Building the African Union Continental-wide eHealth Network: Making the Case for IP Wireless Broadband Networks

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Abstract

This paper reviews the African Union New Economic Development for Africa's strategy for synergy between Health and Telecommunication sector development. The need to build a continental-wide telecommunication infrastructure for supporting health system and health human capacity development in Africa for the achievement of the Millennium Development Goals targets is identified as an urgent initiative. Hence, to achieve the goal of this proposed initiative, a case for making use of low-cost and easy to implement IP wireless broadband networks such as GPRS/3G/HSPDA, WiFi, WiMax and VSATs is proposed as the most appropriate solution. Furthermore, the World Health Organization African Health InfoWay concept is adopted here to push this argument forward. In presenting the case, Also, a distinction between terrestrial and space based IP wireless broadband networks is made in order to capture emergent telecommunication development on the continent. Making a case for terrestrial based IP wireless network is a focus in this paper and a case study analysis of a near similar continental-wide eHealth network in Africa is employed to contextualize the argument here. This reveals an increasing use of wireless IP broadband for eHealth networks in some African nations. But, the combined use of both types of wireless networks with fiber-optics seems to be appropriate for now. However, terrestrial IP wireless and regional fiber-optics networks are argued here as the most appropriate platform for building a continental-wide eHealth network.

1. Introduction

The African Union New Partnership for Africa's Development (AU/NEPAD) Health Strategy [1] positions health as an integral and a major prerequisite to the achievement of human resource, economic, infrastructure agricultural and environmental developments of the continent. However, the poor state of health systems in Africa has been a matter of numerous policies and fora discourses, but with limited commensurate actions or impacts. The recently released health strategy in 2007 by AU/NEPAD titled "Strengthening of Health Systems for Equity and Development in Africa: Africa Health Strategy 2007-2015" [2] supports this point. This strategic document sheds light on what it is known as the "triple burden" of communicable, non-communicable and violence and traumatic injuries and their associated and resultant social consequences or impacts on retarding Africa's development. The document also raises alarm on the possibility of not meeting the health-related Millennium Development Goals (MDGs) targets of achieving considerable improvement on certain disease burdens by the year 2015. These MDGs-related diseases [3] include:

1. To reduce child mortality from childhood diseases
2. To improve maternal health from associated causes.
3. To combat HIV/AIDS, Tuberculosis (TB) malaria.

This NEPAD Health Strategy [1] together with the new Africa Health Strategy 2007-2015 paints and describes the health picture of the continent in statistical illustrations. For example HIV/AIDS epidemic on the African continent is extremely alarming with 2.4 million people to have died from AIDS and with estimated 3.5 million new HIV infections in 2002. The HIV prevalence is reported to as high as 30% with an estimated 2.6% economic growth retardation in some African countries. Malaria causes 1 million deaths annually 600,000 of which are children under the age of five years old. Malaria has a reported 1.3% negative impact on economic growth in severely affected countries. Under five years old childhood deaths are also from AIDS-related diarrhoea accounting for 800,000 deaths, 500, 000 from measles and 1.2 million from pneumonia. Tuberculosis has also achieved the level of a public health problem with 300 cases per 100 000 population and 600,000 annual deaths especially in the middle age of the population reported.

In addition, Africa is reported to have the highest maternal mortality rate in the world with about 1000

deaths per 100 000 live births recorded. In as much that no improvement is achieved within the health system to deal with this public health problem, a projected 2.5 million and 7.5 million infantile deaths will be recorded between 2001 and 2010.

The burden of these diseases has impacted negatively on all fabrics of the society and health systems in Africa. For example, deaths from AIDS have resulted in the depletion of skilled workforce especially health personnel as a result of high mortality rates. Health personnel mortality is further complicated by massive brain drain within the health systems of most African countries [1, 2]. This brain drain is binary in nature: internal rural–urban and external local-international migration of qualified health personnel. Statistically speaking, Africa is reported to have 10% of the world population but bears 25% of the global disease burden managed by only 3% of the global health workforce [2]. These figures are presented here to vividly illustrate the poor state of Africa's population health and also to highlight the need for exploring alternative strategies for healthcare delivery in Africa.

As it is an overarching goal of the Africa Health Strategy [1] to improve Africa's population health through equitable access to essential health services by the year 2015 in order to contribute to the socio-economic development of the continent. Achieving this laudable objective might demand strengthening Africa's health systems through multi-sectoral collaboration and cooperation. Understanding that multisectorality in service and infrastructure development is a practice recommended in the NEPAD Africa Health Strategy, this paper will therefore build on this strategy by advocating multi-sectorality in developing Africa's health system. Of particular focus here is creating linkages with NEPAD's of Information and Communication Technologies (ICTs) infrastructure development strategy. Moreover, NEPAD's Action Plan Strategy on health sector development has as a policy[4] of making health service delivery to be facilitated through bridging of digital divide with regional telecommunication (ICTs) infrastructure development.

Still on NEPAD, its Action Plan Strategy on ICT infrastructure sector development proposed the development of an African Regional Telemedicine network as one of its six strategic initiatives. As a matter of short and medium term imperative, the AU has further made a commitment to support a of the building of a continent-wide telecommunication network with wireless and satellite technology [4].

Hence, in this paper a case will be made for a close alignment of the telecommunications infrastructure development plan with the health system strategic development in Africa.

A background to this proposition is NEPAD's Health Strategy for the year 2007-2015 [2] position of making ICTs as integral to the building of a functional health system on the continent. Here the application of telecommunication innovations for enhancing Africa's health systems operations and performance is being promoted for meeting the need of:

1. An effective communication system;
2. the integration and access to distributed health information systems (HIS); and
3. the extension of health services to isolated and rural health facilities and health personnel

These identified functional needs are also in congruence with the WHO's objectives of using ICTs for health system development [5].

In lieu of NEPAD's aim of using ICTs to develop the health systems in Africa, the rest of this paper will be focused on presenting a model of this can be achieved. The use of ICTs in healthcare will be explored and a case will be made for the use of mobile /wireless technologies for the building of a continental-wide health telecommunication network.

2. Health and telecommunications in synergy

The exploitation of the potentials inherent in the effective, appropriate and contextual applications of ICTs could provide an alternative or complementary model for health system development in Africa [6]. However, it is worth noting that using ICTs for health system development in Africa is also in line with global development agendas. For example, the World Health Organization (WHO) as the custodian of global health has provided strategic leadership in the use of ICTs for health system development [5]. Using ICTs for health in low-resource settings as in Africa is also of strategic interest to the WHO.

eHealth as defined by the WHO is the use in the health sector of digital data, transmitted, stored and retrieved electronically either locally or at a distance in the support of healthcare processes [7]. It is further regarded by WHO as a cost-effective and secure use of ICTs for supporting healthcare processes such as healthcare service delivery, disease surveillance, health education and knowledge archiving and delivery, and health research enterprises. eHealth according to the WHO can further be divided into:

1. Tele-education, termed as the use of ICTs for education either locally or at a distance. It is also known as e-learning;
2. Telemedicine, the delivery of health services at a distance through ICTs. For example teleconsultation through telephone or videoconferencing. This is also referred to as telehealth;

3. ICTs for health research, the gathering and analyzing of health system data and information for health service research purposes. This also involves access to health literature and knowledge for research activities; and
4. ICT for health services management refers to the use of ICTs for enabling health system administration and policy formulation.

The WHO has since created a Global eHealth Observatory in 2005 with a role for providing strategic guidance to WHO's member states in the implementation and use of eHealth services [5, 8]. The thrust of the GOe is to leverage eHealth for supporting:

- health system performance
- health human resource capacity
- access to health knowledge
- decision and policy making process
- better health outcomes for patients

Specifically highlighted in the NEPAD Africa Health Strategy is how eHealth can contribute to the development and building of health human capacity, and in supporting and extending health services to the mostly rural, urban and geographically distributed population of the continent [2]. Of specific mention also is the potential of using eHealth for providing a means of maximizing and distributing the skills and knowledge of the health workers located either locally, regionally or internationally.

In congruence with the NEPAD'sAction Plan for Health [4] of building a continental-wide eHealth system, the WHO through its African Regional Office has proposed the building of 'Africa Health Infoway' (AHI) [9]. The concepts employed in developing the AHI will further set the tone for the remaining part of this article.

3. Model for an Africa wide eHealth Network

The AHI is defined as a

system to support the collection of sub national health data and statistics for analysis, dissemination and use to support decision making in Health, and strengthen capacity of African countries to use information in decision making. This will include: data for epidemiological research; indicators for monitoring and evaluation; financial and cost reporting for clinic management; drug, equipment, supply stock reporting for supply management [9].

The AHI has three components but of interest to this paper are ""infostructure" and "connectivity". As lofty as the AHI project plan is, it incorporates only scope of eHealth. Measuring it against the WHO's defined eHealth scope, it only focuses on ICT for health management and ICT for health research sub-components of eHealth. A perceived observation is that due regard is not being paid to other eHealth applications such as telemedicine and tele-education that are central to AU/NEPAD's and WHO's GOe objectives in Africa. This is despite the fact that NEPAD through its e-Africa Commission is involved in the AHI programme. However, in spite of this perceived shortcomings, the idea and concept of AHI is worthy of emulation. Hence, this will be employed here as a model-template for synthesizing knowledge on how to achieve NEPAD's goal of building a continental-wide eHealth network for Africa. Peradventure, the AHI implementers might integrate this observation into their plan before the commencement of any pilot projects. Specific focus of integration will be the *infostructure* and *connectivity* component of AHI. For of simplicity sake, this component will be regarded as *continental eHealth telecommunication infrastructure*.

Building an African continental-wide e-network is not really a new development, NEPAD through its e-Africa Commission has made some progress in the educational sector. The NEPAD e-Schools project [10] is an example. Also, the African Virtual University (AVU), a project led by the World Bank [11] is another example. These two projects are employing the use of satellite wireless telecommunication networks for linking schools and universities together in sharing and exchanging knowledge within the continent. Despite the progress made in the education sector, the health sector seems to be lagging behind.

Infostructure and *connectivity* according to AHI is defined as the: "*design* and *implementation* of *solution architectures*, data exchange standards and the development of integration tools needed to ensure the *interoperability* of databases and *systems* and the reuse of common components to *reduce implementation costs*" [9]. This definition presents an integration of terms that are italicized for emphasis. These italicized terms will be employed in this paper as "scaffolds" for hanging the discussion in this paper. *Implementation cost* as highlighted above is employed here to make a case for using mobile/wireless technologies for the *design* and *implementation* of *solution architectures* of the proposed African continental eHealth telecommunication. For example, evidence that shows wireless ICTs have faster roll-out time (reduced implementation duration), lower maintenance costs and higher network adaptability in comparison with wired networks [12-14]. That is, the reduced implementation cost of wireless ICTs make them suitable for providing connectivity in low-resource settings like in Africa.

Therefore, the next section of this paper will focus on presenting and exploring the several wireless ICTs that have been deployed in some low-resource settings including Africa. Then a case will be made for the building of the proposed *continental eHealth*

telecommunication infrastructure with IP wireless networks.

4. Wireless Networks for telecommunication infrastructure

The use of low-cost wireless telecommunication access technologies for in health education, business and community development in developing countries has been a top agenda for the International Telecommunication Union (ITU) for some time now [14]. Further, a recent publication from ITU tilted "ICT and Telecommunications in the Least Developed Countries: Mid Term Review for the Decade 2001-2010" was focused on the reviewed ITU's efforts in meeting the target of achieving universal access for developing countries by 2010 [13]. This report positions terrestrial and space wireless telecommunication networks as the appropriate and affordable technologies for deployment. This position was supported by ITU's observation of successful wireless ICTs diffusion in these regions. Supporting this notion also is that wireless ICTs have been reported as an appropriate means of providing internet access to rural and urban communities in some developing countries [12]. Hence, it is this internet carrying capability of wireless ICTs that is a focus of this paper.

Using wireless ICTs for providing connectivity in developing countries including Africa is not a recent occurrence but that with a history of experimentation with out-dated and emerging innovative technologies. A scoping exercise carried out by an ITU Working Group (WG) [15] in 1998 provides a suitable illustration in this direction. The exercise aimed at mapping out the different types of wireless ICTs in use for providing communication and internet access and in developing countries between 1998 and 2002 revealed the following. Myriads technologies such as Very High Frequency (VHF), meteor burst communications (MBC), Very Small Aperture Terminals (VSATs), TDMA-point-to-multipoint terrestrial radio system, Wireless Local Loop systems (WLL), satellite, digital satellite radio, wireless router with VOIP, CDMA-450 AND GSM-400, and the IMT-2000 (GSM) families (1G, 2G, 3G networks) were the observed wireless ICTs.

The present wide diffusion and adoption of terrestrial GSM-based wireless telecommunication network in Africa is a phenomenon that has compounded many observers [13]. For example, at the Connect Africa Summit in Rwanda October 2007, African mobile subscribers were put at 198 million at the end of 2006. Based on this present trend, a projected figure of 278 million subscribers was envisioned by the ITU will be attained by the end of 2007 . This simple statistics provides an illustration of how wireless ICTs could be harnessed for building a continental-wide telecommunication network for Africa. However, at the moment most use of GSM wireless telecommunication tools has being that of voice communication with little use for data transmission. Reason for this might be due both technological and policy deficiencies [14, 16]. But this situation is about to change.

The ITU in the World Information Society Report 2007 [17], prescribed that the digital divide movement should shift from focusing solely on "quantity" (i.e number of population with access to mobile phone) to "quality" (i.e. providing access to broadband internet connectivity). That is a paradigmatic shift from focusing on number of people with ICTs' access and connectivity to emphasis on ICTs data carrying capacity and speed of access. Supporting this declaration is the recent development of IP wireless ICTs such as Wireless Fidelity (WiFi) and Worldwide Interoperability for Microwave Access (IEEE 802.16) (WiMAX), 3G/HSPDA and broadband satellite wireless technologies making available internet access and connectivity in some developing countries [14, 16]. WiFi and WiMax IP wireless ICTs have been predicted in the nearest future to be able to attain the present status of a GSM cellular technology architecture [12]. That is to be able to make both mobile and fixed broadband connectivity and access available and affordable to the developing world. However, wireless broadband is already existing in Africa if going by a report produced by the Swedish International Development Agency (SIDA) tilted "Options for Terrestrial Connectivity in Sub-Saharan Africa" [18].

The SIDA report argues for using the existing GPRS/EDGE infrastructure as a benchmark for broadband *architecture solutions* in Africa. Although, the bandwidth of these networks cannot be regarded as broadband in comparison with the global standard, but this could provide foundation for future development. Furthermore, the report argued that wide availability of GSM infrastructure (some already with GPRS/EDGE) in many African countries positions it as an immediate solution for broadband connectivity. Based on this, it might be a practical policy shift to start building the proposed *continental eHealth telecommunication infrastructure* on the existing the wireless GSM telecommunication network. Notwithstanding this present state, telecommunication infrastructure development in Africa is now moving towards a global standard of broadband *solution architectures*.

At the aforementioned summit in Rwanda, commitments were made by the incumbent and emerging telecom operators to move beyond voice to broadband wireless telecommunication deployments.These commitments will include deploying WiFi, WiMAX, 3G and HSDPA broadband wireless ICTs throughout the

continent. However, it must be pointed out that wireless broadband networks are already being deployed in many parts of Africa. For example South Africa has 60% of its population covered by 3G broadband network. A recent report on mobile telephony diffusion in Africa described a pilot projects of using broadband wireless IP ICTs such as GPRS, EDGE and 3G/HSDPA for providing connectivity to Community Information Centres (CICs) and Internet Cafes in South Africa [19].

Likewise, Nigeria and Uganda has up to 90% of the population covered with GPRS networks. Furthermore, in Nigeria, the capital city Abuja is now covered with a WiMax network. In addition, the two biggest GSM telecom operators in the country have recently launched 3.5G networks. The newly launched NigComSat1 satellite with footprint all over Africa also has enormous 3G capability. Generally in Africa broadband WiFi networks have been deployed for numerous pilot developmental projects but what is lacking is to scale beyond this point.

This section has presented briefly trends and development of wireless ICTs in Africa through an historical lens but with a futuristic telescope. The next section will then make a case for their usage in building an Africa-wide eHealth network.

5. Building Africa's continental-wide eHealth network

Health systems as process organizations require the collection and exchange of health data and information with and between different sub-units for effective healthcare delivery [20]. This then requires effective communication and cooperation between health workers and *systems.* Meeting this need will therefore require *solution architectures* with necessary data carrying capacity. Aside, providing access and connectivity to several vertical and horizontal HISs within Africa's health is also valid reason for appropriate *solution architectures* of this nature. A benefit of this kind of solution is that effective patient care and health system performance could be achieved. Thereby, further reinforces the need for a *continental eHealth telecommunication infrastructure* in Africa. IP wireless networks have inherent capacity to provide broadband services such as internet telephony and voice over internet protocol (VOIP), internet and multimedia services i.e. videoconferencing for eHealth purposes . Examples of cases employing IP wireless *solution architectures* for eHealth purposes are abounds. Few will be presented here for supporting their use for building *continental eHealth telecommunication infrastructure* in Africa. These cases are drawn from ongoing and emerging projects in Africa and other developing regions of the world. These are:

1. A large scale and successful wireless eHealth *system* has been implemented in Uganda over the last three years. The Uganda Health Information Network (UHIN) employed over 350 PDAs to empower health workers with access to continuing medical education, for collecting routine health data, and e-mail for communications. This system is built on the existing GPRS wireless network [21].
2. An EDGE-enabled low-cost videoconferencing system that efficiently supported surgical and medical treatment by a health team on a floating hospital in Bangladesh has also been piloted. The system enabled the health team to seek informed second opinions through teleconsultation from local and international specialists. [22].A WiFi network in combination with VSAT has been employed to develop a Voice Over Internet Protocol (VOIP) and web-based telemedicine *system* in South Africa. [23]. Similarly, a recent development in WiFi technology has made it possible to use for it building WAN and this has been used for a large scale eHealth network in rural Peru [24]
3. A WiMax has also been piloted successfully in a telemedicine project in South Africa. The system enabled the exchange of video and digital medical data over a teleconsultation eHealth network [25].

Summarizing, these short cases presented here could be taken as demonstrated evidence to support using broadband wireless IP networks for building the proposed *eHealth telecommunication infrastructure.*

6. The case for IP wireless broadband eHealth network for Africa

The Broadband initiative of NEPAD through the e-Africa Commission has focused mostly on building fibre-optics networks for intra- and inter-continental communication *solution architectures*. This is laudable effort but for Africa to rapidly achieve the goal of a "connected continent", the wireless broadband option might be the most effective approach [13, 16]. In addition, the ubiquity of and the comparative economic advantage of wireless broadband over fibre-optics reinforces this proposition. In the same vein, the use of wireless *solution architectures* were argued to have three times cheaper *implementation cost* than that of fibre-optic alternative with even infinite data transmission capacity [18]. Here however, wireless *solution architectures* are suggested for intra-national transmission. Therefore,

building a *continental eHealth telecommunication infrastructure* in Africa with fiber optics infrastructure might also be an effort in futility. Even though, fiber-optic infrastructure provides the most efficient means for intra- and inter-continental data transmission [18], wireless *solution architectures* however presently provide the best immediate alternative for building ay *telecommunication infrastructure* on the continent [13]. However, ruling out a role for fiber-optics is not also the case as they provide connection to international gateways required for the much needed internet access and connectivity. Supporting this argument is that there is availability of broadband fiber-optics *telecommunication infrastructure* at "coastal" regional and national levels in Africa. An exception to this is the Eastern part of Africa, bridging this *telecommunication infrastructure* gap is however a major priority of the e-Africa Commission under the EASSY project. Landlocked countries also lack access to fiber-optics *telecommunication infrastructure* thereby limiting or precluding their access to internet connectivity. Notwithstanding, fiber-optics *telecommunication infrastructure* are available in some urban cities of "coastal" countries but extension beyond these cities especially to the rural areas is non-existent at the moment. Therefore, extending internet access from the immediate to deficient localities makes the case for wireless *solution architectures* as appropriate platforms. Specifically here is making the case for IP wireless *solution architectures* as appropriate for building a *continental eHealth telecommunication infrastructure* for Africa as listed above in this paper. At this junction, a distinction between terrestrial and space wireless *telecommunication infrastructure* will be made to further broaden the discussion. Satellite wireless *telecommunication infrastructure* especially VSATs are common examples of space networks while examples of terrestrial wireless networks are already listed above in this paper. Implication of this distinction will further be explored below in this paper within a selected case study. Further, this case study taken from an eHealth programme in Africa will also be employed to deepen the discussion of focus.

7. The Case Study

The Multilateral Initiative on Malaria Communication Network (MimCom) project [26] is employed here as the case study. MiMCom project was developed to enable a continental-wide malaria research initiative in Africa. The MimCom *solution architectures* support the communication and information transmission and access of widely distributed national nodes. The project was initiated by the National Library of Medicine (NLM) USA and connects up to 19 centres of excellence malaria research centres within 12 countries together for knowledge transfer and exchange through the internet. At the project's inception in 1999 satellite wireless *telecommunication infrastructure* was employed as a means of connecting the NLM central node with the peripheral African national nodes. This means that internet exchange between African nodes had to be relayed firstly to the NLM central node and before being routed back to the respective national nodes. This prevented optimal communication and cooperation between the African nodes that is required for a knowledge intensive research of this nature. In order to devise appropriate telecommunication *solution architectures* for enabling a *continental eHealth telecommunication infrastructure*, the renowned Royal Institute of Technology (KTH) Sweden was commissioned. KTH in their proposed *design* solution opted for the use VSAT satellite wireless *telecommunication infrastructure* as their desired *solution architectures* for connecting their African nodes together between 1999-2003 [27]. This decision, made after a detailed evaluation of existing *telecommunication infrastructures* with broadband capacity including fiber-optics backbone. It was therefore concluded that for data exchange between African nodes, satellite *telecommunication infrastructure* provides the immediate *solution architectures* over fiber-optics and terrestrial IP wireless (WiFi) for a foreseeable future [27].

In majority of the national nodes, VSATs *telecommunication infrastructure* was deployed as the sole means of accessing the MiMCom *continental eHealth telecommunication infrastructure but* with a notable exception [27]. The exception was a particular national, node where broadband landline was adopted. Notwithstanding, the preferred choice then, a plan was put in place to accommodate future *telecommunication infrastructure* development in the African nodes, However, this was prior to 2004, when fiber-optics *telecommunication infrastructure* was lacking in most African cities. Also then, the broadband capabilities of and terrestrial IP wireless *telecommunication infrastructure* was not fully appreciated. Tracking the trajectory of the MimCom *solution architectures* has however revealed an emergent embracing of terrestrial IP wireless *telecommunication infrastructure* as a *solution architectures.* Supporting this is that increasing numbers of the African national nodes have adopted WiFi and wireless microwave *telecommunication infrastructure* for their internal communication [28].

Analyzing, it can be observed that a gradual shift towards terrestrial IP wireless *telecommunication infrastructure* is emerging especially for intra nodal communications. But, VSAT still remains the preferred *telecommunication infrastructure* for intra-continental communication. However, the continued sustainability of

VSATs for connectivity in Africa has been a matter of evaluation in some projects. For example, evaluation reports on connectivity projects in Zambia and Tanzania listed the exorbitant costs of VSAT bandwidths as a major threat to their sustainability [29, 30].

The present non-availability of fiber-optics and financially non-viable VSAT *telecommunication infrastructure* therefore makes the case for IP wireless *telecommunication infrastructure* for a *continental eHealth telecommunication infrastructure.* , The financial and structural rationality presented in this paper also reinforces this point. Moreover, the various wireless IP *telecommunication infrastructure* enabled eHealth cases presented above in this paper further supports this possibility. From the MiMCom case study, it is obvious that wireless IP *telecommunication infrastructure* can be employed for building national eHealth *solution architectures,* but how do we networked these together? The answer is that presently, VSAT *telecommunication infrastructure* seems to be the appropriate means of linking the different national nodes together in the meanwhile. However with the recent commitments made by the telecom operators at the recently concluded Connect Africa Summit in Rwanda, wireless IP *telecommunication infrastructure* seems to hold the ace for continental-wide *solution architectures.* At national node levels, existing GSM based networks will provide a starting point. Already some countries in Africa have broadband GSM (GPRS/EDGE) networks but this might not still be adequate enough. But with the commitments made by the telecom operators at the Connect Africa Summit, wireless broadband networks such as 3G/HSPDA and WiMax will soon be rolled-out in their countries of operations. For inter-country connectivity, existing terrestrial wireless microwave links and long distance WiFi networks can be employed as a means of interconnecting national nodes. Also, increasingly deployment of fiber-optics undergoing in the continent provides a near future means for achieving the same purpose. Regional fiber-optics *telecommunication infrastructure* aggregation such as those available in West and Southern Africa would make inter-national *solution architectures* available for a rapid development of a *continental eHealth telecommunication infrastructure.*

This still leaves out landlocked countries where ubiquitous wireless IP *telecommunication infrastructure* should be adequate to this bridge the connectivity gap. Interestingly, mobile/wireless telecom operators in Africa have also started aggregating and inter-connecting their networks on regional and even continental basis. This emerging regional wireless aggregation also supports the case being made here for a *continental eHealth telecommunication infrastructure* enabled by wireless IP networks.

Moreover, at present not all cities in Africa have a fiber-optic network and the high cost of their deployment further preclude their ubiquitous availability in the nearest future. Again, this gap in connectivity can also be bridged by using existing and expanding wireless IP *telecommunication infrastructure* on the continent. It important to emphasize here that a total exclusion of space wireless IP network is not being made here. But the lack of an African owned satellite networks and the perceived high cost of deployment relative to terrestrial wireless networks preclude their viability for this set purpose. However, the revamped RASCOM and the new NigComSat1 programmes might be a silver lining on the horizon.

9. Conclusion

As demonstrated in this paper, the vision of continental-wide eHealth *solution architectures* based on mostly wireless IP *telecommunication infrastructure* seems very feasible. However, achieving this lofty vision will involve overcoming the perennial economic, organisational, social, human and even technological barriers. As the first four factors are not the focus of this particular paper, technically, building a *continental eHealth telecommunication infrastructure in* Africa will require setting standards for *interoperability*. Especially, *interoperability* of different wireless IP *telecommunication infrastructure* should be paramount. Ensuring their *interoperability,* exploring the concept of ambient wireless network is a recommended approach. ITU under the Next Generation Networks (NGN) programme is already providing leadership on standardization for interoperability and integration of IP *telecommunication infrastructure*. Furthermore, the European Union (EU), through the Information Society and Technology (IST) programme has developed protocols on how different wireless networks can be made interoperable for building seamless and integrated *solution architectures* under its ambient network project. Touching briefly on financial barrier, high *implementation cost* is also an issue to be considered in choosing a terrestrial IP wireless *solution architectures* especially for eHealth purposes. Notably, this could be more relevant with new and emerging technologies. For example, the much taunted WiMax enabled eHealth network in the Amazonian forest was abandoned due to high cost of equipments that was required for setting up the project [31].

Finally, exploring and exploiting the health and telecommunication multisectorality strategy as being promoted by NEPAD is recommended as appropriate for the timely implementation of this proposal.

10. References

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