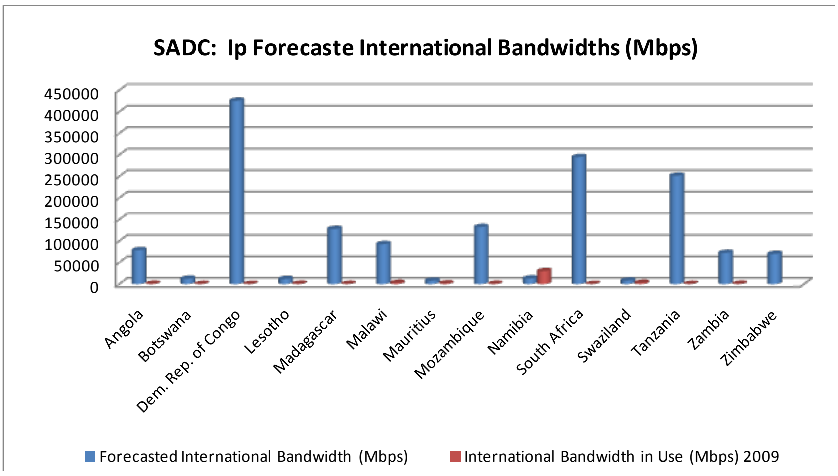

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Figure 33: International bandwidth gap in % for SADC

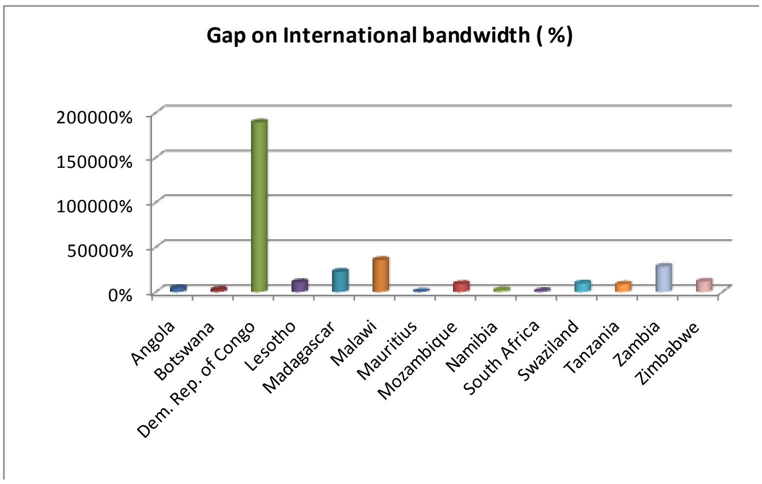

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Table 5: International bandwidth for EAC

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Burundi	118 357	59 179	75	59 104
Kenya	480 559	240 279	9 881	230 398
Rwanda	132 672	66 336	871	65 465
Tanzania	502 715	251 357	3 000	248 357
Uganda	400 784	200 392	1 200	199 192

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Figure 34: International bandwidth forecasts for EAC

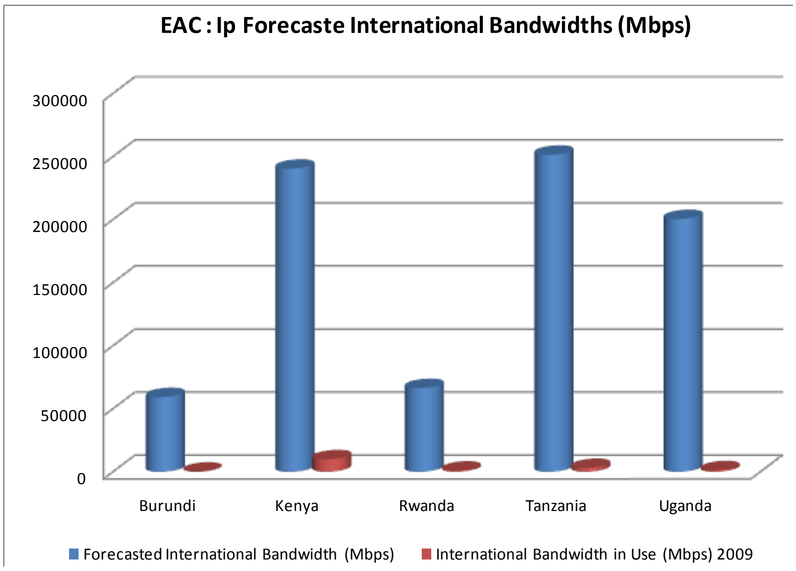

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Figure 35: International bandwidth gap in % for EAC

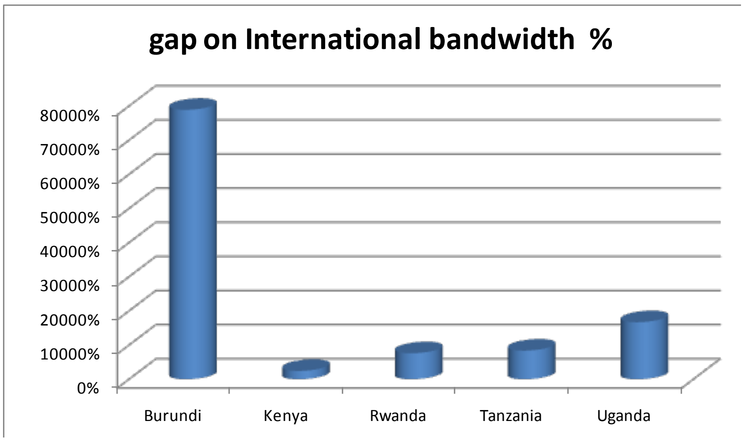

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Table 6: International bandwidth for ECOWAS

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth Gap (Mbps)
Benin	108 672	54 336	520	53 816
Burkina Faso	194 902	97 451	646	96 805
Cape Verde	6 104	3 052	394	2 658
Gambia	21 890	10 945	311	10 634
Ghana	292 078	146 039	1 596	144 443
Guinea	123 888	61 944	470	61 474
Guinea-Bissau	18 782	9 391	156	9 235
Ivory Coast	252 706	126 353	2 500	123 853
Liberia	44 221	22 110	18	22 092
Mali	165 556	82 778	431	82 347
Niger	190 539	95 270	176	95 094
Nigeria	1 826 608	913 304	14 754	898 550
Senegal	169 033	84 517	4 200	80 317
Sierra Leone	62 948	31 474	47	31 427
Togo	74 398	37 199	455	36 744

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Figure 36: International bandwidth forecasts for ECOWAS

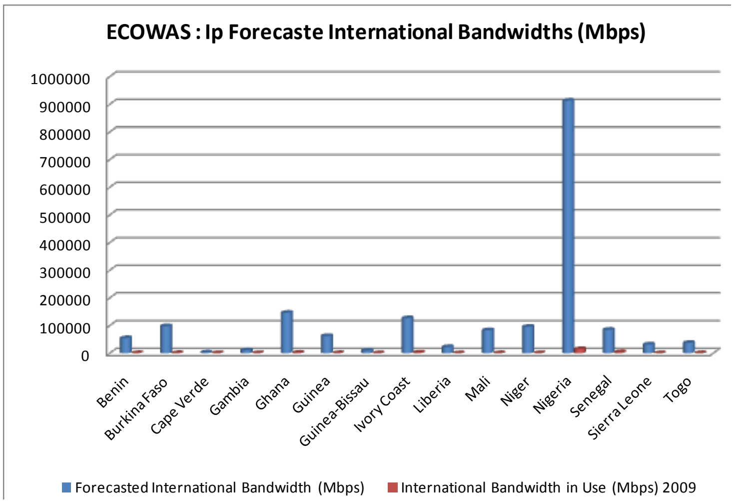

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Figure 37: International bandwidth gap in % for ECOWAS

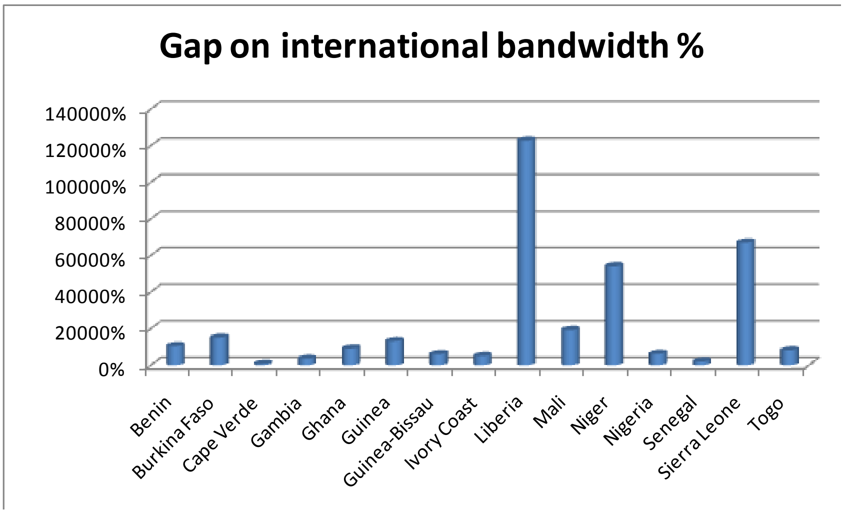

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Table 7: International bandwidth for ECCAS

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Angola	156 818	78 409	1 800	76 609
Burundi	118 357	59 179	75	59 104
Cameroon	231 530	115 765	800	114 965
Central African Rep	58 139	29 070	25	29 045
Chad	126 522	63 261	70	63 191
Rep. of Congo	49 511	24 755	221	24 534
Dem. Rep. of Congo	850 997	425 499	225	425 274
Equatorial Guinea	7 808	3 904	132	3 772
Gabon	18 543	9 272	515	8 757
Sao Tome & Principe	2 110	1 055	32	1 023

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Figure 38: International bandwidth forecasts for ECCAS

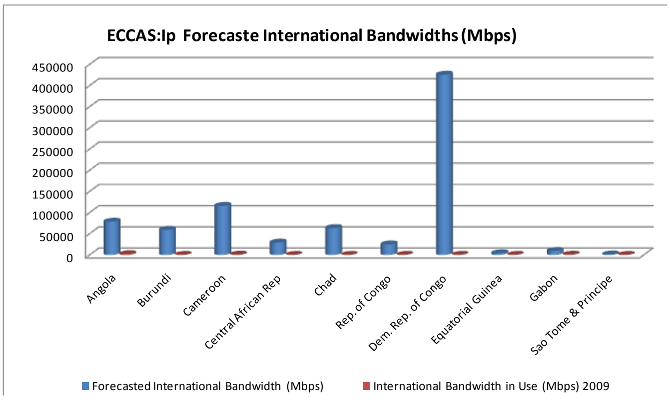

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Figure 39: International bandwidth gap in % for ECCAS

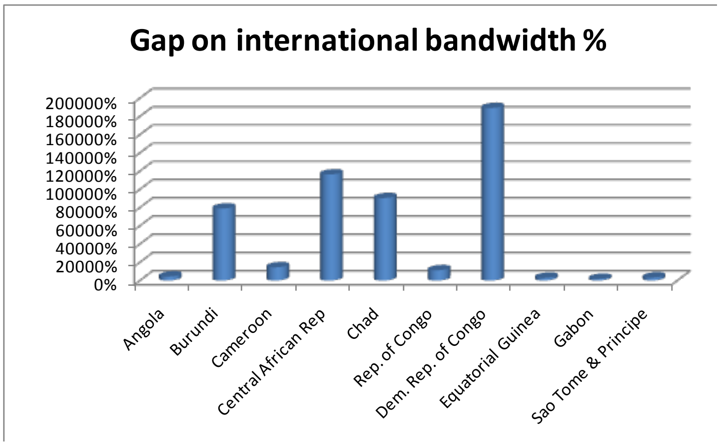

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Table 8: International bandwidth for IGAD

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	Gap International bandwidth (Mbps)
Djibouti	415 034	207 517	600	206 917
Ethiopia	156 818	78 409	898	77 511
Kenya	108 672	54 336	9 881	44 455
Somalia	24 352	12 176	324	11 852
Sudan	194 902	97 451	7 500	89 951
Uganda	118 357	59 179	1 200	57 979

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Figure 40: International bandwidth forecasts for IGAD

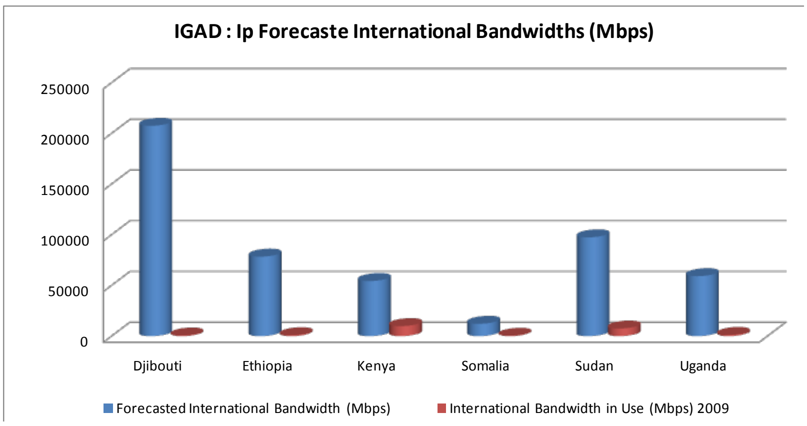

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Figure 41: International bandwidth gap in % for IGAD

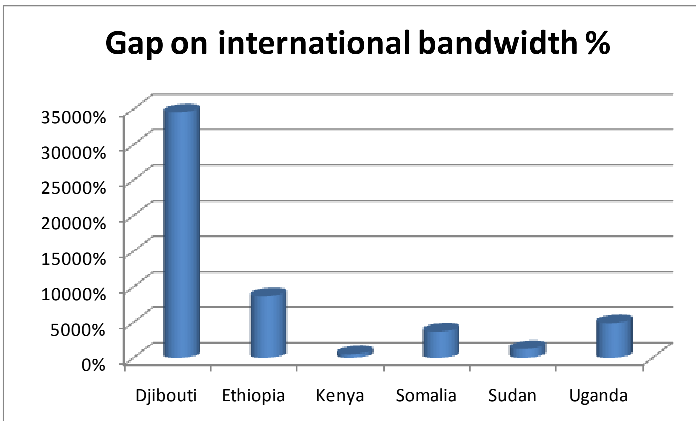

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Table 9: International bandwidth for UMA

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Algeria	415 034	207 517	24 800	182 717
Libya	77 537	38 769	2 800	35 969
Mauritania	38 461	19 230	310	18 920
Morocco	379 529	189 765	42 000	147 765
Tunisia	127 068	63 534	49 000	14 534

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Figure 42: International bandwidth forecasts for UMA

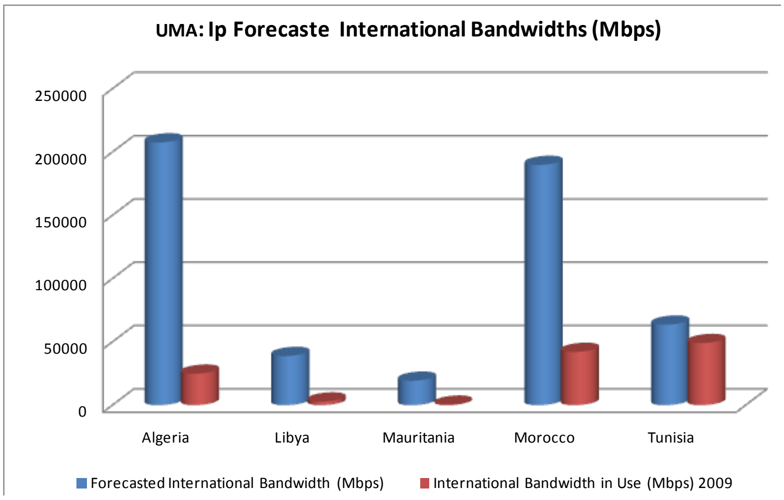

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Figure 43: International bandwidth gap in % for UMA

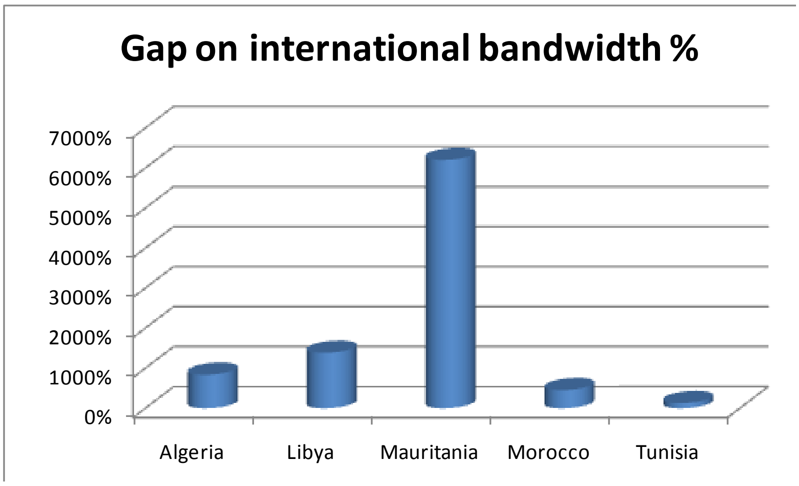

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Table 10: International bandwidth for LLC

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Botswana	24 352	12 176	500	11 676
Burkina Faso	156 818	78 409	646	77 763
Burundi	108 672	54 336	75	54 261
Central African Rep	24 352	12 176	25	12 151
Chad	194 902	97 451	70	97 381
Ethiopia	231 530	115 765	898	114 867
Lesotho	6 104	3 052	106	2 946
Malawi	58 139	29 070	260	28 810
Mali	126 522	63 261	431	62 830
Niger	9 281	4 640	176	4 464
Rwanda	49 511	24 755	871	23 884
Swaziland	850 997	425 499	85	425 414
Uganda	8 886	4 443	1 200	3 243
Zambia	965 662	482 831	255	482 576
Zimbabwe	7 808	3 904	600	3 304

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Figure 44: International bandwidth forecasts for landlocked countries

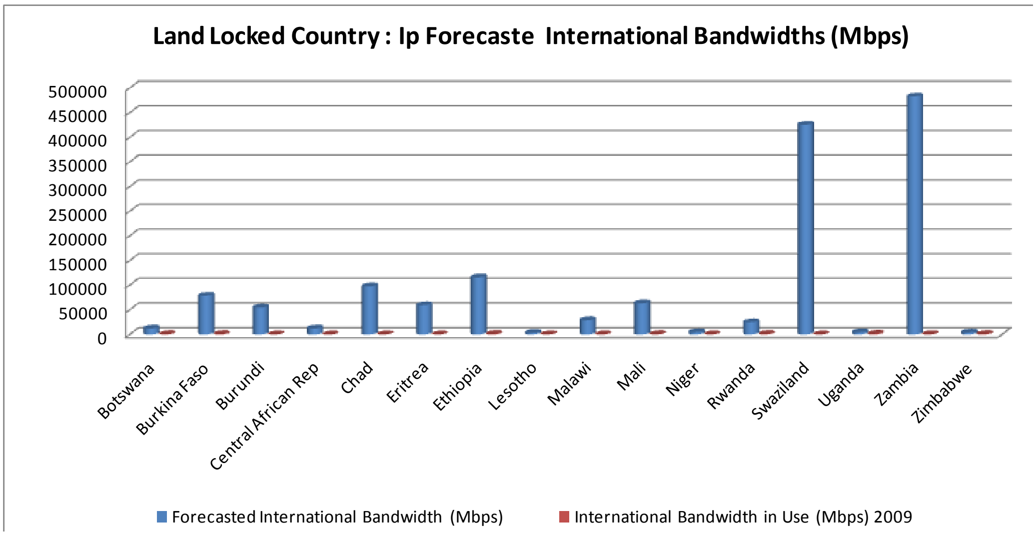

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Figure 45: International bandwidth gap in % for landlocked countries

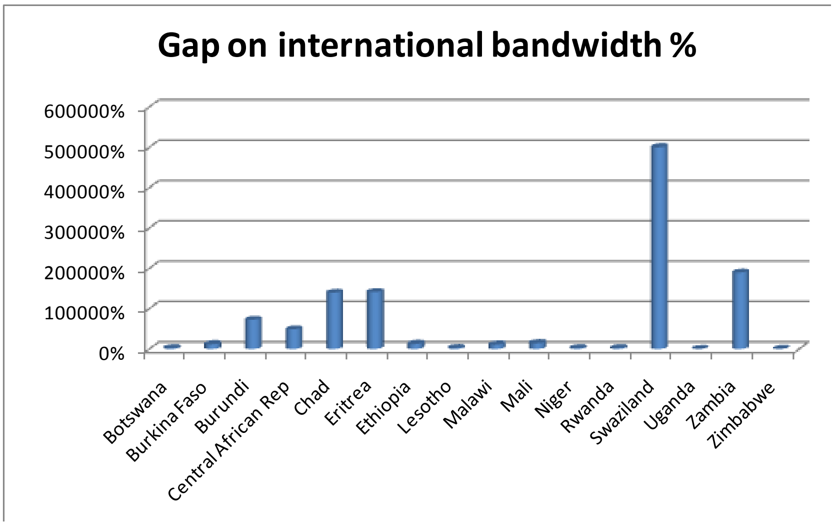

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Table 11: International bandwidth for LLC (ECOWAS-ECCAS)

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Burkina Faso	194 902	97 451	646	96 805
Central African Rep.	58 139	29 070	25	29 045
Chad	126 522	63 261	70	63 191
Mali	165 556	82 778	431	82 347
Niger	190 539	95 270	176	95 094

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Figure 46: International bandwidth forecasts for landlocked countries (ECOWAS-ECCAS)

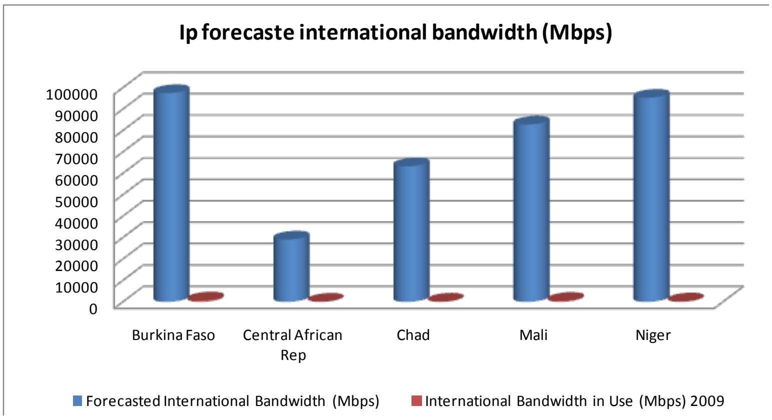

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Figure 47: International bandwidth gap in % for landlocked countries (ECOWAS-ECCAS)

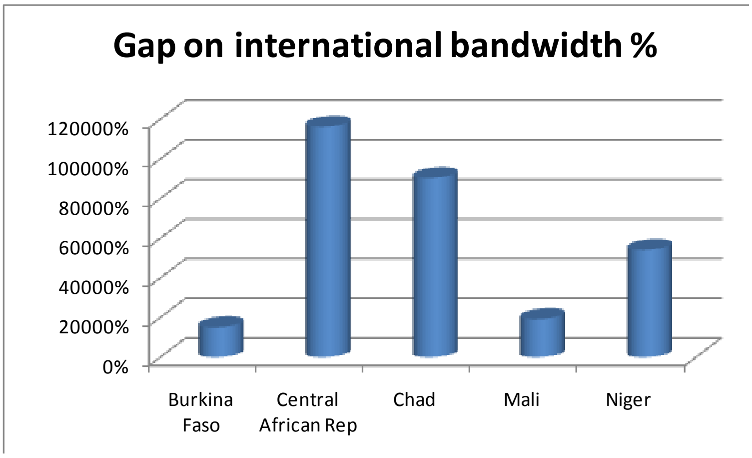

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Table 12: International bandwidth for LLC (SADC)

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Botswana	24 352	12 176	500	10 661
Malawi	185 370	92 685	260	26 387
Zambia	144 683	72 342	255	442 340
Zimbabwe	139 822	69 911	600	2 979

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Figure 48: International bandwidth forecasts for landlocked countries (SADC)

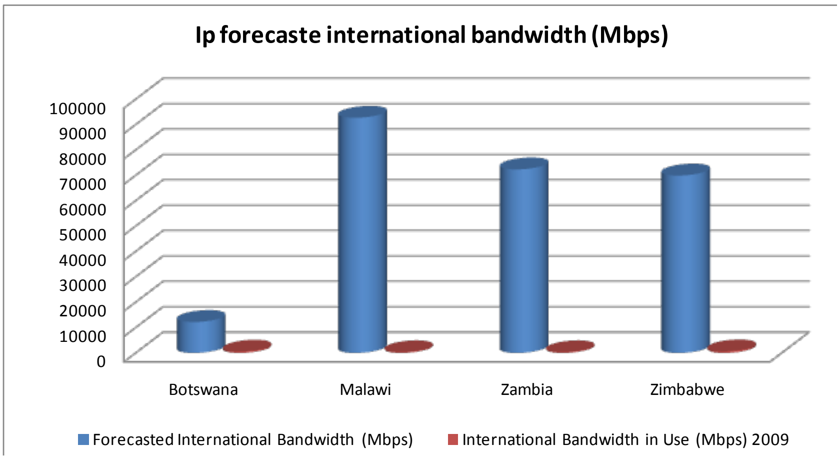

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Figure 49: International bandwidth gap in % for landlocked countries (SADC)

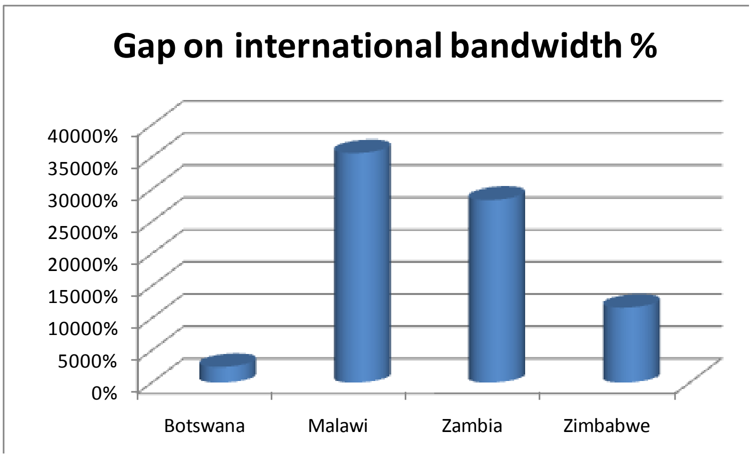

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Table 13: International bandwidth for LLC (Est)

Country	Forecasted National Bandwidth (Mbps)	Forecasted International Bandwidth (Mbps)	International Bandwidth in use (Mbps) 2009	International bandwidth gap (Mbps)
Burundi	118 357	59 179	75	59 104
Malawi	185 370	92 685	260	92 425
Rwanda	132 672	66 336	871	65 465
Uganda	400 784	200 392	1 200	199 192

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Figure 50: **International bandwidth forecasts for landlocked countries (Est)**

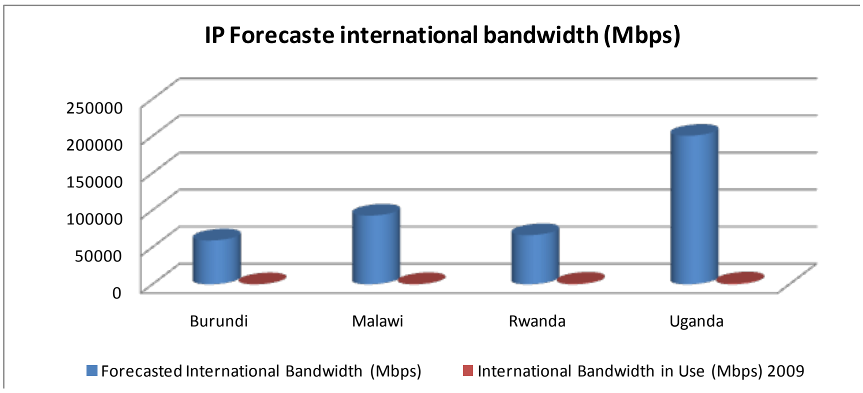

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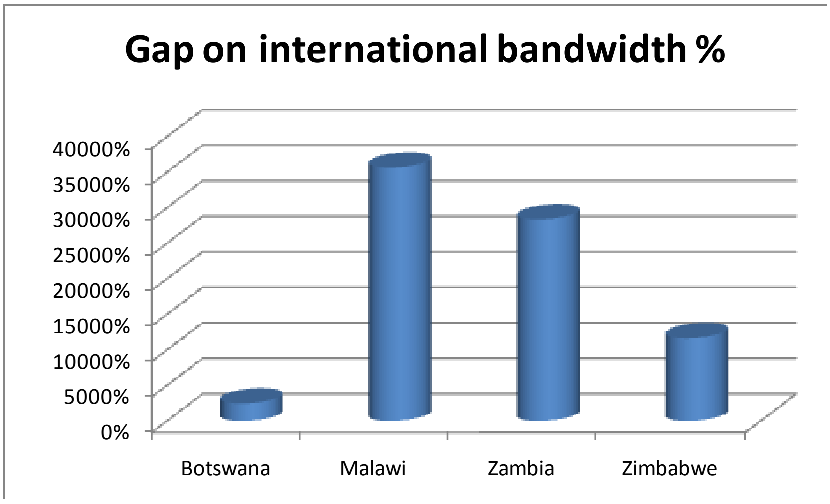
Figure 51: **International bandwidth gap in % for landlocked countries (Est)**



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2.4 Sensitivity Tests Providing a Vision for 2012-2025

The sensitivity test of the continental and regional bandwidths according to 2 fundamental parameters:

- Broadband access density
- Bandwidth per access

They highlight the international bandwidth gap to be closed by African countries

If, in 2011, international bandwidth was mainly routed to the landing stations because of the absence of IXP and Datacenters, this traffic has developed by a certain percentage to become intra-continental traffic depending on:

- The geographical positioning of datacenters
- The technological evolutions such as the development of transparent caches[46] allowing the reduction of international bandwidth usage.

The consultant simulated 3 sensitivity tests using “Traffic Model PIDA Study ICT”...

- Variable access, fixed bandwidth
- Fixed density, bandwidth per variable access
- Variation of density and bandwidth per access

[46] See explanation here below (IXP)

2.4.1 Variable access, fixed bandwidth[47]

Table 14: International bandwidth (Mbps) in Africa

density of BB access (%)	International bandwidth (Mbps)								
	COMESA	SADC	EAC	ECOWAS	CEEAC	UMA	LLC	IGAD	Africa Bandwidth (Mbps)
2009	**125860**	**42202**	**15027**	**26674**	**3895**	**118910**	**6240**	**20403**	**308324**
2%	543227	319454	163509	355233	162034	103763	294189	101814	1214671
5%	1358068	798635	408772	888081	405084	259407	735473	254534	3036677
7%	1901295	1118089	572280	1243314	567117	363170	1029663	356347	4251348
10%	2716136	1597270	817543	1776163	810168	518815	1470947	509068	6073354
12%	3259363	1916724	981052	2131395	972201	622578	1765136	610881	7288025
15%	4074204	2395905	1226315	2664244	1215251	778222	2206420	763601	9110032
20%	5432272	3194540	1635087	3552325	1620335	1037630	2941893	1018135	12146709

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Figure 52: Elasticity of Africa bandwidth (Mbps) vs % of BB access with 60 Kbps

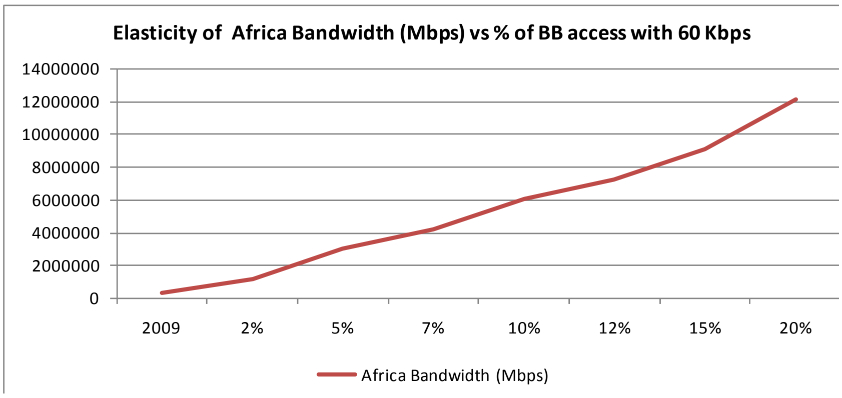

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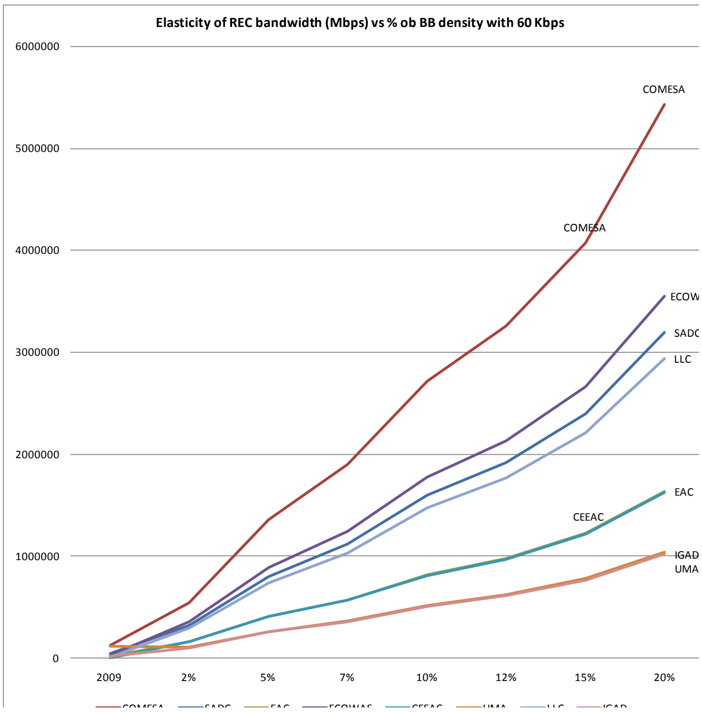
Figure 53: Elasticity of REC bandwidth (Mbps) vs % of BB density with 60 Kbps



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[47] 60 Kbps

2.4.2 Fixed density, bandwidth per variable access[48]

Table 15: International bandwidth (Mbps) in Africa

	International bandwidth (Mbps)								
density of BB access (Kbps)	COMESA	SADC	EAC	ECOWAS	CEEAC	UMA	LLC	IGAD	Africa Bandwidth (Mbps)
2009	**125860**	**42202**	**15027**	**26674**	**3895**	**118910**	**6240**	**20403**	**308324**
20	905379	532423	272514	592054	270056	172938	490316	169689	2024451
30	1358068	798635	408772	888081	405084	259407	735473	254534	3036677
40	1810757	1064847	545029	1184108	540112	345877	980631	339378	4048903
50	2263447	1331058	681286	1480136	675140	432346	1225789	424223	5061129
60	2716136	1597270	817543	1776163	810168	518815	1470947	509068	6073354
80	3621515	2129693	1090058	2368217	1080224	691753	1961262	678757	8097806
100	4526893	2662117	1362572	2960271	1350279	864692	2451578	848446	10122257

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Figure 54: Elasticity of Africa bandwidth (Mbps) vs Kbps (density 10%)

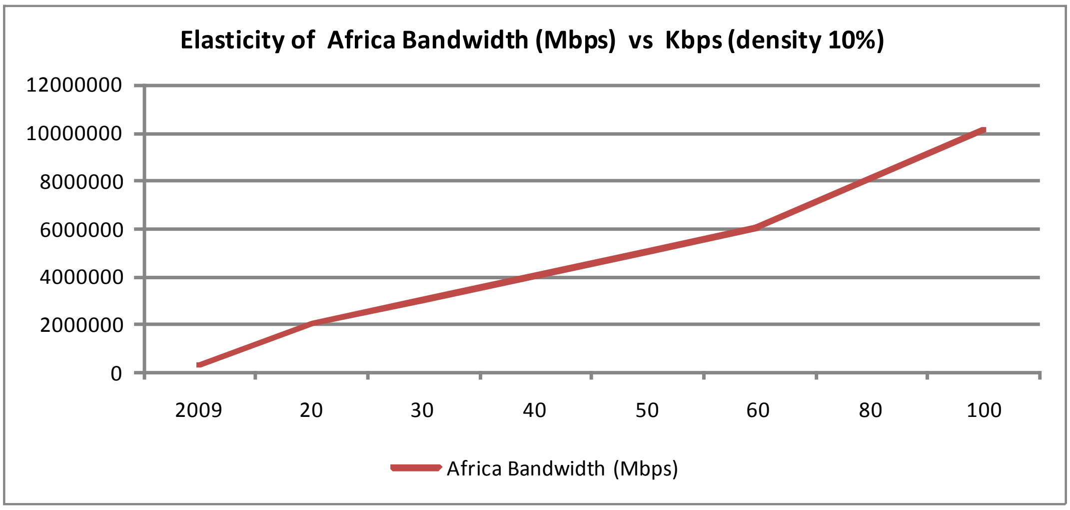

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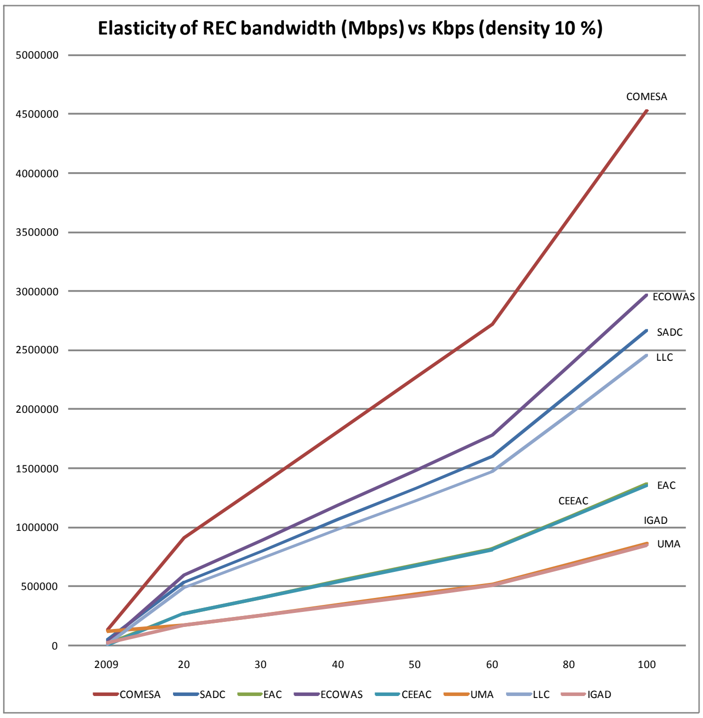
Figure 55: Elasticity of REC bandwidth (Mbps) vs Kbps (density 10%)



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48 10%

2.4.3 Variation of density and bandwidth per access

Table 16: International bandwidth (Mbps) in Africa

	International bandwidth (Mbps)								
BB access density % and Kbps	COMESA	SADC	EAC	ECOWAS	CEEAC	UMA	LLC	IGAD	Africa Bandwidth (Mbps)
2009	**125860**	**42202**	**15027**	**26674**	**3895**	**118910**	**6240**	**20403**	**308324**
10% ,20K	905379	532423	272514	592054	270056	172938	490316	169689	2024451
10 %,30 K	1358068	798635	408772	888081	405084	259407	735473	254534	3036677
10 %, 50 K	2263447	1331058	681286	1480136	675140	432346	1225789	424223	5061129
15 %, 30 K	2037102	1197952	613158	1332122	607626	389111	1103210	381801	4555016
15 % , 50 K	3395170	1996587	1021929	2220203	1012710	648519	1838683	636334	7591693
20% , 40 K	3621515	2129693	1090058	2368217	1080224	691753	1961262	678757	8097806
25 % , 60 K	6790340	3993175	2043859	4440407	2025419	1297037	3677367	1272669	15183386

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Figure 56: Elasticity of Africa bandwidth (Mbps) vs Kbps and density

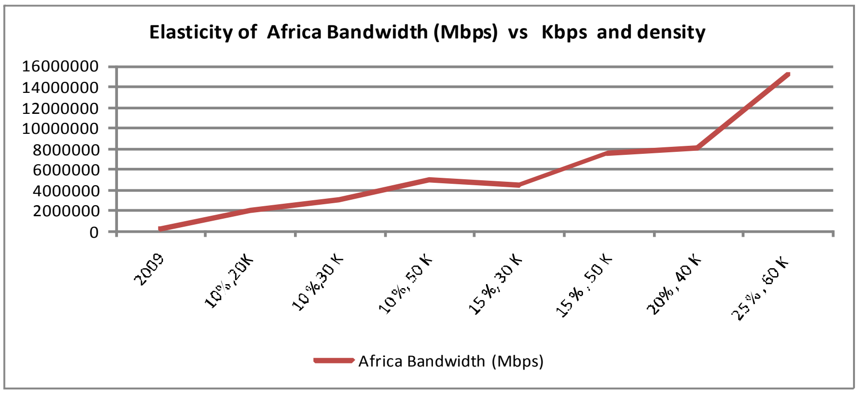

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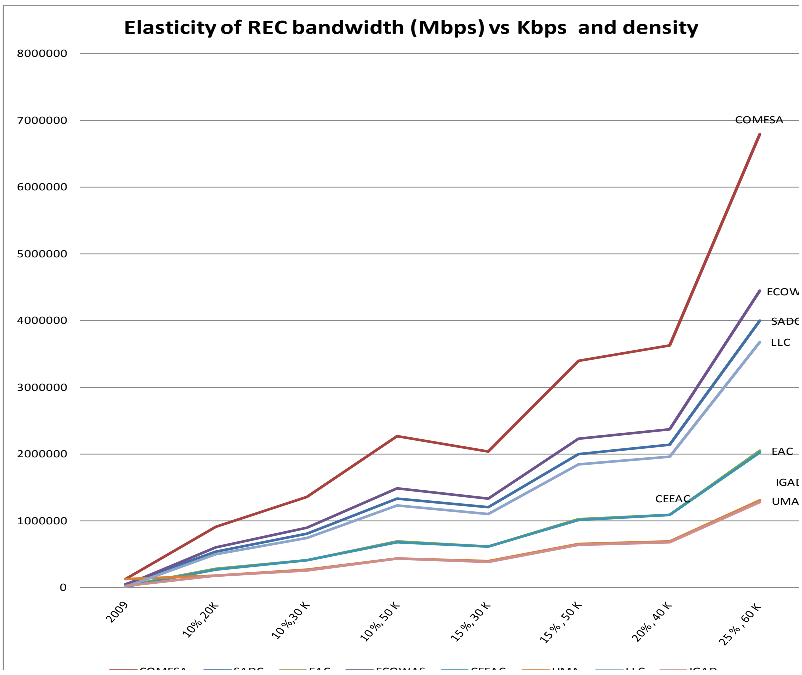
Figure 57: Elasticity of REC bandwidth (Mbps) vs Kbps and density



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2.4.4 Conclusion

The sensitivity tests highlight the huge international bandwidth gaps to be filled in by the countries in order to develop the broadband and its use.

These traffics will have to be carried by transborder and transcontinental infrastructure, which shows the necessity to undertake all the reforms needed for the deployment of infrastructure and networks.

It is worth noting that the bandwidth deficit does not represent the continental, regional or national infrastructure deficit.

Bandwidth deficit will be filled in thanks to the equipments developed by each operator ISP to carry the traffics of their customers.

Infrastructure gaps will be filled in through the implementation of optical fibre infrastructure on which active equipments will be installed. This national and regional infrastructure can be:

- infrastructure implemented by each operator,
- infrastructure known as alternative infrastructure
- Infrastructure shared by many operators.

The geographical deployment of this infrastructure must fulfill many objectives, often divergent:

- The need for land-use planning: Governments and RECs' responsibility at regional level.
- Meet the operators' expectations and fall within their strategies

*The challenge of the PIDA program is the resolution of this dilemma and this challenge can only be taken up by a **major involvement of the private operators** which will be the main investors.*

3. REVIEW OF THE EXISTING REGIONAL INFRASTRUCTURE

3.1 What is the Regional and Continental Infrastructure?

In the PIDA Study, infrastructure taken into account is mainly the "passive"[49] and sustainable infrastructure, which means optical fiber infrastructure that is currently the only one capable of meeting the capacity needs in the medium term.

The Consultant's analysis mainly focuses on the land-based infrastructure that plays a role **in bandwidth development** and **reduces the digital divide**.

As a result, the regional and continental infrastructure analyzed is:

- Submarine cables and landing stations
- optical fiber land-based infrastructure
- Internet eXchange Points (IXP) and data centers.

3.1.1 Submarine cables and landing stations

Submarine cables and their landing stations are "offshore" infrastructure which connect Africa to the rest of the world.

Playing an essential role in connecting Africa to the rest of the world, landing stations have a unique position in the regional and continental infrastructure.

3.1.2 Land-based infrastructure made up of optical fibres

Infrastructure vs. Networks

The synopsis below shows the difference between infrastructure and networks.

- **Infrastructure**

The main components are the full passive equipments developed by a network or passive infrastructure operator (supply of infrastructure to the network operators[50]).

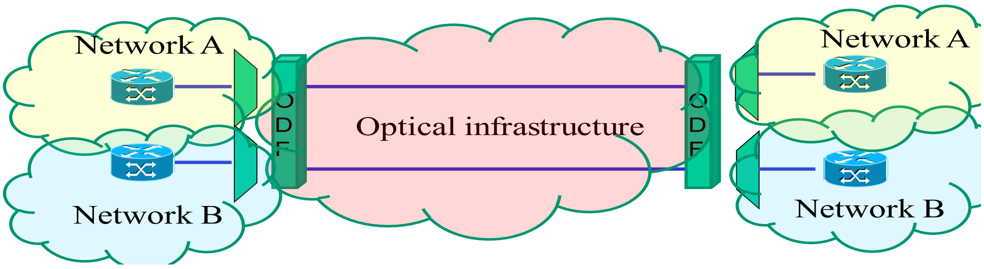
- Optical cables and the associated civil engineering
- ODF (Optical Digital Frame)
- Hosting sites (terminals and repeaters)
- Energy and air conditioning

- **Networks**

The major components are the full active equipments developed by a network operator.

- Terminal active equipments (DWDM, IP switch…)
- IP Transponders
- SDH Interfaces,
- Optical amplifiers

Figure 58: Infrastructure vs. Operators' networks



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[49] The Consultant recalls that ICT infrastructure is passive equipments on which the operators set up their active equipments (networks). Such equipments provide services. The infrastructure projects (European Union, Australia, Singapore) have the same definition. This point remains divergent with the position of stakeholders. Taking into consideration this difference certainly allows efficiency gains to be obtained, amongst others, thanks to the use of what is known as passive infrastructure. In Europe, alternative infrastructure has played an important role in the development of broadband and competition amongst operators. (See Inception Report, the case of highways in France)

[50] Example: a highway in France, electricity company with OPGW cable, railway........

Infrastructure can be classified into 3 types:

- **Incumbent operators' infrastructure**

Incumbent operators' infrastructure is that which has been or is deployed by fixed operators from the historical monopoly and potentially the infrastructure developed by their mobile subsidiaries

- **Private operators' infrastructure**

Private operators (Mobile operators, Carrier to Carrier, ISP…), are players who implement optical fibre infrastructure for their own needs.

- **Alternative Infrastructure**

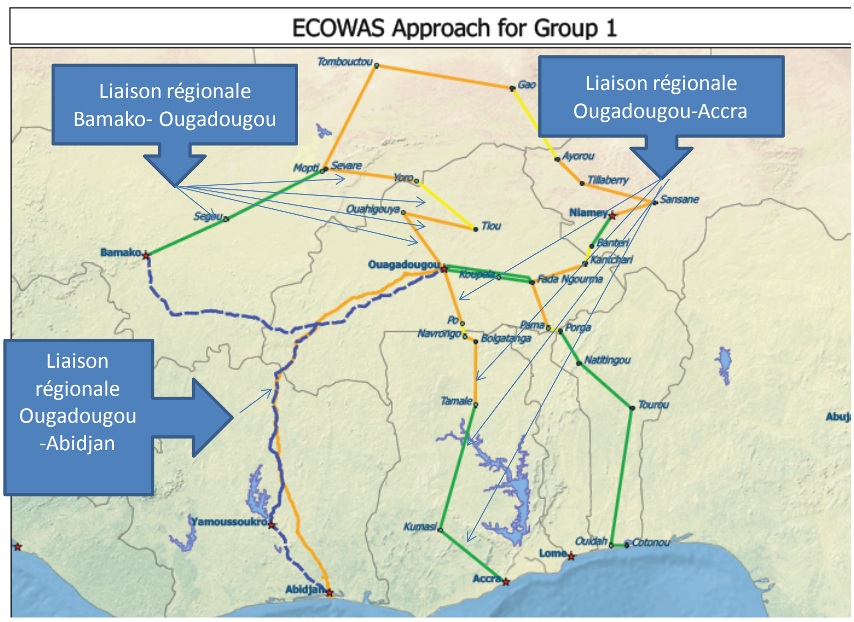
Alternative infrastructure is optical cables implemented by players from other sectors such as energy, transport (railways, road networks….) or any other player not operating a service. Generally speaking, part of the resources are used for the own needs of the owners and the extra capacity available may be used by the ICT sector.

Definition of regional or continental optical infrastructure from a PIDA perspective

Continental or regional infrastructure taken into account is optical infrastructure from end to end; that is generally extending from

- one country to another allowing operators to interconnect their networks and therefore exchange voice traffic, IP or other
- an international interconnection point to a submarine cable landing station
- national infrastructure subsets enabling a better connection between at least two countries

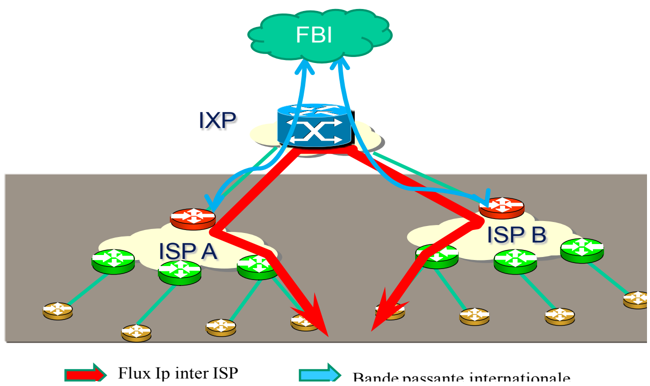
Figure 59: ECOWAS regional infrastructure project



3.1.3 IXP Internet eXchange Point and Data Center

Internet eXchange Points have been taken into account because they are key elements in the routing of IP traffics carried through regional infrastructure. Moreover, they are structuring elements at both national and regional levels as they enable an interconnection between infrastructure and IP operators' networks.

Figure 60: Operational synopsis of an IXP



Generally, they are set up either by collective or private initiatives (IXP and Datacenter). Some African operators have deployed or scheduled their deployment.

3.2 Main Findings of the Review of the Existing Infrastructure and the Implementation of ICT Projects

At this stage of the PIDA ICT Study and although the objective only focuses on regional and continental infrastructure, it seems important to broaden the study synthesis because the reduction of the digital divide in Africa and the development of broadband require a global vision of both the sector and the state of progress of the various components.

In order to facilitate the understanding, the Consultant has classified them as follows:

3.2.1 International connectivity (Submarine stations and its related offers)

Connectivity of Africa

In respect of the reduction of the digital divide between Africa and the rest of the world, submarine cables and the landing stations play an essential role. In fact, until 2010, Africa's connectivity was essentially carried out on the West Coast through SAT3 cables and for the great majority of countries and players (Operators, ISP) through satellite stations.

Since the end of 2012, Africa (excluding UMA, Egypt and Djibouti which have had excellent connectivity for many years now) has more than 70 submarine stations operated by 8 different consortiums/investors (SAT3, ACE, GLO, EASSY, SeaCOM, WACS, MainOne, Teams). This change in the situation is essentially the result of private initiatives and provides great perspectives on the development of internet use provided that the countries know how to benefit from this and recognize the necessity of continental integration in order to take into account more particularly the landlocked countries.

Table 17 below provides the geographical breakdown at continental level as well as the operation dates:

SAT3 2002	SE-ME-WE 2005	Atlas 2007	TEAMs 2008	Seacom 2010	EASSy 2010	GLO1 2010	EIG 2010	MainOne 2010	Wacs 2011	ACE 2011
Cote Ouest	Afrique du nord		Cote Est			Cote Ouest	Afrique du nord	Cote Ouest		

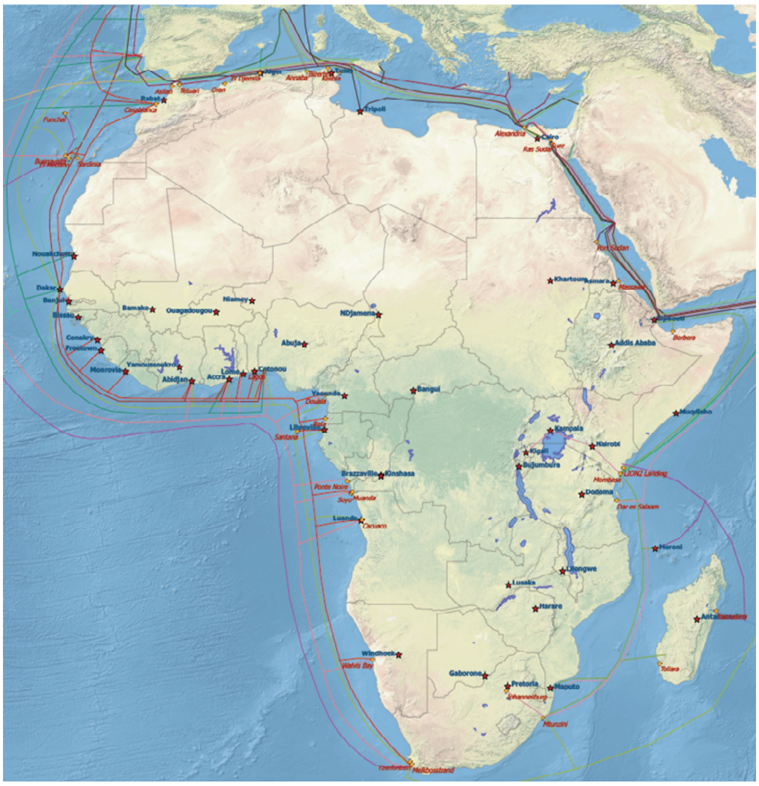
Table 18 below provides an overview of the different cables on the Eastern and Western coasts as well as their characteristics.

East and West Sub-marine cables								
Name	SAT3	Seacom	TEAMs	EASSy	GLO1	MainOne	Wacs	ACE
Date	2005	2009	2010	2010	2010	2010	2011	2012
cost (M $)	260	650	130	265	150	240	600	700
length	14500	13700	4500	10000	9500	7000	14000	14000
bandwidth (Gbits)	340	1280	1280	1400	2500	1920	5120	5120
Cumulativ bandwidth(Gbits)	340	1620	2900	4300	6800	8720	13840	18960

This new international connectivity of the continent replacing the satellite offers[51] on this segment should be characterized by a significant increase in broadband used by the countries and a very important decrease in prices ($/Mbps). This has already been observed in countries where there is a competition between players (East Coast (E SSy-SEACOM-TEAM)).

[51] African Fiber and Satellite Markets, Russell Southwood, Balancing Act 2010

Figure 61: Map of the submarine connections (2012)



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Country connectivity and international bandwidth price

More than 80 submarine stations are either in operation or being currently built in African countries. Some countries like Egypt, Djibouti, Tunisia, Senegal, Nigeria or South Africa take advantage of the landing of several submarine cables belonging to different consortiums.

The 2 cases show that:

- Egypt benefits from the landing of several cables at various locations on its territory
- Guinea Bissau will soon have a GLO1 station

Figure 62: Submarine cable landing stations in Egypt

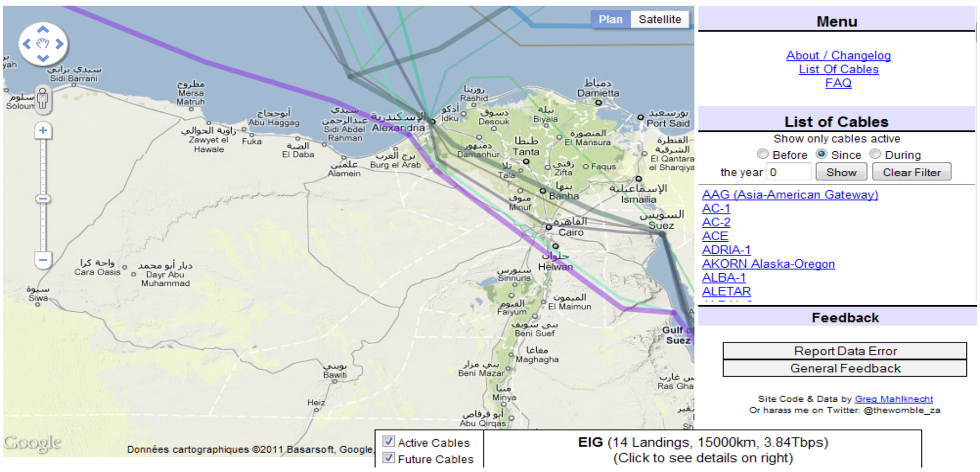

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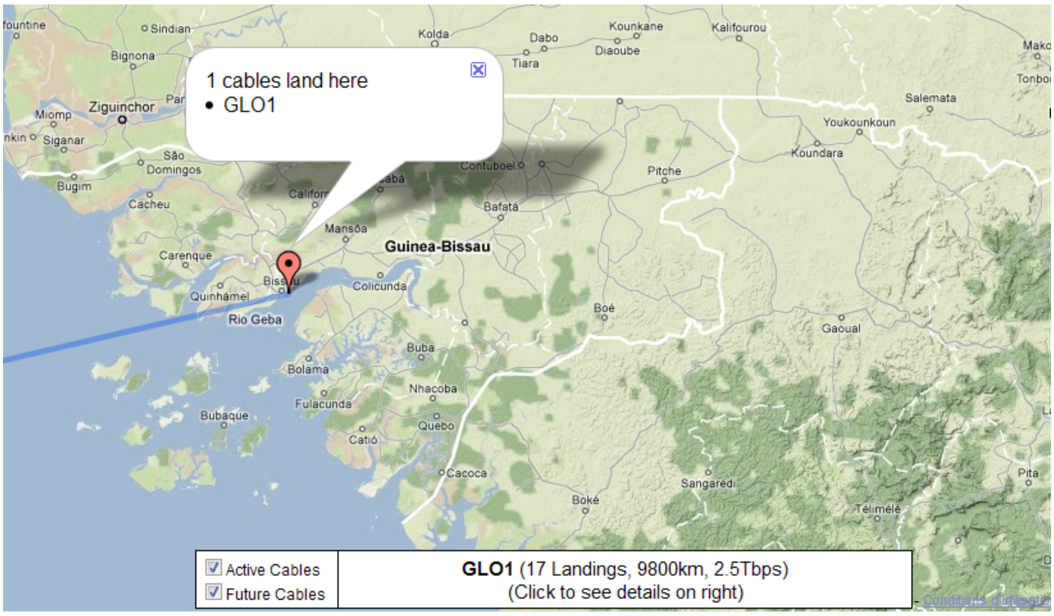
Figure 63: Submarine cable landing stations in Guinea Bissau



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However, this access of operators and ISPs to international bandwidth is related to the connectivity between infrastructure and the various stations. This accessibility is sometimes hindered by the existing monopolies generally awarded to the incumbent operator (for instance Cameroon, Cote d'Ivoire, Senegal and SAT3, or countries with one single station (de facto competitive monopoly) or even duopoly (risk of commercial agreement)). These monopolies are significant obstacles to the development and to the implementation of an e-economy and an advanced society.

The benchmarking analysis below provides an overview of the differences in Mbps prices

Example of Mbps monthly rate and international linkages

This is expressed by an significant disparity of the Mbps monthly rate between African countries which can be illustrated by the following examples (Wholesale offer) :

- 40$/Mbps[52] per month in Tunisia (regulated price /monitored by INTT[53] despite monopoly of Tunisie Télécom on the three landing stations)
- Between 100 and 500 $/Mbps per month for EASSy and Seacom[54] (5000 $ early 2010 in the region).
- 10 000$/Mbps[55] per month in Cameroon where the SAT3 station is under the monopoly of Camtel and the prices are not regulated.
- 60 000$/Mbps per month in Burkina Faso[56] which is dependent on the incumbent operators in Cote d'Ivoire and Benin to access SAT 3.

[51] Source ATI, June 2011, interview of the Consultant

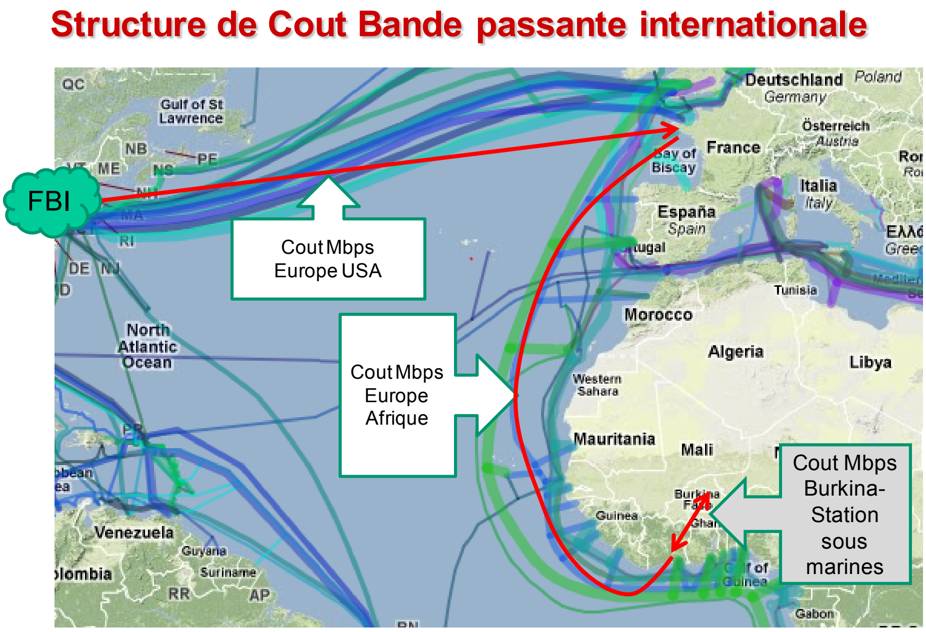
[53] Tunisian Regulator

[54] june 2011

[55] http://www.art.cm:81/images/doc/catalogue_interconnexion_orto_2010%20camtel.pdf

[56] http://www.onatel.bf/fixe/abonnements.htm

Figure 64: **Structure of International Broadband Cost, the case of Burkina Faso**



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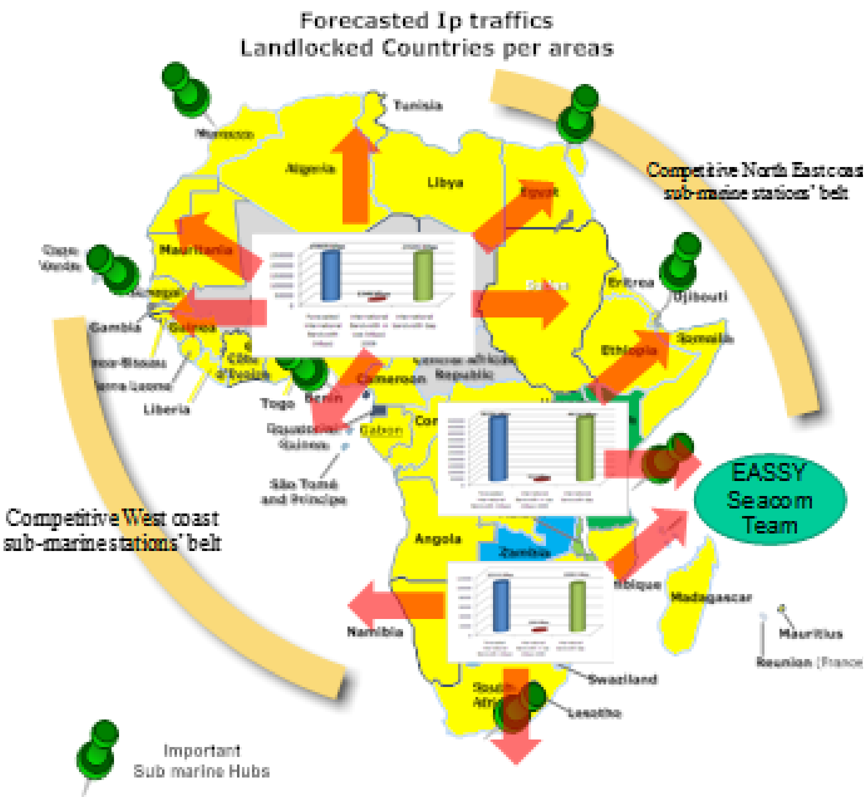
The case of Burkina Faso or countries like Botswana or Zambia with the "de facto" monopoly by the South African operator "Telkom South Africa" shows the issue of landlocked countries which must specifically be addressed. Conversely, for countries like Uganda or Rwanda, the emergence of private carrier to carrier (KDN…) in competition with incumbent operators enables them to have an easier access to international bandwidth at a better rate.

The case of both landlocked countries and access to submarine cables landing stations

This analysis must be completed by :

- The analysis of Phase I highlighting the risks facing players in some countries to be under monopoly (countries with one single station) or duopoly (two stations).
- A consultation of all the country operators (fixed, mobile ISPs) would help identify the exit points to which they would like to be connected. For instance, it is obvious that operators which are subsidiaries of Maroc Télécom (Burkina Faso, Niger) would seek access to Morocco through land-based infrastructure[57]; Orange subsidiaries in Mali, Guinea, and Senegal want to access either SAT3 or ACE. If for these operators with many licenses[58], it is possible to deploy their own land-based infrastructure, the competition rules will be distorted if “small operators’ are not able to access independently or neutrally landing stations in competition, but are “obliged” to connect to stations[59] held by “consortiums”

Figure 65: Landlocked countries and connectivity



Elasticity of broadband gross prices[60] according to transmitted traffic

[57] Being deployed

[58] Orange, MTN, Maroc Telecom, Barthi,

[59] The regulation of submarine stations is extremely difficult

[60] WACC method (10 years, 8%) and 4% for maintenance

Table 19 below and the corresponding figure provide Mbps gross prices according to the submarine cable loading

Cost breakdown over submarine cables								
Name	**SAT3**	**Seacom**	**TEAMs**	**EASSy**	**GLO1**	**MainOne**	**Wacs**	**ACE**
Capex per year	-36 134 868,19 €	-90 337 170,48 €	-18 067 434,10 €	-36 829 769,51 €	-20 847 039,34 €	-33 355 262,95 €	-83 388 157,37 €	-97 286 183,60 €
Opex per year	10400000	26000000	5200000	10600000	6000000	9600000	24000000	28000000
Value C + O per Year	46 534 868 €	116 337 170 €	23 267 434 €	47 429 770 €	26 847 039 €	42 955 263 €	107 388 157 €	125 286 184 €
Value C + O per Months	3 877 906 €	9 694 764 €	1 938 953 €	3 952 481 €	2 237 253 €	3 579 605 €	8 949 013 €	10 440 515 €
2,5 Gbits	1 551 €	3 878 €	776 €	1 581 €	895 €	1 432 €	3 580 €	4 176 €
10 Gbits	388 €	969 €	194 €	395 €	224 €	358 €	895 €	1 044 €
50 Gbits	78 €	194 €	39 €	79 €	45 €	72 €	179 €	209 €
100 Gbits	39 €	97 €	19 €	40 €	22 €	36 €	89 €	104 €
300 Gbits	13 €	32 €	6 €	13 €	7 €	12 €	30 €	35 €
500 Gbits		19 €	4 €	8 €	4 €	7 €	18 €	21 €
1 000 Gbits		10 €	2 €	4 €	2 €	4 €	9 €	10 €

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Figure 66: Costs of Mbps/month regarding bandwidth payload per SM cable

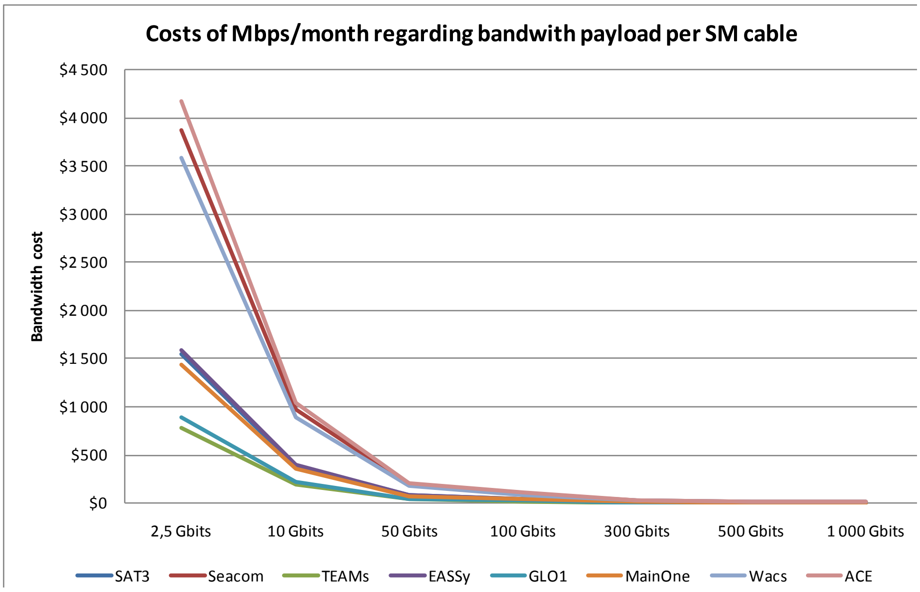

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Figure 66 shows that the international broadband price offer is conversely proportionate to the cable's capacity which means that the more the broadband will develop in the African countries, the more Mbps prices[61] will drop.

Countries' connectivity and security access to FBI[62]

Between 2010 and 2011, the Consultant was able to analyze in depth (IP ecosystem)[63] two cable cuts (EASSy (July 2010) and SAT3 (May 2011) which were characterized by a total isolation, during several days, of many countries connected to these cables.

The case of EASSY cable in June 2010 was explained during the Addis Ababa seminar.

[61] Price that « satellite » offers cannot provide

[62] Internet band provider (Cogent, Level3, Telecom Italia Sparkle, Orange, Tata, Interoute

[63] See Addis Ababa Workshop

Analysis of the Burkina Faso Case: SAT3 failure in May 2011

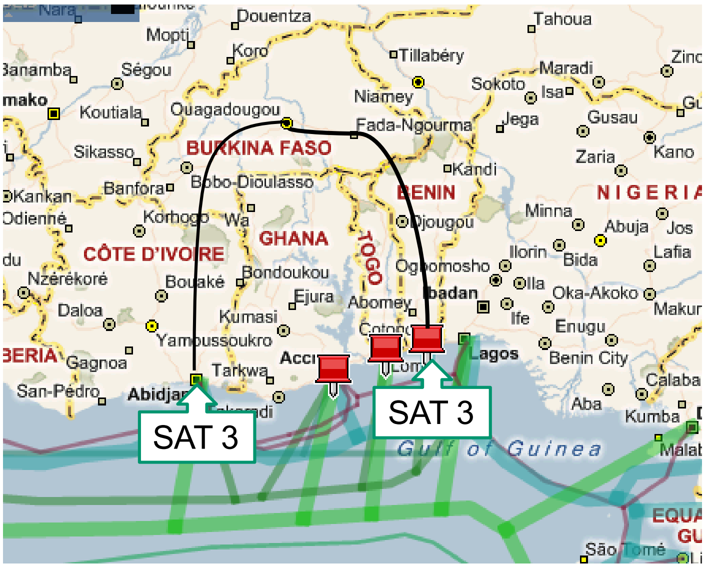
Burkina Faso is one of the West African landlocked countries. The development of regional land-based infrastructure has helped end the isolation of this country thanks to land-based infrastructure linking it to SAT3 submarine landing stations through Benin and Cote d'Ivoire[64].

Following a technical failure of SAT3 cable (mid May 2011), Onatel lost all international connection therefore paralyzing its customers whose economic activities depend or are essentially linked to the internet use while two internet service providers (ISPs) remained connected.

Onatel Ecosystem

During the SAT3 technical breakdown, the ecosystem analysis carried out by the Consultant on Onatel's international connectivity showed that the latter had lost all international connection and that all its customers had no access to the FBI cloud

Figure 67: Probable Connectivity of Onatel[65] 2011



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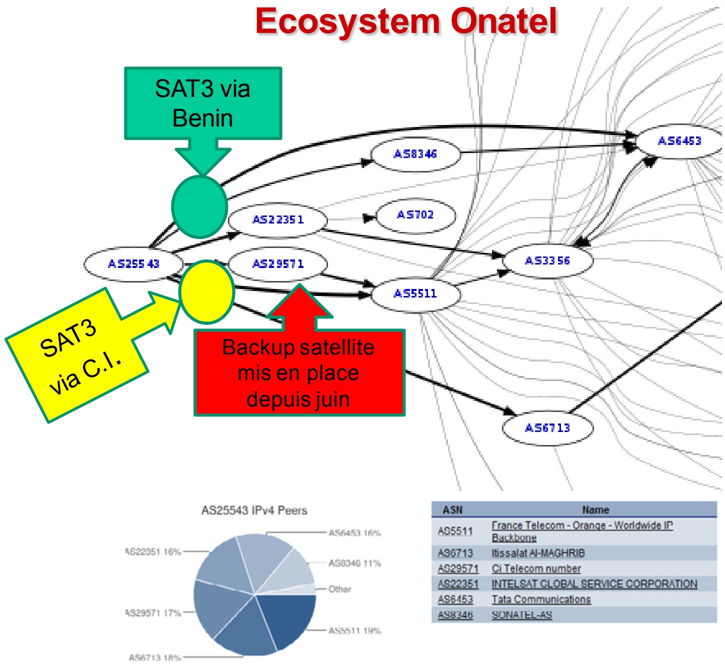
[64] The other stations (for the GLO-1,Wacs, ACE cables) as they were not operational in this zone

[65] PIDA ICT does not have the history of all the African countries' ecosystem in particular that of Burkina Faso before the SAT3 incident in May 2011.

Figure 68: **Burkina Faso ISP Ecosystem**



©http://bgp.he.net/AS25543#_graph4-Pida Study ICT sector July 2011

An analysis of the ecosystem carried out after the re-operation shows that Onatel, which was entirely dependent on SAT3, seems to have established since a satellite connection via Intelsat[66].

No access to the station of another cable: weakness of land-based connection

No satellite connection provided as a backup: **Strategic weakness of the operator**

[66] Interviews carried out by the Consultant highlight the weakness of the Rascom offer which owns a single satellite and therefore remains fragile in terms of connectivity in the case of a beam break. (interview of African Operators June 2011)

The ecosystems of the two Burkinabe ISPs show two points :

- They were not affected by the SAT3 breakdown as they were connected via satellite links
- They do not use SAT3 ***probably because international bandwidth price*** sold off by Onatel is excessively expensive because of
  - the price of international bandwidth on SAT3 (Benin Telecom and Cote d'Ivoire Telecom)
  - The price of international bandwidth on the land part (Onatel, CI telecom...)

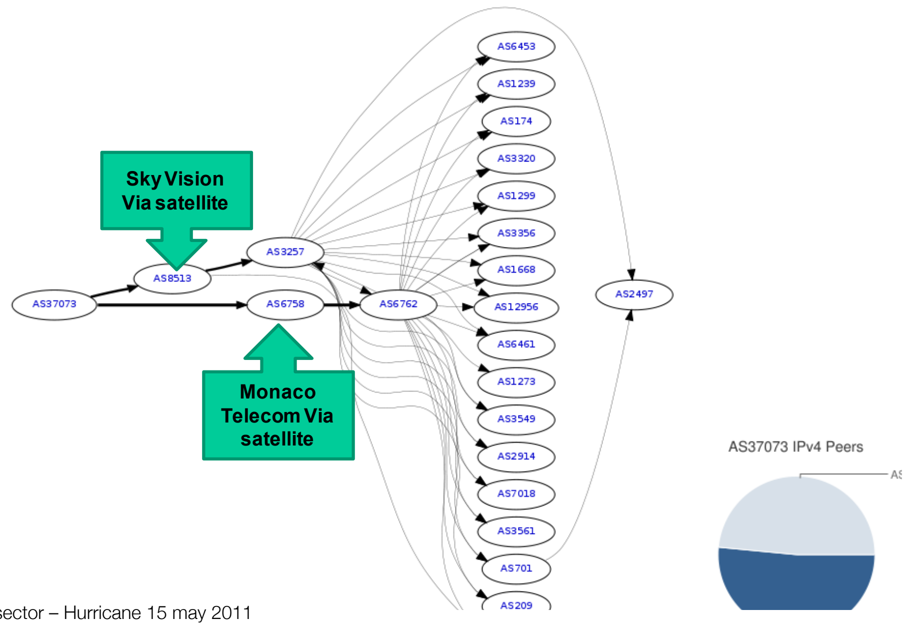
Connecteo Burkina Faso

The international connectivity of Connecteo BF in degraded operation mode (no record available in the PIDA ICT data base) is carried out by 2 satellite links as shown in figure 69 below:

Liaison satelitte	ASN	Name
Liaison N°1 50%	AS6758	MONACO TELECOM
Liaison N°2 50 %	AS8513	SkyVision Network Services

Figure 69: Connecteo Burkina Faso Ecosystem

AS37073 IPv4 Route Propagation



PIDA ICT sector – Hurricane 15 may 2011

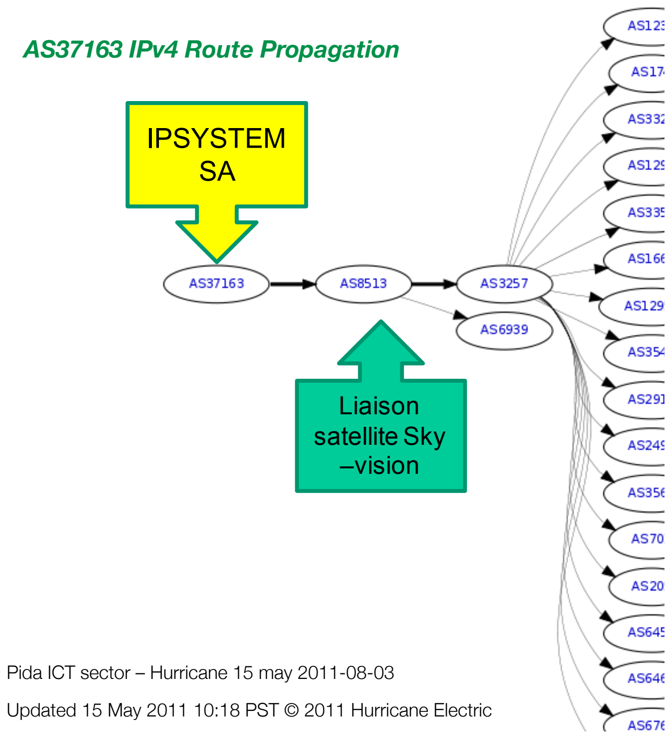
Updated 15 May 2011 10:18 PST © 2011 Hurricane Electric

IPSYSTEM SA

International connectivity of IPSYSTEM SA in degraded operation mode (no record available on the PIDA ICT database) is carried out by one satellite link as shown in figure 70 below.

Liaison satelitte	ASN	Name
Liaison N°1 100 %	AS8513	SkyVision Network Services

Figure 70: IPSYSTEM SA Ecosystem



This cable breakdown (electronic failure) on SAT3 has then resulted in a break of efficient connectivity (land-based infrastructure + submarine cables) to the IP world. On 15 May, Burkina Faso's connectivity to the internet world was extremely reduced as this connectivity was carried out by only two operators using satellite connections offering neither the capacity nor the performance of optical fiber connectivity.

This analysis highlights many weaknesses in the African legal and regulatory framework as well as the connectivity of countries:

- The connection of one country to a single submarine cable does not guarantee any reliability on the connectivity
- Monopoly of one cable keeps international bandwidth prices at prices which are not economically reasonable compared to the rest of the world.
- The lack of regulation17[67] of wholesale offer prices for land-based infrastructure highly penalizes landlocked countries

[67] This point will be raised later in this report

Conclusion on African connectivity

Main conclusions

Access to international bandwidth *is an* ***essential resource*** *for the development of an e-economy*.

Therefore, it is obvious that accessibility to submarine cable landing stations must be reinforced by regional land-based infrastructure in the majority of cases so as to:

- Ensure competition between operators of submarine cables in order to reduce international broadband prices
- Connect all countries to at least 2 landing stations operated by two different operators to ensure international connectivity for all players (Operators, ISPs…) as it is not possible to develop an economy using internet if it can be isolated from the web by one single incident
- Give landlocked countries access to landing stations at prices and security conditions similar to those of the coastal countries in order to avoid an intra-African digital divide.
- Take into account the fact that satellite solutions are not/will not be competitive any longer compared to submarine cable offers as international gateways. They will position themselves as links guaranteeing security and the end of the isolation of remote areas or for the broadcasting television services
- Achieve the objective of aligning international bandwidth prices with international good practice[68].

3.2.2 Continental, regional and national land-based infrastructure

Optical fibre infrastructure in Africa, implemented by operators

Regional, national land-based infrastructure can be decomposed into subsets:

- Infrastructure implemented by operators
- Alternative passive infrastructure (if any used by operators)
- Passive Infrastructure implemented by States

Status report

There is currently at institutions level (RECs and UAC) or even at regulators level, no official inventory of land-based infrastructure developed by African players.

Various maps are available but with incomplete and non official data, therefore reducing their ability to be used to plan effectively.

Figure 71 and figure 72 below provide an incomplete continental overview of the development of optical fibre infrastructure.

[68] In Europe, the average prices of Mbps for international traffic to the USA is less than 8$/month

Figure 71: Africa marine cables and network

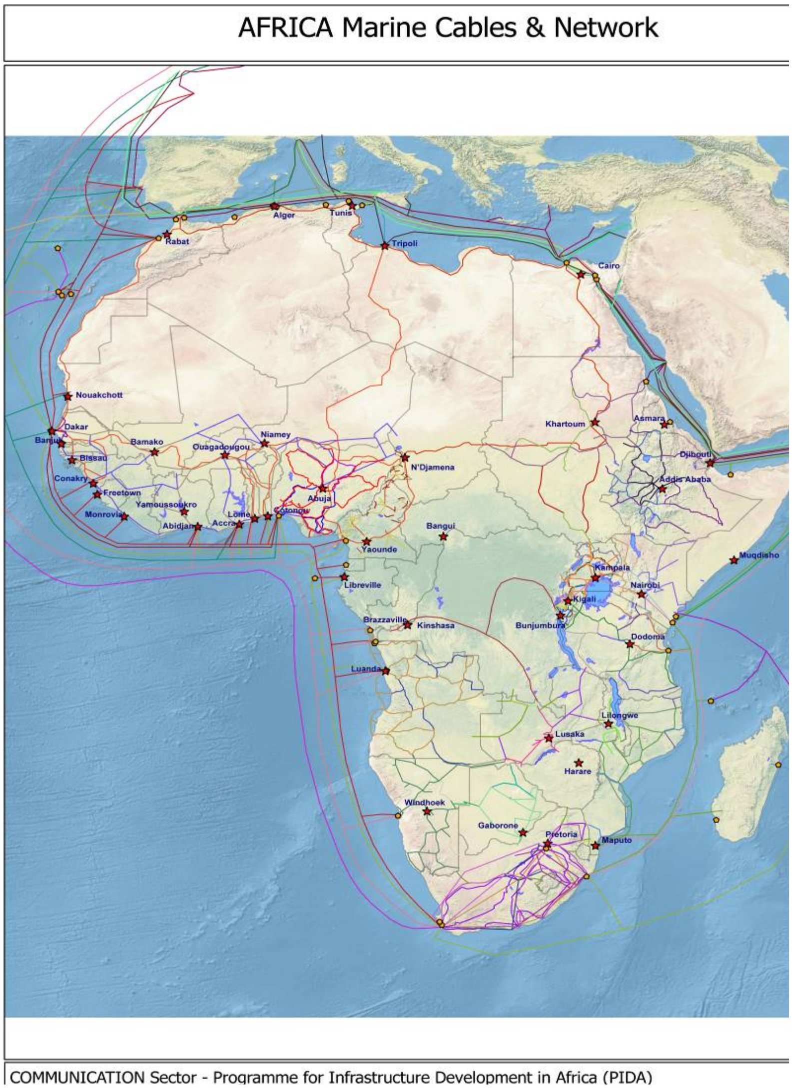
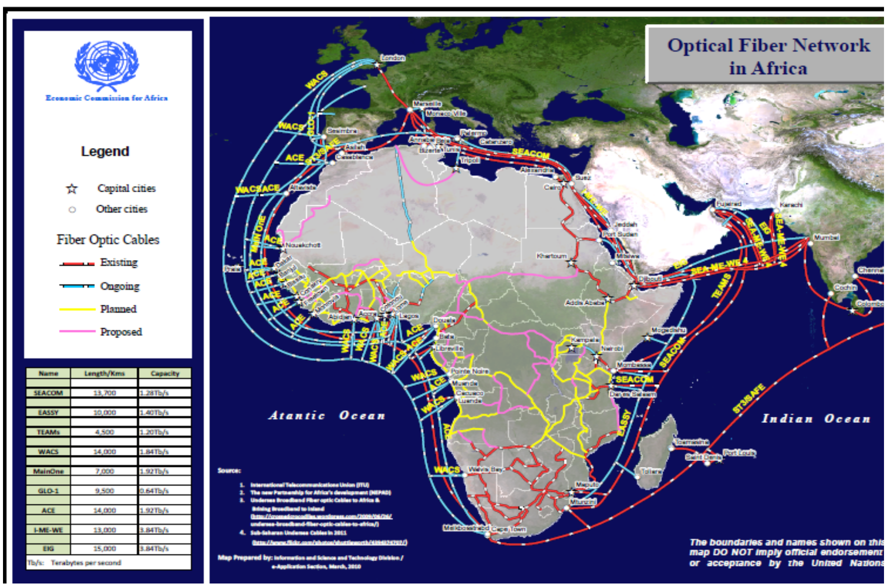


Figure 72: Optical fiber network in Africa



Name	Length/Kms	Capacity
SEACOM	13,700	1.28Tb/s
EASSY	10,000	1.40Tb/s
TEAMs	4,500	1.20Tb/s
WACS	14,000	1.84Tb/s
MainOne	7,000	1.92Tb/s
GLO-1	9,500	0.64Tb/s
ACE	14,000	1.92Tb/s
I-ME-WE	13,000	3.84Tb/s
EIG	15,000	3.84Tb/s

Tb/s: Terabytes per second

http://geoinfo.uneca.org/downloads/Fibre Optic Network.pdf

Since 2009, changes in the development by operators of optical fiber infrastructure happened very quickly, « boosted » by the landing of submarine cables. However, this development has not reached all African countries. Indeed, countries which currently have set up their infrastructure are those which undertook legal and regulatory reforms, providing as a consequence an enabling environment for private investment.

These countries are mainly Morocco, Tunisia, Nigeria, EAC countries and some ECOWAS countries

Africa makes quicker moves where possible

Africa's International Bandwidth Reaches 500 Gbps Mark

Africa's total international Internet bandwidth reached 520 Gbps in December 2010, a 78% increase compared to 2009. This was split between North Africa, which increased by 56% to reach 312 Gbps, and Sub-Saharan Africa which increased by 125% to reach 208 Gbps.

This bandwidth growth is clearly the result of the arrival of multiple, competing submarine cables in 2010. This has seen dramatic increases in countries connected to submarine cables for the first time: Comoros Telecom for example, which was connected to EASSy in July 2010, increased its Internet bandwidth from 12 Mbps in 2008 to 180 Mbps by December 2010. Meanwhile, Mauritius Telecom which was first connected to SAFE since 2002 and has also invested in the EASSy, LION, EIG, and WACS cables initially activated four STM-1 circuits (622 Mbps) on EASSy and had increased its Internet bandwidth from 3 Gbps to 4.8 Gbps by December 2010.

Growth has also been driven by the completion of cross-border backhaul routes from landlocked countries. The volume of cross-border traffic backhauled to submarine cables doubled again for the second year in a row, reaching almost 20 Gbps in December 2010. There has also been significant progress in the expansion of national fiber backbones delivering greater bandwidth to inland cities and towns. In the first quarter of 2011, a total of 45,338.7-kms of network was added or edited in the Africa Telecom Transmission Map, bringing the total inventory of land-based transmission network to 645,938.2-km. By comparison, in July 2010 this stood at 585,471-km and in July 2009 at 465,659-km (restated).

Africa Telecom Transmission Map Updates Q1, 2011

A total of 372 changes were made to land-based transmission networks on the map during the first quarter, with fiber backbones extended to Burkina Faso, Cameroon, Chad, Comoros, Ghana, Kenya, Malawi, Rwanda, South Africa, Tanzania, Zambia and Zimbabwe. This included 17,232.3-km of operational fiber, 14,417.5-km of fiber under construction, 6,731.6-km of fiber which was planned, and 4,417.3-km of fiber which was proposed

http://www.africabandwidthmaps.com/?p=2058

According to the same source, optical fibre infrastructure estimates are as follows:

Table 20: Optical fiber infrastructure estimates

Status	Operational	ongoing	In the pipeline
Kilometers	300 000	50 000	80 000
Estimated[69] costs	7,5 $ Bn	1,25 $ Bn	2 $ Bn

They fall into 3 broad categories:

Incumbent operators' infrastructure

A number of incumbent operators developed optical fibre cable national infrastructure to meet their national needs and possibly the needs of their mobile division. The distribution on the African continent is quite uneven, with an important concentration in North Africa (Morocco, Algeria, Tunisia, Libya), in South Africa and in Eastern Africa. On the west coast, Senegal and Nigeria have a good coverage, and countries like Cameroon, Cote d'Ivoire are developing their networks.

[69] For the evaluation, an average cost of 25 000 $/Km has been selected

Figure 73: Sudatel Optical Infrastructure

The above figure shows the willingness of Sudatel operator to connect with neighboring countries. It is worth mentioning that Chad is still one of the landlocked countries, because no optical fibre infrastructure on the Chadian side is connected to Sudan infrastructure.

National infrastructure interconnection, that was among others, one of the main objectives of the Kigali Agreement, has not been fully achieved yet and a number of « missing links » still remain.

Operators' regional infrastructure

The analysis of operators' regional infrastructure shows that in order to maximize their regional presence, some operators joined forces to combine their infrastructure and interconnect their networks (Backbone).

The most relevant cases are:

- SRII: SADC Incumbents' Associations
- EABs : Mixed association of incumbents and private operators in EAC.
- WIOCC

Figure 74: Sata Infrastructure in 2010

WIOCC overview

WIOCC is a telecommunications carrier to carrier created to provide customers with reliable, low cost, high-speed telecommunications services between Eastern and Southern Africa and the rest of the world.

WIOCC's carrier customers can take advantage of a one-stop shop contract for cost-effective, reliable and seamless connectivity between numerous city POP's and landing stations in Eastern and Southern Africa and the WIOCC hub at Djibouti, Port Sudan or Mtunzini, where international carriers can hand-off traffic for carriage into Africa, and African operators can do the same for onward transfer to international destinations, financial and commercial centers and internet exchanges.

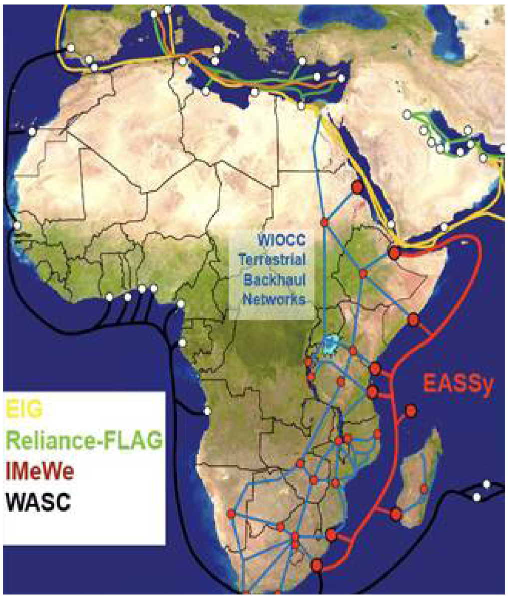
WIOCC offers a range of services to African and international carriers, extending the access to EASSy network through interconnection agreements with operators of other international submarine cable systems giving access to Asia, the Middle East, Europe and the Americas. WIOCC is also taking advantage of its owners' extensive national networks to extend services from EASSy's coastal landing stations to key cities in each country, and for the first time open up access to many African land-locked countries in namely;

- Botswana
- Burundi
- Ethiopia
- Lesotho
- Malawi
- Rwanda
- Swaziland
- Uganda
- Zambia
- Zimbabwe
- Sudan

WIOCC has development objectives embedded in its operations:

- Open access principle ensuring openness and fair access to all.
- Selling capacity on a cost-based pricing policy.

Figure 75: WIOCC Land-based backhaul networks



The services, delivered throughout the region via the East African Submarine System (EASSy) and WIOCC shareholders land-based national networks are enabling African and international telecommunication service providers to interconnect and provide ICT services to spur development and growth.

WIOCC is a special purpose African investment company, jointly owned by 14 major telecom operators in Africa – all first or second tier operators in their respective countries and funded by a number of global Development Finance Institutions (DFIs) such as World Bank, AfDB, AFD and KFW. http://wiocc.net

These 3 examples show that when there is a political, legal and regulatory framework, regional infrastructure based on national infrastructure interconnection can be implemented.

WIOCC case should be analyzed, keeping in mind the private operators[70] located in the same geographic area which can foster competition in respect of land-based infrastructure level.

Private operators land-based infrastructure - regional carrier to carrier

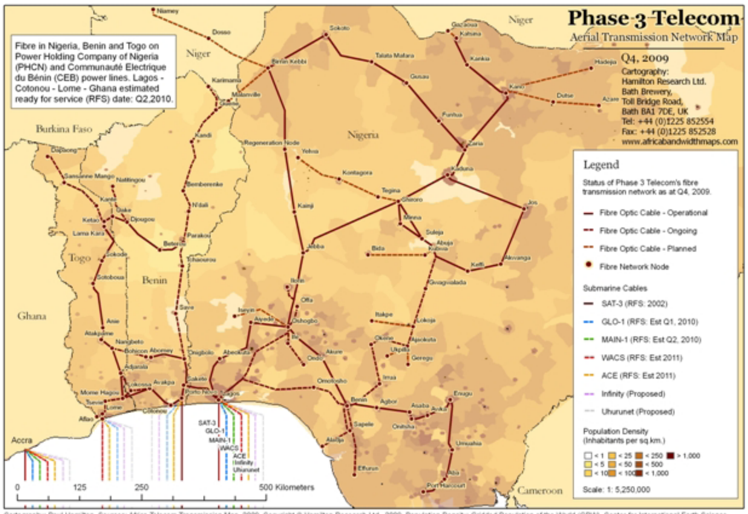
In some countries like Nigeria, Kenya, Uganda, Morocco, Tunisia, or RECs (EAC, COMESA), private operators set up infrastructure and developed « carrier to carrier » offers; the most significant and incomplete examples are : KDN (EAC), Liquid (SADC), Phase3 and SubUrban (Nigeria, ECOWAS).

[70] See later KDN, Zaico as well as opening up Malawi

Phase 3

Phase3 Telecom is a National Long Distance Telecommunications Network Operator licensed by the Nigeria Communication Commission (NCC) to provide transmission services in Nigeria. Incorporated in 2003 and licensed in 2006, Phase 3 Telecom secured a concession agreement with Power Holding Company of Nigeria (PHCN) to design, build, manage and expand a reliable and effective optical fiber backbone on PHCN High Voltage Transmission lines. In Nigeria, we currently have an optical fiber network of over 4,000km deployed on High Voltage transmission lines and have commissioned several points of presence at sites located in key cities including last mile connectivity to clients on our network. All the major telecom operators, Internet Service Providers (ISPs) and major corporate bodies are currently using our network in Nigeria

Figure 76: © Phase 3



Cartography: Paul Hamilton. Sources: Africa Telecom Transmission Map, 2009. Copyright © Hamilton Research Ltd., 2009. Population Density: Gridded Population of the World (GPW). Center for International Earth Science Information Network (CIESIN), Columbia University; International Food Policy Research Institute (IFPRI); The World Bank; and Centro Internacional de Agricultura Tropical (CIAT). 2004. Global Rural-Urban Mapping Project (GRUMP), Alpha Version. Palisades, NY: CIESIN, Columbia University. Available: http://sedac.ciesin.columbia.edu/gpw.

Towards the realization of our vision to expand the network across the West African region, Phase3 has secured the right of way from Communauté Électrique du Benin (CEB), to use the high voltage powerlines to deploy optical fiber within Benin and Togo

Thanks to this development, Phase3's network shall become the longest regional land-based optical fiber network linking Nigeria to the Republics of Benin and Togo, with potential for connections to Ghana, Cote d'Ivoire, Burkina Faso from Togo as well as anticipated connection to the Republic of Niger from Nigeria and Republic of Benin.

We have established a partnership with the Economic Communities of West African States (ECOWAS) whereby the Commission provides the required support across the region for a successful implementation of the project

The major challenges facing the project which we are overcoming as they arise are the reluctance and the delay that are associated with the acquisition of permits to cross from one country to the other. A number of countries in the West African region ***are yet to see the need to open up their telecommunication sector for a liberalized participation.*** A continent that is coming late in terms of broadband availability needs to create a simple, conducive and smooth process for the acquisition of permits for operations. For a project of such nature with very wide scope, adequate funding is also required. The need for long term credit facilities to facilitate the achievement of this objective cannot be over emphasized. ***Provision of credit facilities with minimal interest rate and long repayment period will further galvanized this project to anticipated success.***

Note from Phase 3 to PIDA Study ICT sector July 2011

Other projects more or less confidential and seeking funds and regulatory authorizations are in the pipeline since 2010.

Operators' offers are different from one another and each one is based on a rather different strategy. Offers are ranging from bandwidth rental to dark fiber rental and hosting.

These carriers to carrier are located in countries with an enabling legal and regulatory environment (Unified[71] License). It is worth mentioning that the majority of these private projects derive from the pan African business world (Globalcom, Liquid, SubUrban, KDN, and Phase 3).

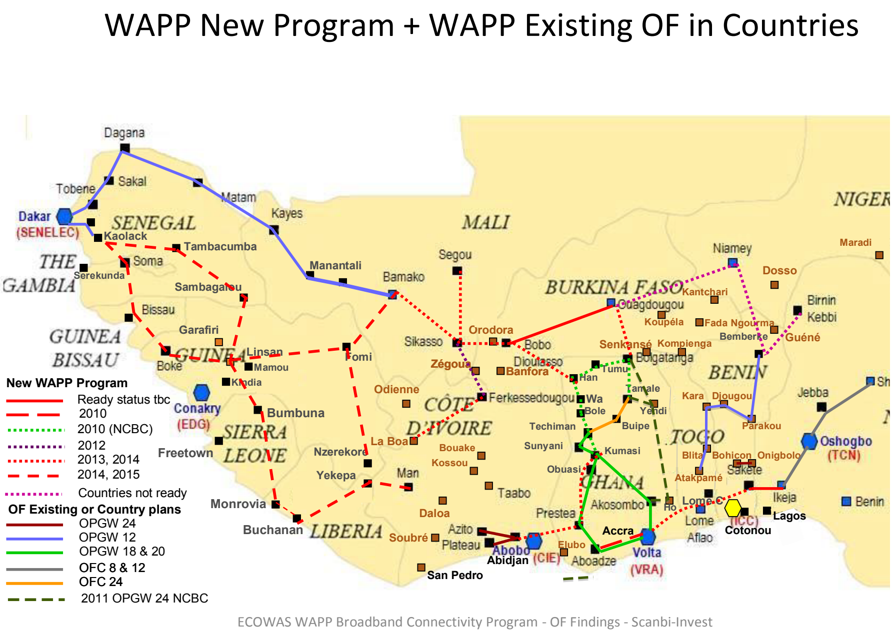
Alternative Infrastructure

The first analyses show that alternative infrastructure developed in general by the energy and the railway sector does exist or is underway.

The main alternative infrastructure identified is:

- West Africa Power Pool
- South Africa Power Pool
- Sitarail
- CEB
- OMVS

Figure 77: Alternative Infrastructure OPGW WAPP



It is worth noting that on other continents and especially in Europe, such infrastructure is widely used by non incumbent operators and in most cases, the infrastructure owners (Highway, Railway, Energy...) rent "black fiber" and do not provide bandwidth services.

In Zimbabwe, the operator Powertel bases its services on OPGW infrastructure, like in Zambia with Copperbelt Energy Corporation or ZESCO.

[71] See I Policy analysis

Figure 78: Alternative Infrastructure OPGW Powertel

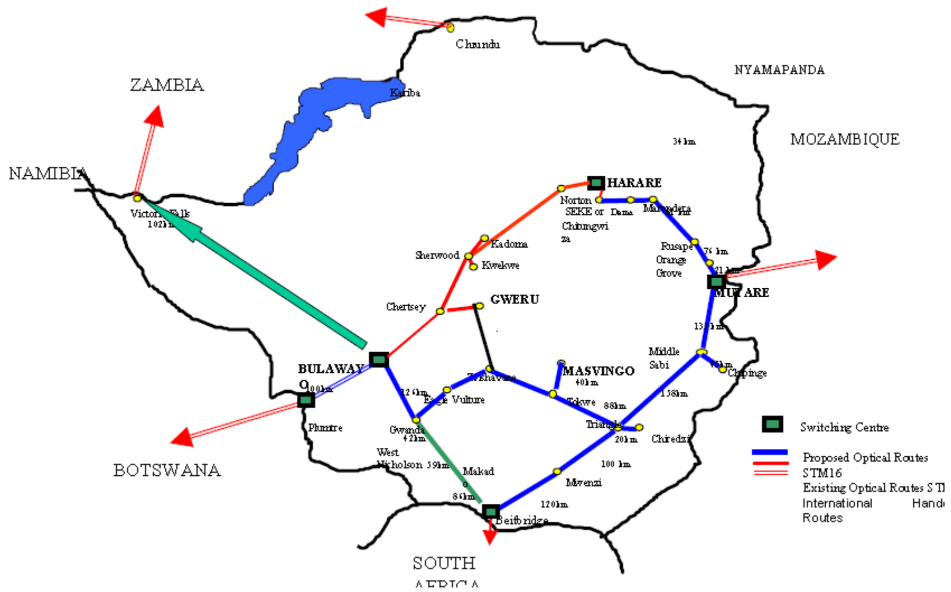


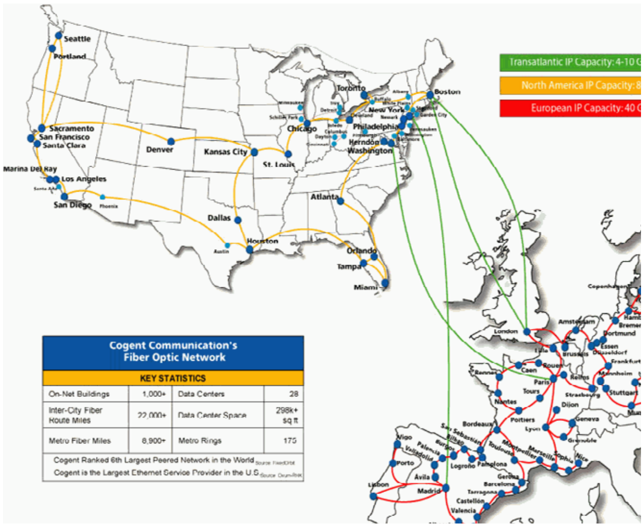
Figure 79 below highlights a large number of countries with alternative infrastructure and provides a non exhaustive inventory of the current and future potential.

Figure 79: Existing or potential alternative infrastructure

Alternative Infrastructure vs. incumbent operators' infrastructure

In Europe, such infrastructure (Highway, railway, power company...) was as of 1998 the driving force of the development of a competition between incumbents and alternative operators on the provision of infrastructure. Today, a vast majority of operators, resulting from the liberalization, use widely such infrastructure to implement their national or regional networks[72] (from an international perspective).

Figure 80: An FBI network based on the use of alternative infrastructure



C Jacquelot ENSTB training 2008

Initiated as of 1998, the opening of alternative infrastructure in Europe and USA triggered competition. Such competition has been implemented through wholesale price regulation imposed on dominant operators (SMP) and a full liberalization of alternative infrastructure use.

The results of this regulatory and proactive policy, as of 2000 are:

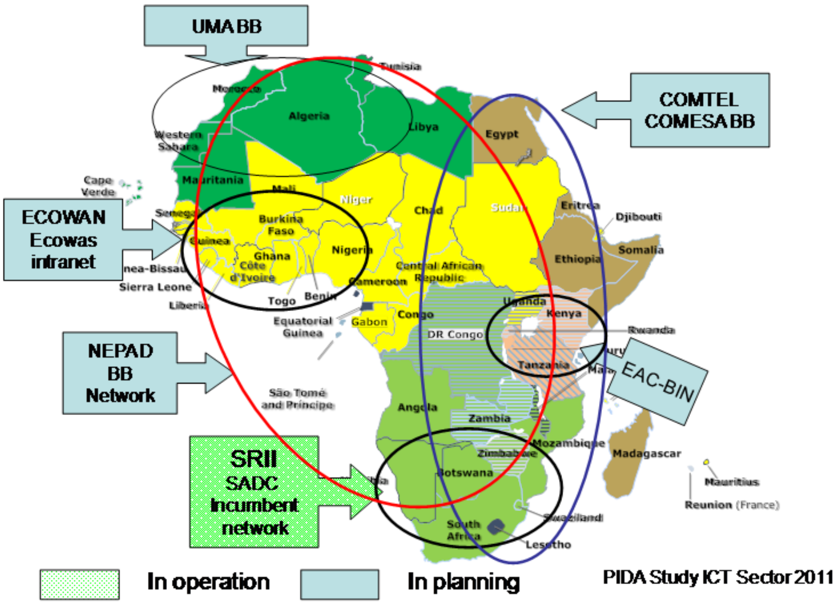
- The emergence of carriers to carriers offers at national and « regional » level
- Lower consumer prices
- Competition on broadband offers and a sharp increase of its use[73]
- Significant development of incumbents' optical fiber infrastructure as well as alternative offers

It is also worth noting that since 2010, the price of bandwidth (Wholesale offer), wavelength (λ) or black fiber is no more a relevant sector to regulate, and therefore, it has been fully liberalized in the European Union and USA, and now Mbps monthly price varies from 2 to 8 € depending on whether the route is highly competitive or not.

[72] Cf. Inception report §2.2.3

[73] Associated with unbundling and regulated bitstream offers

Figure 81: REC and NEPAD BB network projects (4Q 2010)



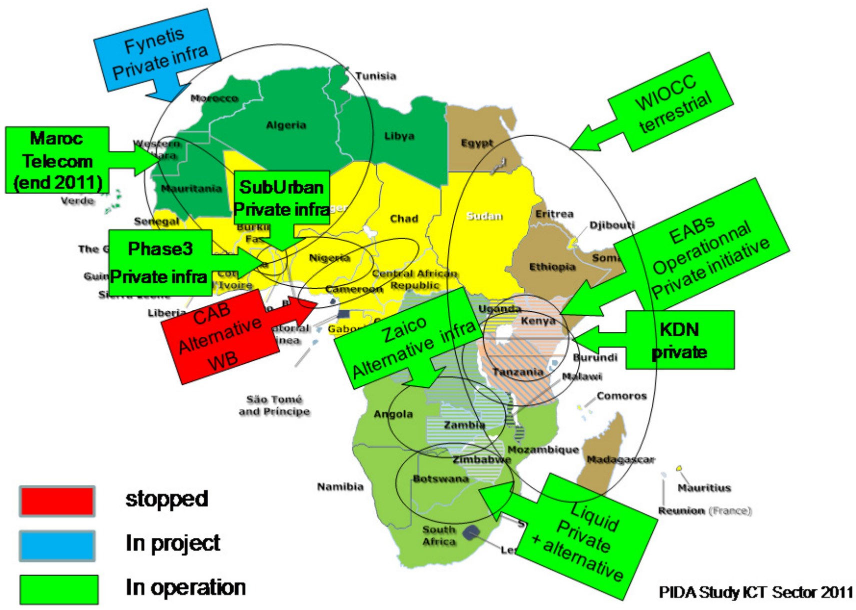
Regional networks review, end of 2010

Network projects initiated by NEPAD and RECs

Based on existing infrastructure or private/alternative infrastructure, a number of regional/continental network projects have been initiated by NEPAD and the RECs as soon as 2005.

At the end of 2010, it appeared that none of these projects were in operation despite various public funding allocated, except for SRII.

Figure 82: Regional broadband networks achievement (4Q 2010)



*Private networks or operators venture*

Since 2009, in countries and regions where the legal and regulatory framework has been revised to encourage private investment in land-based infrastructure, a number of projects were initiated and became, at the end of 2010, effective alternative networks.

Analysis of landlocked countries

A number of countries are still landlocked and this is a problem to be solved primarily by governments and institutions. For other countries, the situation changed significantly since 2009, although the opening up is quite fragile.

The opening up of ***Chad*** and ***CAR*** that should have been achieved by CAB[74] was delayed due to a political and trade disagreement between the parties and an alternative solution via Sudan was then under study[75].

Rwanda and ***Uganda's*** opening up is effective since late 2010 – early 2011; this opening up was achieved thanks to two separate regional infrastructure (EABs and KDN). Since the effective landing of EASSY and Seacom in 2010, there is a competition on both land-based infrastructure and international IP bandwidth access which has already resulted in a decrease in international IP Mbps costs for the operators/ISPs of these two countries.

Burkina Faso is a slightly different case. The incumbent, Onatel, has opened up via Cote d'Ivoire and Benin thanks to Cote d'Ivoire Telecom and Benin Telecom infrastructure. These are monopoly positions for both incumbents and SAT3 access which might cause problems (high prices, quality, and reliability). However, the two other ISP (IPSYSTEM SA and Connecteo) have only access to international gateways via satellite (Cf. Onatel Wholesale Offer).

Mali and Niger are in the same situation as Burkina Faso via Senegal. The situation of the 3 countries will partially improve thanks to an optical fiber cable linking the three countries to Morocco.

The accelerated opening up, especially in Eastern Africa (EAC, COMESA) is due to both:

- The emergence of private regional operators positioned as carrier to carrier
- Competition between these carriers to carrier and « regional networks » based on incumbents interconnection.

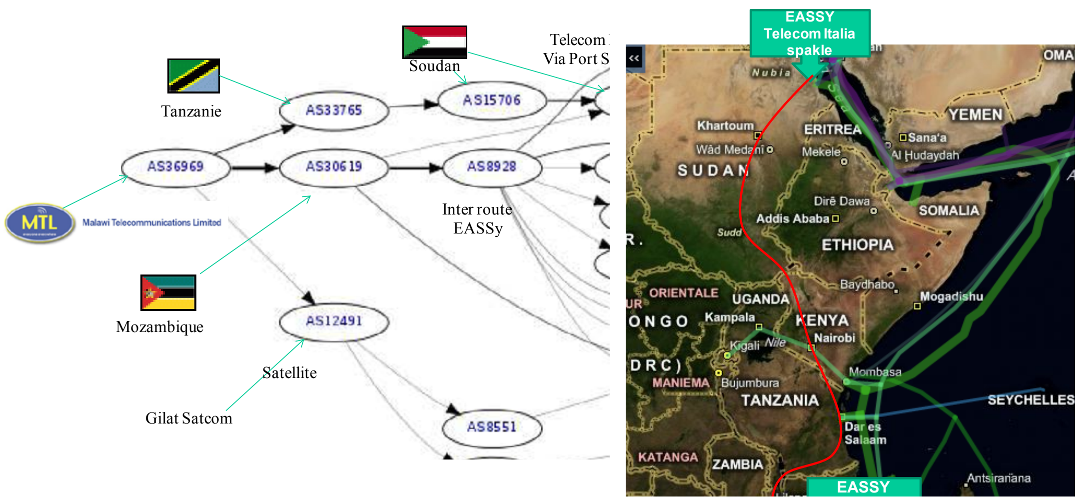
Case analysis : Malawi opening up

Malawi and Malawi Telecom in particular is the typical example of a country and its incumbent operator which succeeded, between 2010-2011, in opening up using carrier to carrier Wiocc services through :

- Various land-based routes (Mozambique and Soudan)
- Various providers of international IP bandwidth (Telecom Italia Sparkle and Interoute)
- 2 landing stations : EASSY in Mozambique and another submarine cable in Port Sudan
- Security by satellite.

Figure 83 below explains the process and the land-based routes used:

Figure 83: Ecosystem of Malawi Telecom opening up



PIDA Study ICT sector June 2011

[74] Central Africa Backbone

[75] WB 2Q Project 2011

In SADC, **Zambia**, **Zimbabwe** and **Botswana's** opening up is effective via AFS. Unlike Malawi's case, the opening up of these three countries is a sensitive issue because it has **only one** land-based **access** to landing stations in South Africa via TelKom SA Ltd and Neotel Pty Ltd gateways.

Ethiopia has been opened up, thanks to land-based infrastructure linking **Sudan and Djibouti** and is therefore for the only operator (Ethio Telecom) a good security enhanced by satellite links.

Table 21: Landlocked countries ecosystem in June 2011 (PIDA ICT Study)

Status of landlocked countries		
Countries	Status	Comments
Botswana	Opened up	Exclusively via South Africa
Burkina Faso	Opened up	Via Benin and Cote d'Ivoire but only for incumbent and connectivity to SAT3.
Burundi	Unknown Status	Country without ASN.
C A R	Landlocked	Awaiting a hypothetical opening via Chad and Sudan following the failure of CAB project due to political and trade issues with the government of Cameroun and CAMTEL.
Chad	Landlocked	Same as CAR
Ethiopia	Opened up	2 alternative routes via Sudan (Sudatel) and Djibouti (Djibouti Telecom)
Lesotho	Opened up	via TelKom SA Ltd
Malawi	Opened up	2 alternative routes via Sudan and Mozambique
Mali	Opened up	Via Senegal and Cote d'Ivoire. Another output via Morocco is operational since 2011/2012.
Niger	Opened up	Since 2011, only one provider (Orange Niger), 2 other ISP seem to have "disappeared"
Rwanda	Opened up	Different existing land-based infrastructures
Swaziland	Opened up	Via AFS exclusively
Uganda	Opened up	Different existing land-based infrastructure
Zambia	Opened up	Via AFS exclusively
Zimbabwe	Opened up	Via AFS exclusively

Other « de facto landlocked countries[76]»

While awaiting a landing station, **Sierra Leone** is still « landlocked » in respect of access to landing stations. The funding of a station by the World Bank and the AfDB will raise the issue of de facto monopoly because price regulation for submarine cables is not completed yet.

This is also the case for **Liberia** and **Eritrea**

Synthesis of the status of landlocked countries in June 2011

Without being exhaustive, **figure 84** below shows the status of landlocked countries.

- States in green are the states with various accesses to submarine stations through several land-based infrastructure.
- States in Orange are those with a single access to stations via one single infrastructure generally subject to monopoly.
- States in red are countries with no access to submarine cables landing stations yet. Liberia[77] and Sierra Leone have stations projects[78]; once the stations will be set up, both countries will be in orange because they will be connected to a single station.

[76] Countries with no submarine cables landing stations

[77] Mentioned here because they have the same status than landlocked countries

[78] WAPP Project, WB April 2011.

Figure 84: Status of landlocked countries

PIDA Study ICT sector June 2011

3.2.3 IXP and data centers

Figure 85 below shows IXP status by late 2010. Also, it is worth mentioning that Tunisia through ATI has an IXP.

Figure 85: IXP status by late 2010

©http://nsrc.org/AFRICA/ixp/

Key findings on IXP

IXP deployment on the African continent is important because it could

1. reduce traffic exchanged between African ISPs provided that :

- African IXP are virtually connected to each other at regional level (but not in terms of RECs institution)

Interconnection between IXPs with the same language or important economic and cultural exchanges would improve economic and cultural regional integration. This need could be amplified by the arrival of data centre that will make traffic flows from countries « speaking » more or less the same language converge (for example UMA-Egypt)

- all ISPs connected to an IXP as traffic exchange point with each other (peering).

2. serve as a gateway to the international bandwidth for “small” ISPs

A country IXP can act as a wholesaler to buy the international bandwidth on behalf of ISPs, small consumers of international bandwidth, reducing Mbps costs with a volume effect.

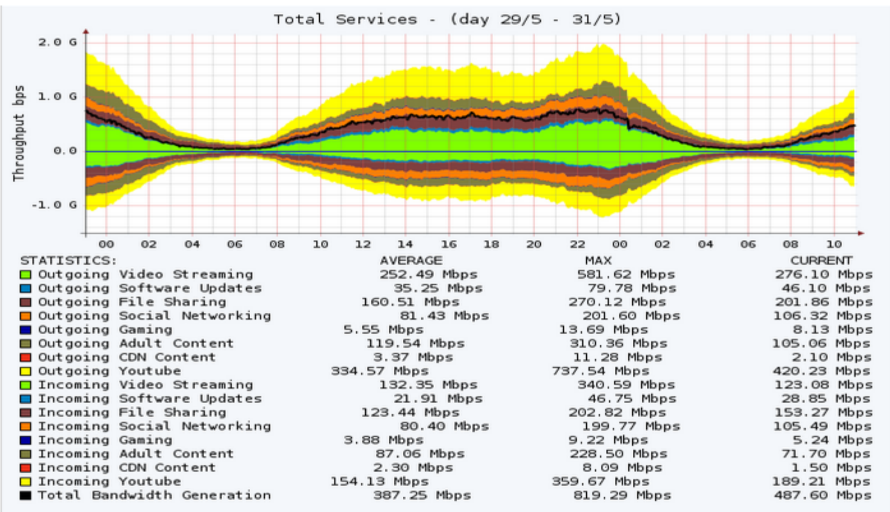
3. Reduce the use of international bandwidth through the introduction of cache.

The development of cache tools at IXP level will reduce the use of international bandwidth through the “storing” of the most relevant pages for African consumers (example Facebook, YouTube, Dailymotion…).

The development of both an IXP and a transparent cache would save a large amount of international bandwidth « purchased » from submarine cables operators

Its objective is to reduce international bandwidth while keeping in cache the most popular and voluminous pages/videos/peer-to-peer

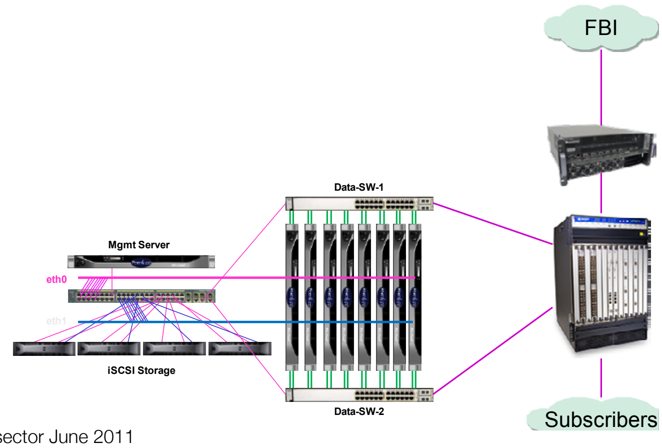
Figure 86: Transparent cache principle



•IN_Trafic: ~450Mbps (Youtube+Video Streaming)
•Out_Trafic: ~950Mbps (Youtube+Video Streaming)
•→ ~500Mbps (Youtube+Video Streaming) Generated by Cache

Example of a traffic gain on an African ISP network

Figure 87: Synopsis of a transparent cache



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3.2.4 Other planned or developed infrastructure

The study would not be complete without a specific analysis of projects recently launched or mobile operators' national infrastructure

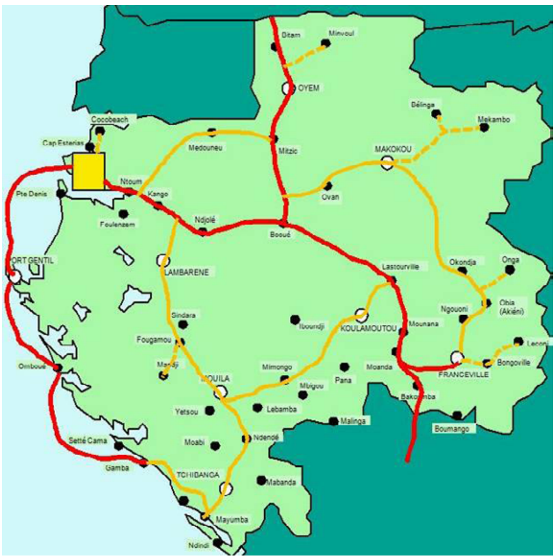
Infrastructure initiated by States

Countries such as Gabon or Guinea have backbone network projects to offset the incumbent's failure and bridge national optical fiber infrastructure[79] gap.

During 2011, the Gabonese government[80] has commissioned a study on the feasibility and funding of an optical fiber national infrastructure project. This project is meant to offset the failure of the incumbent Gabon Télécom which despite its monopoly on land-based infrastructure and its privatization (2005) did not invest in such infrastructure.

This approach is new therefore infrastructure impact cannot be measured.

Figure 88: Optical fiber national infrastructure government project



Source WB 2011

The government of Guinea seems to have taken the same initiative late 2010-early 2011.

[79] Existing infrastructure and master plans analysis highlights the fact that ECCAS is the African REC with the lowest national optical fiber network in Africa

[80] Source WB- April 2011

Radio infrastructure developed by mobile operators

National infrastructure

This subject has been extensively covered by the AICD Study and by the other studies such as the Scanbi-Invest[81] (Sida) Study in 2008.

The infrastructure developed by the various mobile operators in the 53 African countries, were for more than 90 % developed by radio techniques (Radio Link) whose technical capacity is just a few Mbps and the necessity of relay little.

Resulting from the opening of the mobile phone sector, we could consider that on the African continent as a whole, there is as much independent infrastructure as active mobile licenses and sometimes only pylons are shared by operators.

Access Infrastructure

Mobile phone sector in all African countries mainly uses 2G technology. This technology cannot provide bandwidth services.

Potential to move to bandwidth

Technically, neither the base stations (2G) nor the current radio relay links can withstand the flows that will be generated by NodeB 3G (30-59 Mbps) and LTE (> 300 Mbps). Such 2G developments achieved mainly by private operators account for most investment in Africa since 2005 and have all been duplicated, tripled and more since each operator has developed its own network and infrastructure. Since 2010, these operators, aware of the need to optimize their investment, started to share pylons.

Current infrastructure, developed for voice service, could not, on the short term, support a broadband evolution and therefore a massive migration 3G or LTE will wipe out *80 % of the previous investment and yet recent* (5 -7 years).

Migration 3G

Some African States started to grant 3G licenses. **Figure 89** below shows June 2010 inventory.

Figure 89: Countries with 3G licensing

Source WB 2011

Associated investments are national investment (outside PIDA) and rely essentially on several points:

- The number of licenses granted per country (example 1 in Tunisia, 3 in Morocco,..). For counties that have not granted licenses yet, it is not possible to provide an estimated date, which will depend on each State.
- Operators' strategies: in general infrastructure is mixed :
  - 2G : use of existing infrastructure
  - 3G need to change NodeB (end emitters) and possibly links connecting stations to MSC. 3G emitters are developed on a case by case basis by operators depending on their own approach of the market and their marketing strategy.

[81] Options for Terrestrial Connectivity in Sub—Saharan Africa (2008)

However it is worth noting that the first « field » feedback collected shows migration to 3G will be used in Africa as a substitute to wired access networks and the key/Box 3G associated to a "fixed internet 3G "offer will be used the way an ADSL modem or a cable modem is used in developed countries. The first traffic analyses show that IP traffic generated by keys and box in Africa is much higher[82] than the traffic generated by developed countries where this offer is targeting mobility and not « residential » using ADSL. In Tunisia, for example, Orange has to use optical fiber to connect its busiest NodeBs through its offer « FlyBox » and key.

Migration to a 3G BB offer and even more LTE will require operators to interconnect their NodeBs through optical fiber infrastructure.

3.2.5 Land-based access infrastructure[83]

In order to have a better understanding of the challenges facing African countries in developing broadband, it is necessary at this stage of the report to talk about land-based access infrastructure, although it is not part of the PIDA Study terms of reference.

Inventory

As already stated above, incumbent operators in African countries are extremely underdeveloped and have barely invested in access infrastructure since 2000.

Except a few African countries, access infrastructure is under developed and generally in very poor condition due to the lack of maintenance.

Only the largest cities in most African countries have a semblance of copper access infrastructure which, more or less, allows some operators to provide broadband services via DSL technology[84].

UMA countries (Morocco, Tunisia and to a lesser extent Algeria), Senegal, South Africa, are the countries with the best ADSL coverage in urban areas. Although this offer does exist in most countries, it represents a very low percentage both in terms of broadband access penetration and potential.

Indeed, the poor quality of copper access networks does not allow the implementation of DSL2+ or VDSL technologies, which are currently most commonly used for broadband access.

Given incumbents' financial status and the investment that is needed to spread the use of DSL, it is clear that European and even North American models (coaxial Cable and modem Cable) could never be applied in African countries.

3.2.6 Satellite infrastructure

Before the introduction of submarine cables in Africa, satellites have long been the « infrastructure » supporting international gateways and they still are for some landlocked countries.

At present, neither their technical capacity (less than one Gbps available on one satellite) nor the Mbps price is able to compete on this segment with submarine cables and land-based infrastructure on the busiest routes.

In respect of international gateway, they can still be used for some time (1 year to 5 years) as back up[85] international gateways.

Satellite connections have, among others, two advantages:

- The flexibility to set up a network : connecting a site anywhere in Africa, only requires the creation of an infrastructure on this site
- Information dissemination: a signal can be received in many locations, simplifying large-scale dissemination, television being the first application.

But there are currently two main disadvantages:

- High operating costs (rental cost of bandwidth)
- Capacities available on a same satellite are limited.

The availability of high speed connections at low operating costs reduces the benefits of satellite services for international connections, national communications (especially to big cities) and mobile networks transmissions, although operators are still interested in this application while waiting for a high speed connection.

In summary, the main satellite services which still have a competitive advantage after the development of optical fiber infrastructure are:

- Broadcasting TV signals emissions either directly to subscriber, or to regional transmitters,
- The connection of remote areas, in the vast African continent there will always be remote and isolated areas,
- National transmission of mobile networks, especially in large countries such as DR Congo or Nigeria. But, the Balancing Act[86] states that in Nigeria, the capacity used by mobile networks has been divided by 4 between 2005 and 2008.
- Machine-machine connections to transmit or receive information in small quantity over a

[82] Volume Access: IP traffic modeling through PIDA is achieved on this basis. Early "field "feedback shows that an "African 3G fixed" access uses as much international bandwidth as an ADSL access in Europe.

[83] Land-based access infrastructure is cable (copper, coaxial or FO) which links the last operator's mutualised active equipment to a customer

[84] Sampled audit of DSL offers in Africa via operators' websites.

[85] See ecosystems (Onatel for instance)

[86] Balancing Act – African Fiber and Satellite Markets 2nd edition

large area; the small amount of information to be transmitted allows the use of a small bandwidth to reach a large number of points,

- Back up connections in case of land-based connection failure.

Their market segment is shown in figure 90 and figure 91 below.

- One is an application on a VSAT network in Africa (initiated by UAC)
- The other one is an application in Europe.

They also have a role to play in the provision of broadband access (Vast) to remote areas, far from the concentration points, or cities not connected by an optical fiber infrastructure (national application). ***The major issue would be the price of Mbps !***

Figure 90: KA-SAT - Heart of the network IP MPLS electronic

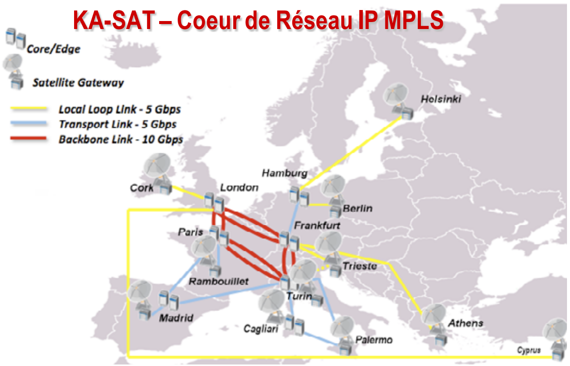
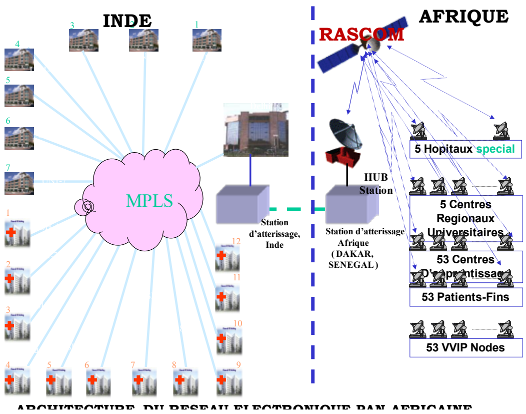


Figure 91: Architecture of the pan-african network



It is also important to consider securing satellite-based infrastructure, which means having a connection[87] with two satellites for the most strategic applications (Vsat "business" network multi sites)

[87] Pan African VSAT ISP field feedback

3.2.7 Conclusion on land-based infrastructure in Africa

Key findings

National and regional optical fiber infrastructure

- A comprehensive quantitative and qualitative inventory of optical fiber infrastructure in Africa is lacking both at the institutional and regulatory levels; this lack of knowledge (continental, regional and national) is very detrimental to the determination of the missing infrastructure.

There is optical fiber infrastructure in Africa that is :

- Often Under-exploited
- Few are interconnected (hence a missing link)
- Their geographic distribution is very uneven at the continental level; UMA countries as well as South Africa being the countries using optical fiber infrastructure the most, while in other countries (Gabon, Chad, DRC,..) optical fiber infrastructure is virtually non-existent.
- The emergence since 2010 of alternative operators[88] in some countries (Morocco, Nigeria…) and regions such as[89] EAC, COMESA, SADC which is due to regulatory changes at the national level.
- Some countries have a land-use planning project for the development of national infrastructure (Gabon, Guinea, Mauritania…)
- The opening up of Central African countries is underway, only two countries are still landlocked (Chad and CAR) and 3 costal countries have no access to landing stations (Liberia, Sierra Leone and Eretria). However weak competition and the alternatives between land-based infrastructure and the non-connectivity to multiple submarine cables landing stations are not conducive to a real decrease in bandwidth prices and provide a low security access (Cf. Burkina Faso, Benin, Cote d'Ivoire May 2011).

Under use of existing optical fiber infrastructure

Lack of national optical fiber infrastructure (incumbents, private or alternative) and lack of interconnection to develop "regional infrastructure"

Lack of multiple connectivity to landing stations in many countries

Emergence of private « carrier to carrier » where there is an enabling regulatory environment. But, in general, there is a lack of competition with respect to land-based infrastructure.

Mobile operators' radio Infrastructure

- Each operator invested in its own backbone infrastructure[90] and this infrastructure is not able, in its current state, to support a migration to broadband (lack of transmission capacity)

Inability of past investment to migrate to traffic transport generated by the development of broadband

Fixed and mobile operators' access infrastructure

- It is obvious that land-based access infrastructure has a huge deficit with less than 5% of fixed access; and, in addition, it is generally concentrated in most important cities limiting the development of broad band through DSL technology.
- Similarly, mobile operators' access infrastructure which has a good national coverage in most countries is not able, in its current technological state (2G), to provide broadband service.

Deficit of access networks capable of providing broadband connectivity.

"Massive" use of ADSL is not an option at the continental level as a means to access broadband for African consumers.

[88] Africa could finally be emerging as a vibrant international services market as operators and governments invest in extensive land-based fiber networks. By Joanne Taaffe (Totaltele may 2011)

[89] cf. Phase I report, private operators' Infrastructure and associated map.

[90] Important duplication that doubled private operators' investment

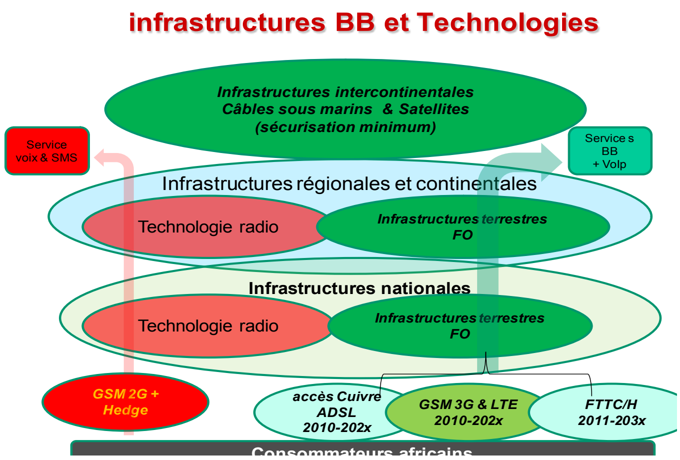
4. DEFICIT, EFFICIENCY GAIN AND FUTURE NEEDS OF LAND-BASED INFRASTRUCTURE

4.1 Future Infrastructure

The analysis focuses on all the segments of ICT infrastructure which also means both the cover and the use or the usage price.

Figure 92 below recalls the structure of ICT infrastructure and the related networks.

Figure 92: BB Infrastructure and technologies



4.2 Submarine Cables and Landing Stations

Submarine cables and IXPs are the only components where active equipments could amount to infrastructure in the same way as passive equipments; the first being a reaction to demand (offer services), the second being the tool allowing to save on the use of the first (optimizing the use of offer).

4.2.1 International bandwidth needs

Access to international bandwidth at a reasonable price is an essential resource for the development of an e-economy. The African continent, with its capacities and the landing stations in operation or underway has in the medium term sufficient international bandwidth[91] to meet globally the demand of the 54 countries.

4.2.2 Mbps Price: Tomorrow's challenge

Provided for a long time by satellite offers, international bandwidth price, for the majority of African countries, was outside international standards. Today, the arrival of cables has significantly decreased prices in particular, on the Eastern Coast with Seacom and EASSy and a bandwidth cost that went down from thousands of $/Mbps to hundreds of[92] $/Mbps. This was also the case on the Western Coast in 2011-2012.

However, one of the key points for a further decrease[93] in prices to happen is to ensure competition between the landing stations run by different consortiums. Besides, in order to enable competition for national offers by ISPs, it is important that they connect to one/many stations corresponding to their strategic interests.

The other key issue is that the landlocked countries should equally have access to such resources in similar conditions and that coastal countries and their operators make this task easier".

[92] 15-30 $ in some Maghreb countries, 2 to 10 $ in Europe, 100 $ in Australia

[93] Prices of broadband on submarine cables are not subject to regulation of rates (Offshore Infrastructure) except if a State proceeds that way or imposes it during the landing.

4.2.3 Security access: The bedrock of an e-society

The events of July[94] 2010 and May[95] 2011 have shown that security access to international broadband is a corner stone in the development of an e-society and e-economy. **A country will no longer be able to afford being cut away from the world because its infrastructure may accidentally break down, if it wants to be part of the e-World.**

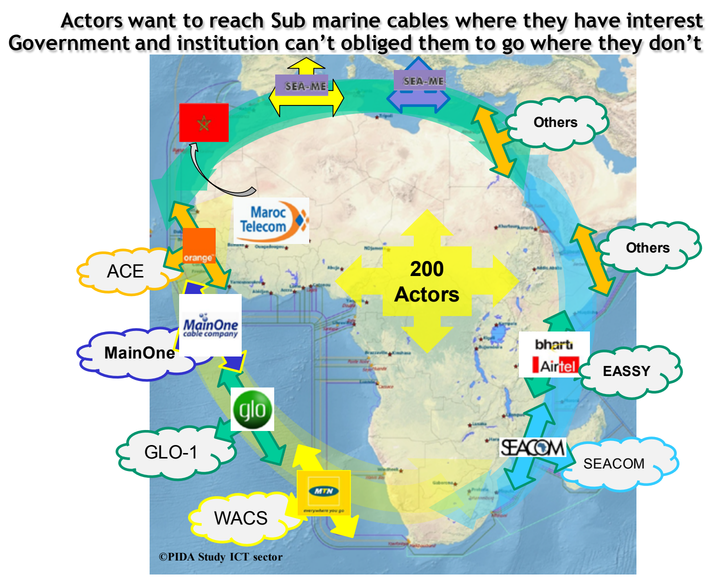
4.2.4 The solution to provide

As part of the PIDA Strategic Framework, the responses are:

Efficiency Gain

4 responses to be implemented

- **Decrease in Mbps prices** ⟶ ensuring competition between consortiums (landing stations) regardless of territoriality.
- **Security access** ⟶ 1) Each country must have access to many stations[96] operated by different consortiums.
  ⟶ 2) Each country must have[97] many different land-based accesses at stations.
- **Meet the players expectations** ⟶ to allow them to go wherever they wish[98]



[94] EASSY cut, see presentation Addis Ababa July 2010.

[95] SAT 3 cut, see Burkina Faso Ecosystem

[96] A country with a single station will have to be connected to another consortium in another country

[97] The case of Chad/CAB is a typical « blocking of accessibility » to landing stations by Cameroon and Camtel

[98] See ending isolation of Malawi

4.3 Land-based Infrastructure

4.3.1 Deficit in national and regional infrastructure

The increasing demand for international bandwidth can be divided into two segments:

- Bandwidth outside Africa (Cf. landing stations)
- Continental and regional bandwidth (inter ISP, Datacenters and hosting sites)

In addition, the increasing demand for national bandwidth[99] required for the development of broadband in Africa highlights the huge deficit in optical infrastructure on the continent as a whole and requires that the African continent acquire a larger number of land-based infrastructure (optical cables) allowing operators to create their own backbone networks

National deficit

The analysis of the cartography data on optical infrastructure in the African countries highlights the fact that even if a large number of African countries has optical fiber land-based infrastructure, the main national infrastructure is essentially radio infrastructure.

This national deficit is not homogenous on the continent. North African countries (Morocco, Algeria, Tunisia), South Africa, Nigeria and to a lesser extent Kenya and Senegal already have a good national coverage. Some countries even have competitive infrastructure (Morocco with Maroc Telecom and Wana; Nigeria with Phase3, MTN, SubUrban, GLO; Kenya with Telkom Kenya and KDN...).However, other regions and more particularly ECCAS countries[100] and ECOWAS suffer from an significant infrastructure deficit.

This deficit is articulated in 3 segments of a national architecture:

- **« Backbone » infrastructure deficit**: all African countries must develop optical infrastructure to interconnect all the big cities.
- **« Backhaul » and collecting[101] infrastructure deficit**: Broadband access networks whether they are (3G, LTE) or land-based (ADSL, and mainly FTTH) require to be connected through optical infrastructure.
- **Metropolitan networks:** In the biggest cities, it is important that metropolitan optical networks be installed to collect traffic coming from various collection points or to serve buildings with active equipments (DSLAM, ONU).

This deficit can be expressed in:

- Deficit in optical infrastructure developed by incumbent operators
- Deficit in optical infrastructure developed by mobile operators
- Deficit in passive alternative infrastructure deficit open to the ICT sector.

Deficit in competition

Except some countries,[102] there is no competition on land-based infrastructure which are generally held by incumbent operators.

This lack of competition associated with inadequate regulation is one of the causes of the high costs of services. These points are very well highlighted by the bandwidth prices indicated in ONATEL's RIO[103] and CAMTEL.

Deficit in connectivity between countries

As a main result of the deficit in national infrastructure, deficit in connectivity between countries is significant.

The Missing Links policy, resulting from the Declaration of Kigali which recommends that capitals and big cities should all be interconnected, has allowed this problem to be partially solved but also shows its limits. In fact, the construction of the missing links was not carried out with the involvement of all the players. A typical example is the SRII network (SADC-SATA) which has helped increase significantly the connectivity between SADC countries and which is a success in this respect. It was carried out merely for the benefit of incumbent operators of these countries; therefore discriminating against the other players.

[99] See country forecasts

[100] Cf. Master plan PDILB-AC_2

[101] See 3G infrastructure figure provided in this report

[102] Nigeria, Morocco, Kenya, Tunisia

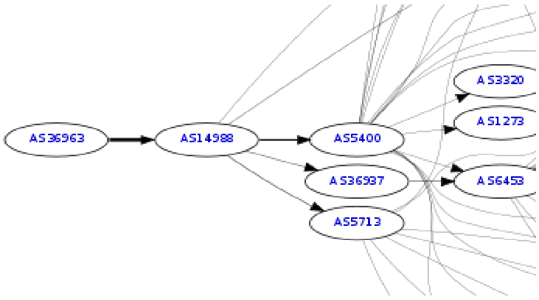
[103] Reference Interconnection Offer – Catalogue of wholesale offers

Analysis of the Botswana ecosystem

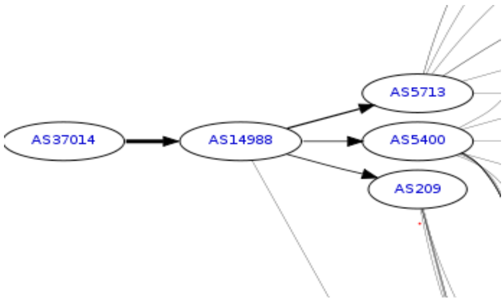
The detailed analysis of the ecosystem of the two unique ASNs in Botswana highlights the lack of connectivity of the country with the submarine cables in South Africa.

The 2 ecosystems are similar and show that Botswana is closely related to South Africa through a single regional architecture. Therefore there is no competition neither on land-based infrastructure nor on international bandwidth.

Figure 93: **Orange IP Connectivity, Botswana (Pty) Ltd**



Mascom Wireless Connectivity, Botswana



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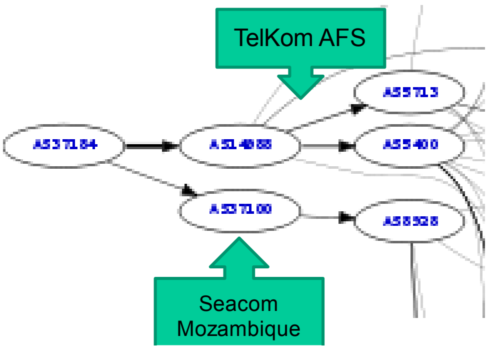
Analysis of the Zimbabwe ecosystem

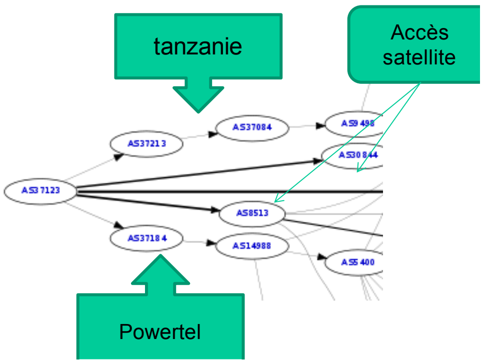
A simplified study of 2 ASN shows that IP connectivity is better in Zimbabwe.

Powertel is connected to South Africa and Mozambique's stations whereas Telecontract is connected via Powertel to South Africa but also to Tanzania and in addition, has emergency solutions via satellite

Figure 94: **IP Connectivity for Powertel Communications**



IP Connectivity for Telecontract Pvt Ltd



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Efficiency Gain

3 responses should be put in place

- **Security access** ⟶ each country must have different infrastructure to access landing stations :
- **Responses to players' expectations** ⟶ allowing them to go where they wish[104]
- **Decrease in Mbps prices** ⟶ enhancement of competition between land-based infrastructure in order to access landing stations or interconnect with another country.

Regional infrastructure is essential infrastructure for the development of broadband but, also, more generally to facilitate communication "between countries".

We can classify regional infrastructure into many types.

Elements of interconnected operators' national infrastructure

It is the interconnection between the infrastructure of 2 operators (players). This physical interconnection is made through one point (International Interconnection Point) located on one of the territories.

Depending on the operators' offers (wholesale), this interconnection can be:

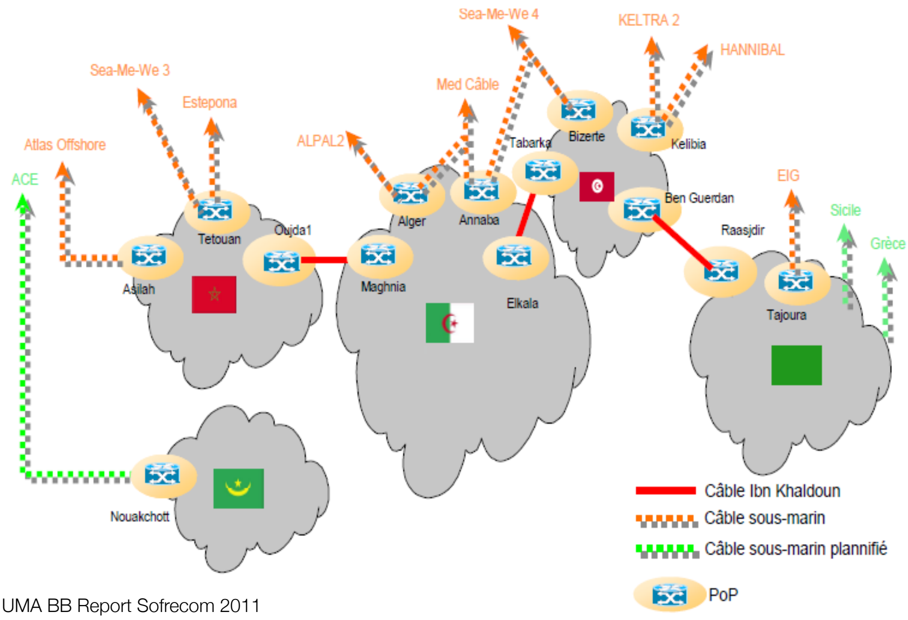
- Exchange of minutes (wholesale of international minutes)
- Bandwidth (capacity offers)
- Black fiber

Generally, these offers are described and rated in an interconnection catalogue

The example[105] provided below illustrates the creation of a regional "BB Backbone" and not a regional infrastructure.

The first figure provides the current state.

Figure 95: Existing interconnection network UMA intra-country

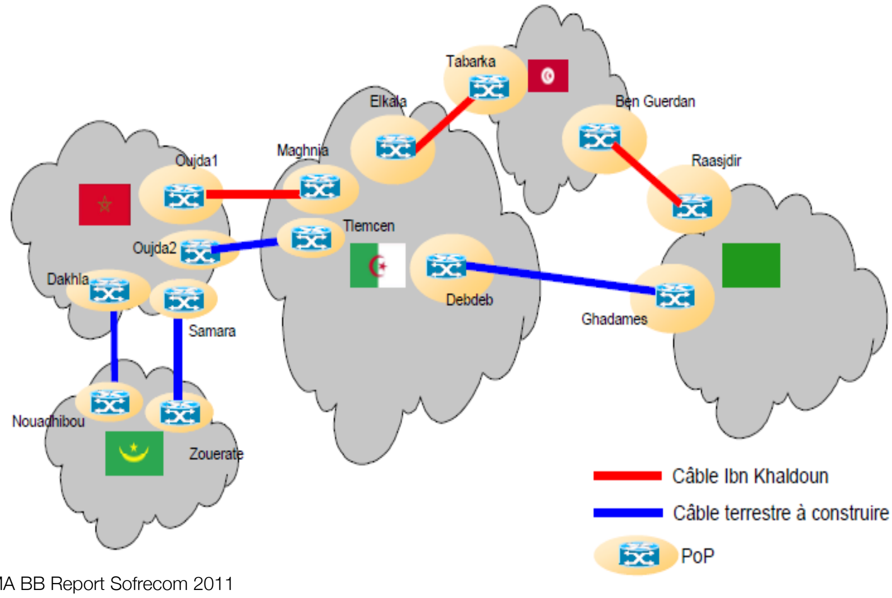


The second figure below provides a synopsis of a network made up of elements belonging to incumbent operators (one of the study's scenarios).

[104] See ending the isolation of Malawi

[105] UMA BB Network, AfDB-UMA project 2010,2011

Figure 96: Scenario 1bis: UMA countries interconnection axes by 2020



© UMA BB Report Sofrecom 2011

Optimization of the efficiency gain project

If the analysis perfectly meets the specifications, the project raises many questions on the efficiency of such a project whose study was financed by the AfDB.

This project is similar to the SRII program of SATA-SADAC's and is quite close to programs set up by some RECs such as (EAC-Bin, COMTEL, NEPAD, EBB...).

This project only serves the interests of the incumbent operators and does not solve the issue of the need to have regional infrastructure open to all the players.

Important efficiency gain could be obtained from:

The obligations of the incumbent operators (de facto SMP) to open this network to competition and to make a regional carrier to carrier infrastructure. To do so, an interconnection catalogue (RIO) whose prices are cost oriented should be associated.

The setting up of POI along the project allowing national players to connect or interconnect with other infrastructure (Competition on one segment)

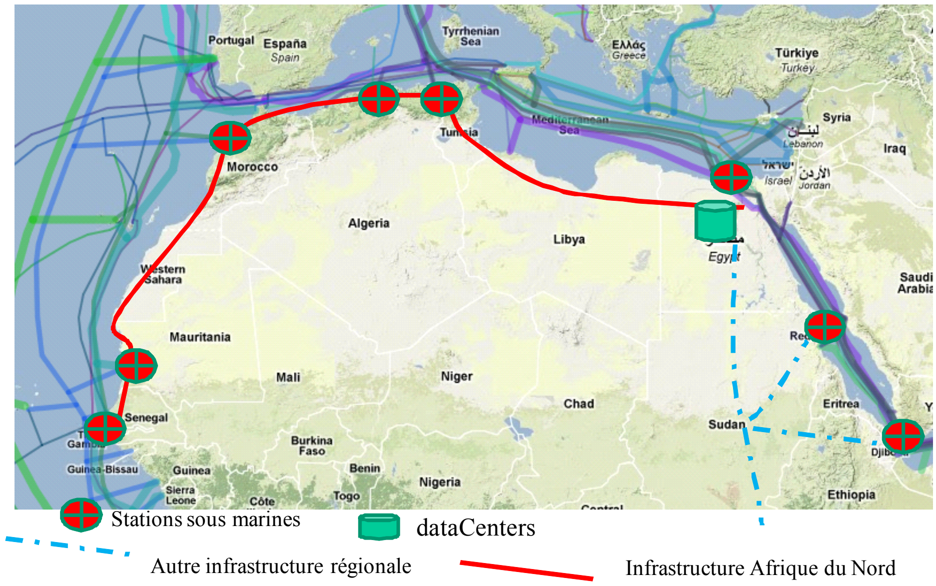
The setting up of an alternative infrastructure made up of the alternative infrastructure of the countries involved or at least on some segments. In fact, in Morocco, Tunisia and even more in Algeria, alternative infrastructure is not or is badly used by the ICT sector and is not always open to all the players.

The extension of the project to Egypt (Not the UMA): the extension of the project (UMA BB and the potential alternative based on other optical infrastructure) would allow a significant increase in regional connectivity:

- Connectivity to data centers in Cairo.
- Connectivity to WIOCC via Sudan (North-South belt (Mozambique-Egypt)
- North West- North East Connectivity 'North belt (Senegal-Cairo)
- Increasing connectivity to landing stations in the Maghreb (18 Tbps) and to the hubs in Cairo and possibly in Djibouti via WIOCC or other

In this respect, the creation of **a carrier to carrier**[106] in charge of managing infrastructure and services open to all and independent from the incumbent operators (even if they are shareholders) would allow to have in the short term a project that will considerably improve regional integration (UMA) but also that will improve intra-country connectivity in Africa ("Virtual" Connection Dakar-Cairo, Dakar-Djibouti...)

Figure 97: © http://www.cablemap.info/ PIDA Study ICT sector 2011



Elements of interconnected operators' national infrastructure and state infrastructure

In some cases, such as Gabon or Chad, international interconnectivity could link infrastructure developed by the State and operators' infrastructure.

Figure 98 below is provided as an example underlining the key points to be taken into consideration during the implementation of the project.

International Interconnection Point: It should be open to all the countries' players in order for them to complete their transiting traffic and exchange it with another operator.

Infrastructure set up by the State: The use of this infrastructure, in particular the use of black fiber in the form of wholesale offers or IRU, should be open to all the players in the relevant country (competition and non discrimination of use) with a catalogue of price based on cost. In addition, operation and maintenance should be carried out by an independent dedicated entity.

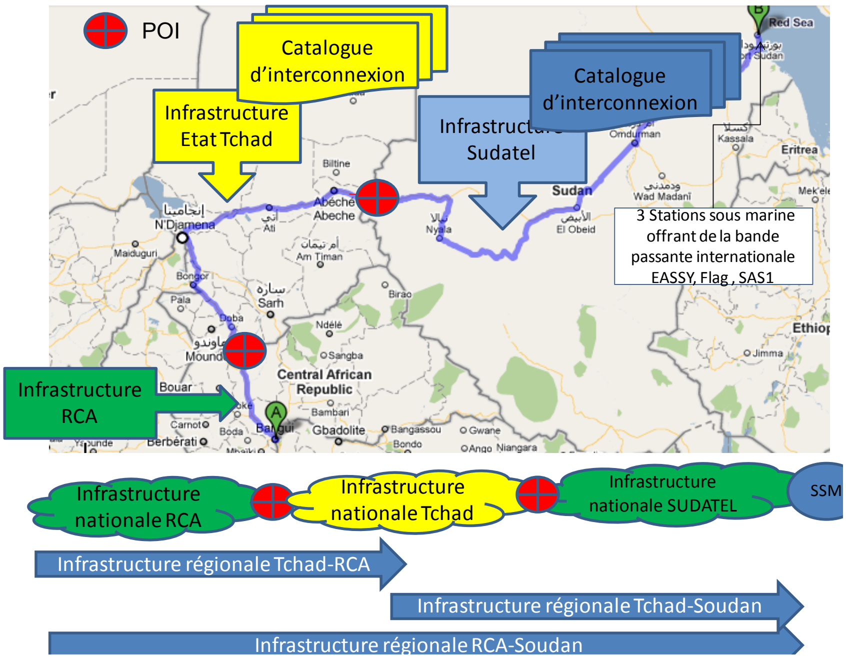
Furthermore, the development of infrastructure by the State should not be based on de facto monopoly on land-based infrastructure. The legal and regulatory framework must authorize the deployment of competitive infrastructure by actors or private investors.

Offers of operators with national infrastructure: In order to optimize the use of existing infrastructure and guarantee competition, the operators[107] connected to an international interconnection point must have a cost-oriented and non-discriminatory interconnection catalogue (wholesale).

[106] The case of Openreach (BT offer) can be taken as example (http://www.openreach.co.uk)

[107] In the case given as example, Sudatel must have an interconnection catalogue describing service offers and providing their technical and financial conditions

Figure 98: RCA-TCHAD-Sudan Example of interconnectivity of State Networks and Operators



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Elements of alternative Infrastructure used by ICT

The analysis has shown that, in Africa, a number of alternative infrastructure (WAPP, SAPP Sitarail, Sonatrach) can be used as infrastructure at the service of operators and for a national and regional use.

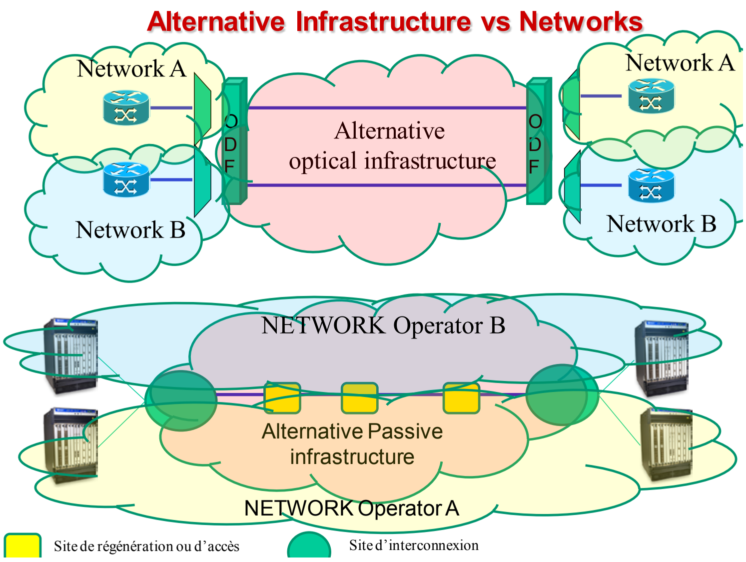
It seems very important that an enabling legal and regulatory environment makes the use of alternative infrastructure possible and that this use be open to all players.

Passive Infrastructure

It is also preferable if alternative infrastructure is provided to players as "passive infrastructure" rather than as an operator's offer (the case of Zaico for instance). In fact, operators seem to cling to their independence in terms of service offer and therefore want to manage entirely the active equipments and broadband.

It is worth noting that in Europe and North America, offers of "passive alternative infrastructure" were a key element in the "mutual" development of infrastructure and in the decrease in bandwidth prices through the development of competition of infrastructure

Figure 99: Synopsis on the use of alternative passive infrastructure by operators



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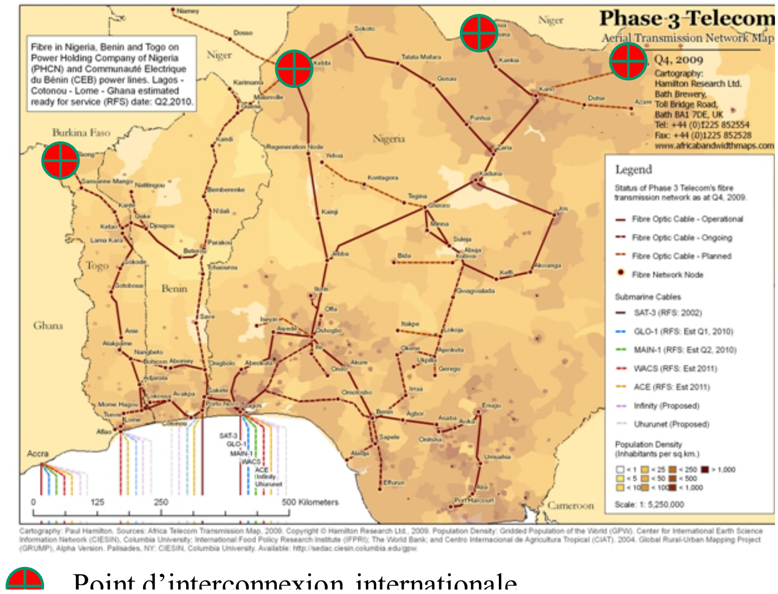
Carrier to carrier based on passive Infrastructure

The open use of alternative infrastructure, as is the case in Nigeria with Phase3, would allow the creation of a carrier to carrier. This will help create competition between infrastructure and services, and therefore will contribute to the development of national and regional infrastructure.

Figure 100: Phase 3 Nigeria: Example of a carriers' carrier infrastructure using alternatives infrastructure



©Phase 3 –PIDA Study ICT sector July 2011

In the case of Phase 3 which signed an agreement with CEB (Compagnie d'électricité du Bénin) and others in TOGO, it appears today that the extension at the regional level and therefore the development of regional connectivity is stalled by both the Governments of Togo and Benin.

International Connectivity

From the signature of a protocol agreement between Ministers to a mere declaration

Efficiency gain and the reform of the legal and regulatory framework

While at the highest level, regional integration is proclaimed as one of the most important issues for the development of Africa, reality is a complete different matter.

In fact, today the implementation process of an ICT interconnection between two countries requires in a large number of countries the signature of a specific protocol by the two ministers of the countries involved.

An efficiency gain would be made if setting up international interconnection (regional) between two countries was simplified and provided for by a legal and regulatory framework.

Therefore, one of the priorities is the development of a continental and regional guide simplifying the implementation of such infrastructure and especially the transposition at national level in all the African countries.

This can be structured in the following way:

- Connectivity agreement between all the countries signed by the Heads of State
- Players' freedom to set up infrastructure with the obligation to declare it and provide the location to each country's regulator

In order to optimize investments, and before realization, the players of the relevant countries should be consulted in order for them to be able to deploy simultaneously their own infrastructure or to share investments.

Carriers to carriers based on new infrastructure

In countries[108] where the legal and regulatory framework was subject to reform since 2009/2010, private investors have developed new land-based infrastructure and have become carriers to carriers.

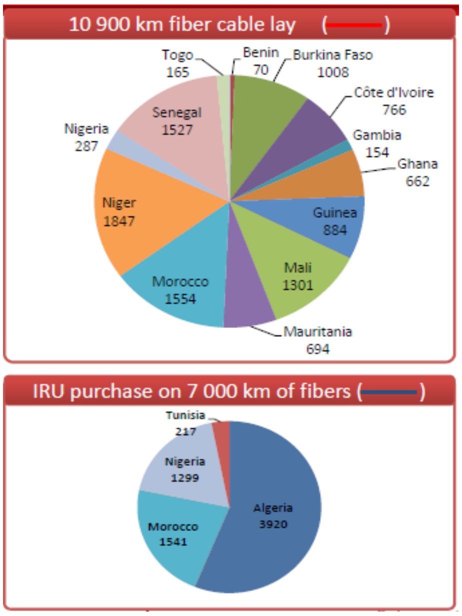
Operators partially enable the setting up of real competitive offers and also allow the high increase of regional connectivity.

Figure 103 below provides an overview of a project covering the Maghreb and part of ECOWAS. Its completion would allow, among other things, the increase of competition on national infrastructure in particular in Senegal, Mali, Niger and Mauritania and also the increase of the connectivity of Burkina Faso.

The 3 Figures below provide an overview of an infrastructure project of Finetis but also its sector market approach.

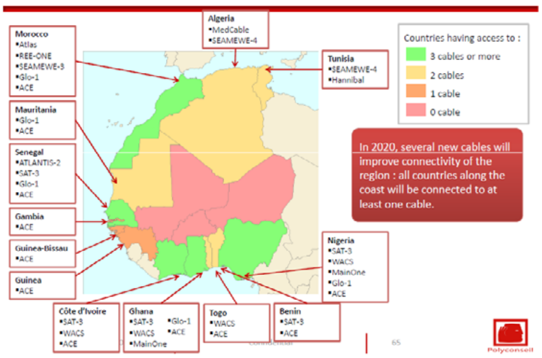
Figure 101: Map of infrastructure to be deployed

Figure 102: Infrastructure per country



© Finetis- Carriers' Carrier Business plan

Figure 103: Improve competition on landing stations



© Finetis- Carriers' Carrier Business plan

Figure 104: Finetis- Carriers' Carrier Business plan

108 Nigeria, Kenya, Uganda, Rwanda, Tanzania, Morocco, (KDN, LIQUID, Suburban,..)

New approach for both institutions and States

Improving efficiency in the development of infrastructure by States or institutions

The market approach implemented by Finetis shows the path to be followed more often by institutions and which should possibly be one of their major roles in implementing infrastructure with financing.

During the feasibility study of a regional project which can just be a link between two cities improving connectivity between countries or a bigger infrastructure (CAR Type -TCHAD), it seems important to consult ALL the actors in the relevant countries in order to know their needs on this segment which can be expressed by:

The need to use bandwidth (wholesale offer) and

This can be structured in the following way:

- Interconnection point where they can terminate their international part
- Advantage of sharing and co-investing in PPPs or by an IRU on the international part
- Advantage of sharing and co-investing in national segments as part of their backbone or backhaul
- Moreover, these links could also be used partially to provide services to the non profitable areas and possibly universal services[109] funding could partially be allocated to the project.

Sensitivity analysis of a shared investment

This analysis conducted by the Consultant on a regional investment project is provided here as an example to introduce the economies of scale achieved by shared investments and the impact on bandwidth cost

This study is carried out on a new infrastructure of 625 km.

Table 22: Financial table for an investment of 16 000 000 $

		Cout Fibre Noire							
		Nb de Fibres (paire) louées							
	Nb de paires	1	2	3	4	5	6	8	10
IRU DFO 10 ans	Cout Capex brut (~IRU Dark FO)	$16 250 000	$8 125 000	$5 416 667	$4 062 500	$3 250 000	$2 708 333	$2 031 250	$1 625 000
	WACO (IRU)	-$2 242 342	-$1 121 171	-$747 447	-$560 585	-$448 468	-$373 724	-$280 293	-$224 234
	Cout Opex ans	$650 000	$325 000	$216 667	$162 500	$130 000	$108 333	$81 250	$65 000
Annuel IRU + OPEX	Cout Annuel D F	$2 892 342	$1 446 171	$964 114	$723 085	$578 468	$482 057	$361 543	$289 234
	Mbps (155)	$22 955	$11 478	$7 652	$5 739	$4 591	$3 826	$2 869	$2 296
	Mbps (644)	$4 491	$2 246	$1 497	$1 123	$898	$749	$561	$449
	Mbps (2,5 Gbps)	$1 157	$578	$386	$289	$231	$193	$145	$116
	Mbps (10 Ge)	$289	$145	$96	$72	$58	$48	$36	$29
Mensuel IRU + OPEX et bande passante	Cout Mensuel D F	$241 028	$120 514	$80 343	$60 257	$48 206	$40 171	$30 129	$24 103
	Mbps (155)	$1 913	$956	$638	$478	$383	$319	$239	$191
	Mbps (644)	$374	$187	$125	$94	$75	$62	$47	$37
	Mbps (2,5 Gbps)	$96	$48	$32	$24	$19	$16	$12	$10
	Mbps (10 Ge)	$24	$12	$8	$6	$5	$4	$3	$2
	Analyse au métre linéaire								
	Cout brut au métre IRU $ (10 ans)	$36	$18	$12	$9	$7	$6	$4	$4
	Cout annuel métre	4,6 €	2,3 €	1,5 €	1,2 €	0,9 €	0,8 €	0,6 €	0,5 €

[109] See Mauritania in the UMA BB Project

Figures 105 and 106 below provide the IRU potential costs (monthly) and that of Mbps according to the number of investors (1 to 5 optical fiber invested by operators) and the transmitted bandwidth

Figure 105: Monthly production cost of black fiber traffic

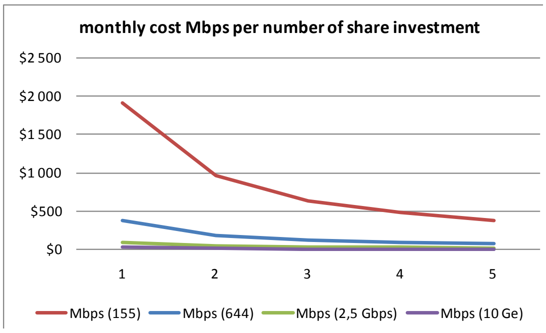
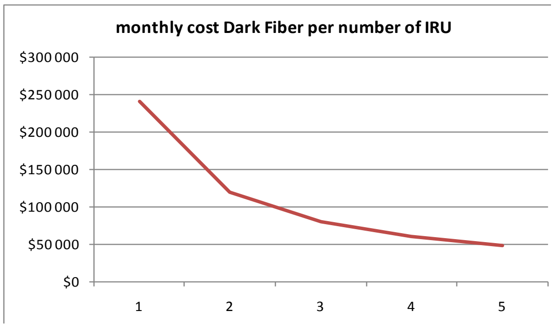


Figure 106: Monthly cost of Mbps according to traffic



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For investment by one to 5 operators

4.3.2 Exhaustive definition of PIDA regional infrastructure

Definition of a regional infrastructure from a PIDA perspective

A regional infrastructure is a passive infrastructure allowing a better connectivity between States and improving broadband connectivity of African consumers

A regional infrastructure can be

- A passive « autonomous » infrastructure extending from a capital to an interconnection point towards the landing stations
- A part of a national infrastructure offering interconnectivity capacities with the infrastructure of another country.
- A « missing » element between existing infrastructure knowing that in this case, the term regional infrastructure covers the parts of existing infrastructure on which the missing element ends.

To meet the criteria of open access and strengthen competition, regional infrastructure must be accompanied with :

- Passive Interconnection points: a site where operators can physically interconnect the elements of their infrastructure to the regional one.
- Co-location rooms situated along its course allowing the installation of optical amplifiers by the players or any other necessary active element in the transmission.
- The interconnection catalogue providing the technical and rate conditions for the use of regional infrastructure

4.3.3 Deficit in access infrastructure

The various analyses conducted and the market data have shown that Africa, in most of the countries, suffers from a deficit in access infrastructure which help obtain broadband connections.

Land access deficit (Local copper loop)

Currently, it is the most penalizing as it does not enable a massive use of xDSL technologies.

Today, in the light of technological evolutions and the challenge of high speed access, it is unthinkable and economically unreasonable that African countries invest in a copper local loop or coaxial loop. They may extend that to cities where it partially already exists and improve the quality of the existing copper local loop in order to optimize performance. It remains the prerogative and the responsibility of incumbent operators.

The governments must imperatively raise the issue of land-use planning and more particularly in access networks. In fact, a large part can be deployed by other sectors such as electricity, water supply and the cities' roads.

Similarly, thanks to the current economic development in Africa, a large number of buildings are currently under construction. A reformed legal and regulatory framework should oblige developers to preinstall and set up cables in buildings and other business premises.

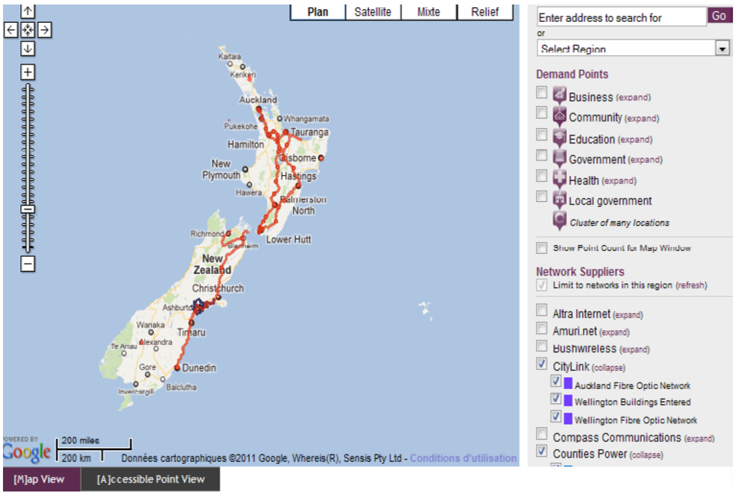
New Zealand government initiative

The National Broadband Map

The National Broadband Map aims to comprehensively map New Zealand's broadband landscape and provides information and tools to aid in demand aggregation and infrastructure planning.

The national broadband supply and demand for raw access to the underlying data.

Broadband map can be accessed and consumed in a number of ways from the visual representation.



http://www.broadbandmap.govt.nz

Electricity Ashburton Fibre

Our Fiber Network

Electricity Ashburton is developing an advanced next generation optical fiber network throughout the Ashburton DistrTIC. This is a multi-year project that aims to provide every resident of the DistrTIC with access to ultra-fast internet and communications.

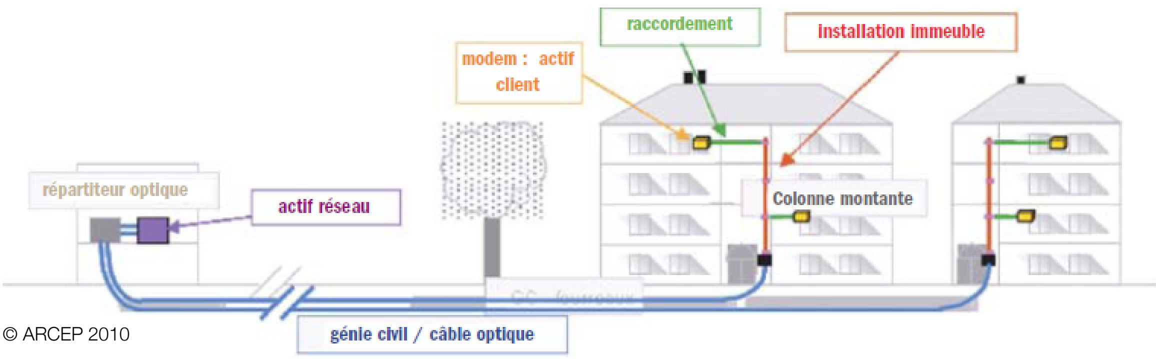
Utilizing our knowledge of network management and construction we are currently building a core network that forms two Ethernet rings, one south of Ashburton and the other north. Each Ethernet ring is approximately 100km in circumference and will form the backbone of our network. From this backbone we have already developed spurs that reach further into the DistrTIC. This design ensures that our network reaches every school in the DistrTIC, both rural and urban.

To date we have laid underground approximately 330km of optical fiber duct. Almost 200km of optical fiber cabling has been blown into the duct and these figures increase daily.

http://www.electricityashburton.co.nz

This site shows how the government of New Zealand plans the use of its land for the development of broadband. Infrastructure suppliers are the operators, electricity companies, the cities..... an example of *« **best practice** ».*

Figure 107: FTTH Architecture– managing buildings (Guidelines of the French regulator)



© ARCEP 2010

These 2 points will be addressed again in the strategic framework and the implementation of guidelines explaining to decision makers the necessity to take into consideration the ICT sector in land-use planning.

Déficit in radio infrastructure (3G, LTE)

The current deficit in broadband access offered by 3G technologies (2005-201x) and LTE (2011-202X) comes from the fact that in the current situation, the majority of mobile operators have a 2G license.

The grant of 3G licenses and/or LTE at economic prices should allow mobile operators to become important actors in the broadband access network.

This means that migration from 2G to 3G/LTE will require that mobile operators change a large part of their equipments:

- Backhaul and backbone radio for optical land based infrastructure
- 2G transmitters: change into 3G/LTE transmitters on high speed mobile internet spots.

This observation must be brought closer to the need to develop national land-based infrastructure and if possible shared by operators in order to reduce investment costs.

Efficiency Gain

- Accelerate at an economic price the 2G-3G migration
- Develop in each country shared investments[110] in the development of land-based infrastructure

National infrastructure and information gathering

As expressed earlier in other reports, in order to control and monitor developments in the ICT sector, it is essential that each country's legal and regulatory framework be reformed, thus compelling operators to provide the regulators with information on the sector. The most relevant data is as follows:

- End of call rates
- Interconnection rates
- Number of active subscribers per market segment
- Cartographic information on infrastructure

This topic will be raised in the strategic framework as well as the possibility for the RECs to have access to some information, amongst others, for the coordination of regional or inter-REC projects

4.4 Main Findings of the Review of the Existing Policies and Institutional and Regulatory Frameworks

The box below provides a synthesis of the main findings on policies and regulatory frameworks. Many points have been raised in previous examples. The box only provides a simple synthesis and will be reconsidered as part of the strategic framework and programs to be implemented

[110] Close to the carrier to carrier model

Main findings

The situation of land-based infrastructure is the consequence of policies and regulations implemented in Africa by the States :

- Legal and regulatory powers of the RECs. Harmonization of legal and regulatory framework in the States

The RECs have been a very strong driving force in respect of the various harmonization programs. But, it appears that transposition in each State has not been achieved. The main indicator of this conclusion is for example the case of EAC, Nigeria and some ECOWAS countries where the development of the unified license has enabled private infrastructure operators to emergence (KDN, Liquid, Phase 3).

Lack of power of the AUC and the RECs to compell States to harmonize their legal and regulatory frameworks

Harmonization (HIPSSA): the 7 priorities identified generally cover quite well the key aspect of the regulation. However, some fundamental points, such as the notion of the dominant operator (Significant Market Power), regulation of retail service tariffs, wholesale and resale, are still missing. Also, it seems that transposition of HIPPSA recommendations[111] at the national level was not carried out in a uniform way by the all the States.

Lack of economic regulation on the main tariffs (retail, wholesale and resale)

Lack of harmonization in the transposition of regulations at the national level

- **Privatization, competition[112] and maintenance of de facto monopolies**

Privatization and therefore, the introduction of competitive offers in the sector have been widely implemented in Africa. However, in respect of land-based infrastructure and landing stations[113], the maintenance of a monopoly by some operators associated with the notion of License are the main impediments to the development of competition on these infrastructure. If African countries have opened their markets to competition, some have done so without completing the sector's reform process which has resulted in monopoly practices from the incumbent operators as well as anti-competitive practices from the dominant operators.

Lack of competition on land-based infrastructure

Anti-competitive and discriminatory practices

- **National regulators authority**

Almost, all African countries have set up a regulation authority as well as regional regulation associations. However, their operation does not seem to be in line with the sectors' expectations.

The main key points seem[114] to be:

- Independence towards the authorities but also an effective independence towards the players[115]
- Non operation[116] of some NRAs
- Lack of capacity and regulation tools[117]
- Lack of separation between operators accounts and breakdown of costs
- Technological neutrality[118]
- Frequency management (tariffs aspects) but also the release[119] /and grant of frequencies to the ICT sector.

[110] Close to the carrier to carrier model

[111] Vol_2_Paper_2_-_Comparative_Sector_Performance_Review_2009_2010.pdf page 5

[112] Idem, page 6,7

[113] The regulation of prices for international bandwidth is not truly possible. However, some States/regulators have not framed these prices while the stations belong to them directly or indirectly. The case of Tunisia is a good example where the government and the regulator have imposed a reasonable price without opening competition.

[114] Analysis of NRA/NRA and topic by topic is needed to identify the lack of NRA.

[115] Discriminatory policy

[116] Result of an audit of all the NRA websites

[117] This result is due to the non publication of Reference Offers for Interconnection or for wholesale (dominant operators); see also Vol_2_Paper_2_-_Comparative_Sector_Performance_Review_2009_2010.pdf page 5 page 34

[118] The regulation/interdiction of VoIP by some States is one example

[119] Accelerating migration to digital broadcasting would free frequency for LTE

- **Knowledge of the sector and dissemination of information**

The lack of data gathering by the regulation authorities and/or the lack of public or confidential dissemination at the national and institutional levels make the sector's approach difficult on a number of issues (land-based infrastructure[120], RIO, state of market development …).

Lack of reliable information on the sector and its state of development and evolution

Lack of dynamic indicators to measure the effects caused by reform or the deployment of an infrastructure.

- **Continental, regional and national master plans**

The master plans seem to lack coordination (Inter RECs) and especially have not always taken into consideration the rapid evolution of the sector and private players to implement land-based infrastructure. This highlights

The lack of human resources at the institutional level (AUC, RECs and AfDB)

The lack of involvement of the private players[121] in the development of infrastructure policies

- **Broadband network projects under the authority of the RECs**

It appears that the RECs and NEPAD have initiated since 2005 various regional carrier to carrier projects. But in 2011, no project was operational. However, when the legal and regulatory framework is adequate, the private actors or an association of operators (SRII, EAbs, WIOCC) have been able to develop regional and interregional infrastructure.

The role of institutions and RECs must be refocused on regional planning policies and the synchronization of regional projects as well as the implementation by countries of the measures aimed at harmonizing the legal and regulatory framework.

- **AUC : Reference Framework (2008)**

The reference framework prepared by the AUC generally provides good lines for reforms and adjustments to be implemented. Unfortunately, many States have not transposed these guidelines at the national level. Therefore, it seems important to complement the Reference Framework with Guidelines for implementation and that RECs work with the States to transpose them at the national level and ensure their effective implementation

[120] But allows some fee paying commercial offers of services for non secured data

[121] SADC/SATA being the most consultative policy identified but unfortunately oriented to incumbent operators.

5. IDENTIFICATION OF KEY ISSUES AND CHALLENGES

5.1 Key issues

The forecasted bandwidth demand shows the need for Africa to solve key issues in order to bridge the digital divide between most African countries and the rest of the world.

- Upstream, consumers are waiting for a broadband internet offer to penetrate the digital world, outside the continent but also inside the continent if the local content is developed.
- Downstream, bandwidth supply is available on the shores of Africa.

Continental and regional infrastructure is not developed enough to link supply to demand.

5.1.1 Response to the expectations of consumer demand

Further analyses show that to meet consumers' expectation, each country should address these 3 bottlenecks:

Development of the use of personal computer (access terminals)

Benchmarking studies involving operators and the study on the Top 10 sites visited by Africans show that:

- Africans have the same use of the internet as the rest of the world and websites like Facebook, YouTube, Google, are the most visited
- A comfortable access to the internet and to the bandwidth extensive applications require the use of a personal computer, while terminals like Smartphones generate only marginal traffic that do not impact on the traffic "peak" needed to determine the necessary bandwidth. The traffic generated is also more important than the traffic generated by traditional voice service (pay-per- minute).

  The decrease in the use of international bandwidth can partly be solved by the development of IXP equipped with transparent caches.

Access infrastructure

Continental and regional traffic is exclusively generated by national access networks and the under-use of the internet in Africa is partly due to the deficit in broadband access.

Fixed access deficit:

In the short to medium term, except for some countries, because of the fixed access deficit due to the lack of incumbents' investment, in cities, technology and investment will have to be based on other technologies than the copper cable.

Wireless access

It appears that in the short term (2015), the access deficit will have to be closed by wireless technologies in all African countries. In this context, and given the technological developments, mobile infrastructure migration to LTE (and to a lesser extent to 3G and the fixed wireless for professional use) would enable Africa to make a double technological leap fostering the development of faster broad band internet use.

Migration to LTE requires the release of frequencies currently used by analogue TV. It is therefore urgent to speed up the migration process to digital TV and allocate the released frequencies to the telecommunication sector.

5.1.2 National and regional infrastructure deficit

The analysis of national infrastructure development also shows a lack of infrastructure. The deficit is unevenly distributed across countries. Some countries like Nigeria, Morocco or even South Africa have a good land-based infrastructure density.

It is important that countries with the least developed land-based infrastructure, implement an enabling policy and a regulatory framework to foster the development of such infrastructure essentially through the private sector as it has been achieved in several countries.

Policy and regulatory frameworks should be more conducive to private investors which will be the main players in the implementation. It is important that such policies and regulatory frameworks lead to competition at the land-based infrastructure level.

5.1.3 Conclusion

Africa must also meet the following challenge:

A challenge in terms of infrastructure

Implement a policy in synergy with the three major issues:

• Regional infrastructure development

• National infrastructure development

• Access infrastructure development

To reduce investment costs and increase their effectiveness:*

Better invest to have more infrastructure

Encourage private investors in the implementation of land-based infrastructure.

The above analyses show an important deficit in land-based infrastructure to attract broad band traffic to landing stations and interconnection points inside the continent. This development is a priority because it is a pre-requisite to the full establishment of the infrastructure chain to be implemented.

Stages	Key elements	Status
Stage 1	Submarine infrastructure-Satellite	▪ Operational 2010-2012
Stage 2	Continental and regional infrastructure	▪ Minimum end of 2012 ▪ Important development 2011-2018
Stage 3	National Infrastructure	▪ Minimum end of 2012 ▪ Important development 2011-2030
Stage 4	Access Infrastructure	▪ Minimum end of 2012 ▪ Important development 2011-2030
Stage 5	Computer use ; e-content	

Infrastructure challenges

The challenge is not to define active equipments which remain the prerogative of operators and are constantly changing[122] (transmission capacity) but to encourage the implementation of passive infrastructure or the release of some frequency bands while meeting several requirements :

• **Qualitative:** to be able to support active sustainable devices.

• **Quantitative:** be adequately sized to meet short term and especially long term need (15-20 years).

• **Geostrategic :**

- Meet operators" expectations in terms of destination
- Meet governments' expectations in terms of land digital development.
- Meet reliability criteria, required to build a digital economy and society

[122] On Forecast Report: 2011–16 Ovum June 2011

Infrastructure development

Both diagrams provide an overview of the infrastructure deployment processes

Figure 108: Overview of infrastructure deployment process

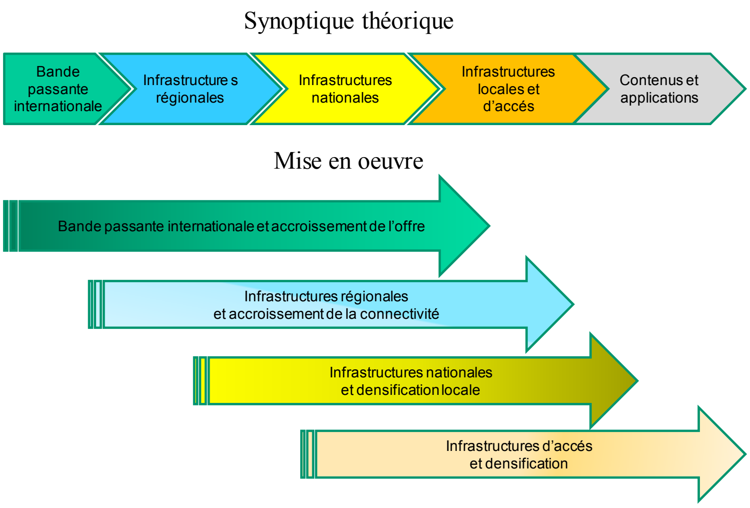
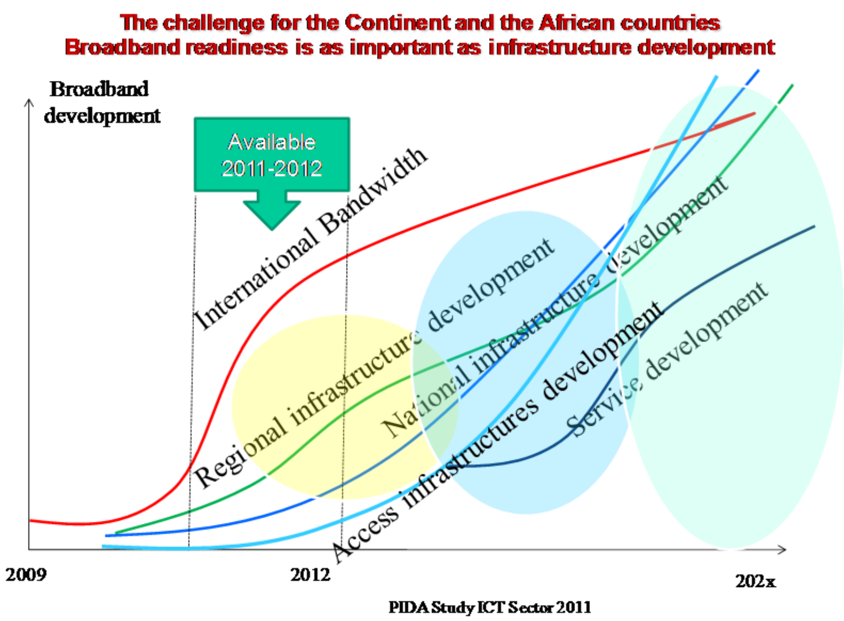


Figure 109 : The challenge for the continent and the African countries: Broadband readiness



5.2 Priority Investments

The analyses have shown that the situation in Africa in terms of regional infrastructure would improve with the speeding up of initiatives and private investment in some countries.

However, priority investments have been identified during the study phases.

- Opening up of the last countries still landlocked
- Improvement of the quality of the opening up of some countries (at least 2 connections)
- Improvement of competition on access to landing stations

Opening up Status in June 2011

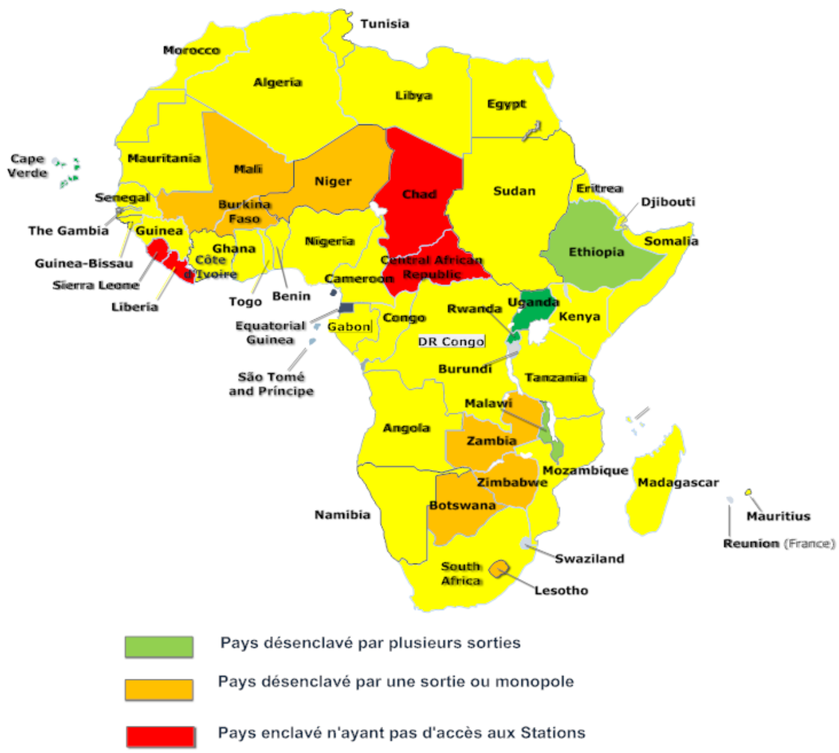
Without being exhaustive, **Figure 110** below provides the countries opening status.

1. The States in green are States with several accesses to landing stations through land-based infrastructure.
2. The States in orange are those with only one access to stations via a single infrastructure often under monopoly.
3. The States in red are countries that do not yet have access to landing stations. Liberia[123] and Sierra Leone have stations projects[124]. When these stations will be installed, both states will turn orange because they will be connected to a single station.

Case of landlocked countries and access to landing stations

A number of countries have a poor connectivity to landing stations. One of the priorities is to improve this connectivity.

Figure 110: the countries opening status



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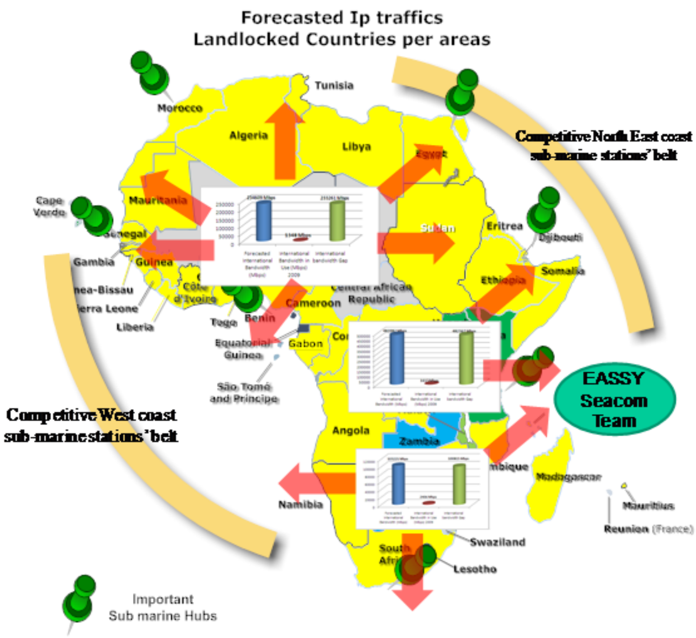
- **Countries with one or 2 stations :** Phase 1 study shows the risks faced by stakeholders in some countries due to monopoly (countries with a single station) or duopoly (2 stations)
- Burkina Faso
- Sierra Leone (still landlocked)
- Liberia (ditto)
- Benin, Togo.
- These investments could be made largely in partnership with private actors or carriers to carriers already in operation in the region.
- All these projects will be dealt with in phase 2 in the PIDA PAP project list and will be reviewed with RECs.

[123] They are mentioned here because currently they are in the same situation as the landlocked countries

[124] WAPP WB Project April 2011

Figure 111: **Landlocked countries and connectivity**



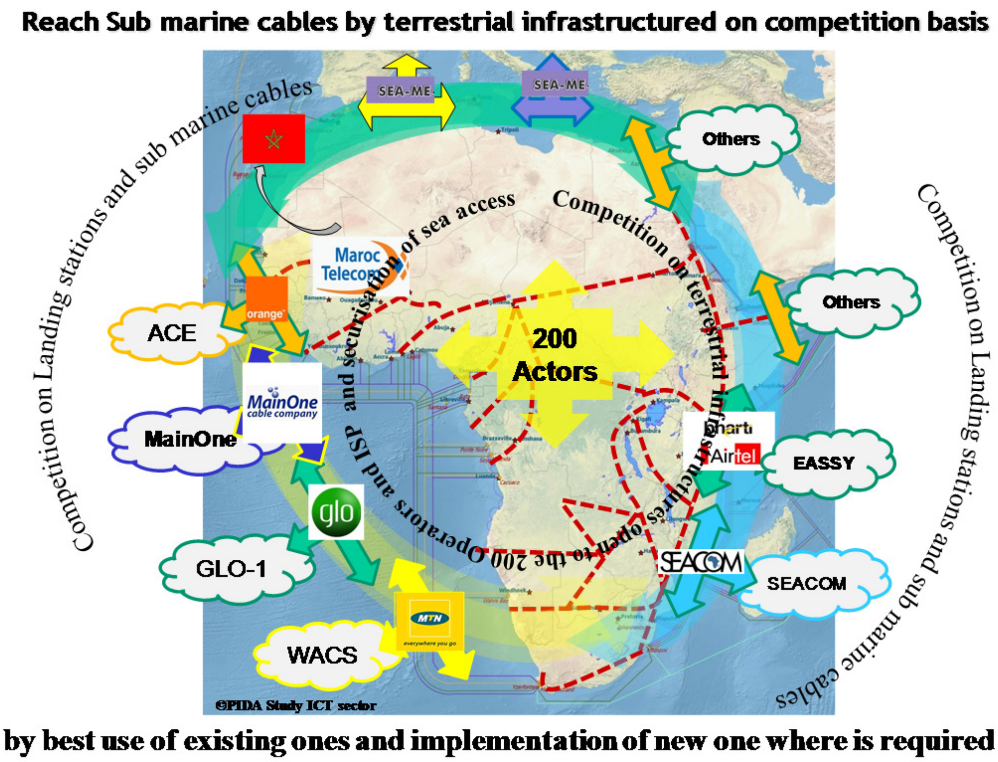
National/regional IXP and transparent caches

A feasibility study and investment proposal will be made during phase II as well as investment programs

Similarly, a preliminary strategic study on IXP development will be finalized with RECs and AUC.

Synthesis diagram

Figure 112: **Synthesis diagram**



5.3 Synergy with Other Sectors (energy, transport, territorial authorities)

In addressing the issue of alternative infrastructure, the consultant recommends the strengthening of synergies between sectors such as transport and energy, because those 2 sectors are two areas that can provide both national and regional connectivity.

In addition, energy carrier structures and corridor authorities are structures suitable for the operation and maintenance of alternative infrastructure for the use of ICT.

It is important that decision makers consider implementing a policy in this regard. Systematically installing OPGW cables on transmission lines, promoting optical fiber development during the electrification of cities or regions, placing optical fiber along all corridors and highways are probably good solutions to improve connectivity in the entire African territory and thus increase competition on land-based infrastructure.

Figures 113 and 114 below show the synergies between transport and ICT infrastructure development strategy.

Figure 113: ICT West-East belt

Figure 113: Improving Liberia and Sierra Leone connectivity