SUBMARINE OPTICAL CABLE MARKET IN AFRICA: CHALLENGE AND POTENTIAL

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Abstract: In Africa during the past decade, ICTs have experienced considerable growth. The popularity of African countries for these technologies is real. The evolution of the bandwidth and the connections to the Internet is impressive. All evidence suggests that this trend is going to continue, as the availability expands and the cost of access continues to decline.
This is even more real than after decades of stagnation, Africa's economy is growing. Over this period, the continental GDP has grown at an average annual increase 5 % making Africa one of the most dynamic areas in the world.

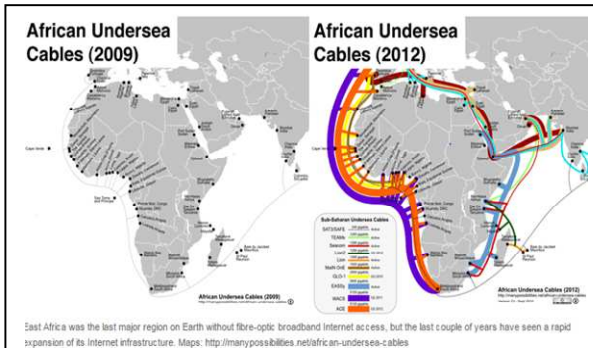
1. INTRODUCTION

The deployment of the submarine cables in African coasts over the last decade is at the origin of transformations that begin to occur in African society, **the digital divide** between developed societies and developing is more and more reduced. Thanks to this indicators such as International Bandwidth. Internet penetration, access to mobile broadband, digital television, have significantly advanced during last five years. The apprehension of marginalization of Africa finally turns out utopian and the gap narrows day by day.

2. INFRASTRUCTURE AND INTERNET AT THE BEGINNING OF THE 1ST DECADE (2002 – 2010)

Submarine Cable

In 2002, there was only one submarine cable – SAT 3 – along the West African coast for Internet connection. Telecommunications operators that participated in a consortium for construction and maintenance of the submarine cable are all incumbent operators. Landlocked West African countries that are not members of the consortium have thus become dependent on SAT 3, which remains indispensable in the provision of international Internet connection.



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Internet

The first African countries to connect to the Internet were South Africa, Tunisia, Egypt, Algeria, Senegal, around the year 1988. From 1988 (South Africa) to 2000

(Eritrea), all African countries were connected to the Internet.

AFRICA INTERNET USERS (Year 2000)	
Country	**Internet Users 31-Dec-2000**
South Africa	2,400,000
Eritrea	5,000
Nigeria	200,000
Liberia	500,000
Cote d'Ivoire	40,000
Gabon	15,000
Cameroon	20,000
Tanzania	115,000
Guinea	8,000
Angola	30,000
TOTAL AFRICA(2000)	**4,514,400**

(2)

While the origins of the global Internet can be traced to the US-based ARPANET in the 1960s, the first network in sub-Saharan Africa came nearly three decades later, in 1988 at Rhodes.

University in Grahamstown, South Africa.
In 1991 the first data packet transmitted from sub-Saharan Africa was sent from South Africa to Portland, Oregon. This heralded the arrival of the Internet to Africa. In 1991 the first data packet transmitted from sub-Saharan Africa was sent from South Africa.

3. CURRENT SITUATION

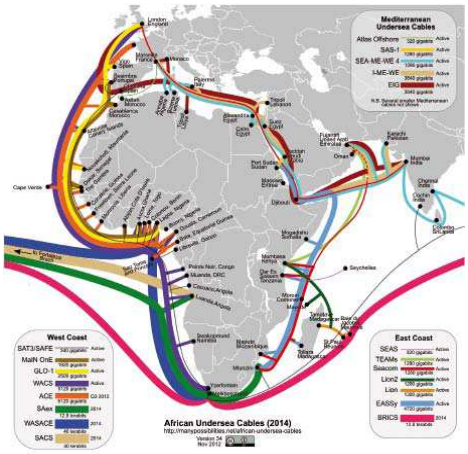
Role of submarines systems in the development of the internet in Africa

The enormous growth of the Internet in Africa sub-Saharan started with the deployment of five submarine cables (SAT3, Main One, Glo One, WACS and ACE). The East African coast is served mainly by three submarine cables (SEACOM, EASSy and LION 2) from 2010.

These abundant cables increased connectivity in Africa. If the projects have mainly concerned the coastal countries in North Africa, Southern Africa, West Africa and East Africa, the countries of Central Africa have also, interest began to broadband through fiber optics.
In Central Africa, Internet access was traditionally by satellites, which capped the costs without necessarily providing high speeds of connection. Multiple cables projects that have arisen over the past years now allow the countries in the area to be more connected to the fiber and have broadband.

According to a **G**lobal **I**nternet **G**eography study, the bandwidth in Africa has experienced an annual growth of 51% over the past five years. Contrary to global trends that indicate a slowdown in the growth of the Internet bandwidth of 41% in 2011 to 31% in 2015. Between 2014 and 2015, the African continent Internet bandwidth increased 41%, to reach 2.9 Tbitps. Between 2011 and 2015, Internet bandwidth connected to sub-Saharan African countries has increased by 66%, a faster rate than that of the countries of North Africa which is 43% per year.

This growth is attributed to the installation of submarine cables on the East and West African coasts. Including ACE, SEACOM, EASSY and WACS so that new terrestrial networks that have increased considerably the capacity available in the Sub-Saharan region.



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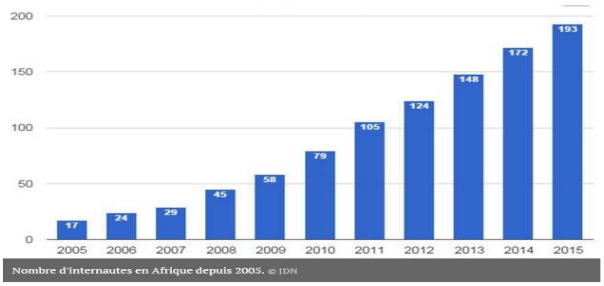
According to a Telegeography report released in March, 2015, the sub capacity reaches 33 countries vs just 10 before 2009 (60 landing points vs 12). Seven countries have access to three or more cables. Africa is world's fasted growing region for Internet bandwidth growth over last five years. Int'Internet capacity increased more than 400% since 2011 (500% in SSA).



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Main evolution indicators

- USD 3.8 billion invested In Submarine cable in recent years
- Total lit capacity in Sub-Saharan African submarine cable systems increasing by 57% annually (between 2007 and 2013)
- Seven countries have had their first landing station
- Eleven other countries have an additional landing station
- Most existing African submarine systems have been upgraded to support either 40 Gbps or 100 Gbps wavelengths.

Main Systems

	Seacom	EASSy	TEAMs	WACS	MainOne	GLO1	ACE	SAex	WASACE	BRICS
Cost (millions of USD)	650	265	130	600	240	800	700	500	(unknown)	(unknown)
Length (km)	13,700	10,000	4,500	14,000	7,000	9,500	14,000	9,000	9,000	34,000
Capacity	1.28 Tb/s	4.72 Tb/s	1.28 Tb/s	5.12 Tb/s	1.92 Tb/s	2.5 Tb/s	5.12 Tb/s	12.8 Tb/s	40 Tb/s	12.8 Tb/s
Completion	July 2009	July 2010	Sept 2009	Q3 2011	Q2 2010	Q3 2010	Q2 2012	Q2 2013		

(5)
Source : https://manypossibilities.net/african-undersea-cables/
TerabitConsulting
http://www.terabitconsulting.com/downloads/2014-submarine-cable-market-industry-report.pdf, accessed January 2015

Potential New Systems

- **SAex** : Is conceived as a system to link the developing economies of Southern Africa and South America independently of traditional hubs and so to contribute to a link between BRICS economic regions without recourse to traditional northern hemisphere hubs. The initial design capacity of the cable is 40 TBit/s and will be over 10,000 kilometres in length (7,400 km from South Africa to Brazil and 3,000 km from Cape Town to Mtunzini). It will consist of four fibre pairs, each capable of carrying 10 TBit/s of data using 100 GBit/s wavelength technology.

- **WASACE**: the planned WASACE system has four new submarine cables, including one running from South Africa to Angola and Nigeria, and a second across the Atlantic from Nigeria to Brazil. This would potentially be the fifth cable running between South Africa to Nigeria, the third cable linking Latin America to Africa, It will deploy the latest "100G" technology.

(6)

- **SACS**: also known as the **Angola-Brazil Cable**, is a planned submarine communications cable in the South Atlantic Ocean linking Luanda, Angola with Fortaleza, Brazil. The SACS will feature the latest high quality 4-fiber-pair cable and optical transmission technologies with an initial design capacity of 40Tb/s (100Gb/s x 100 wavelengths x 4 fiber-pairs). The system is targeted to be ready-for-service during the fourth quarter of 2016. the SouthAtlanticOcean. It is designed to provide low latency routing between Africa and Asia in the east and the Americas in the west. Data traffic between Angola and Brazil will no longer have to pass through Europe and the US, as currently occurs.

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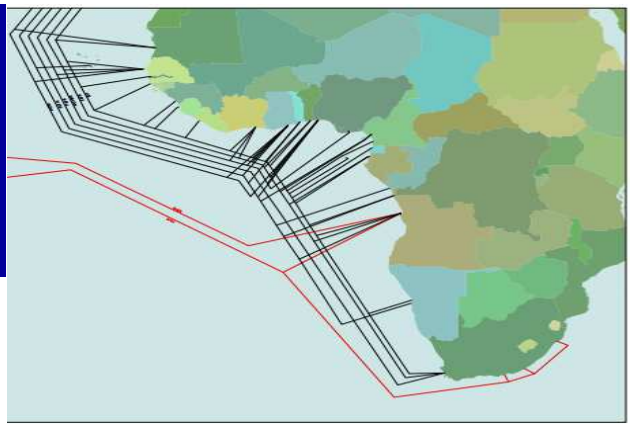
Existing vs Planned Sub-Saharan Africa cables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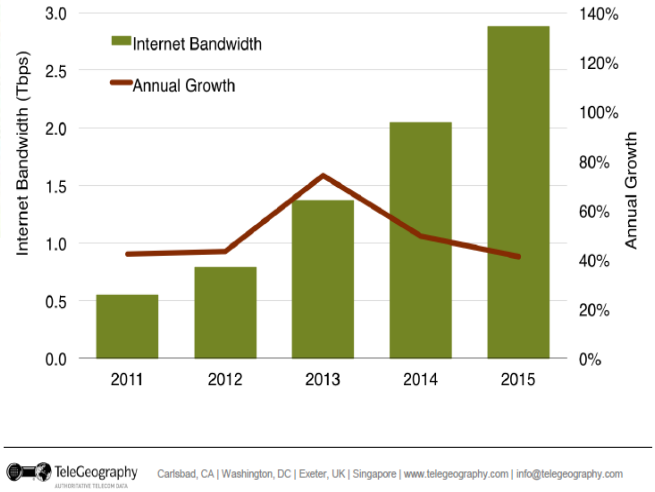
Internet &Bandwidth Evolution

The developments have created consistent growth in international Internet bandwidth on the continent.

From 2009 to 2014, Africa's international Internet bandwidth increased twenty-fold and has now passed 2 Tbps. In the same period, Africa's terrestrial network has more than doubled. In general, developing countries' share of international bandwidth has jumped from only 9% in 2004 to 30% now. Similar growth figures are reported for terrestrial networks from a total of 465,659 km in 2009; to 676,739 km in 2011; 732, 662 in 2012; and 958,901 km by June 2014

Growth of International Bandwidth



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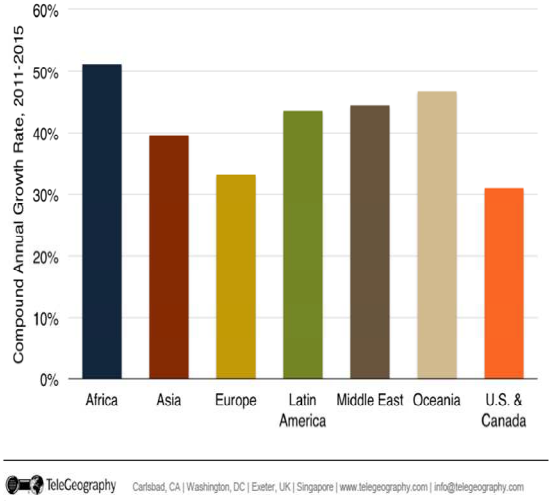
According to TeleGeography, between 2014 and 2015, Internet bandwidth of the African continent increased 41%, to 2.9 Tbitps.

2011-2015, Internet bandwidth connected to sub-Saharan African countries has increased by 66%, a faster pace than that of the countries of North Africa which is 43% per year. The bandwidth in Africa has experienced an annual growth of 51% over the past 5 years. Which goes against global trends that indicate a slowdown in the growth of the Internet bandwidth from 41% in 2011 to 31% in 2015.

Compound Annual Growth rate 2011-2015 (Internet Bandwidth)



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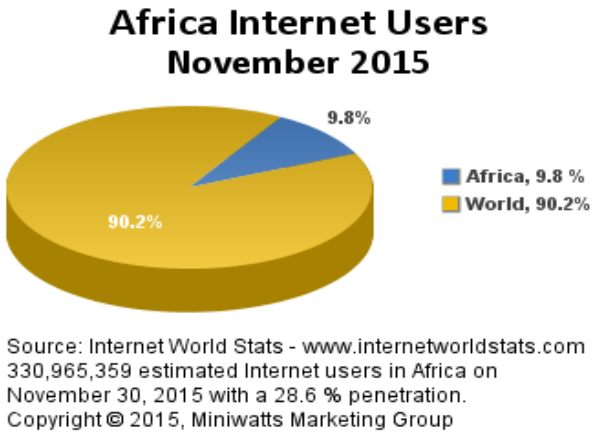
- Rapid growth – In 2005, Internet penetration in Europe was almost 20 times that of Africa. By 2014, it was less than 4 times greater.
- In just 5 years – from 2009 to 2014 – Africa's international bandwidth increased 20-fold and its terrestrial network more than doubled
- There are now more than 30 IXPs across Africa.
- Landlocked Uganda, Rwanda and Burundi have backbone access to submarine fiber at close to the same price as coastal countries.



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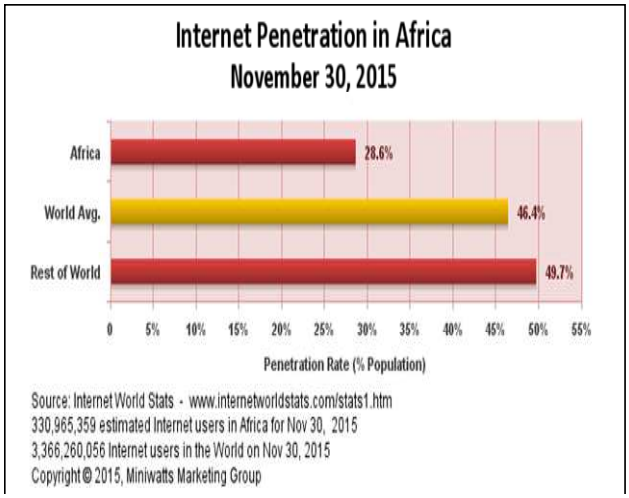

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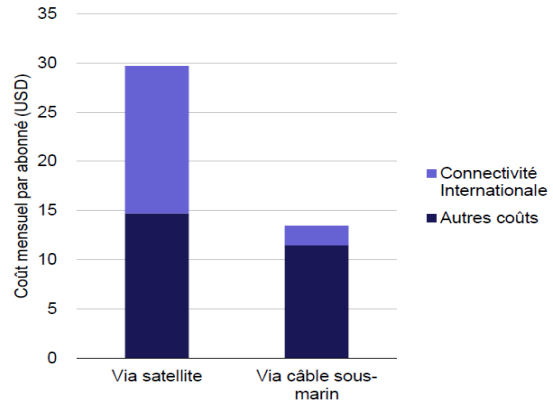
Connection Cost

Before the arrival of the submarine cables in Western Africa coast, connections were established essentially via the satellites whose costs were not affordable. The influx of submarine cables in Africa has contributed considerably to the improvement of international connectivity and therefore, the improvement of Internet subscribers connection. However since the access to Internet services become

affordable in many African countries, price cuts have attracted more subscribers and create a virtuous circle of growth of utilization and price reduction. The costs of international capacity continue to constitute a substantial part of the Internet costs for landlocked countries.

Indicative impact of submarine cable on the Cost connectivity of service broadband.



[Source : Analysys Mason, 2011]
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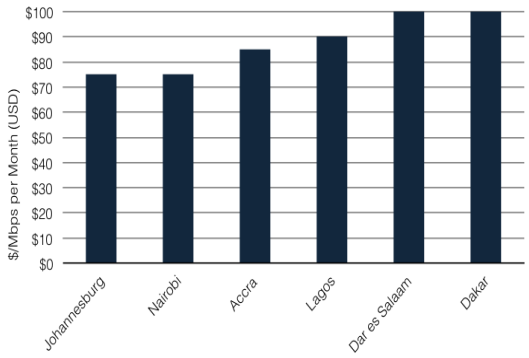
The deployment of submarine cables had an impact on the international STM-1 costs which have experienced a net decrease. Despite that costs remain still expensive compared with prices in Europe, but the decrease continues its path of regression.

Media STM-1 IP Transit Price In Africa Q2 2015



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Cable Cuts and Maintenance

Given the importance of the submarine cables and adverse consequences of interruptions and break of this infrastructure on the economies of the countries, it's very important to be care on ability to monitor the systems.
This inevitably requires good maintenance practice of this infrastructure by:

- Protection and coverage of the cable: Mainly in areas subject to a dense fishing activity
- Submerged Plant Maintenance

Consisting of the elements of marine maintenance and depot services. Submerged Plant Maintenance is the area of OPERATIONS ADMINISTRATION AND MAINTENANCE (OAM) that has undergone the most evident changes.

- Terminal (Terrestrial) Maintenance

There have been changes too in the Terminal sector. Pressures from owners for reduction of O&M costs hassled to many stations revering from 24 x 7 to reduced coverage ranging from 16 x 7 to 8 x 5. In many instances this has been compensated by establishment of SNOCs.

- System Administration

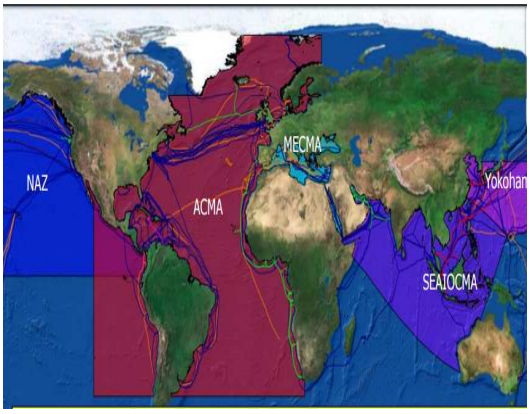
Join internationals organizations to be updated of the latest techniques of protection and monitoring of the submarines cables such as ICPC.

This critical global infrastructure of Fiber Optic cables that traverse the bottom of the ocean form the backbone of the Internet.
It relies on small group of companies responsible for both installation and maintenance of the more than 300 active submarine cable systems that interconnect world.
These cooperatives enable operators of submarine cable systems to share the cost of dedicate cable vessels in the respective zone. Some cable operators choose to sign a private CMA directly with a service

provider. Although CMAs keep cable vessels ready, delays may still arise from concurrent cable breaks that constrain vessel availability, lengthy permit processes for accessing territorial waters, and vessel transit time.

Cable operators participate in **Cable Maintenance Agreement** (CMA) zones,

- **ACMA** (Atlantic),
- **MECMA** (Mediterranean),
- **2OCMA** (2 oceans),
- **SEAIOCMA** (South-East Asia Indian Ocean),
- **Yokohama**
- **NAZ** (North American Zone).



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However, in order to avoid and reduce the cuts of submarines cables, the owners should undertake preventive actions such as:

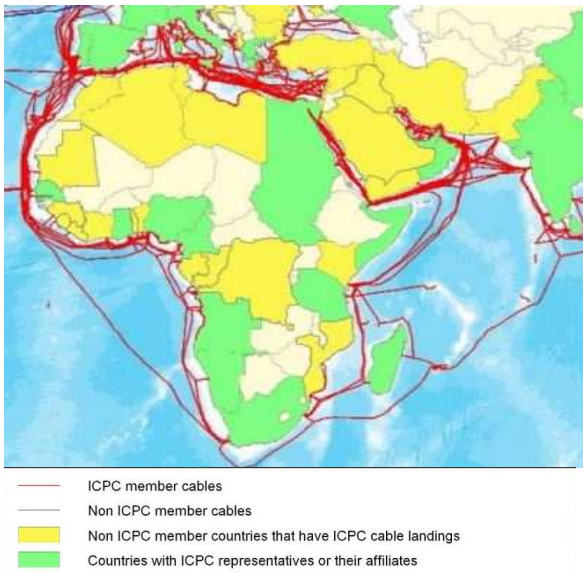
- Submerged plant actions need to be complemented with effective monitoring of the land route
- Daily patrol

A cable owner representative should be present during any authorized work in vicinity of the cable with authority to stop work.

As long as possible, put into action the recommendations of the ICPC witch Recommendations# 6 provides Best Industry Practice for Protection of Submarine Cables and covers during operation: .

- VMS
- AIS
- Patrols (Terrestrial, air and sea)
- Legal

However, according to the updated list of members of ICPC committee, only eleven African countries are already registered as members of the said committee (until December 2015).



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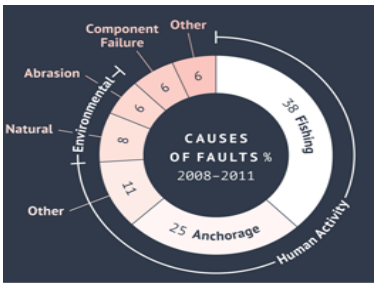
Some of African's cable cuts recorded

System	Date	Cause
SMW4	October 2015	
SAT-3	March 2015	Sabotage ?
Hannibal	Dec 2013	
SMW4	April 2013	
SAT-3	Dec 2012	
Teams	Feb 2012	anchorage
Eassy	2012	
SAT3	mai-11	anchorage
SAT3	Jully 2009	

In accordance with studies of specialized organizations, the origin of the submarines cables cuts is as follows:

- Nearly 90% of cable faults arise from environmental factors and human activity, often referred to as "external aggression".
- 10% due to Component failures and unknown factors



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4. PERSPECTIVE AND CHALLENGE EXPECTED

The African continent has attracted numerous international investors seeking new business deals across the continent. Africa is being promoted as the next global technology hub and the continent is said to be on the brink of unprecedented growth and prosperity. Africa has experienced rapid growth in the ICT sector, the continent is set to become a choice destination for telecom investors. The experts predict that Africa will lead global bandwidth growth 2015-2019 especially for the following considerations

- Population: Youth & potential for market growth
- Inadequacy of existing infrastructure compared to the new needs
- National goals for broadband connectivity

Internet Users and populations statistics(Africa)

INTERNET USERS AND POPULATION STATISTICS FOR AFRICA						
AFRICA REGION	Population (2015 Est.)	Pop. % of World	Internet Users, Latest	Penetration (% Population)	Internet % Users	Facebook 15-Nov-2015
Total for Africa	1,158,355,663	16.0 %	330,965,359	28.6 %	9.8 %	124,568,500
Rest of World	6,101,546,580	84.0 %	3,035,295,797	49.7 %	90.2 %	1,390,635,650
WORLD TOTAL	7,259,902,243	100.0 %	3,366,261,156	46.4 %	100.0 %	1,515,204,150

NOTES: (1) Africa Population data are 2015 mid-year estimates. (2) Africa Internet Usage Statistics in this table are for November 30, 2015. (3) The Facebook subscriber data are for Nov. 15, 2015, the last available from FB. (4) CLICK on each region or country name for details for each individual location. (5) For methology, help and definitions please see the site surfing guide. (6) Population estimates are based mainly on figures from the U.S. Census Bureau and local sources. (7) The Internet usage numbers come mainly from data published by WWW , ITU , the Nielsen Company, Facebook, and other trustworthy sources. (8) Data from this table may be cited, giving the due credit and establishing an active link back to Internet World Stats. Copyright © 2016, Miniwatts Marketing Group. All rights reserved worldwide.

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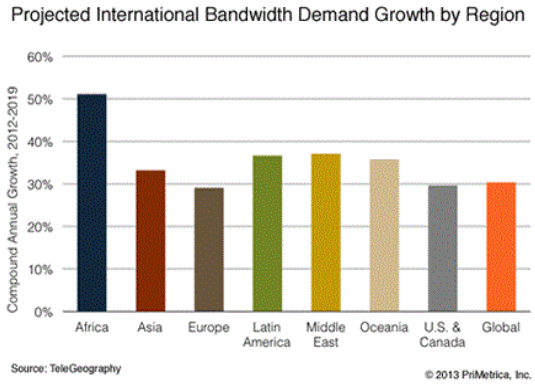
Africa to lead global bandwidth growth:

- Mobile data revenue in Africa is expected to double by 2019, from about $11 billion 2014 to $22 billion.
- Mobile voice revenue also retains growth potential, with revenue expected to increase from about $50 billion in 2014 to $55 billion in 2019
- Africa's international bandwidth demand will skyrocket at a compound annual growth rate (CAGR) of 51 percent between 2012 and 2019 (according to a TeleGeography Global repor)
- By 2019, the region's traffic demand will reach 17.2 Tbps (TeleGeography)



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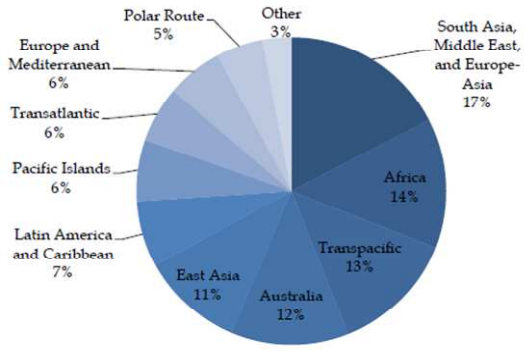
It's also expected that International capacity to Africa will increase via upgrades to existing and new submarine cable systems and bandwidth costs will continue to decline. The credible proposed Submarine Fiber Optic Projects by region 2015 and beyond are shown on the picture bellow:



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Telecommunications market growth

The African market feature comes from:

- Structure of its population with about 40% less than 15 years.
- This segment of the population provides approximately 30 million potential new customers each year on the African market of mobile telephony
- Apart from the contribution of less than 15 years, there is a second source of growth of the population over 15 years which does not yet have a mobile phone.
- Pyramid shape of the structure of the African population,
- Non-saturation of the market

Even if the penetration rate has reached 100% in 2011, the access to mobile telephony market is not yet saturated. This is particularly related to the multiplicity of clients with multiple SIM cards. Under the reasonable assumption of 3 SIM cards for two people, this penetration rate drops to 67%.

Population: Youth Growth

According to Department of Economic and Social Affairs, (Population Division) of United Nation's report published in May 2015, the number of youth is growing rapidly in Africa.

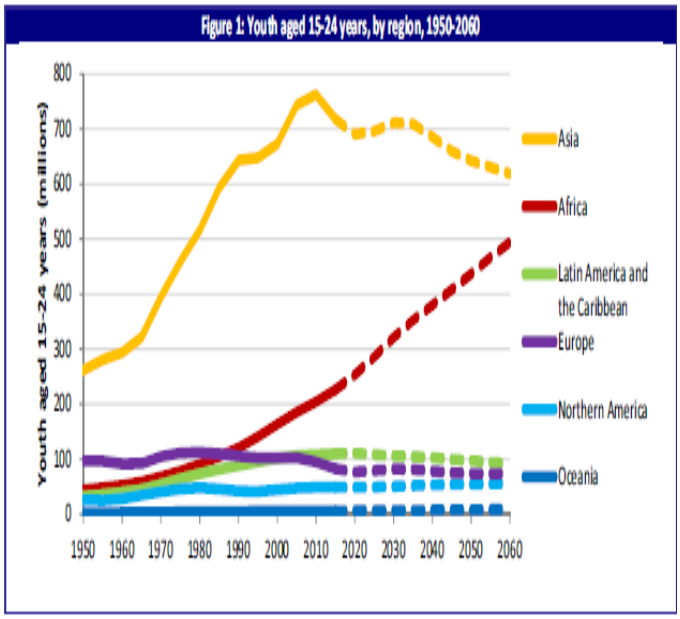
- In 2015, 226 million youth aged 15-24 lived in Africa, accounting for 19 % of the global youth population.
- By 2030, it is projected that the number of youth in Africa will have increased by 42 per cent.
- Africa's youth population is expected to continue to grow throughout the remainder of the 21st century,
- More than doubling from current levels by 2055,
- pyramid shape of the structure of the African population.

Population and internet users 2015 Vs 2000, Statistics 2015

AFRICA Countries	Population (2015 Est.)	Internet Users 31-Dec-2000	Internet Users 30-nov-15	Penetration (% Population)	Internet % Africa
Angola	19,625,353	30,000	**5,102,592**	26.0 %	1.5 %
Benin	10,448,647	15,000	**1,232,940**	11.8 %	0.4 %
Cameroon	23,739,218	20,0000	**2,611,314**	11.0 %	0.8 %
Congo	4,755,097	500,0000	**338,087**	7.1 %	0.1 %
Congo, Dem. Rep.	79,375,136	500,0000	**2,381,254**	3.0 %	0.7 %
Cote d'Ivoire	23,295,302	40,0000	**5,230,000**	22.5 %	1.6 %
Egypt	88,487,396	450,0000	**48,300,000**	54.6 %	14.6 %
Equatorial Guinea	740,743	500,0000	**139,704**	18.9 %	0.0 %
Eritrea	6,527,689	5,0000	**67000**	1.0 %	0.0 %
Gabon	1,705,336	15,0000	**670,197**	39.3 %	0.2 %
Gambia	1,967,709	4,0000	**373,865**	19.0 %	0.1 %
Ghana	26,327,649	30,0000	**5,171,993**	19.6 %	1.6 %
Guinea	11,780,162	8,0000	**770000**	6.5 %	0.2 %
Guinea-Bissau	1,726,170	1,5000	**70000**	4.1 %	0.0 %
Kenya	45,925,301	200,0000	**31,985,048**	69.6 %	9.7 %
Liberia	4,195,666	500,0000	**348,24**	8.3 %	0.1 %
Madagascar	23,812,681	30,0000	**1,100,000**	4.6 %	0.3 %
Mozambique	25,303,113	30,0000	**1,503,005**	5.9 %	0.5 %
Namibia	2,212,307	30,0000	**470000**	21.2 %	0.1 %
Nigeria	181,562,056	200,0000	**92,699,924**	51.1 %	28.0 %
Senegal	13,975,834	40,0000	**7,260,000**	51.9 %	2.2 %
Sierra Leone	5,879,098	5,0000	**260000**	4.4 %	0.1 %
South Africa	54,777,809	2,400,000	**26,841,126**	49.0 %	8.1 %
Tanzania	51,045,882	115,0000	**7,590,794**	14.9 %	2.3 %
Togo	7,552,318	100,0000	**430,482**	5.7 %	0.1 %
Tunisia	11,037,225	100,0000	**5,408,240**	49.0 %	1.6 %
Zambia	15,066,266	20,0000	**2,711,928**	18.0 %	0.8 %
Zimbabwe	14,229,541	50,0000	**6,759,032**	47.5 %	2.0 %
TOTAL AFRICA	**1,158,355,663**	**4,514,400**	**330,965,359**	**28.6 %**	**100.0 %**

(21)

Youth aged 15-24 years, by region, 1950-2060



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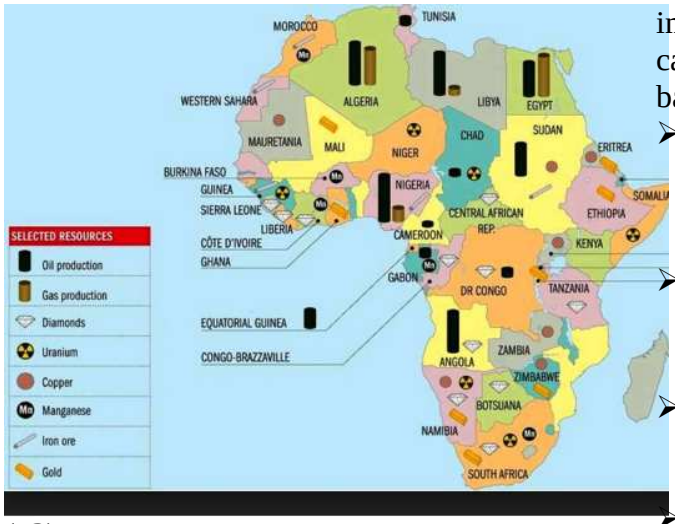
Natural ressources of Africa

Africa has a large quantity of natural resources including diamonds, salt, gold, iron, cobalt, uranium, copper, bauxite, silver, petroleum and cocoa beans, but also woods and tropical fruits. Much of its natural resources are undiscovered or barely harnessed. Having a low human density, for a long period of time Africa has been colonized by more dynamic groups, exploiting African resources. Some economists have talked about the 'scourge of raw materials', large quantities of rare raw materials putting Africa under heavy pressures and tensions.



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The African continent has attracted numerous international investors seeking new business deals across the continent. Africa is being promoted as the next global technology hub and the continent is said to be on the brink of unprecedented growth and prosperity.

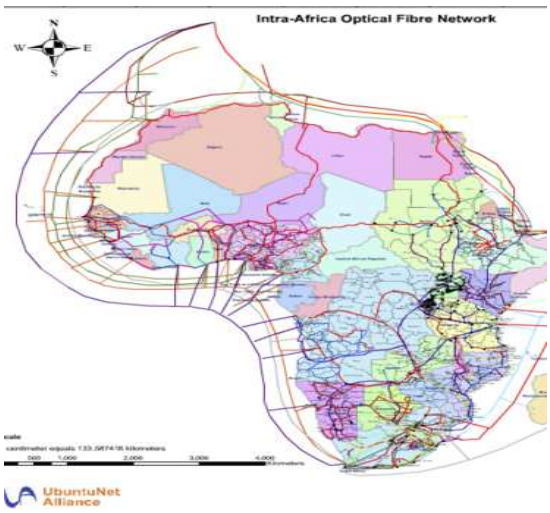
Inadequacy of existing infrastructure compared to the new needs, inadequate bandwidth required

Over the course of 2013 and 2014 it has become clearer that African governments have made greater efforts to ensure the effective delivery of submarine cable bandwidth to end-users via enhanced inter-city and metropolitan fiber networks as well as end-user broadband deployment. The weakness of the continent's international bandwidth is not due to a lack of submarine cable deployment but rather a series of market failures which include, discriminatory access to submarine cable capacity and international gateways, exorbitant backhaul and interconnection fees, expensive domestic transit prices, lack of intercity fiber connectivity, uncompetitive broadband access infrastructure.

However, despite the volume of the investment and the availability of an important infrastructure of submarine cables that can provide significant bandwidth, some inadequacies persist:

- Some landlocked countries in Africa that require cross-border terrestrial capacity to access international connectivity at cable landing stations,
- Number of countries is still underperforming due to policy and regulatory shortfalls
- Evidence that cross-border connections are still limited, resulting in indirect traffic exchange
- In countries where there will be only one or two cables, there may be need for some form of price regulation.

In Africa, there are 16 landlocked countries, which by definition cannot benefit **directly** access to a cable landing station. The landlocked countries may benefit from the presence of multiple submarine landing station in various neighboring countries, by taking part in the setting up or operation of a landing in a neighboring country, by deploying a terrestrial infrastructure improved with that country, or by developing a virtual station of submarine cable at their border.



(24)

5. PROMOTING THE MARKET OF SUBMARINE CABLE

The majority of the systems installed since the last decade both on the West of the African continent coast and the East side, experienced upgrades. Most of them are undergoing upgrades with 100G technologies which enable the system to ultimately carry capacity in excess of 10Tbps and more. Upgrading 10G systems to 100G enable affordable Internet access and a smoother evolution path for the future, incorporate more countries on submarine existing systems, address the growing demand for connectivity throughout the continent, and boost traffic to meet the growing capacity demands of the customers.

The main systems upgraded in Africa:

- **Main one** : upgraded with 100G + new branch (Morocco, Canary, Cote d'Ivoire, Senegal)
- **EASSY**: *Upgrade with 100G* + Upgrade to 10,000km subsea system linking South Africa to Sudan
- **WACS:** Upgraded with 100G (from South Africa to Portugal and Portugal to United Kingdom)
- **ACE :** Upgraded with 100G + 2 new branch (Cotonou,, Benin and Tenerife, Canary Islands, Spain).
- **SMW4**: Upgraded to 100G

Strengthen the existing capacity

As reported above, the submarine cable infrastructure will be strengthened by the entry into service of new systems that will offer a wider bandwidth to respond to the new challenge of the future. Despite the apparent disconnect between submarine bandwidth and end-users, growth in Sub-Saharan African bandwidth demand continues to exceed forecasts. Several initiatives would further expand sub-Saharan connectivity.

Most of the proposed investment in Sub-Saharan African undersea market focuses on the construction of transatlantic systems between Africa and Latin America. Some projects specifically target the linguistic ties between Lusophone countries including Brazil and Angola.

However, as of mid-2014, the proposed South Atlantic cables had struggled to gain traction.
As reported by Terabit Consulting, the Proposed Sub-Saharan African Intercontinental Systems are indicated in the table below.

System	Owners
South Atlantic Cable System (SACS) (formerly Angola-Brazil)	Angola Cables / Telebras
South Atlantic Express (SAEx)	South Atlantic Express Cable Ltd.

(25)

New Mechanisms, Models and law to access and to govern Submarine Cable stations:

Models and law to access and to govern

Prior to 2006, the operation of a landing submarine cable in most African countries was a monopoly granted to the incumbent historical operators. The only submarine cable linking the Sub-Saharan Africa to the Internet, on the West Coast, came into service in 2002. Despite high prices and demand for additional cables, policy makers opposed the liberalization of the international market of data in most countries. Since this time, much work has been done in terms of regulation, new model and Law. These measures and models have contributed to the promotion of investment in Africa.

Public-private partnership (PPP): This partnership model has been at the origin of a large expansion of submarine cables in West Africa based on a regulation organizing an open access to cable landing stations in the countries of West Africa coast. This model has been supported by The World Bank, ECOWAS and ITU.

Case of Gambia, Nigeria and Ghana
Thanks to **PPP** partnership, it was recorded the deployment of multiple systems including
Private systems (Main One, Glo-1), And Consortium systems (WACS, ACE).

Case of Kenya
Kenyan Government has launched a **reform of its licensing regime** to support the deployment of new cables.
In 2008, the government introduced a unified licensing regime in which the number of licenses was not limited and any qualified actor could acquire a license of submarine cable station for a fixed price of 15 million KES (US $ 175,000). As consequence, 3 licenses of submarine stations cable were attributed: **TEAMS, SEACOM, EASSy**

Some states have established ICT development agencies. Mention can be made here of AgeTIC (*Agence des Technologies de l'Information et de la Communication*) in Mali, and AgeNTIC (*AgenceNationale des Technologies de l'Information et de la Communication*) in Benin. These agencies work for the development of ICTs in their countries and act as implementing agencies of government projects in the ICT field. With insignificant exception, all countries in sub-Saharan Africa have an autonomous and independent national regulatory authority (NRA). In the Republic of Guinea, the national regulatory authority is under the direct supervision of the telecommunications ministry.
NRAs intervene in the Internet access market by controlling wholesale and retail prices and enforcing regulations. The NRAs have to ensure interconnectivity of networks and infrastructure sharing, and these are legal requirements under the telecommunications codes of many countries. These two aspects of regulation are necessary for the rapid development of Internet connectivity in sub-Saharan Africa.

WATRO: **W**est **A**frican **T**elecommunications **R**egulators' another tool of regulation. Assembly, consisting of the ECOWAS, Economic Community of West African States, common regulatory environment for the region that would foster more rapid and cost effective telecommunications infrastructure open access.
Liberalization and open access to submarine cable landing stations have boosted the deployment of new submarine systems in West Africa. These mechanisms enabled the development of the market.
Further evidence of the success of this policy, other submarines cables would soon arrive on the shores of West African cost.

Constraints affecting the access to submarine cable capacity:
Despite greater efforts made by African governments to ensure the effective delivery of submarine cable bandwidth, Sub-Saharan Africa still suffers from :

- low levels of connectivity,
- high pricing of bandwidth and Internet services.

Per-capita international bandwidth:
less than 1 Kbps in Sub-Saharan Africa
100 Kbps per capita in Western Europe.

The continent's lack of access to affordable and reliable international bandwidth has been a significant development constraint and a key obstacle to economic growth while hindering social development projects.
The weakness of the continent's international bandwidth is not due to a lack of submarine cable deployment but rather a series of market failures which include:

- Discriminatory access to submarine capacity and international gateways,
- Exorbitant backhaul and interconnection fees,
- Expensive domestic transit prices

The infrastructure leasing market is generally uncompetitive as a result of the lack of broadband Infrastructure. To illustrate this, the case of Niger in West Africa is considered.

Niger is a landlocked country that borders on seven countries (Algeria, Benin, Burkina Faso, Chad, Libya, Mali, and Nigeria). Among those seven countries, four (Algeria, Benin, Libya, and Nigeria) are coastal countries with submarine cable landing stations.
The lack of infrastructure between Niger and its neighbours effectively forces Niger to use the Cotonou landing station of the SAT 3 submarine cable because the country is connected only via Benin. Niger is therefore chronically dependent on the Cotonou landing station and cannot take advantage of competition to negotiate a lower price.

However, and in order to boost the development of bandwidth, it is recommended to persevere in the same policy which has amongst Africa growth observed on submarine cables domain. The rest of the countries of Africa should follow the same mechanisms which were at the origin of the development recorded. It's recommended:

- Adopt National Broadband Strategy
- Reassure investors through clear policy and transparent laws
- Provide Equal access to international bandwidth
- Promote Projects sponsored by development financial institutions to expand terrestrial fiber connectivity
- Facilitate infrastructure sharing Public Private Partnerships
- Regulatory regime by allowing competition, in particular markets related to submarine cables and international gateways
- Reduce the tax burden
- Improve access for landlocked bandwidth
- Improving transport and distribution terrestrial networks

Provide solid training on fiber optical and new technologies for the human resources.

To cope with cable cuts

According to some analyses:

- Nearly 90% of cable faults arise from environmental factors and human activities often referred to as "external aggression".
- 10% due to Component failures and unknown factors.
- Environmental aggression, such as storms, earthquakes, and volcanic activity, typically damage cables further away from shore.
- Human activity in less than 200meters of water accounts for most external aggression, including fishing net entanglement, dropped anchors, and mining operations.

- Accordingly, submarine cable breaks are typically concentrated where these activities occur.

Anyway, a good culture and best practice of exploitation and management of submarine cables can prevent and reduce the cut of this infrastructure. This culture can be acquired through:

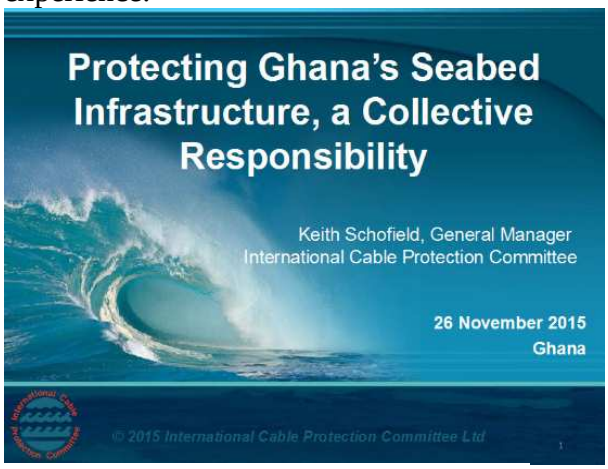
Seminary and Forums[2]

You can refer to this effect to the workshop on "Submarine Cable Awareness" organized on 2015 in Accra (Ghana- West Africa) by submarine cable and pipeline infrastructure owners and landing parties -namely MainOne Cable, MTN (WACS) Dolphin (ACE Cable) and the West Africa Gas Pipeline Company (WAPCo).

The workshop was attended by stakeholders from sectors such as fisheries, oil and gas, transport, the Navy, National Communication Authority and telecommunication companies. Participants hinted that the workshop will not be a one-off event, as several other activities have been planned to increase awareness about the need to protect the cable and pipeline infrastructure.

([2])source:http://www.ghanaweb.com/GhanaHomePage/NewsArchive/Fibre-optic-operators-call-for-cable-protection-law-397325

During his presentation on the occasion of the event, ICPC's General Manager included information on how the interests of different seabed users are addressed internationally by ICPC members (which include five governments), and stated: "This gathering provides an excellent foundation for increased communication and collaboration between different seabed interests to increase the resilience of Ghana's international connections while paying due regard to other seabed users." ICPC's General Manager further commented, "Ghana's proud progress in developing its international trade and economic development can be underpinned both by the protection of her critical infrastructure and by delivering Ghanaian solutions informed by international experience."



Source : ICPC_Ghana_Awareness_Workshop_News_Release_pdf

(26)

ICPC's recommendations

- Dissemination of cable route information
- Stakeholder Liaison & Education
- Monitoring Security of Cables Route
  - Air and Sea Patrols
  - Terrestrial Patrols
- Legal: National Legislation could help reduce the risk of cable damage
- Vessel Monitoring System (VMS)
- Automatic Identification System (AIS)

Submarine cables security is further enhanced through good practice and accustomed rigorous and persistent maintenance of this infrastructure which include also:

- Strengthen the protection of the cable at the shore end (to reduce

the risk and accidents of fishing nets)

- Regulate the management and protection of subsea cable
- Ensure the security and maximize the redundancy
- Ensure all procedures of maintenance according to the ICPC recommendations.
- Staff qualified on the control of submarine cable route and coordination process
- All African owners of submarine cable to join ICPC.

If despite awareness campaigns, ships were to cut cables, they will be judged fully responsible for any fees related to the repair, but also for financial and moral damages caused to Millions of Internet users and businesses. The issue needs a regional and international legislation.

6. CONCLUSION

The last 20 years have been very conducive to Africa, which continue to catch up its backlog for decades, on the other parts of the world. Indeed, the African ICT sector records incomparable growth. This rapid evolution is explained by three major changes that have occurred over the past ten years. The massive adoption of technologies of the information on the continent, the importance and huge foreign investment in Africa, finally, the policies and institutions put in place to regulate the sector of ICTs in Africa helped to ensure its growth.

In sum, the pyramid shape of the structure of the African population, non-saturation of the market and the shortage of basic infrastructure, the advent of new technologies (4G, LTE), the potential of access to bandwidth of landlocked countries whose connection rate is still very low, guarantee the existence of a potential for growth in the submarine sector in Africa**.**

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