Submarine and terrestrial fibre-optic cabling in continental Africa

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The significance of telecommunications cannot be over-emphasized in today's technology landscape; neither can the importance of fibre-optic cables to produce extremely high speed (bandwidth) transmission of data between devices. Moreover, the construction and deployment of the fibre-optic medium of data transmission is nowadays considered to be an important step to economic growth and development. Both the submarine (undersea) communication cables, which connect countries and continents to the internet, and their terrestrial counterparts, which extend this connectivity to landlocked countries or urban centres within a country (that has a submarine access),are significant in this context.

The African bandwidth problem

Data from the bandwidth consortium (BWC) will be used to illustrate Africa's bandwidth problem compared to the rest of world. The consortium was launched in 2005 to address the minuscule amount of bandwidth available to the major universities in Africa, and to specifically join efforts to address the problem via solicitations for funding from international organizations. BWC consists of 11 African universities and tertiary institutions, including in GHANA (Association of African Universities, University of Education-Winneba, University of Ghana); MOZAMBIQUE (Eduardo Mondlane University), UGANDA (Makerere University), NIGERIA (Ahmadu Bello University, Bayero University, Obafemi Awolowo University, University of Ibadan, University of Jos, University of Port Harcourt); TANZANIA (University of Dares Salaam) and KENYA (KENET). Table 1 below shows the initial bandwidth available to a selection of the member institutions. Although this data is a few years old, my interaction with some of these institutions show that the situation hasnot reallychanged significantly for most of them.

From the last column in the table, the average bandwidth that the major universities in Africa have is approximately 7.2 megabits per second, which has to be shared amongst all the students, lecturers, and staff of the university. The situation is not any better in government ministries and agencies. Using Nigeria as an example, the bandwidth available to these establishments is typically 5 megabits per second or less.

Now, let us compare these numbers with the average bandwidth available to a single household in the United States of America. This number is 10 megabits per second, with an average of 4 persons per household. The shortfall in Africa is obviously mindboggling. This situation appears to have motivated the aggressive cabling initiatives that we have seen in Africa in the past few years. The fact that the BWC does not obtain its bandwidth through fibre optics does not invalidate the essence of the message in this section, which is to demonstrate the modest global internet connectivity in continental Africa.

[illegible]	[illegible]	[illegible]	[illegible]
AAU	512	500	1012
KENET	5000	2000	7000
UEW (Winneba)	5888	2000	7888
Eduardo Mondlane	8500	4000	12500
Dar - es Salaam	5000	4000	9000
Ahmadu Bello	2560	4000	6560
Port Harcourt	2560	2500	5060
Ghana	5120	4000	9120
Bayero	2048	2500	4548
Obafemi Awolowo	2560	4000	6560
Jos	2560	4000	6560
Ibadan	3840	4000	7840
Makerere	5000	5000	10000
TOTAL	51148	42500	93648

Table 1 First year bandwidth allocation to BWC member institutions. The data is a few years old and the situation might have improved in a few of the institutions. Table is taken from the BWC website.

Fibre optic-cable basics

Fibre-optic cables in telecommunications are a medium for transmitting data (text, sound, videos, movies, etc.) from one device to another. To move data, it must first be encoded into patterns that can be recognized by the device that will forward the data or receive the data at the other end of the transmission medium. The encoded data is converted into a series of patterns of ones ("on") and zeroes ("off"), also known as bits. These bits are arranged in the logical order required by the rules (protocols) for communication in the transmission systems involved. The bits travel over a physical medium, of which there are three main types: copper cable, glass-fibre optical cable, or wirelessly in waves through air. These media are capable of carrying a signal, respectively in the form of voltage, light, or radio (electromagnetic) waves from one device to another.

Copper is the most common medium used for data transfer between network devices, and has been used for several decades. Copper's high electric conductivity makes it suitable as a medium for transferring data in the form of pulses of electric voltage. For the fibre-optic option, the cable carries light pulses through special, hair-thin glass fibres for the purpose of transferring the data.

Why the love offibre-optic cable?

With light travelling at approximately 186,000 miles per second, it isn't surprising that, of the three data transmission media, a fibre-optic cable offers the fastest means of data transfer. That is, fibre has the greatest bandwidth. A single copper pair conductor can carry six phone calls, whereas a single fibre-optic cable pair can carry more than 2.5 million phone calls at the same time! This is the basis of our love for fibre-optic cable.

Fibre cables require some care

Afibre-optic cable and the connectors that go with it are much more expensive than copper cable and its accessories. Fibre-optic cables are also less rugged compared to copper cables. A laser or a light-emitting diode (LED) is used to convert the bit version of the data to the light pulses that are transferred. At the receiving end, the light signal is interpreted and the bit pattern decoded by devices known as photodiodes. Because lasers can be intense and can damage the human eye, extra care is usually required when installing a fibre-optic cable.

The African fibrecabling efforts

Somehow, in Africa, we have always found ourselves on the catching-up end of many technologies, of whichfibre-optics deployment is one. For example, not an inch of fibre-optic cable was laid in Africa prior to the year 1999. The historical evolution of fibre-optics in Africa will be summarized below for submarine cables, which will be followed by a short note on terrestrial cable efforts around the continent.

Historical development of submarine cable in Africa

The historical development of submarine fibre cabling in Africa is described in this section. The material here is essentially the author's interpretation of the graphical depiction contained in "African Undersea Cables – A History," by Steve Song.

*Year 2000:*In the first quarter of 2000, the SEA-ME-WE3 fibre line was laid from London (England) via the west coast of Spain and into the Mediterranean Sea, through Egypt, and all the way to Mumbai in India, via Jeddah in Saudi Arabia, and Karachi in Pakistan.

Year 2001: The famous SAT3 cable was laid in the second quarter of 2001. This cable system services the West African coast, from Spain to South Africa, with branches to Dakar (Senegal), Abidjan (Ivory Coast), Accra (Ghana), Lome (Togo), Coutonou (Benin), Lagos (Nigeria), Douala (Cameroon), and through Gabon and Angola. From South Africa, the fibre was laid in the Atlantic Ocean, east of Africa. Note that at this point in time, the east coast of Africa was omitted, and countries like Somalia, Kenya, and Tanzania did not have fibre.Figure 1 (a) shows SAT3 line, which is inclusive of SEA-ME-WE3.

Year 2005: The SEA-ME-WE3 was extended to Marseille, France in the fourth quarter of 2005. This new line was dubbed SEA-ME-WE4. This is shown in Figure 1 (b).

Year 2009: The SEACOM layout was deployed in the second quarter of the year 2009. This line is basically an extension of SEA-ME-WE4 to the east African coast to service Mombasa (Kenya), DaresSalam (Tanzania), and Maputo (Mozambique), down to South Africa. The line is also extended in the north to the United Arab Emirates (UAE). The TEAMs line was laid in the third quarter of 2009, and it goes from Mombasa (Kenya) to UAE. The LION line connecting Madagascar to Reunion Island in the east coast of Madagascar in the Atlantic Ocean was laid in the fourth quarter of 2009.

Year 2010: During the third quarter of 2010, the company MainOne laid its fibre along the west coast of Africa, to connect Portugal (Spain), Casablanca (Morocco), Dakar (Senegal), Abidjan (Cote D'Ivoire), Accra (Ghana), and ending in Lagos (Nigeria). During the same period, the EASSy line was laid along the east coast of Africa, from Port Sudan (Sudan) to Djibouti, to Mogadishu (Somalia), Mombasa (Kenya), DaresSalam (Tanzania), to Madagascar in the Atlantic Ocean, Maputo (Mozambique) and to South Africa. Also during the same period, the GLO1 line was laid, which is essentially the same route as MainOne, but now goes all the way to London (England), with an extra branch in Northern Spain. In the fourth quarter of the year, the Madagascar-Reunion line now has a line that intercepts SEA-ME-WE4. See Figure 1 (c) for some of these cable lines.

Year 2011: In the second quarter of 2011, the EIG line was laid to go from London (England) through the west coast of Spain, to Marseilles (France), Tripoli (Libya), and along

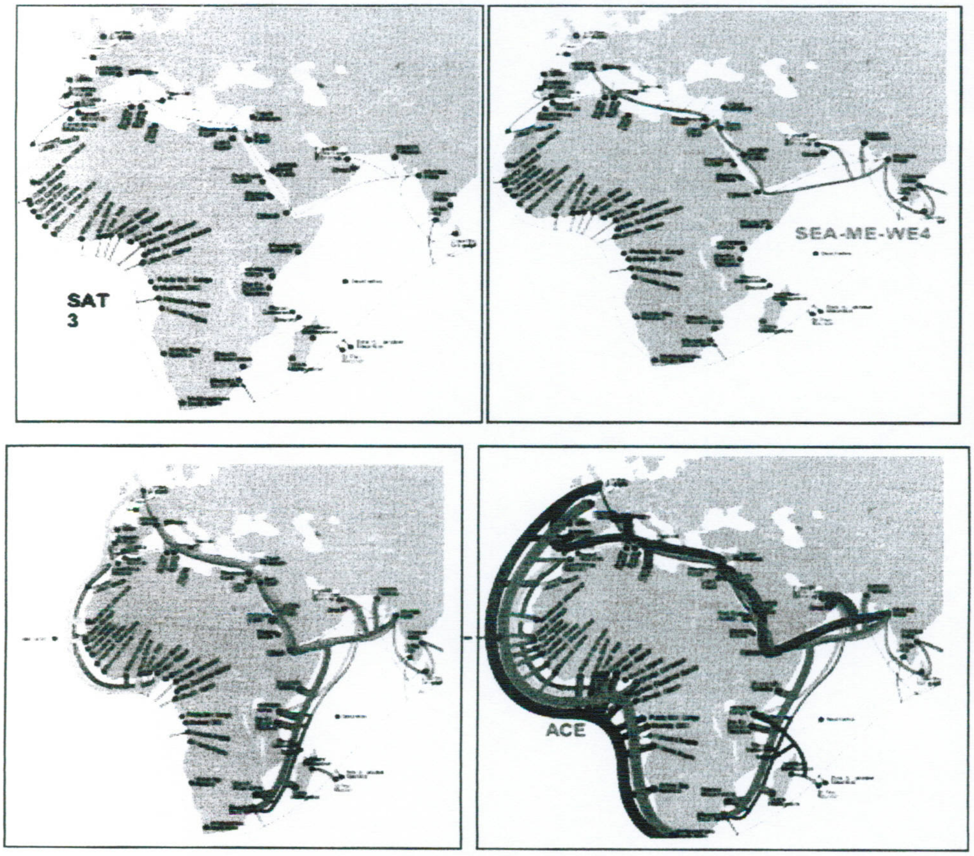

Figure 1 Evolution of fiber optic layout in and around Africa. The fibre-optic cable medium was virtually non-existent in Africa prior to 1999, but saw an explosion within a decade: a) 2001 - Quarter 2, b) 2005 - Quarter 4, c) 2010 - Quarter 3, and d) 2012 – Quarter 3. The colour code is as follows: Thin grey: SAT3 (SEA-ME-WE3), Light Blue: (SEA-ME-WE4), Thick Yellow: Glo1, Thick Dark Blue: EASSy, Brick Red: SEACOM, Light Green: TEAMS, Peach: LION, Olive: MainOne, Thick Purple: WACS, Dark Green: LION2, Thick Brown: EIG, Thick Peach: ACE, Baby Pink: SEAS. Note that because of overlap, some of the lines are not visible. ***ACE: West African Cable System, WACS: West African Cable System.***

The information was extracted from "African Undersea Cables – A History" by Steve Song.

the Mediterranean Sea all the way to UAE and Mumbai (India). During the same period, the African west-coast line WACS came up, almost following the SAT 3 route, but branching into more countries (Togo, Congo, Democratic Republic of Congo, and Namibia). However, this line does not branch into Senegal, Gabon, or Angola. The SEAS cabling from DaresSalam (Tanzania) into an island in the Atlantic Ocean East of Mombasa was carried out.

Year 2012: The LION2 line was laid, which connects Mombasa to the middle of the LION line somewhere inside the Atlantic Ocean. The ACE line came out less than six months ago. This cable runs along the west coast of Africa, similar to SAT 3, but with branches into virtually **all** countries on the west coast of Africa.

The table below, adopted from "African Undersea Cables" online publication summarizes a few attributes of a selection of the cabling initiatives. Please contact the original source for more information, such as the ownership of the various cable lines.

	Seacom	EASSy	TEAMs	WACS	MainOne	GLO1	ACE	SAex
Cost (millions of USD)	650	265	130	600	240	800	700	500
Length (km)	13,700	10,000	4,500	14,000	7,000	9,500	14,000	9,000
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
Completion	July 2009	July 2010	Sept 2009	Q3 2011	Q2 2010	Q3 2010	Q2 2012	Q2 2013

Table 2A few attributes of a selection of the African submarine cabling initiatives. The table has been adopted from "African Undersea Cables" online publication. Please refer to the original source (e.g., by "googling") for more information, such as the ownership of the various cables. In the table, cable length is in kilometers, Tb/s stands for terabits per second,which refers to the speed of data transfer through the cables. Note that"tera" implies one million in a million places (or one followed by twelve zeroes).

Terrestrial cabling efforts in Africa

The prolific rate at which submarine cable is being laid in Africa is matched by a similar energy in the terrestrial cable arena. For example, most African countries, including Angola, Benin Republic, Botswana, Burkina Faso, Cameroon,Cote d'Ivoire,Djibouti, Gambia, Madagascar, Malawi, Mali, Mozambique, Namibia,Rwanda, Senegal, Somalia, Sudan, Tanzania, Togo, Uganda, and Zambia have at least one terrestrial fibre cabling project. More resourceful countries, such as Nigeria and South Africa have an abundance of these projects. For example in Nigeria, the following companies are laying fibre cables all over the country: Glo, Nitel, Phase3 Telecoms, Suburban Telecoms, 21st Century, MTN Nigeria, and Multi-Links. The companies laying fibres in South Africa include Telkom, Broadband Infraco, Neotel, Dark Fibre Africa (DFA), Fibreco, NLD Consortium, and OneDotCom.

The map below shows the fibre networks in South Africa.

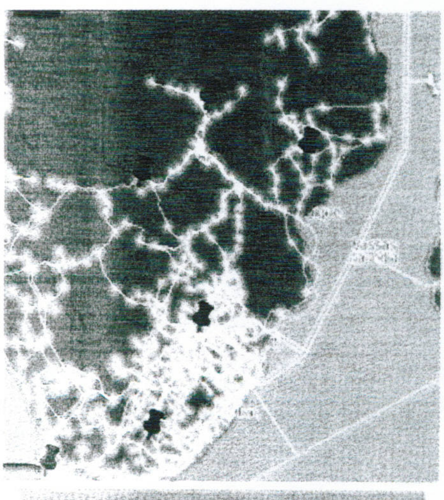

Figure 2Network of fibre optic cables in South Africa. From Africa Bandwidth Maps (http://www.africabandwidthmps.com)

Whither impact?

Given the aggressiveness with which fibre is being laid in all parts of Africa, it is fair to expect significant improvement in the bandwidth situation in the continent. As the data presented earlier in this article shows, it is the case that the bandwidth problem in Africa still persists to a significant extent. I can point to several reasons for this apparent ineffectiveness. One issue is affordability by consumers. As Table 2 shows, the cost of laying fibre cables is exorbitant. Therefore, the cost passed on to the consumer appears to be too much for the consumer, given the poverty level in most African countries. However, as the initial costs of the projects are recouped, the expectation is that the costs passed on to consumers will reduce gradually.

Another issue with the fibre medium is data transmission in the so-called "last mile," which refers to distance between the location of the computer requiring internet access and the nearest fibre line. In the developed countries the fibre is often brought to the computer device, wherever it is located inside a building. As of today, fibre deployment in the last mile remains an issue in African countries. This means that other means, mostly radio, are used for this part of the transmission. The weakest link determines the overall bandwidth, meaning that joining a low bandwidth radio transmission to a fibre line leads to an overall low bandwidth transmission.

It is also the case that the potential capacity of existing submarine cables has not been tapped. So, a question is whether or not we shouldn't slow down new cable construction and try to utilize what has been laid down so far. It is the belief of Tim Stronge, an analyst for TeleGeography, that "capacity constraints are not driving most new cable projects!" His opinion is that "operators are deploying new systems for a variety of reasons, including physical route diversity, latency reduction, strategic advantage, and the lure of relatively high price margins on some routes." The proliferation of high bandwidth demanding applications from tablet and mobile devices on 3G and 4G networks that enable live video calls, movies and TV on demand in more developed countries may also be encouraging several of the corporations laying the cables to get ahead of the expected demand as it takes several years to get cable projects from vision and planning to deployment. So far, in many other parts of the world, the maxim has proven true that if you build the bandwidth, developers and consumers will find use for it.

Conclusion

Anyone will be pleased by the numerous fibre cabling initiatives that are taking place all over Africa. However, the projects need to be truly transitioned in order to improve the continent's internet connectivity and therefore the continent's information and communications technology (ICT) portfolio. It is well known that ICT drives global economy these days. Affordable and technologically effective means of handling the last mile has to be implemented, and the cost of fibre-optic cableservice to the consumer has to be brought down considerably, so that ordinary Africans can afford high bandwidth internet connections.

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