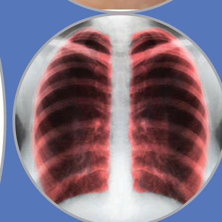
Approved November 2012



Proposed Telehealth System for HIV and AIDS, TB and Malaria Surveillance and Information Sharing in the SADC Region

Acknowledgements

This work was made possible through the collaboration of the Southern African Development Community (SADC) Secretariat with Member States and various stakeholders. The Secretariat would like to acknowledge all the contributions.

We wish to thank Member States of SADC, through their Permanent Secretaries or Directors General, their Department Directors and Programme Managers for HIV and AIDS, TB and Malaria, and other SADC focal points in Member States, for their support during the field assessments. In addition, disease surveillance experts from Member States provided valuable technical input and guidance to the development of the Telehealth system. Data managers and monitoring and evaluation (M&E) experts also reviewed drafts of the data collection instruments and provided technical inputs.

A Technical Review Group composed of senior government officials in the area of surveillance of communicable diseases, and representatives of partner organisations from the international community, as well as from the private sector, reviewed drafts and made recommendations to facilitate finalisation and subsequent approval of the document at the joint SADC Ministerial Meeting of Ministers of Health and Ministers responsible for HIV and AIDS.

The work also benefitted from collaboration with other partners, including the World Health Organization (WHO) and the United States Centres for Diseases Control (CDC). The SADC Secretariat thanks them for their technical inputs in reviewing various drafts of the document, as well as for participating in technical meetings to discuss the work.

The consultant for this work was Global eHealth Consultants, which collected data from the Member States and produced an Assessment Report, which, in turn, informed the current document. Additionally, the consultant provided valuable technical inputs and prepared various drafts of both the assessment and proposed system reports. The work done by Global eHealth Consultants is greatly appreciated.

At the SADC Secretariat the work was led by the Directorate of Social and Human Development and Special Programmes, under the leadership of Mr. Stephen Sianga. The work was coordinated by the SADC Communicable Diseases Project, led by Dr. Ityai Muvandi (Monitoring and Evaluation Expert), under the overall coordination of Mr. Innocent Modisaotsile (Project Coordinator). Members of a Technical Review Group made significant contributions by reviewing various drafts of the work and providing valuable feedback.

Finally, this report would not have been possible without the financial support provided by the African Development Bank (AfDB), to whom SADC Secretariat is grateful for funding this work through their grant to the SADC Secretariat on Communicable Diseases.

ISBN: 978-99968-402-7-2

For more Information

Directorate of Social and Human Development
And Special Programs
SADC Secretariat
Private Bag 0095
Gaborone, Botswana
Tel (267) 395 1863
Fax (267) 397 2848
Email: registry@sadc.int
Website: www.sadc.int

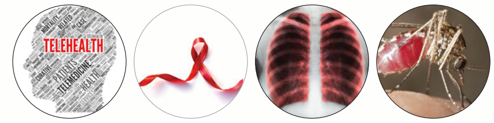
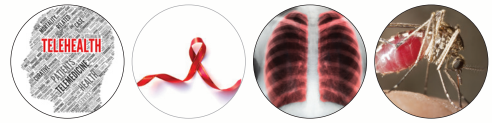
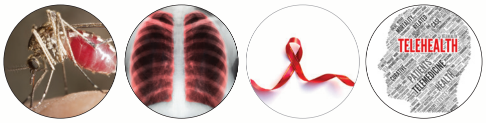


Table of Contents



ACRONYMS AND ABBREVIATIONS

ADF	African Development Fund
ADSL	Asymmetric Digital Subscriber Line
AfDB	African Development Bank
AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral therapy
CDC	Centres for Communicable Disease Prevention and Control (U.S.)
DHIS	District Health Information System
DRC	Democratic Republic of Congo
DSL	Digital Subscriber Loop
GIS	Geographical Information Systems
GSM	Global System for Mobile communications
HIV	Human Immunodeficiency Virus
HMN	Health Metrics Network
ICT	Information and Communication Technology
IDSR	Integrated Disease Surveillance and Response
IHR	International Health Regulations
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MDR-TB	Multi Drug Resistant TB
M&E	Monitoring and Evaluation
NGO	Nongovernmental Organisation
NHIS	National Health Information System
NHLS	National Health Laboratory Service
NICD	National Institute for Communicable Diseases
NICI	National Information and Communication Infrastructure
SADC	Southern African Development Community
SICI	Sectoral Information and Communication Infrastructure
SMS	Short Message Service
SNRL	Supra-National Reference Laboratory
TB	Tuberculosis
TNDS	Telehealth Network for Disease Surveillance
UNECA	United Nations Economic Commission for Africa
UNFPA	United Nations Population Fund
UPS	Uninterruptible Power Supply
UNICEF	United Nations Children Fund
VSAT	Very Small Aperture Terminal
WAN	Wide Area Network
WHO	World Health Organization
WiFi	Trademark of the Wi-Fi Alliance
XDR-TB	Extensively Drug Resistant Tuberculosis



DEFINITION OF TERMS

Information and communication technology (ICT), as a whole, and the Internet, in particular, have ushered in an era of great opportunities in public health and clinical care. It is therefore important to define some of the key terms that pertain to the use of ICT in the health sector: telemedicine, Telehealth, eHealth and mHealth.

Telemedicine: The delivery of health care services, where distance is a critical factor, by health care professionals using ICT for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers. All this occurs in the interest of advancing the health of individuals and their communities (1). An example would be when clinicians obtain second opinions about patients or consult specialists at remote locations about a case, either by telephone, email or through the Internet.

Telehealth: The use of electronic ICT to support long-distance clinical health care, patient and professional health-related education, public health and health administration (2). Telehealth is therefore broader than telemedicine, in that it also includes public health interventions. When health professionals use information and communication tools to interact with other health professionals or with the public in order to support public health interventions, they are engaged in Telehealth activities.

eHealth: A systematic review of published materials carried out in 2005 identified 51 unique definitions for eHealth (3). They ranged from broad and all-embracing statements to concise descriptions, for example:

"eHealth is the use of information and communication technologies (ICT) for health"—WHO, Global Observatory for eHealth, 2005 (4).

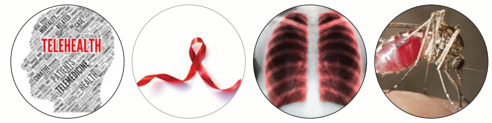
"eHealth is an emerging field of medical informatics, referring to the organisation and delivery of health services and information using the Internet and related technologies. In a broader sense, the term characterises not only a technical development, but also a new way of working, an attitude, and a commitment for networked, global thinking to improve health care locally, regionally, and worldwide by using information and communication technology"—adapted from Eysenbach (2001) (5).

For the purposes of this report, the term eHealth is used as defined by WHO above, i.e. the use of ICT for health. Examples of eHealth include the development, maintenance and use of electronic medical records; the use of the Internet for health purposes; and the employment of decision support tools for diagnosis and/or case management.

mHealth: The term mHealth is a contraction of "mobile eHealth". It broadly encompasses health related uses of mobile telecommunication and multimedia technologies in health service delivery and public health systems (6).

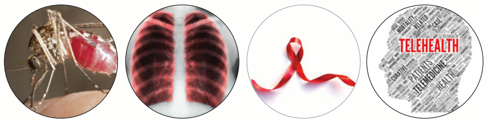
It is therefore eHealth, with the further requirement that the dominant technology platform is a hand-held device, such as a mobile phone (cell phone), personal digital assistant, or more recent devices such as smart phones and tablet computers. The most common examples of mHealth for the purposes of this document are the use of mobile phones for (a) data collection and transfer directly into databases; (b) professional communications among health workers; and (c) consultation of websites with smart phones and tablet computers. If any of the above activities, are performed with the use of mobile devices, then the activities are considered to be mHealth.

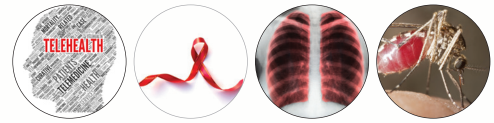
This report deals with Telehealth, but also makes reference to the other terms, especially eHealth, since the latter is the most encompassing of these terms. Appropriate policy and strategy, infrastructure and human resources for eHealth generally would cover telemedicine, Telehealth, and mHealth, as well.



LIST OF FIGURES

LIST OF TABLES


TELEHEALTH



EXECUTIVE SUMMARY

Health challenges in the Southern African Development Community (SADC) continue to undermine the attainment of a SADC vision that includes healthy citizens in all its Member States. Among these health challenges are the communicable diseases, human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS), Tuberculosis (TB) and Malaria.

In order to help address these challenges, the SADC Protocol on Health was invoked to produce an agreement on the harmonisation of disease surveillance throughout the SADC region. To support such harmonisation, and in accordance with the e-SADC framework, the SADC Secretariat has undertaken a study to assess the status of Telehealth and its potential as a surveillance and information-sharing tool for HIV and AIDS, TB and Malaria. A further objective of the study was to propose a Telehealth system that could serve as a platform for strengthening all aspects of surveillance of these diseases, as well as national referral hospitals and reference laboratories in the region.

The assessment highlighted several challenges, including: policy and the regulatory environment for eHealth in Member States; health information systems; human and financial resources; and the current use of, and available equipment and infrastructure for Telehealth in Member States.

The study also identified several strengths, which could form the foundation for a regional Telehealth network for disease surveillance (TNDS) to meet the needs of Member States and the SADC Secretariat.

Informed by the findings, the TNDS thus aims to support the harmonised control of HIV and AIDS, TB, Malaria and other communicable and non-communicable diseases, and to mitigate the impact of these diseases in the SADC region. The objectives are to:

- Enable timely collection and reporting of data on the three diseases through Internet links between Ministries of Health in SADC Member States and the SADC Secretariat, as well as through links between the Ministry of Health, the national referral hospital and national reference laboratory in each Member State;
- Serve as an early warning system for disease outbreaks;
- Support programming and management of communicable diseases;
- mprove referrals for the three diseases within and across SADC Member States;
- Strengthen sharing of information and knowledge among reference laboratories for HIV and AIDS, TB and Malaria; and
- Network the databases, as well as individuals, in order to create communities of practice for disease surveillance in the SADC region.

In terms of their use of Telehealth to meet these objectives, Member States fit into three broad categories:

- Mauritius and South Africa are well advanced, with policies and systems, as well as the technical infrastructure to support ICT-mediated services;
- Nine Member States (Angola, Botswana, DRC, Lesotho, Malawi, Mozambique, Namibia, Seychelles and Tanzania) are at various stages of building technical and human capacity for eHealth, and are implementing projects and programmes to improve health services through the use of ICT; and
- Swaziland, Zambia and Zimbabwe have ICT infrastructure in the health sector that is in its early stages and that needs to be strengthened to provide basic eHealth services.

The main service areas are disease surveillance and early warning; patient referrals among hospitals; and specialised testing and quality assurance in national and supranational reference laboratories.

Three levels of ICT use are shown for each service area: an entry level, a intermediate level and an advanced level.
For disease surveillance and early warning, the levels are:

- Data collection, storage and analysis, with periodic non-automated updating and reporting;
- Data collection, storage and analysis, with periodic non-automated updating and reporting, with much greater speed and reliability; and
- Data collection, storage and analysis, with automated updating and reporting (web-based full early-warning system).

- For referral hospitals, the levels are:
- Communication between referring and receiving hospitals without imaging;
- Communication between referring and receiving hospitals, supported by full imaging studies; and
- Full videoconferencing for real-time Teleconsultations.

For national and supranational reference laboratories, the levels are:

- Telepathology with store and forward technology;
- Telepathology with remote reading of locally-prepared and -stored slides; and
- Real-time telepathology with remote handling of slides from the reference laboratory.

In order to assist Member States to progress to the next level in each of the three service areas through the implementation of the TNDS, the equipment and connectivity requirements for each level of service have been determined.

Since the SADC Secretariat is expected to assist African Development Fund (ADF) Member States in their implementation of the TNDS, a gap analysis identifies the additional infrastructure, equipment and other needs (such as geographic information systems, or GIS) that are needed in each ADF Member State. In addition to these technology requirements, specific human resources (such as ICT experts and ICT-skilled health workers), financial resources and institutional structures are required to put the network into operation.

The TNDS is designed to connect SADC Secretariat and each national node to the Internet, and to have the national node serve the national referral hospital and reference laboratory through a local area network (LAN) or wide area network (WAN). There are four options for connectivity:

- A mobile monitoring and reporting system;
- Cloud-based services;
- Digital subscriber loop (DSL) connectivity from local providers; and
- The TNDS as a component of a SADC-wide satellite-based communication services.

A scoring system for the options assesses their respective:

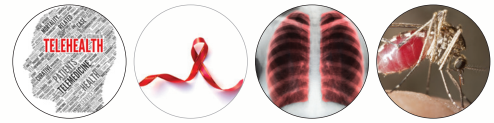
- Cost considerations;
- Reliability and maintainability;
- Levels of integration of various programmes with differing needs into the network; and
- Other considerations, including the SADC Secretariat's remit with regards to activities in Member States.

Based on these considerations, the satellite option is recommended for connectivity. However, Member States can also leverage fibre optic and other connectivity options for connectivity to the TNDS.

The TNDS will connect not only computers and equipment, but will link users of the computers and equipment into a disease surveillance network of health professionals. Three options for structuring this human network into an efficient mechanism for knowledge and information sharing are provided in the Annexes:

- A formal network that is endorsed at the highest levels of the SADC Secretariat and that has a governing structure;
- A semi-structured formal collaboration among the nodes that has an advisory body to serve as a governance mechanism; and
- An informal network that grows organically and is self-managed.

The success of the TNDS in fulfilling its purpose will depend on long-term political commitment, the establishment of real conditions for ownership of the process within Member States, continued availability of a critical mass of trained technical personnel, effective resource mobilisation, and adequate budget provision. It will also be necessary to set up an monitoring and evaluation (M&E) system for the TNDS.



1. INTRODUCTION

SADC is a regional economic community of 15 Member States: Angola, Botswana, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, United Republic of Tanzania, Zambia and Zimbabwe. SADC's vision is that of a regional community that ensures the economic well-being, improvement in the standards of living and quality of life, freedom, social justice, peace and security for the people of Southern Africa. Consistent with its vision, SADC's Mission Statement commits it:

"To promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper cooperation and integration, good governance, and durable peace and security, so that the region emerges as a competitive and effective player in international relations and the world economy".

Among the policies of SADC is a commitment to combat HIV and AIDS, and other deadly or communicable diseases. Article 21 of the Treaty of SADC provides for areas of cooperation, while Article 22 provides for the conclusion of protocols in the areas of cooperation (7). In accordance with these provisions, Member States have agreed on a policy framework document, adopted by the SADC Council in September 1998, which forms the basis for cooperation under the SADC Protocol on Health (8). It recognises that close cooperation in the area of health is essential for the effective control of communicable diseases, non-communicable diseases and for addressing common health concerns in the region.

Cooperation is especially important in the context of policies that are aimed at the progressive elimination of obstacles to the free movement between Member States of capital and labour, goods and services, and of the peoples of the region generally. Such free movement has the potential to increase the spread of communicable diseases, such as HIV and AIDS, TB and Malaria. The health challenges in the region continue to undermine the attainment of the SADC vision. This is largely due to the heavy burdens of disease in the region, particularly of HIV and AIDS, TB and Malaria.

HIV and AIDS: The SADC region accounts for 34% of all people living with HIV and almost one third (32%) of all new HIV infections and AIDS deaths globally.[1] In 2009, national adult HIV prevalence rates exceeded 13% in seven SADC countries (Botswana, Lesotho, Namibia, South Africa, Swaziland, Zambia and Zimbabwe).[2] While there is evidence of a significant decline in the national adult HIV prevalence rate in Zimbabwe and a slow but continuous decline in prevalence in Botswana, the epidemic in the rest of the region has either reached or is approaching a plateau.

The HIV and AIDS pandemic, by virtue of its magnitude, is the single greatest developmental and public health concern in the SADC region, and the SADC Protocol on Health is intended to address this challenge especially. The Protocol is a binding agreement that obliges Member States to submit annual progress reports, as directed by SADC Heads of State and Government.

TB: Southern African countries bear a disproportionate burden of TB and HIV-related disease compared to Africa and the rest of the world. The region is home to 25% of the sub-Saharan African population, but accounts for 50% of its TB cases.[3] Five SADC Member States are among the 22 global high-burden countries that together account for approximately 80% of all new TB cases in the world. Ten of the 15 Member States are high HIV prevalence countries. These 10 Member States have TB prevalence rates that range from 300 to 1,000 cases per 100 000 population (compared with the global TB prevalence rate of 139 per 100 000).

Malaria: It is estimated that 74% of the population in the SADC region live in malarious areas. However, the intensity of Malaria transmission varies considerably within the region and within individual Member States. About 20 million clinical Malaria cases and an estimated 30,000 - 40,000 Malaria deaths occur annually. At least 60% of pregnant women and children younger than 5 years are at risk of Malaria. The disease remains a major cause of morbidity, mortality and poverty in the SADC region, and accounts for up to 30% of outpatient health facility attendance and 40% of in-patient hospital admissions.[4] It is a major impediment to socioeconomic development in the region.

---

1 *UNAIDS data. See http://www.unaids.org/en/regionscountries/regions/easternandsouthernafrica/*
2 *See UNAIDS country fact sheets at http://www.unaids.org/en/regionscountries/countries/*
3 *WHO. Global Tuberculosis Report 2010. Geneva : WHO ; 2010.*
4 *See http://www.sadc.int/english/regional-integration/shdsp/sarn/about-sarn/*

It is therefore imperative to enhance surveillance for communicable and non-communicable diseases in the region to access strategic information for decision-making purposes at both the regional and national levels. This can be achieved in line with the dictates of the Protocol on Health that mandate Member States to cooperate in the area of diseases surveillance. In 2010, the SADC region accordingly approved a harmonised surveillance framework for HIV and AIDS, TB and Malaria, along with core indicators for each of the three diseases.

In order to strengthen this effort, the SADC Secretariat is implementing an initiative to support the control of HIV and AIDS, TB and Malaria. One of the components of the initiative is to upgrade the surveillance systems for HIV and AIDS, TB and Malaria. The initiative includes a component that focuses on the need to develop a Telehealth system in the SADC region, to serve as a timely surveillance and information-sharing tool that can provide information for action.

The SADC Secretariat subsequently sought the services of a consultancy firm to assess the status and potential use of such a Telehealth system in the region. The consultancy was tasked with assessing the extent to which Telehealth is currently being used in the region, and the equipment that would be required to establish a fully functional Telehealth system.

In addition, the assessment examined the feasibility of a Telehealth system to support existing surveillance systems, and the potential of such a network to serve as an early warning tool, and to improve:

- Surveillance systems and their harmonisation;
- Networking of national reference laboratories; and
- Networking national referral hospitals in SADC Member States.

This report describes a Telehealth Network for Diseases Surveillance (TNDS) that is informed by an assessment of the status of Telehealth and its potential as a surveillance and information-sharing tool for communicable diseases.

The report has nine sections. The current section presents the background to the establishment of a regional Telehealth system, including a literature review and the key findings that informed the design of the system. It also provides the rationale for developing a Telehealth system.

Section 2 presents the goals and objectives of the report, while Section 3 describes the analysis criteria for the major functionalities and architecture of the proposed Telehealth system for diseases surveillance.

In Section 4, a gap analysis is presented, along with four options for the connectivity aspects of the proposed architecture and functionalities. Details of the preferred option are provided in Section 5.

Section 6 provides further details for putting the network into operation, and considers the key components, including hardware, software, infrastructure, capacity building, early warning system and GIS aspects.

Section 7 discusses the added value of the network in terms of connecting both data repositories and people in a community of practice. It suggests ways for structuring such a community, as well as tools that could be used to facilitate its operations. The final two sections discuss implementation arrangements (Section 8) and M&E (Section 9).

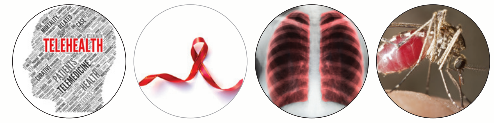
1.2 Literature review

This sub-section surveys the literature that demonstrates the successful use of ICT to address public health challenges.

Issues that have been encountered elsewhere in the application of ICT in public health, generally, and diseases surveillance, specifically, were taken into account in designing the proposed Telehealth system for disease surveillance. This focused literature review explores the application of ICT for disease surveillance, delivery of health services, laboratory services, and disease early warning systems

At the policy level, ICT is a strategic focus for the SADC region. SADC therefore has developed the e-SADC strategy framework to guide implementation of the “Information Society” in the region. It consists of three forward-looking, long-term and action-oriented themes (9):

- Enabling the delivery of quality ICT services;
- E-applications and innovation; and
- Governance of the e-SADC Strategy.



Seven strategic objectives are identified to support the three overarching themes, namely:

- A conducive legal, policy and regulatory environment for the development of an ICT culture;
- Development of ICT infrastructure and security;
- Investment in human resource development;
- Development of e-applications including e-government;
- Increase the usage of ICT in business;
- Develop an ICT industry; and
- Development of institutional mechanisms.

The development of the Telehealth system (or TNDS) is in line with the strategic focus on ICT for the SADC region, as well as with eGovernment initiatives in SADC Member States. Some of the existing, relevant initiatives and experiences with ICT in the region are discussed below.

1.2.1 Disease surveillance

The World Wide Web is a potentially powerful tool for diseases surveillance. A web-based notification system, such as the one available in South Africa, provides a single, consistent approach to the collection and provision of health data, using a standards-based, integrated system. It is expected to improve the accuracy, quality, timeliness and coordination of surveillance information for notifiable medical conditions (10).

The effects can be dramatic. Online telemedicine has helped avert an epidemic in India, for example (11). Daily reporting of in-patient and outpatient cases at a hospital near a grand religious fair in north India revealed a surge of diarrhoea cases among pilgrims. Vibrio cholerae was isolated through microbial examination of stools samples referred to the Sanjay Gandhi Post Graduate Institute of Medical Sciences. This information was relayed online to the main hospital at the fair and to the health authorities, who took strict and prompt measures to improve hygiene, thereby averting a likely outbreak of cholera. Even in the absence of web services, a telephone-based Telehealth service for data collection from public health laboratories and triage for medical emergencies can supply valuable data and can function as an important part of a SADC surveillance Telehealth system.

The value has already been demonstrated in the surveillance of communicable diseases in Canada (12). In Ontario province, a telephone-based health information service and emergency department triage were integrated with a first-line, real-time, 24-hour-a-day syndrome surveillance system. The automated system was seen as a new option for detecting disease outbreaks at the first contact with the health care system, and was deemed beneficial in detecting and monitoring disease outbreaks such as influenza, Norwalk, West Nile virus, Escherichia coli 0157 and severe acute respiratory syndrome.

In addition to Telehealth applications, ICT-related technologies have been used successfully in disease surveillance. Moss et al. (2011) identified environmental risk factors for Malaria transmission using remote sensing technologies to guide Malaria control interventions in a region with a declining burden of Malaria. Satellite images were used to construct a sampling frame for the random selection of households enrolled in prospective longitudinal and cross-sectional surveys of Malaria parasitaemia in Southern Province, Zambia. A total of 768 individuals from 128 randomly selected households were enrolled over 21 months, of whom 117 (15.2%) tested positive in Malaria rapid diagnostic tests (RDT). Individuals residing within 3.75 km of a third-order stream were at increased risk of Malaria, while households at elevations above the baseline elevation for the region were at decreasing risk of having RDT-positive residents. Based on the spatial risk map, targeting households in the top 80th percentile of Malaria risk would require that Malaria control interventions be directed at only 24% of households. The authors concluded that remote sensing technologies can be used to target Malaria control interventions in a region of declining Malaria transmission, thus enabling more efficient use of resources for Malaria elimination (13).

1.2.2 Delivery of health services

In Zambia, as in some other SADC Member States, medical expertise, equipment and information resources are concentrated largely in the major cities. Chanda et al. (2010) did a descriptive study of the Zambian National Telehealth Steering Committee, based on the literature, news reports and personal experience. The study sought to outline the benefits of Telehealth initiatives in ameliorating some of the problems caused by an inequitable distribution of health care expertise, equipment and knowledge resources (14).

The authors concluded that librarians at the University of Zambia Medical Library, who have a history of making knowledge available and who have been involved in the national Telehealth strategy, could provide outreach services to hospitals and health facilities throughout the country. The learning would be of use in building capacity and would help referral hospitals and supranational laboratories provide information to other hospitals and laboratories in SADC Member States that lack such highly skilled workers.

Another feature of health services in SADC Member States (and in other developing countries) is that access in rural areas usually involves considerable transport costs. Although community health workers and volunteers from local villages have been integral in bridging the patient-physician gap, large amounts of time are spent in transit between hospitals and villages. Mahmud, Rodriguez and Nesbit reported the results of a retrospective mobile health (mHealth) pilot at St. Gabriel's Hospital in Malawi, which was designed to eliminate much of the travel by communicating via text messages.

A group of 75 community health workers were supplied with cell phones and trained to use the network, including for patient adherence reporting, appointment reminders and physician queries. At the end of the pilot, the hospital had saved approximately 2,048 hours of worker time and US$2,750 (US$3,000 in fuel savings minus US$250 in operational costs), and it had doubled the capacity of the TB treatment programme. The authors concluded that mHealth interventions could provide cost-effective solutions to communication barriers in rural health care in developing countries (15).

1.2.3 Laboratory services

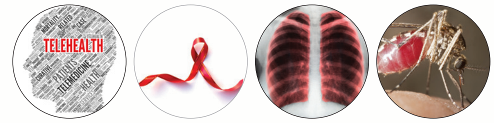
The Africa Telepathology project had been providing dermatology support to local providers in Africa (including in Botswana, Malawi, Lesotho and Swaziland) by using store-and-forward teledermatology/teledermatopathology since 2007 (see http://africa.telederm.org).

The project had severe limitations, however, including the limited number and quality of images available to consultants, as well as reliance on the referring provider (who sometimes lacked dermatopathology training) to produce representative photomicrographs. Fischer et al. (2011) installed a Zeiss Mirax Live RT system at the National Health Laboratory in Gaborone, Botswana, in 2009. With up to four slides placed on the motorised microscope, the consultant could remotely control stage position, focus and magnification. The system showed that telepathology is feasible in resource-limited settings, and its routine use could improve clinical care and education (16). The replicability of the experience, however, depended on socioeconomic and health contexts and adaptation to local settings.

Sometimes even low-cost options for microscopy are not available due to unavailability of qualified staff. For example, use of an affordable strategy to address the challenge of implementing the low-cost microscopic observation drug susceptibility assay, a non-proprietary test that delivers rapid and accurate diagnosis of TB and multidrug-resistant TB in isolated settings avoided because unavailability of trained staff. Zimic et al. (2009) used mobile phones in Peru, first to transmit images captured by an inverted microscope to a remote site where trained personnel performed pattern recognition. It was then used to receive the resulting output of the analysis. The authors concluded that such a system could be used to train laboratory personnel through distance learning, resolution of equivocal appearances and quality assurance (17).

In many instances, there is a need to harness the power of the collective through collaboration. Suhanic et al. (2009) examined collaborative diagnostics for laboratory medicine microbiology protocols, where free and open communication and networking applications are used to link distributed collaborators for reciprocal assistance in organising and interpreting digital diagnostic data. They also examined commodity engineering, which leverages globally available consumer electronics and open-source informatics applications, to build generic open systems that measure information in ways that are substantially equivalent to more complex proprietary systems. Routine microscopic examination of Giemsa and fluorescently stained blood smears for diagnosing Malaria was used as an example to validate the model (18).

The authors showed that open telemicroscopy workstation design and use-processes can address clinical microbiology infrastructure deficits in an economically sound and sustainable manner. It can boost capacity to deal with comprehensive measurement of disease and care outcomes in individuals and groups in a distributed and collaborative fashion. The workstation enabled local control over the creation and use of diagnostic data, while allowing for remote collaborative support of diagnostic data interpretation and tracking. It can therefore enable regional pooling of Malaria disease information and the development of open, participatory and adaptable laboratory medicine practices.



These examples demonstrate the possibilities of Telehealth. The Assessment Report contains further examples of Telehealth use in these three areas.

1.2.4 Disease early warning systems

Although disease early warning is presented here as a separate sub-section, it should be noted that early warning is a by-product of good disease surveillance. The literature on early warning places great emphasis on strengthening disease surveillance systems in countries so that they become timely surveillance systems that collect information on epidemic-prone diseases in order to trigger prompt public health interventions.

In the context of the TNDS, early warning is relevant to Malaria but not to HIV and AIDS, and TB. The WHO/RBM Malaria Early Warning Systems (MEWS) framework emphasises three types of indicators: vulnerability indicators, vector transmission risk indicators and early detection indicators (19). The framework indicates that “MEWS may be developed at a range of scales, from the district level to the sub-regional level, involving co-operative partnership between groups of countries sharing common problems.”

WHO (2003) recommends that these early warning systems should apply statistical methods to detect changes in trends or sentinel events that would require public health intervention, and that they should be used to prioritise the review of data on a regular basis (20). Using the case of Serbia as an example, WHO (2004) emphasised the importance of capturing data from primary health care facilities and reporting the weekly, aggregated number of new cases. Software with features for data entry (including quality checks) at facility level and electronic transfer of records to a central site for analysis are also vital for successful early warning (21).

The reliability of both data capture and data transfer is significantly enhanced by meaningful use of ICT, such as in a Telehealth network. Rolland et al. (2006) suggest that a telephone-based triage system, such as the one described earlier in Section 1.2.1 can be used as an early warning system (22).

Other complementary approaches to MEWS are based on Malaria vector capacity or the environmental driving force of Malaria transmission. Satellite-based, near real-time remote sensing data (temperature, vegetation and humidity), weather forecasts, climate models, and a long-term data record are used to predict outbreaks of seasonal Malaria. Grover-Kopec et al. (2006) assert that such information is useful for early warning because “epidemic Malaria tends to occur along the geographical margins of endemic regions, when the equilibrium between the human, parasite and mosquito vector populations is occasionally disturbed and a sharp but temporary increase in disease incidence results” (23).

Predictions based on transmission risk indicators can anticipate the timing of an increase in Malaria transmission 2-4 months before a Malaria epidemic occurs. Where a higher than average seasonal rainfall may be predicted from seasonal climate forecasts 1-6 months in advance, this could lead to as much as 10 month’s early warning of an epidemic situation.

The TNDS could also be of great benefit to Member States in emergency situations. Well-established networks for disease surveillance that can be rapidly expanded can provide early warning and mitigate the effect of potential epidemics during emergencies and disasters. This was shown during the floods in Pakistan in 2010, for example. Two weeks after floods began, the existing network had more than tripled its coverage and the number of patients seen in medical facilities had increased six-fold. Recognising the dangers of a potential epidemic outbreak, diarrhoea treatment centres were established in the most at-risk districts, with up to 63 centres in 41 districts. In three months, more than 60,500 patients were treated and 15,000 were admitted for longer-term care at district treatment centres; among those admitted, only 58 diarrhoea-related deaths were recorded (24).

The literature review reveals that ICT has been successfully applied in the areas of diseases surveillance, laboratory work, general health services delivery and early warning, especially for Malaria. The information from the literature review, together with the findings from the assessment of the potential of Telehealth as a disease surveillance and information-sharing tool, informed the Telehealth system proposed in this document.

1.3 Summary of findings from the assessment

The proposed Telehealth System for HIV and AIDS, TB and Malaria surveillance and information- sharing presented in this report is informed by the results of an assessment study conducted between December 2010 and March 2011 in 14 SADC Member States. A summary of the key findings is presented here. They cover the following areas:

- Policy;
- Health information systems;
- Use of Telehealth in the three key areas of disease surveillance (early warning, referral hospitals and reference laboratories);
- mHealth;
- Human and financial resources; and
- Prospects for a Telehealth network for disease surveillance.

Policy: Published national eHealth strategies exist in two of the 14 SADC Member States in which the assessment was conducted. Other countries have no such formal published eHealth Strategies. This poses a problem since policy and strategy are needed to guide the use of ICT in the health sector. The absence of published policies and strategies on eHealth also points to a regulatory gap in those SADC Member States that do not have an updated regulatory environment in place.

At the regional level, the e-SADC policy was adopted in May 2010. The policy covers all of ICT; there is no sectoral ICT policy specifically focused on ICT for health. In addition, there is no SADC-level regional eHealth strategy. As with individual Member States, the absence of a regional eHealth strategy points to a regulatory gap at regional level that needs to be filled.

Health information systems: An important finding in terms of Telehealth for disease surveillance relates to the state of the health information system (HIS). The TNDS cannot exist in a vacuum. It should form part of a broader system for gathering data on diseases and threats to health so that it can facilitate analysis and decision-making for both policy development and practical action.

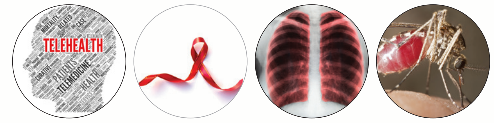
Every Member State has a national HIS. With the exception of Mauritius, the dominant data capture mode at facility level is paper-based and transmission occurs by hand delivery to the district. At district level, data are entered on computers. But because there is no connectivity, the electronic data are sent to the provincial or (in the case of Botswana) national levels on USB keys. Provinces have computers and connectivity, and are able to transmit data to the central level via email (when email services are available) or by USB key.

Use of Telehealth in disease surveillance: The minimum requirements for Telehealth are:

- Adequate connectivity;
- Equipment to enable access to the Internet;
- Available capacity of staff to use the technology; and
- Staff to maintain the system in order to reduce breakdowns and increase availability of the entire system.

The assessment found that 11 SADC Member States (Angola, Botswana, DRC, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania) have the basic minimum requirements for Telehealth, while three (Swaziland, Zambia and Zimbabwe) do not. This holds for HIV and AIDS and TB surveillance programmes. In the case of Malaria surveillance, three SADC Member States (Lesotho, Mauritius and Seychelles) are not Malaria-endemic countries. The eight Member States with adequate connectivity for Malaria surveillance therefore represent 73% of all Malaria-prone SADC Member States.

The HIS, which exists in all Member States, stands at the heart of disease surveillance, and all SADC Member States therefore have the potential for Telehealth for disease surveillance. In South Africa, for example, the Telemedicine Lead Programme of the Medical Research Council has leveraged the networked National Health Information System of South Africa since the 1990s to create the largest telemedicine network on the African continent, with over 70 functional nodes.



Use of Telehealth in referral hospitals: The Pan African eNetwork for Telemedicine and Tele-education project has started in eight SADC Member States, although it is fully functional only in Mauritius (which hosts a regional super-specialty hospital). The network has eight patient-end hospitals (in Botswana, Malawi, Mauritius, Mozambique, Seychelles, Tanzania, Zambia and Zimbabwe) and offers continuing medical education courses to all nodes.

In Botswana, collaboration between Orange Botswana, the Botswana-UPenn Partnership programme and ClickDiagnostics Inc. of the USA has demonstrated the effective use of mobile phones to enable doctors in Princess Marina Hospital to diagnose patients as far away as Maun, Kasane and Tsabong. The assessment also found that referral hospitals in SADC Member States have experience with the use of Telehealth tools and systems, such as the district health information system (DHIS) OpenMRS and OpenClinic (both open-source electronic medical record systems).

Use of Telehealth in reference laboratories: Reference laboratories in SADC Member States all record information electronically, while some provide notification through a wide area network or a web-based system.

mHealth: Cell phones, which could extend the reach of disease surveillance networks, are used creatively in applications such as supply chain management for Malaria drugs in Tanzania, remote Telehealth for diagnosis in Botswana, and patient follow-up to support AIDS treatment compliance in South Africa.

Human resources and capacity to use ICT: The capacity to use and maintain ICT systems in health ministries is weak, and ICT units in health ministries either do not exist or are poorly staffed.

Financial resources: Despite general recognition of the added value of ICT for health, financial resources are not sufficient to attract and maintain a corps of technical staff to develop and maintain ICT services for health systems.

Feasibility of Telehealth for disease surveillance: It was found that it is feasible to use Telehealth as a surveillance and information-sharing tool for communicable and other diseases in the SADC region. All Member States have experience with the electronic transfer of data in disease surveillance programmes. There is a need to expand this in those countries that have limited use of electronic data transfer, and there is keen interest to do so in all Member States.

The assessment made the following recommendations:

- There is a need to develop national eHealth policies and create appropriate regulatory environments in all SADC Member States;
- An interconnected TNDS with three sub-networks (one each for Ministries of Health, national referral hospitals and national reference laboratories) must be developed for the SADC region;
- In each SADC Member State, a cadre of eHealth experts should be trained to support all components of the TNDS and build the capacity of other health professionals to use ICT;
- Ministry of Health email services should be made more reliable and should be used by all public sector professional health workers;
- Plans should be developed to migrate systems to electronic data capture, transfer, processing, sharing and storage, with adequate back-up in the event of failure in primary storage units; and
- The SADC Secretariat should promote professional networking and sharing of information and knowledge within the three sub-networks.

1.4 Rationale

In addition to the SADC Protocol on Health described earlier, the SADC Regional Integration Agenda presents a further rationale for the TNDS. That agenda includes a number of key steps, including a Free Trade Area, followed by a Customs Union, a Common Market, a Monetary Union, and ultimately a single currency. These phases are likely to result in progressively greater numbers of people travelling across borders within the SADC region, with a possible increase in the spread of disease due to the freer movement of people.

One of the ways in which the SADC Secretariat aims to contribute to the agenda, as well as mitigate the threat of disease spread, is through the harmonised control and mitigation of the impact ofHIV and AIDS, TB and Malaria. Data generated by the harmonised surveillance system are crucial for informing communicable disease programmes. However, the usefulness of the data would be enhanced further by a fully functional Telehealth system that is capable of quick and efficient sharing of the data among Member States, and between Member States and the SADC Secretariat.

The harmonised surveillance framework that has been developed will require Member States to annually report data on core indicators. However, communicable diseases (which can require quick attention at the regional level) should be reported more regularly—at least every quarter. This is especially important in the context of certain developments, such as multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB), which require more frequent tracking and reporting. That is only possible if there is a fast and efficient mechanism for reporting and sharing information. A Telehealth system is therefore proposed to facilitate effective, real-time sharing of surveillance information.

Article 9 of the SADC Protocol on Health states that State Parties shall share information related to outbreaks and epidemics of communicable diseases within the region and work together in epidemic control and management. Therefore, the proposed Telehealth system should be used as an “early warning system” for other communicable disease outbreaks. Due to the efficiency associated with Telehealth in sharing information, the proposed system should serve as a surveillance tool for other communicable and non-communicable diseases, in addition to HIV and AIDS, TB and Malaria. In the case of a cholera outbreak, for example, a fully functional Telehealth surveillance system that facilitates rapid sharing of information between SADC Member States and the SADC Secretariat may lead to a more efficient response.

As part of efforts to control communicable diseases in the SADC region, supranational laboratories will be established. These will be highly equipped laboratories that will perform various tests related to communicable diseases (including HIV and AIDS, TB and Malaria). A Telehealth system will allow online consultations among and within Member States. Furthermore, various specimens will be sent to the supranational laboratories and results will be communicated back rapidly. This is especially important for monitoring drug resistance.

The Telehealth system features two additional qualities.

In addition to facilitating the transfer of aggregated country data between national data banks and a SADC Secretariat database, it willenable analysis at the regional level to supplement the national-level analysis. Secondly, a SADC Telehealth network will connect people, not just databases, and serve as a communications link among those whose work and lives are affected by the data. We can identify four initial functions for such a human network, which would:

- Develop common practices for disease surveillance through consensus-building actions on a wide scale;
- Support and strengthen member institutions (especially newer ones), and learn from the experiences of others by identifying and disseminating both positive and negative practices;
- Collaboratively address regional disease surveillance issues that extend beyond the boundaries of individual countries (such as those related to migration); and
- Assist with fundraising for network-wide activities, as well as those of sub-networks and individual institutions.

There are three main options for structuring the people network for disease surveillance:

- A formally created SADC entity;
- A formal collaboration among country nodes; and
- A self-organising informal collaboration among network users.

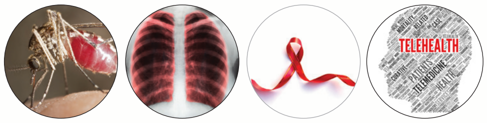
Full details of the added value of the human network, along with options for organising it, are provided in Annex 1.

2. Goals and objectives

The goal of the TNDS is to support the harmonised control of HIV and AIDS, TB, Malaria and other communicable and non-communicable diseases, and to mitigate the impact of these diseases in the SADC region.

Informed by the findings, conclusions and recommendations from the Assessment Report, the objectives of the system are:

- To enable timely collection and reporting of data on HIV and AIDS, TB and Malaria through Internet links between Ministries of Health in SADC Member States and the SADC Secretariat, and (within each Member State) through links between the Ministry of Health, the national referral hospital and a national reference laboratory;
- To serve as an early warning system for disease outbreaks;
- To support programming and management of communicable diseases by leveraging the harmonised surveillance framework throughout the region;
- To improve referrals for the three diseases within and across Member States in the SADC region;
- To strengthen sharing of information and knowledge among reference laboratories for HIV and AIDS, TB and Malaria; and
- To network both the databases and people in order to create communities of practice for disease surveillance in the SADC region.

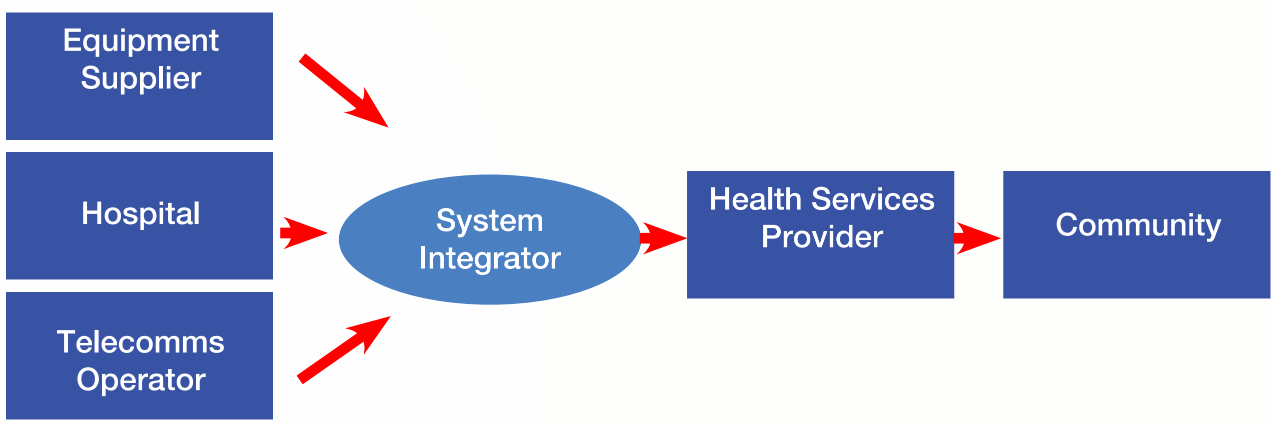


3. Analysis of a functional Telehealth system

3.1 Basics of a Telehealth system

A typical Telehealth system consists of the main elements shown in Figure 1. A system integrator brings together products from an equipment supplier and communications infrastructure from a telecommunications operator to support processes that are performed in a hospital or other health facility. Health care providers then use this integrated package in the health facility to deliver services to the intended beneficiary or community.

Figure 1: A basic Telehealth system



In the specific context of using Telehealth as a tool for disease surveillance and information sharing for HIV and AIDS, TB and Malaria in the SADC region, the "hospital" (in Figure 1) is replaced by the Ministry of Health, the "service provider" refers to the specific disease surveillance programme, and the "community" comprises the SADC Secretariat and the disease surveillance programmes in SADC Member States.

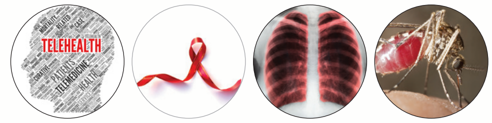
As noted in Section 1.2, the Telehealth system for disease surveillance can serve as an early warning system with the proper coverage of health facilities, good quality data capture and the appropriate software platforms for data analysis. The model involves a slightly different set of actors when Telehealth is used for referral hospitals. In that case, the "hospital" refers to the hospitals that are involved in the referral (i.e. sending and receiving hospitals, which are also the health service providers), and the referred patients constitute the "community".

A similar modification is necessary when Telehealth is used for supporting reference laboratories. The "hospital" then becomes the reference laboratory, the "health services provider" is replaced by the providers of laboratory services at the sending and receiving ends, and the "community" comprises the referring laboratories.

The value of a Telehealth system for early warning lies in the fact that a Telehealth system has two key features:

- It facilitates the transmission of timely data from hospitals, other health facilities and laboratories to central data bases or other facilities; and
- Results of analysis done on large quantities of collected and stored data can be disseminated quickly to trigger an appropriate response.

Equipment: The required equipment depends on the specific Telehealth application. Besides the database equipment, disease surveillance requires a server (preferably with a backup server); a laptop for local access to the server; a LAN or WAN; a printer; and an uninterruptible power supply (UPS) to safeguard data in the case of loss of mains electric power.



A laptop is recommended because it is more useful in testing various features of a network (including hardwired connectivity, as well as wireless connectivity through WiFi) and it can be moved to different locations in a network. The LAN or WAN is generally not specified in terms of its individual components, but rather as a package of router and associated cabling and accessories that function together.

For referral hospitals, a computer (distinct from a server) is needed. It should be connected to the Internet and, preferably, should have a UPS for electrical power backup. More sophisticated Telehealth applications would require an integrated telemedicine station with appropriate probes and built-in data transmission components (either on a roll cart or simply in the form of a portable dispatch case); fixed video camera and associated monitors for videoconferencing; and a Picture Archiving and Communication System if medical imaging studies are to be stored and shared in digital format.

Similarly, for laboratory applications a computer is the main item of equipment. If electrical power supplies are unreliable, the computer should be connected to a UPS. Remote telepathology and other sophisticated applications would require specialised equipment for controlling and viewing slides at a distance.

Telecommunications infrastructure: The main item of telecommunications infrastructure is Internet connectivity. A broadband connection of at least 128k bps is necessary even for basic disease surveillance applications, referrals between hospitals, exchanges between laboratories and reference laboratories, and information-sharing purposes. Higher bandwidths would enable faster service and achieve greater user satisfaction.

Connectivity could be achieved with any of three main platforms:

- Asymmetic Digital Subscriber Line (ADSL) using a plain old telephone system, or fibre optic cables;
- Satellite services via a Very Small Aperture Terminal (VSAT); or
- Wireless connectivity from a mobile telephony provider.

The connectivity infrastructure comes with its own hardware (appropriate modem, cables, connectors) and software. These elements focus on the technology. In addition, there are institutional elements that contribute to the full functionality of a Telehealth system that can be used for disease surveillance in referral systems, reference laboratories, or to support GIS applications. These elements include issues of policy, the health information system, human resources, and financial resources.

Policy: eHealth policies and strategies, policies on ICT in general, and the regulatory environment that governs the implementation of such policies and strategies are all crucial to the success of a Telehealth system.

Health information systems: The health information system constitutes the "brain" of the health system, and affects it in all respects. A Telehealth system for disease surveillance would need to feed up-to-date information into the health information system.

Human resources: In addition to the physical capital represented by infrastructure and equipment, human resources are indispensable for the proper implementation of a Telehealth system. Trained users and maintenance know-how are key elements of the human resources component of a Telehealth system.

Financial resources: Financial resources are needed to acquire the various elements of a Telehealth system, and to operate and maintain it.

3.2 Basics of Telehealth for diseases surveillance

A Telehealth system for disease surveillance consists of two main parts: a health information system, and computer and telecommunications equipment for connectivity among the nodes of the HIS. The basic requirements for Telehealth for disease surveillance therefore are:

- A computer to function as a repository for data and platform for data analysis; and
- A computer server connected to the Internet, and linked to the nodes of the health information system through a LAN or a WAN.

This structure is the same for all disease programmes, since the main function of a Telehealth system for disease surveillance is to support data collection, storage, analysis and dissemination.

In order to improve the reliability of the database element of the system, these basic requirements may be augmented with a back-up server, a laptop (distinct from a desktop) computer, a UPS and a printer. The communications side of the system can be improved vastly by increasing the bandwidth of connectivity among the nodes to enable faster exchanges of data.

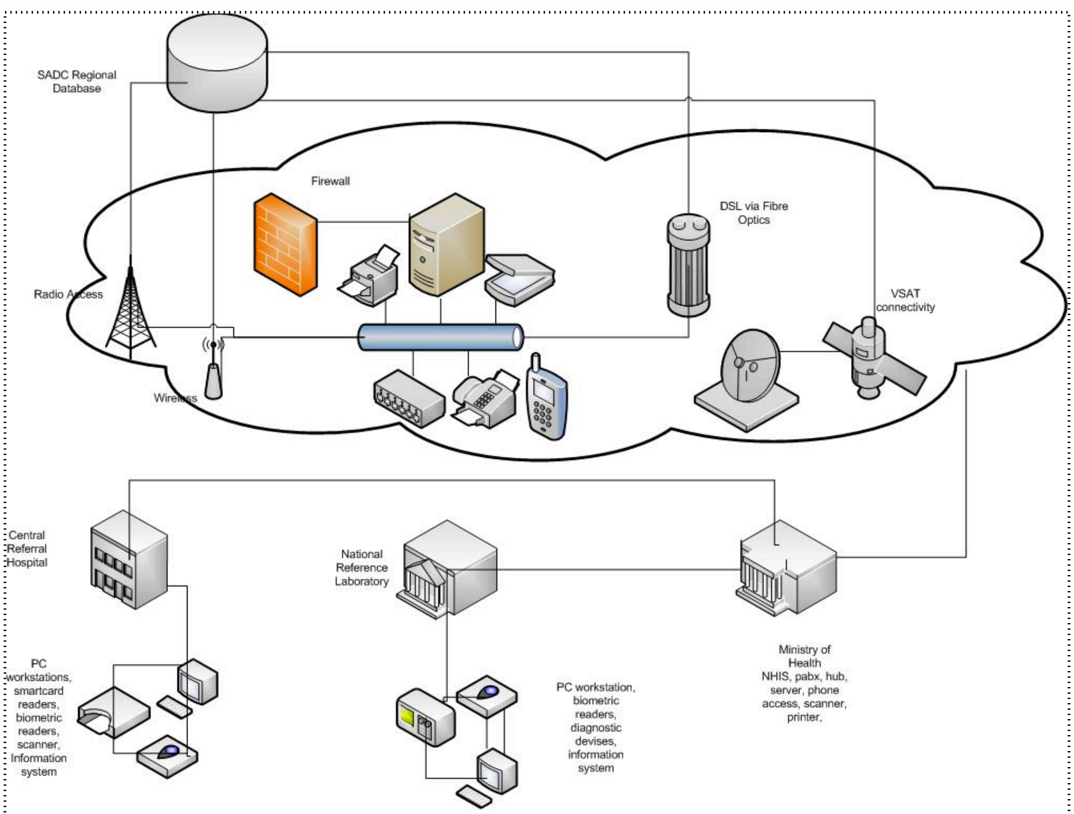
3.3 System architecture

The overall architecture of the proposed TNDS is shown schematically in Figure 2. This is based on the results of the assessment, on the qualitative and quantitative data collected during the field visits, and on information gathered from Internet Service Providers (ISPs) and GIS equipment and services providers.

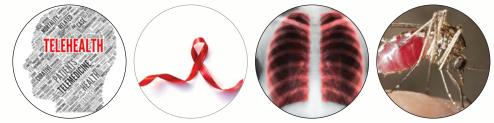
In Figure 2, the cloud-like section represents the SADC Secretariat with various sub-systems for internal communications within the Secretariat. Each Ministry of Health server is linked to the database at the SADC Secretariat through connectivity that is provided by using the options described in Section 4 of this report.

In addition, each Ministry of Health provides links to a referral hospital and a reference laboratory, as part of a LAN/WAN, where the referral hospital and reference laboratory do not already have adequate connectivity. The system will also enable sharing of information directly among Member States, since their servers will be linked to one another through the TNDS.

Figure 2: Overall system architecture



Detailed specifications for the various components of the system are provided in Section 6, which also discusses the other items that are required to put the TNDS into operation.



4. Gap analysis

4.1 Functional capabilities

Before discussing the gap analysis, it is instructive to identify the various levels of functionality for each component: disease surveillance, referral between hospitals, and referral between laboratory and reference laboratory. This will help determine what can be achieved within each component with the means that are currently available in Member States. The gap would then point to improvements that are needed to achieve the next levels of functionality. This approach is guided by the larger goal of contributing to an upgrade of the current disease surveillance systems.

4.1.1 Levels of Telehealth functionality for disease surveillance

Three broad categories, or levels, of functionality can be identified for a TNDS:

- Data collection, storage and analysis, with periodic non-automated updating and reporting;
- Data collection, storage and analysis, with periodic non-automated updating and reporting with greater speed and reliability; and
- Data collection, storage and analysis, with automatic updating and reporting (web-based full early-warning system).

SADC Member States are grouped according to their current functionalities, as shown in Table 1.

Table 1: Grouping of SADC Member States according to Telehealth functional capabilities in disease surveillance and early warning

Level: Functionality	Countries	
I: Data collection, storage and analysis, with periodic non-automated updating and reporting	**1.**	**Swaziland**
	2.	**Zambia**
	3.	**Zimbabwe**
II: Data collection, storage and analysis, with periodic non-automated updating and reporting with greater speed and reliability	**1.**	**Angola**
	2.	**Botswana**
	3.	**DRC**
	4.	**Lesotho**
	5.	**Malawi**
	6.	**Mozambique**
	7.	**Namibia**
	8.	**Seychelles**
	9.	**Tanzania**
III: Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	**1.**	**Mauritius**
	2.	**South Africa**

For data collection, storage and analysis, with non-automated periodic updating and reporting, the basic technology requirements are a server, a LAN/WAN and Internet connectivity. Disease surveillance programmes for HIV and AIDS, TB and Malaria in all SADC Member States already have this basic capability and can thus perform at this level of functionality.

With additional technology (a back-up server, laptop computer, UPS, printer, and Internet connectivity of at least 128 K bps), the disease surveillance system could do data collection, storage and analysis, with periodic non-automated updating and reporting much quicker and more reliably. The back-up server would ensure availability of the services in the event of a server failure. The UPS would ensure such services in the event of electrical power outages, while the laptop and printer would provide additional capabilities in terms of local interaction with, and data outputting from the database.

Additional technology would be required to advance to the next stage of data collection, storage and analysis, with automatic updating and reporting (web-based, full early-warning system):

- An application server that is linked to the Internet; and
- Computing devices that can be used by health facilities and laboratories to enter data into the system (a desktop, laptop or tablet computer, or a smart cell phone or special hardware developed for this purpose).

Additional software would be required both for the application server and for supporting input of data from the handheld devices. The services can either be hosted by the provider (for a fee that would include maintenance and updating of the system) or by the user institution. Training would also be required for users.

The Department of Health in South Africa currently uses such a system for notifiable medical conditions. It can also be used to process routine data from facilities directly into the database. The main advantage is that data capture would not only be electronic; however, there would be no delays in entering the information into the database.

4.1.2 Early warning system

As indicated in Sections 1.2 and 3.1, early warning is predicated on two factors:

- Identifying changes in incidence in reported and confirmed cases of a disease. This is more readily detected in a computerised health information system than in a system where data capture or analysis is at least partially paper-based; and

- Recognising meteorological conditions that are conducive to the growth in numbers of a disease vector, such as Malaria parasite-transmitting Anopheles Gambae mosquitoes. The identification occurs by monitoring rainfall and other weather conditions, or through analysis of satellite imagery.

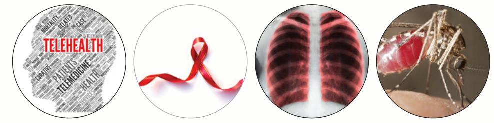
Increased incidence: In order to support this method of early warning, the health information system in Member States includes computer analysis and automatic detection of thresholds, which result in an alert being sounded when the thresholds are reached. The TNDS could facilitate this process by providing direct links to facilities where cases are reported and to those that confirm the suspected cases.

Referral hospitals and reference laboratories are therefore key actors in the early detection system and are included as nodes of the network to leverage the crucial roles they can play in early detection of outbreaks. Member States should be encouraged to improve the links from health facilities to reference laboratories and hospitals. These are sub-national level links, which currently fall outside the remit of the TNDS.

Meteorological monitoring: The three types of meteorological monitoring for disease surveillance are:

- Analysis of weather station reports;
- Satellite imagery, and
- Deployment of unattended smart capture devices in identified areas.

The SADC TNDS will focus on analysis of weather station reports, since this capability already exists in Member States. For conditions such as Malaria, it is important to have weather monitoring and prediction systems that allow for Malaria-prone areas to be monitored for storms (typically an indicator for increased mosquito activity). Telehealth systems can also provide immediate feedback to key individuals within health systems and ministries when infectious diseases are detected.



At present, there is no such system in the SADC Member States that are prone to Malaria. The potential exists for such a system to be developed.

4.1.3 GIS as a sub-category of disease surveillance

Besides routine mapping, advance functions can be used on available GIS platforms in Member States.

One freely available special software system from WHO is AccessMod. The system can be used to determine the optimal placement of new health facilities, given travel times and population distribution in the catchment areas. It can also be used retrospectively to determine the coverage area for a health facility, taking into consideration population distribution and travel times.

More advanced GIS functionalities can be linked to the direct data capture system (described earlier) to provide graphic displays of outbreaks and spread of disease. This would require a map server that is linked to the Internet (possibly the same server as the database server). MapXtreme is the recommended software platform. However, this would not be required in cases where the service provider hosts the application.

4.1.4 Levels of Telehealth functionality for referral hospitals

Telehealth functionality in referral hospitals may be grouped into three broad categories. In order of increasing complexity, these are:

- Communication between referring and receiving hospitals without imaging;
- Communication between referring and receiving hospitals supported by full imaging studies; and
- Full videoconferencing for real-time teleconsultations.

Table 2 groups SADC Member States according to their capabilities to use Telehealth in referral hospitals.

Table 2: Grouping of SADC Member States according to Telehealth functional capabilities in referral hospitals

Level: Functionality	Countries
I: Communication between referring and receiving hospital without imaging	1. Swaziland 2. Zambia 3. Zimbabwe
II: Communication between referring and receiving hospital fully supported by imaging studies	1. Angola 2. Botswana 3. DRC 4. Lesotho 5. Malawi 6. Mozambique 7. Namibia 8. Seychelles 9. Tanzania
III: Full video-conferencing for real-time Teleconsultations	1. Mauritius 2. South Africa

The technology requirements in each of these categories and the contribution to referrals are described briefly below.

For communication between sending and receiving hospitals without imaging, but including sharing of basic medical records, the technology requirements are:

- Voice communication by telephone and/or over the Internet (for example, via Skype);
- Official email services with file attachments; and
- Internet connectivity with a bandwidth of at least 128 Kbps.

Official email services are recommended not only for communication purposes, but also because of the sensitivity of the transferred data and information. Patient records should be handled under conditions that ensure privacy, security and confidentiality. Private email addresses of hospital staff do not meet these conditions.

Referral hospitals in most SADC Member States currently meet these minimum requirements. The exceptions are Swaziland, Zambia and Zimbabwe, where Internet bandwidth presents a challenge. The other Member States have adequate connectivity, the capacity to use the system and the capability to keep it running through maintenance and repair operations.

The improvements in referrals that can be expected by assuring electronic communication between referring and receiving hospitals (along with sharing basic medical records) includes faster and more reliable availability of patient information at the receiving hospital, and quicker exchanges between hospitals for improved joint management of patients.

The next level of functionality involves supporting communications between hospitals with full imaging studies, such as ultrasound, X-ray, computerised-axial tomography scans and magnetic resonance imaging. Due to the large sizes of such data files (which usually include both single and composite images), additional technology is required:

- Increased bandwidth—256 K bps or higher;
- Image server for storage and sharing of images; and
- Picture Archiving and Communication System.

With such functionality, referral is improved by the availability of additional imaging data on patients and the faster speed at which such data and results can be shared and discussed. This greatly improves joint case management of patients.

Full videoconferencing for remote consultations in real time involve additional technology requirements:

- Video conferencing system;
- Large screen displays;
- Image server for storage and sharing of images; and
- Increased bandwidth—1 Mbps or greater.

The main additional advantage of such systems is the real-time interaction they offer between the referring and receiving hospitals, with visualisation of individuals and images.

Telehealth systems at all three levels of functionality for referral purposes can be used for developing specialist skills among hospital staff in the referring hospital, and for teaching (medical students) in the receiving hospitals.

The communication facilities can be used to provide access to the indexed medical literature through programmes and platforms such as HINARI, PLoS, and PubMed (all of which provide full-text articles). In addition, eLearning options can be made available so staff can pursue formal distance-learning courses.

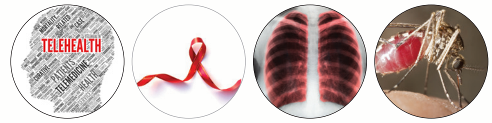
4.1.5 Levels of Telehealth functionality for reference laboratories

Supranational laboratories are expected to carry out three main functions:

- Specialist diagnostic testing;
- Quality assurance operations; and
- Training and capacity building.

Specialist diagnostic testing is done to confirm MDR-TB, XDR-TB, AIDS etc. The role of Telehealth in these areas is similar to its role in supporting referral among hospitals. Store-and-forward telepathology is one example. An histology slide prepared in a laboratory could be scanned and sent as an email attachment to the reference laboratory for analysis. The results of the analysis would then be sent back by email. Reference laboratories in SADC Member States have the capability to undertake this form of Telehealth between laboratories. Internet connectivity at national reference laboratories and at supranational laboratories will enable these two types of institutions to be linked, so that the latter can support the former.

The next level of functionality involves saving the slides on a local site of the sending laboratory so that it can be read directly by the reference laboratory staff. This has the advantage of providing immediate service when reference laboratory staff members are ready to intervene, without waiting for e-mail attachments to arrive. Results could either be written on the sending laboratory’s database or be saved at the reference laboratory for access by the sending site.



In either case, the equipment requirements include servers at both ends and sufficient bandwidth to allow local host and remote access to images and results.

The most sophisticated functionality would be full telelaboratory services. In the case of the pathology example, this would allow for real-time telepathology with remote handling of slides from the reference laboratory. The major advantage is that the reference laboratory staff could intervene directly by handling the slides from their remote location.

The system would require a microscope site, with the appropriate software installed on a computer that is connected to an automated microscope (or a microscope with automation kit), and a viewer site that consists of another computer running compatible microscopy viewer software. The systems would communicate over standard Internet/Intranet lines.

One of the objectives of supranational reference laboratories is to design and implement quality assurance systems in accordance with international standards. Telehealth can support the key components of quality assurance activities—quality control, external quality assessment and quality improvement—by facilitating regular, routine interactions and exchanges between supranational reference laboratories and national reference laboratories. Existing Telehealth components permit such interactions and exchanges.

Based on their current capabilities for Telehealth in reference laboratories, SADC Member States can be grouped into the three categories shown in Table 3.

Table 3: Grouping of SADC Member States according to Telehealth functional capabilities in reference laboratories

Level: Functionality	**Countries**
I: Telepathology with store-and-forward technology	**1. Swaziland 2. Zambia 3. Zimbabwe**
II: Telepathology with remote reading of locally prepared and stored slides	**1. Angola 2. Botswana 3. DRC 4. Lesotho 5. Malawi 6. Mozambique 7. Namibia 8. Seychelles 9. Tanzania**
III: Real-time Telepathology with remote handling of slides from reference laboratory	**1. Mauritius 2. South Africa**

Telehealth can also support the training function of supranational reference laboratories. This would occur along the same lines as the development of specialist skills for referring hospital staff, as outlined earlier.

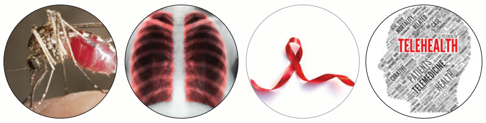
Two basic scenarios can be identified: ICT-enabled distance learning and eLearning (web-based online learning).

Basic ICT-enabled distance learning would leverage the availability of email services for:

- Learner-to-teacher, learner-to-other learner, and teacher-to-teacher communications;
- Transfer/sharing of learning materials; and
- Email discussion groups.

All of this is currently feasible at reference laboratories in SADC Member States.

More elaborate eLearning modalities are possible with additional Internet bandwidth (preferably above 128 Kbps) and course management system software (for example, Moodle). This would enable web-based discussion groups and other levels of eLearning discourse such as "webinars" and courseware development. Both these modalities can be used to help develop specialist skills for staff in the reference laboratories of SADC Member States.



4.2 Gaps

As shown in Tables 1, 2 and 3, SADC Member States currently can be grouped into three categories with respect to their capacity for Telehealth functionalities for disease surveillance and early warning, referrals among hospitals, and exchanges with reference laboratories.

This analysis identifies the gaps in equipment, telecommunications infrastructure, human and financial resources, and other capacity building measures and structures that support effective Telehealth. It also indicates the resource needs for full Telehealth functionality.

Telecommunications infrastructure: The detailed equipment needs for transitioning from one level of functionality to the next are listed in Annex 2. For example, Swaziland Zambia and Zimbabwe would need the specificied additional equipment in order to progress from performing telepathology in reference laboratories with store-and-forward technology, to telepathology with remote reading of locally-prepared and -stored slides..

A detailed country-by-country gap analysis is provided in Annex 2, and is preceded by summary tables (Tables 9-17). The analysis identifies the required equipment and services for each level of functionality, based on the categories shown in Section 4.1. It also notes whether those resources are available in the Member States or need to be acquired.

Telecommunications infrastructure: As shown in Annex 2, disease surveillance programmes in SADC Member States all currently have access to the Internet. The main gap lies in connection speeds, which are deemed inadequate in Swaziland, Zambia and Zimbabwe, and need to be increased to at least 128 K pbs.

In order to render the Telehealth system even more functional for disease programmes, and at referral hospitals and reference laboratories, additional gaps have been identified. These are detailed in Annex 2. The information is summarised in Tables 10-12 (for disease surveillance and early warning), Table 13 (for referral hospitals at the three functional levels), and Table 14 (for reference laboratories at the three functional levels).

4.3 Human and financial resources required for running the Telehealth system: capacity building

The human resources challenges identified in SADC Member States with regard to ICT in the health sector, call for strong interventions around capacity building. Such efforts generally have two main thrusts:

- Developing expertise among ICT staff for proper management of the Telehealth system in this case; and
- Building capacity among other categories of health workers for use of the TNDS.
- The proposed capacity building component of the project would occur through workshops.

4.3.1 ICT experts

Sufficient numbers of qualified staff are needed to effectively use the TNDS. At Ministry of Health level and in healthcare facilities, ICT-trained staff is required. They in turn oversee, operate and maintain systems, as well as train other health workers in the use of ICT. It should be noted that there are no absolute numbers (so many engineers or technicians, for example) or relative numbers (so many engineers or technicians per capita or per hospital bed, for example) associated with these capacities. It is more useful to measure "sufficiency" by determining whether the functions are properly performed by the available staff or by outsourcing to external experts. Nevertheless, broad estimates of the staff numbers that are needed to support eHealth are provided in Table 5. These estimates are based on comprehensive coverage of all levels of the healthcare pyramid. Corresponding functions for each category of staff are provided in Annex 3.

Table 5: Broad estimate of staffing requirements

Institution	eHealth staff needs
Ministry of Health	1 eHealth Manager 1 Senior eHealth Officer
Referral hospital	1 Senior eHealth Officer or eHealth Officer 1 eHealth Technician
Reference Laboratory	1 eHealth Officer or eHealth Technician
Province	1 Senior eHealth Officer at Department of Health 1 Senior eHealth Technician at hospital
District	1 Senior eHealth Technician or eHealth Technician

Salaries should be competitive enough to retain ICT personnel in the public sector of the health system. Incentives should be introduced and salaries should be increased to limit the high staff turnover experienced in some SADC Member States. There should be career prospects for technical staff working in the Ministry of Health, including service schemes for future advancement.

4.3.2 ICT skills for health workers

Incentives should also be provided for health workers who wish to upgrade their skills sets and work portfolios to include Telehealth skills. The SADC TNDS can be leveraged to provide remote assistance from countries that already have the necessary skill sets. The network can also be used to upgrade skills in Member States with fewer skilled workers.

Several Ministries of Health (for example, Botswana, Malawi and Swaziland) currently rely on personnel who are seconded from other ministries or projects to run their ICT systems.

4.3.3 Other capacity building measures

Training on the preferred system should be carried out as part of the installation in each country. This would cover hardware and software for the server and client machines, and the VSAT package. The training is aimed at ICT staff, such as system administrators, database managers and first-line maintenance staff.

In addition to in-country training, two other workshops should be held to train data managers and first-line maintenance staff. In each case, the workshop would bring together participants from all SADC countries.

4.3.4 Creation of eHealth structures

Human resource capacity is one aspect of the ICT requirements. In addition, global eHealth experts recommend that structures be created in countries to support eHealth adoption, including:

- eHealth Council;
- eHealth Corps;
- eHealth Steering Committee;
- Centre or network of excellence; and
- A professional society.

In many SADC Member States these structures still need to be created. A framework for supporting the creation of these eHealth structures has been developed by Global eHealth Consultants (in collaboration with the International Society for telemedicine and eHealth) and is available for use in SADC Member States.

5. Connectivity options

There are several options for realising the Internet connectivity component of the TNDS, four of which are described below. Note that the equipment requirements and gaps discussed in this section do not affect the Internet connectivity options discussed earlier.

5.1 Selection criteria

Five criteria were used to determine the suitability of various connectivity options for the TNDS:

- Cost considerations for setting up and running the system (especially initial set-up costs) and the prospects for leveraging existing infrastructure;
- Reliability and maintenance considerations;
- Levels of integration of the system. This refers to how heterogeneous the various nodes of the system (implementation in Member States) are, how easy or difficult it would be to add new features to the entire network, and how readily manageable the network is as a functional organisational entity;
- Compatibility with the SADC Secretariat mandate in terms of the level (regional, national and sub-national) at which the Secretariat would need to be engaged; and
- Other considerations, including the flexibility of the connectivity option to accommodate disease surveillance programmes at different levels of development, and the governance and other managerial decisions that are required at the various network nodes.

5.2 Option 1: Global eHealth Consultants' mobile monitoring and reporting system

5.2.1 Description of mobile monitoring and reporting system

The latest thinking about health information systems favours a distributed approach whereby users at all levels (facility, sub-national and national) collect the required information in an agreed format and manage the information locally. The system as a whole then has mechanisms and tools that would enable other authenticated users to access the data anywhere in the system for their own analyses and purposes. There are organisations that develop software to provide this capability.

The challenge with this option is that the SADC Secretariat's remit does not include activities at sub-national level. Accessing data directly from health facilities and institutions below the central data repository in a Member State would exceed the Secretariat's mandate.

Global eHealth Consultants nevertheless believes that such a distributed architecture provides the most reliable framework for a health information system at all levels. The proposed solutions therefore begin with a mobile monitoring and reporting system that is based on this architecture.

The following sub-section describes the design and implementation of a mobile monitoring and reporting system for SADC Member States to report indicators in an accurate and timely manner. This would make it possible to report and feed back indicator data to Ministries in ways that allow for validation and that achieve data integrity of the highest quality, as well as timeliness of reporting. The following approach is proposed, along with its various components:

- Two mobile applications for data capture, based on software and protocols, have been developed and tested by a global consortium over the past three years. One is an advanced application that is designed to run on smart phones that allow for good Internet connectivity. The other is intended for low-end cell phones, and uses structured SMS applications.

- The data from these cell phones are routed via data bundles, designated to each Mobile Station International Subscriber Directory Number or an Access Point Name [5], which can be set up free of charge for the users. Depending on the phone being used, WiFi connections may also be used to uplink data at facilities where there is Internet connectivity, but without the need for a computer. For the mobile solution, each cell phone's internal number will be linked to a reporting unit (health facility), and incoming data would be automatically re-formatted and linked to the correct reporting unit in the DHIS.

- The captured data is then inserted, stored and analysed in the web-based version (version 2) of the DHIS, using a Postgre SQL data base management system for storing data. DHIS v2 has sophisticated GIS and mapping functionality and a "dashboard" environment for web-based reporting. DHIS v2 can easily exchange data with earlier versions of DHIS, such as version v1.4, and has been configured in pilot projects.

- Authorised information officers and managers from the national, provincial and district levels will be able to draw reports from the system and export or import data in DHIS v1.4 format. This will enable proper synchronisation and alignment between mobile reporting and the routine reporting that is currently done on a daily, weekly or monthly basis using DHIS v1.4 and similar platforms.

- The tools and implementation also aim to provide the basis for potentially expanding the use of the system to cover all health programmes.

5.2.2 Advantages of Option 1

Option 1 represents the future of a truly optimised health information system for disease surveillance with built-in early warning capability. It offers the following key advantages:

- Improved granularity of data;
- Wide geographic coverage;
- Almost instantaneous access of data, thus eliminating delays in reporting; and
- Automatic updating of information in databases.

It is included here as a beacon to which SADC, as a group, should aim for future health information systems.

5.2.3 Disadvantages of Option 1

The key disadvantage of this option and the main reason why it is not recommended at this stage is the fact that it exceeds the remit of the SADC Secretariat (by involving the sub-national elements of Member States' health systems). This option would also require further developments in the eHealth regulatory environment around issues such as the protection of citizens' data, assigning unique identifiers for each citizen, digital signatures and more.

5.3 Option 2: Cloud services

5.3.1 Description of cloud services

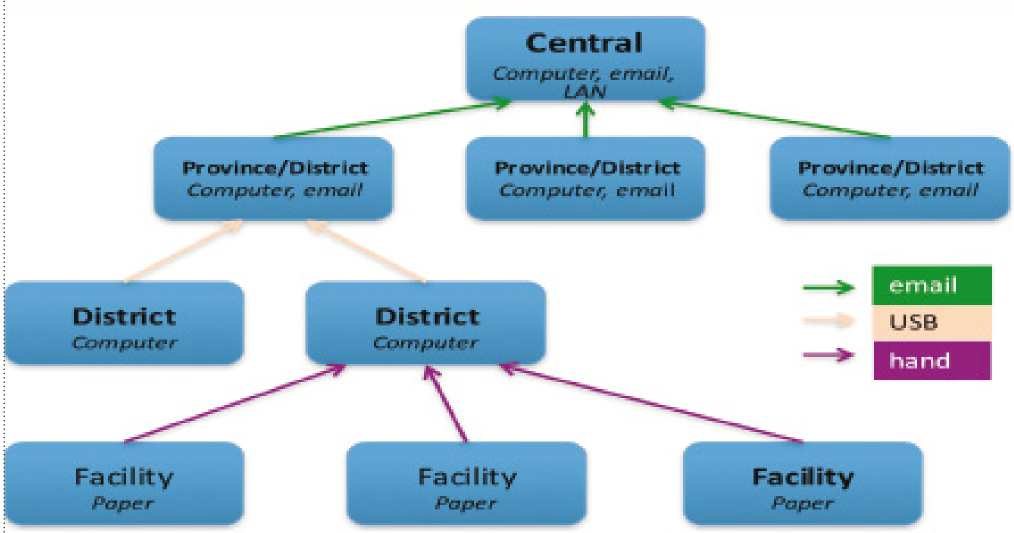
Cloud computing involves the provision of on-demand computational resources via a computer network. The same is true of communications services. Option 2 would use Cloud services in an "Infrastructure as a service" (or "IaaS") paradigm. Cloud services span four layers of the Cloud, namely "IaaS", "Platform as a Service" (or "PaaS"), "Software as a Service" (or "SaaS"), and "Business Process as a Service" (or "BPaaS"), as shown in Figure 3.

The key goal of "IaaS" is to push more business functions off physical desktops and onto the Internet so as to enable user institutions to access cheaper software and customised Internet products. Because the Cloud is an underlying delivery mechanism, Cloud-based applications and services may support any type of software application or service currently in use. These services can extend to data storage, communications and analytical capacity.

5 *APN—a computer protocol that typically allows a user's computer to access the Internet using a mobile phone network.*

The computing resources may or may not reside outside the local network—for example, they may reside in an Internet-connected data centre. What is important to the user is that the contracted services are available when they are needed. This separation between the resources used and the user's computer has also allowed for the development of new business models.

Figure 3: Cloud computing example



5.3.2 Advantages of Option 2

Cloud services provide a low-cost option in terms of initial up-front investments. Depending on usage, especially if the network is used to transfer data only once a month, it could offer the lowest total cost of ownership as well, since services are available only when needed. It also would involve no maintenance. Since there is usually great built-in redundancy, services are typically available as scheduled. Wikipedia notes the following about Cloud computing services:

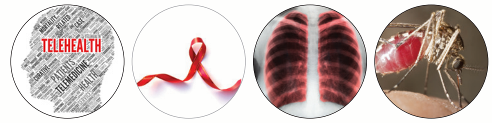
"All of the development and maintenance tasks involved in provisioning the application are performed by the service provider. The user's computer may contain very little software or data (perhaps a minimal operating system and web browser only), serving as little more than a display terminal for processes occurring on a network of computers far away. Consumers now routinely use data intensive applications driven by Cloud technology, which were previously unavailable due to cost and deployment complexity."

5.3.3 Disadvantages of Option 2

The SADC Member States would be totally dependent on the providers of the Cloud services for all aspects of the network. Countries tend to be sensitive about their data and some countries may even have laws and regulations that govern where such information may be stored.[6]

South Africa is the only SADC Member State where Cloud services are currently offered. However, with appropriate connectivity, Cloud services from South Africa could be made available to all SADC nodes in the TNDS.

6 *The legal and regulatory framework lags behind developments in ICT, not only in developing countries but in some middle-income and high-income countries as well.*



5.4 Option 3: Connectivity through local providers in SADC Member States

5.4.1 Description of Digital Subscriber Line Internet services

Digital Subscriber Line technologies, often grouped under the term DSL, connect a computer to the Internet. DSL uses existing copper pair phone line wiring or fibre optic lines in conjunction with special hardware on the switch and user ends of the line. This special hardware allows for a continuous digital connection over the phone or fibre optic lines.

Since the connection is digital, DSL technology does not involve digital-to-analogue conversion in the manner of traditional modems. By using a range of frequencies, DSL can encode more data and allow Internet connection speeds of up to 50 times faster than standard modems, and up to 12 times faster than an ISDN connection. DSL is not a bus technology; it offers more consistent bandwidth than cable modems where multiple users share very high bandwidth media.

While telecommunications networks exist throughout the SADC region, they do not cover entire countries, due to landscape topologies, high cost-to-benefit for the network or the costs of rolling out infrastructure. Fibre optics services either already exist or are planned for Member States' capital cities. All Ministries of Health are located in the principal cities of their respective countries, and thus could have adequate Internet connection speeds once fibre optics are installed in those cities. However only South Africa (and soon Mauritius) currently has this privilege.

Internet connectivity through mobile networks

Every SADC Member State has mobile connectivity, which makes this an alternative option for Internet connectivity in rural and peri-urban areas that lack access to fibre optic connections. The infrastructure may be in the form of DSL connectivity (ethernet or wireless) or via mobile connectivity (3G, GPRS, Edge).

5.4.2 Advantages of Option 3

Advantages of Option 3 include:

- Programmes, units or department at the SADC Secretariat may engage independently with their counterparts in Member States, without the need for a SADC-wide network;
- Lean decision-making with regard to networks—decisions can be made quickly on modifications to the connectivity options; and
- SADC has funding for an independent network for disease surveillance, and can therefore make commitments for a dedicated network for diseases surveillance.

5.4.3 Disadvantages of Option 3

The disadvantages of this option include:

- There would be some difficulty leveraging existing networks if and when other SADC programmes choose to establish their own networks;
- Silo systems would be operating independently, with limited or no interoperability, in single institutions (SADC Secretariat, Ministry of Health or other institutions in Member States);
- Distances can affect transmission rates or render DSL infeasible; and
- The condition of existing wiring can adversely affect transmission rates.

5.5 Option 4: SADC TNDS as a component of SADC-wide satellite-based communication services

5.5.1 Description of Option 4

This option is inspired partially by the Pan-Africa eNetwork for Telemedicine and Tele-education, which is seen as a unifying undertaking for SADC, not least because it includes VVIP communication functionalities (linking the seats of Government in all African countries). The SADC TNDS could serve as a model for the broader SADC network. A full description is provided below.

VSAT packages—Shared Network Internet

Connectivity may be occur by installing a Very Small Aperture Terminal (VSAT) for satellite communications. A typical hardware setup would consist of a VSAT kit—including a modem, a block up-converter for transmission to the satellite, a low-noise block for converting received satellite signals, antenna, cable and mounting hardware.

5.5.2 Advantages of Option 4

Collaborative engagement could reduce costs due to joint upfront investments by client units throughout the SADC Secretariat.

Setting up a single network for the entire SADC region also serves the paradigm shift from ICT for health to ICT for development, with health and other sectors benefitting from the same infrastructure, and thereby reducing costs. The shift involves a recognition that the same investments in ICT can serve multiple sectors of the economy, and the strong influence that economic development has on health indicators.

The satellite network also provides for centralised management of the entire network, rather than separate management of provider-client Internet services by 15 countries, some of which may not have the TNDS high on their priority lists.

The satellite option also would lend itself very well to adding early warning services through Tele-epidemiology or landscape epidemiology functionalities.

5.5.3 Disadvantages of Option 4

One of the concerns for such a joint service at the level of the SADC Secretariat is that there may be considerable delays before it is set up. Programmes, units or departments that have their identified their requirements and that have secure funding may have to wait for others to do likewise before the common network project can proceed.

Another drawback, from the perspective of national network nodes, is its highly centralised nature of this Option. Much of the management would be done centrally by the service provider. On the other hand, given the different levels of engagement by Member States, a centralised system might be an advantage for keeping the entire network operational at all times.

5.6 Recommended connectivity option: Satellite-based network

The summary table below shows the scoring for the various connectivity options according to the selection criteria discussed earlier.

Based on the scores and the preceding considerations, Option 4 is the recommended option for providing connectivity.

Table 5: Summary comparison table for connectivity options

Criteria	Option 1	Option 2	Option 3	Option 4
Cost considerations	Low	Low	Moderate	Moderate
Reliability and maintainability	High	High	Low	High
Level of integration	High	High	Low	High
Compatibility with SADC Secretariat mandate	Low	High	High	High
*** Other considerations**	High	Low	Low	High

** These include flexibility of the connectivity option to accommodate disease surveillance programmes at different levels of development, and the governance and other managerial decisions involved at the various nodes of the network.*

Key: Rankings are "Low", "Moderate" and "High", with the ideal score being "Low" for cost and "High" for all other criteria.

However, the TNDS can be implemented with connectivity provided through any of the other options. As described earlier, a number of Telehealth functionalities can be performed in the areas of disease surveillance and early warning, referrals between hospitals, and interactions among reference laboratories once the basic equipment and Internet communications infrastructure are in place.

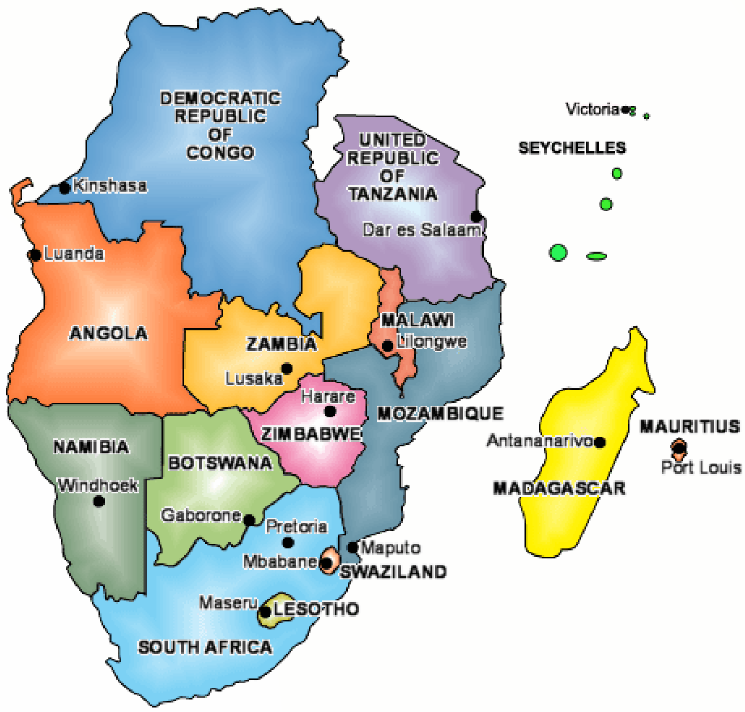
The advantage of the satellite-based TNDS lies in the development of a homogeneous network, with centralised management and control. In addition, the satellite-based TNDS is not incompatible with the ideal architecture—the distributed health information system architecture—if and when this becomes available through a policy change in SADC Secretariat's remit.

Finally, the centralised nature of the operations would ensure that the network is not affected by challenges that individual Member States might encounter when setting up and operating their own connectivity options in a manner that is interoperable with all the other national setups in the network.

5.7 Specification of the satellite connectivity system

Two Mbps of satellite bandwidth with a contention ratio of 14:1 would be required. In addition, value-added services would include monitoring of the satellite network, and management of the associated service levels.

Figure 4: Potential coverage of all SADC countries



The service provider would supply support and management services to the remotes sites and bandwidth for 1024/1024kbps (uplink and downlink) service. The service would provide for a completely private network that would cover all SADC countries in C-Band on high-quality capacity on Intelsat 17 at 66 degrees east.

The broadband VSAT network system should provide highly reliable, secure, two-way Transfer Control Protocol /Internet Protocol (TCP/IP) transmission for high-speed, multi-media service applications in a star topology. The solution should excel in scalability, flexibility, manageability, and superior network bandwidth management and IP traffic management.

5.7.1 Operation

The system is a satellite-based IP solution that operates in a star topology (Evolution X3 remote terminal with 5IF Hub). It consists of a Hub and multiple satellite routers at the remote locations.

It is a 2-way broadband network solution with all traffic on the downstream or outbound broadcast over a Time Division Multiplexing (TDM) carrier. The remote sites pass traffic to the Hub on an upstream or in-route carrier using Deterministic-TDMA (D-TDMA) access scheme. The system is ideally suited for networks with traffic patterns that follow a hub-to-spoke model and traffic that is “bursty” in nature—such as the SADC TNDS, where data from countries is sent up only periodically. The system is designed and developed to optimise the transport of TCP/IP protocol traffic over satellite. The highly efficient D-TDMA achieves efficiencies that are close to 98% of the payload bandwidth.

The system has features and controls that allow it to be easily configured to deliver application Quality of Service (QoS) and other traffic-engineered solutions to the users. It also provides TCP acceleration that supports line rate TCP throughputs in both directions, even to only one TCP session in the network. The system has built-in automatic upstream power control that ensures connectivity even in severely degraded weather conditions.

The features that enhance the solution include TCP/IP optimisation over satellite—TCP and hyper text transfer protocol acceleration, local domain name server caching, QoS and prioritisation of traffic, traffic engineering flexibility options, DHCP/NAT, network configuration and management features, centralised control features and MF-TDMA Frequency Hopping.

A schematic diagram of the system appears in Figure 5, while the footprint coverage is illustrated in Figure 6. All SADC Member States are within the footprint of the C-band coverage.

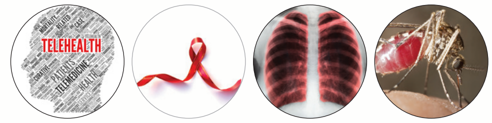
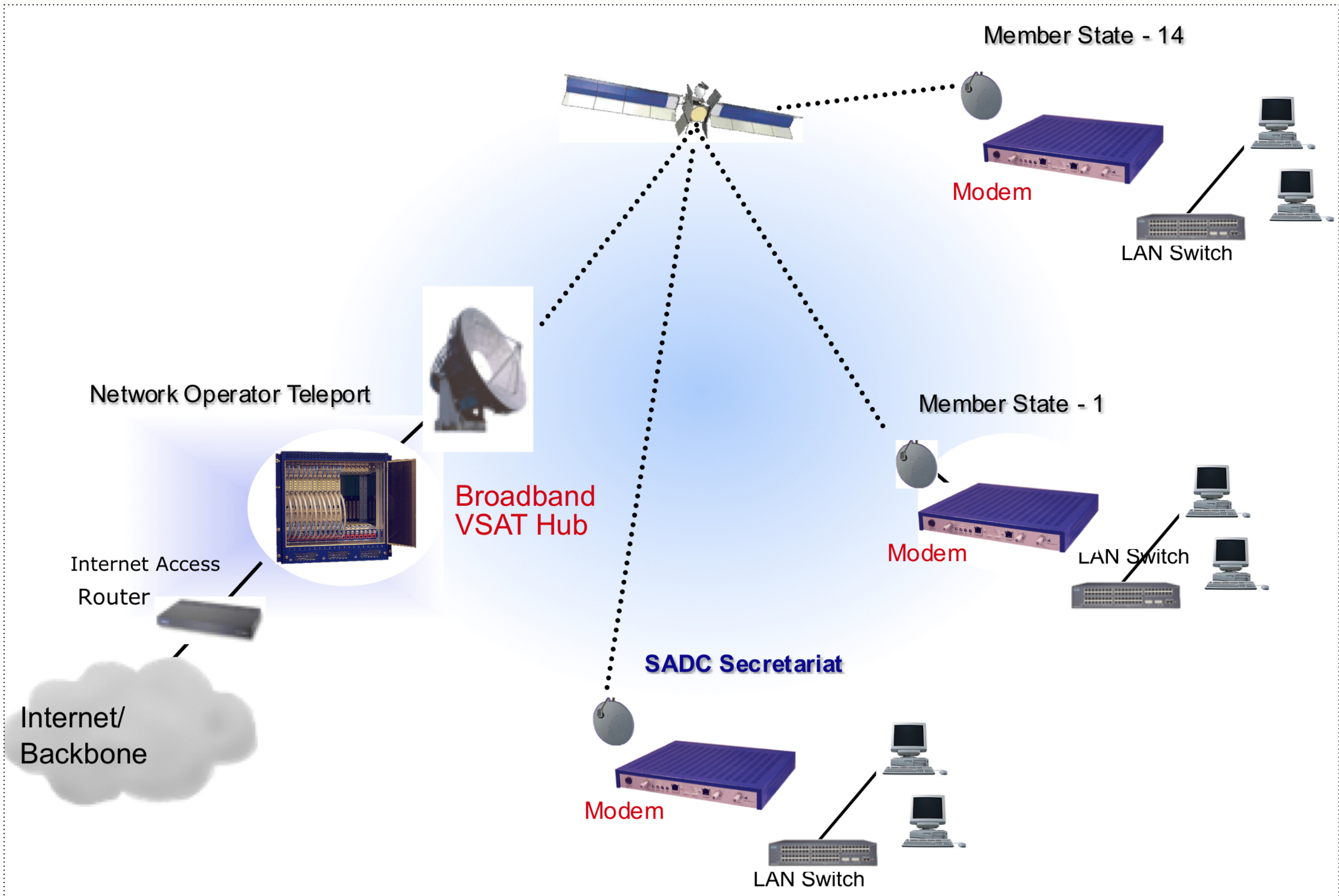


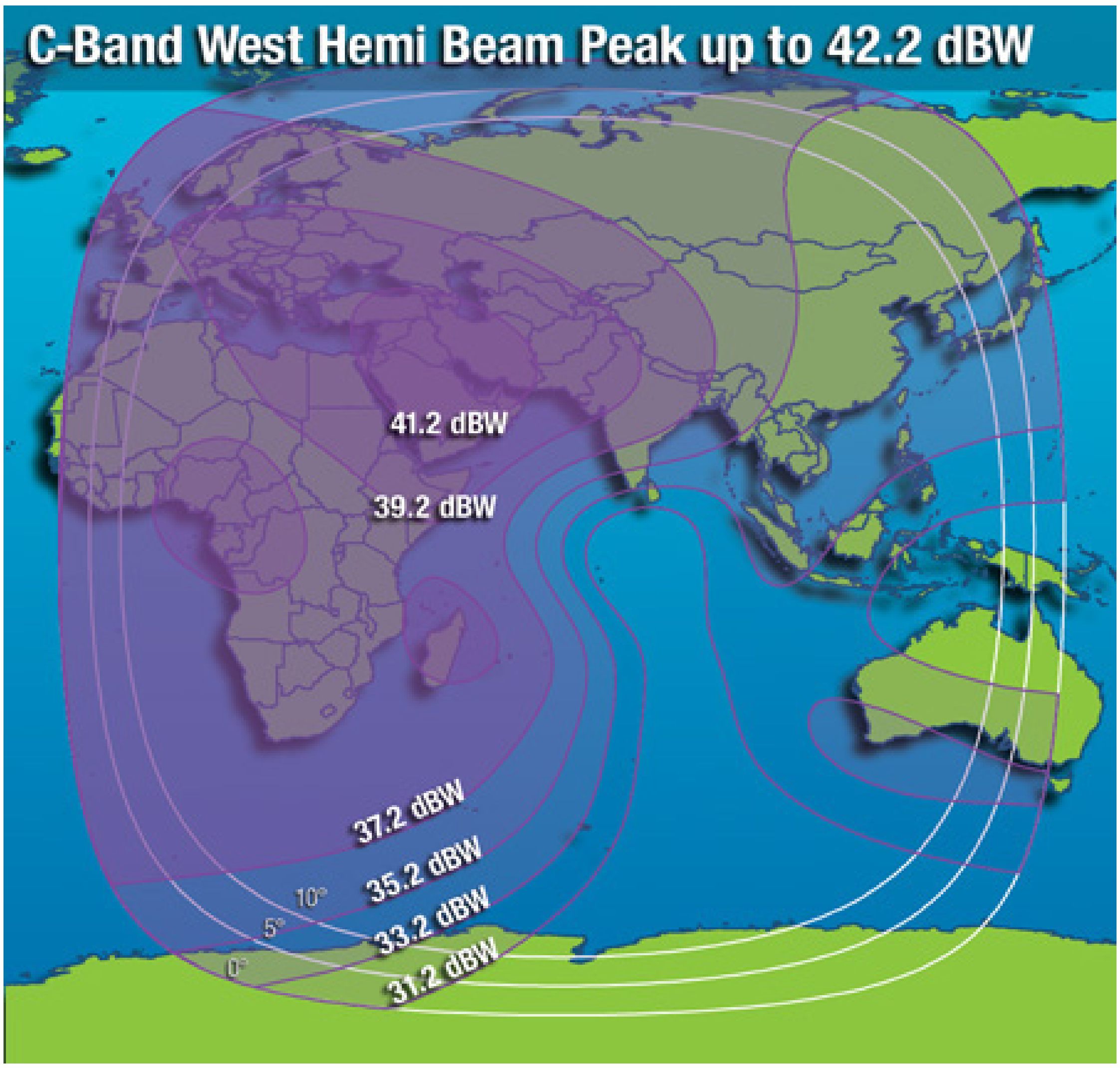
Figure 5: Schematic of VSAT system

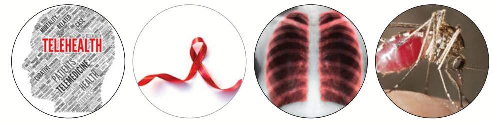


5.7.2 Footprint coverage on C-band

The footprint provides a picture of the signal that is received at a location in the country with respect to what Effective Isotropic Radiated Power is from satellite. The C-band is preferred over the KU band, which would provide good coverage for many SADC countries but would not necessarily include all regions of Tanzania and Seychelles.

Figure 6: Footprint of C-band coverage for various signals strength levels





6. Operationalising the SADC TNDS

6.1 Policy and regulatory environment

A harmonised and conducive policy and regulatory environment in Member States is key to the successful implementation of the TNDS. At regional level, this calls for SADC eHealth policy and strategy that are consistent with the e-SADC strategy, and that serve as an overarching framework for all Member States.

This hierarchical model of eHealth development—both geographically and sectorally—is consistent with an eHealth strategy development process as part of the broader national information and communication infrastructure (NICI), and the sectoral information and communication infrastructure (SICI) processes that the United Nations Economic Commission for Africa (UNECA) supports in African countries. The NICI focuses on ICT for development to benefit all sectors of the economy, while the SICI, in this instance, would support development of ICT to promote health.

Overall, eHealth strategy development covers three key aspects:

- Involving the right stakeholders from four key sectors (namely government, industry, academia and civil society);
- A participatory process that ranges from a mandate to develop the strategy, to a regional situation analysis, regional and sub-regional workshops, publication of an official document, and preparation of plans for its implementation; and
- Getting the content right by addressing the issues that are crucial for the comprehensiveness, coherence and desired impact of the strategy.

Guides are available to assist SADC in this effort.

6.1.1 National eHealth policy and strategy

An eHealth policy is a statement of intent and a commitment to certain principles to guide decisions and actions towards a desired outcome that is based on the use of ICT in the health sector. An eHealth strategy would spell out how the policy should be implemented to achieve the desired outcome.

The eHealth development process outlined above for the SADC region applies, with appropriate modifications, to eHealth strategy development in individual Member States as well.

In addition, Member States should create key structures to support the adoption of eHealth and foster its growth into all areas of health. The value of eHealth increases exponentially with the number of users and service areas in which it is applied. The more widespread the meaningful use ICT in the health sector becomes, the greater the overall benefits can be. There are frameworks (from institutions such as WHO, ITU, the International Society for Telemedicine and eHealth, as well as private sector companies and foundations) that can help Member States develop such structures.[7]

The structures also offer mechanisms for fruitful interaction among the health workforce, as well as with citizens. Such strategies and structures will serve to guide not only the implementation of the SADC TNDS, but also the numerous eHealth initiatives that are being undertaken in Member States.

6.1.2 Regulatory environment for ICT in health

It is equally important to develop and maintain an up-to-date regulatory environment for the use of ICT in the health sector, including the assignment of a unique identifier for all citizens that can be used throughout the region.

Ethical and legal issues are an important consideration in eHealth as a whole and Telehealth in particular, because of the potential for breaches of security, privacy and confidentiality. WHO has identified this as a priority action area for countries that are implementing eHealth. Security, privacy and confidentiality are key aspects of eHealth strategies and master plans. Appropriate regulatory mechanisms include practice guidelines, Ministerial orders and legislation.

7 *See, for example, Kwankam SY. Successful partnerships for international collaboration in eHealth: the need for organized structures in countries, WHO Bulletin, May 2012.*

The development of laws and regulations governing eHealth is a key aspect of policy and strategy. The structures indicated earlier are important for developing an appropriate regulatory environment. SADC Secretariat should support Member States in the development of policies, strategies and an appropriate regulatory environment, through the provision of technical assistance.

6.2 Phased implementation of the TNDS in Member States

The Assessment has shown that SADC Member States are at different levels of “eReadiness”. Although Member States are therefore at different starting points, each of them will be enhancing its surveillance and information-sharing goals by participating in the TNDS with its current capabilities in relation to equipment, infrastructure, connectivity, human and financial resources, and its policy and regulatory environment.

Accordingly, SADC ADF Member States currently may be grouped into two categories—with Zambia and Zimbabwe in one category, and Angola, DRC, Lesotho, Malawi, Mozambique and Tanzania in the other. The latter group of countries can realise Telehealth functionalities at the “middle level” (as described in Section 4.1). However, all SADC ADF Member States can progressively aim for improving their Telehealth functionalities—ideally through the harmonised network of Option 4, or alternatively by using other connectivity options (such as fibre optics).

Category 1: Zambia and Zimbabwe are currently capable of basic Telehealth functionalities in disease surveillance and early warning, referrals among hospitals and interactions among reference laboratories, as spelled out in Section 4.1:

- Disease surveillance—data collection, storage and analysis, with periodic non-automated updating and reporting;
- Referral hospitals—communication between referring and receiving hospitals without imaging; and
- Reference laboratories—basic referral services such as store-and-forward telepathology, where histology slides prepared in a laboratory are scanned and sent as email attachments to the reference laboratory for analysis.

The additional capabilities that are needed to progress to the next category are discussed in Section 4.1.

Category 2: Angola, DRC, Lesotho, Malawi, Mozambique and Tanzania can realize Telehealth functionalities at the “middle level”, and are capable of:

- Data collection, storage and analysis, with periodic non-automated updating and reporting, with high speed and reliability, in the area of disease surveillance;
- Communication between referring and receiving hospitals supported by full imaging studies among referral hospitals; and
- Increased functionality among reference laboratories such as for telepathology, the capability to save histology slides on a local site of the sending laboratory and have these read directly by the reference laboratory staff.

The additional capabilities they require to progress to the next category are discussion in Section 4.1.

Category 3: When SADC ADF Member States reach this level, they are capable of high-level functionality in disease surveillance, referrals among hospitals, and communication among reference laboratories.

- For disease surveillance this would include data collection, storage and analysis, with automatic updating and reporting including a web-based, full early-warning system;
- In terms of referrals among hospitals, this means full videoconferencing for real-time Teleconsultations;
- Full telelaboratory services can be performed. In the case of pathology, for example, real-time telepathology with remote handling of slides is possible at the reference laboratory to which referrals are made.

Transition to a higher category is well within the reach of Member States. This can be done by acquiring the additional capabilities with regard to connectivity and equipment, and by building capacity to use and maintain these more sophisticated systems. All Member States are capable of reaching category 3 within the next 3 to 5 years, with proper investments.

The next section describes in greater detail the additional considerations for setting up the TNDS. These operational instruments are needed irrespective of the connectivity options Member States select.

6.3 ICT equipment required in Member States to feed into the database

6.3.1 ICT equipment in Member States that can be used for Telehealth

In all countries, existing computers can be used in the LANs. However, the server should be of the recommended type. This would minimise interoperability issues, while leveraging existing or new equipment. Having the same system in each SADC Member State would harmonise the data warehousing process.

6.3.2 Requirements for consumables

All nodes in the TNDS system require procurement of a large number of consumables (such as cards for national health identification purposes, labels for printing bar codes, paper, printer cartridges, etc.)

6.4 Additional hardware and software requirements for optimal system effectiveness

If the system is to be most effective, every facility in the health system needs to have ample and adequate workstations for health workers to perform their assigned duties. In a health facility, those duties would include patient registration, patient monitoring, data collection, pharmacy management, laboratory management and referrals of patients.

Once the workstations are in place, the appropriate software or information systems need to be loaded. The software should be user-friendly and useful so that adoption can be widespread.

Adequate Internet connectivity hardware is needed. That requires deploying the correct modems, switches and hubs at strategic positions beyond the three locations covered in the proposed system (Ministry of Health, national referral hospital and national reference laboratory) so that all facilities can act as LANs.

The LANs, in turn, should be connected into a WAN. This will ensure that data transfers can occur from the facility level through the appropriate intermediate levels all the way to the central level. Information resources can then be shared through such internal health-system-wide connectivity.

Systems for remote diagnosis and other consultations also need to be introduced, so that referrals of patients between hospitals (in and between countries) can be done efficiently.

It is recommended that personal computers with uninterrupted power supplies be introduced into the facilities. Where personal computers cannot be introduced, hand-held devices (such as e-pads) be used for various information systems. Suitable printers, scanners and biometric systems should also be deployed to further strengthen health services.

6.4.1 Server specifications

Servers are required at the central ministerial level to house the data that are gathered at other levels of the health care pyramid. Ideally, these servers should be linked to a WAN, which will draw data collected from servers in facilities, and enable data manipulation and reporting to SADC Secretariat.

An example of a recommended server for each node is the HP ProLiant DL585 G6 8439SE 2.8GHz Six Core 4P 16GB 512BBWC ICE Rack Server. It is important that the server meets or exceeds the specifications shown earlier in Table 2. The server would be linked to other computers in the Ministry in a LAN.

6.4.2 Hardware backup

Both data and hardware should be backed up to prevent loss of data, time or service on the server. It is proposed that Ministries deploy two servers at their headquarters, with one server used as a mirror server to avoid loss of service due to server downtime.

Data back-up

Each server needs to be furnished with RAID10, a backup scheme that divides and replicates data among multiple physical hard disk drives, and that mirrors the entire data set. RAID 10 is a nested hybrid backup, and is the most secure type of data backup scheme.

Data backup options include full system backup, incremental backup, differential backup and reverse delta backup. Full system backup allows the entire personal computer to be recovered, without installing an operating system or software. When mirroring is used, the servers automatically form part of a full backup option.

Incremental backups only copy what has altered since the previous backup, and therefore depend on the last full backup (without which data are lost). It is suggested therefore that this type of backup not be used. Differential backup only copies files that have been created or changed since the last full backup. It does not mark files as having been backed up with the archive attribute not cleared. A reverse delta system stores the differences between current versions of a system and previous versions. A reverse delta backup starts with a normal full backup and then tags the differences, which it backs up.

6.5 Addressing the problem of unreliable electric power

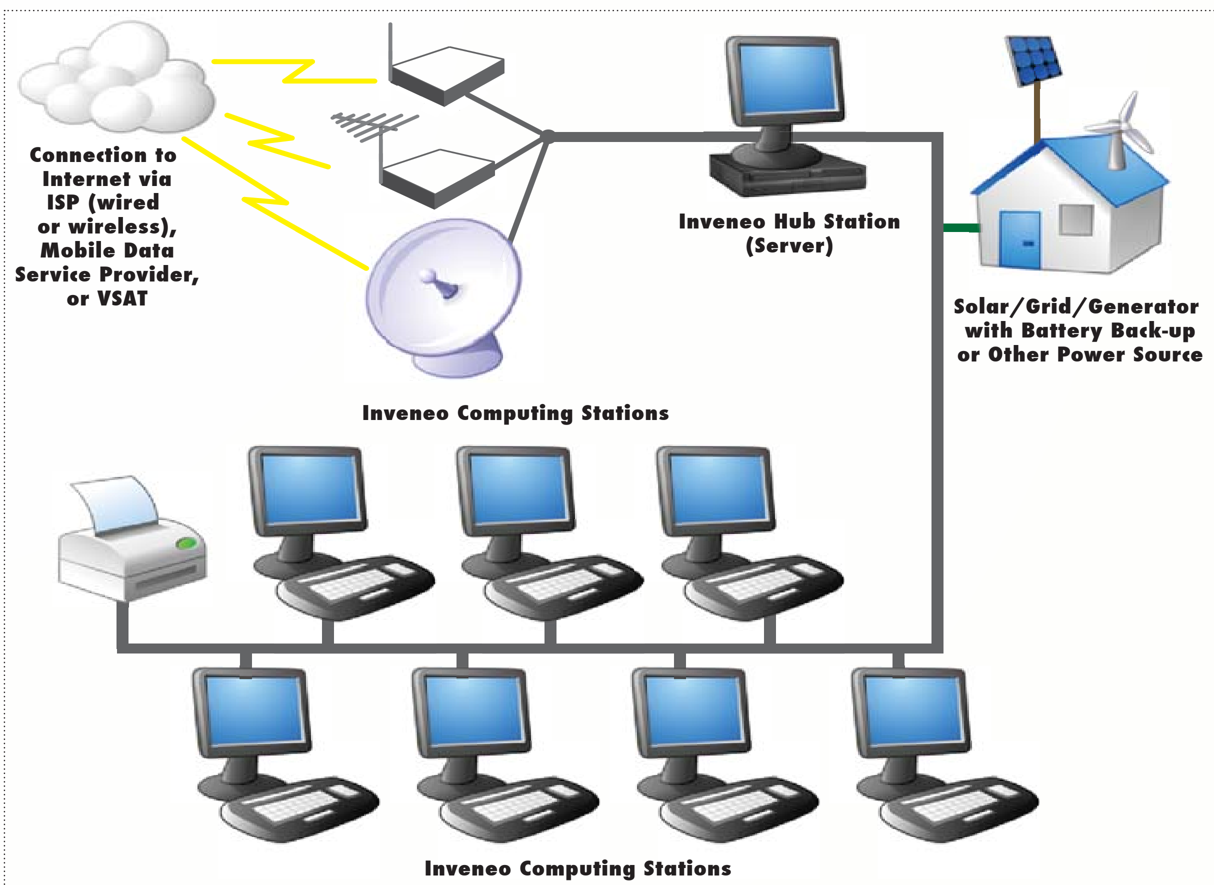
6.5.1 Reliable electric power

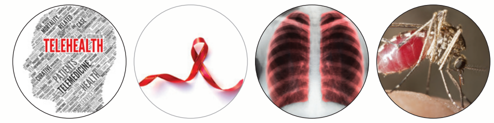
Without power, none of these systems can be implemented. Several countries of the SADC region experience serious problems with electricity supply, due to equipment failures and/or weak electricity infrastructure in some areas. Many SADC Member States lack reliable power supplies to health facilities, especially in remote areas. This presents opportunities to use alternative electricity solutions, such as fuel cell and solar technologies.

Laptops can work effectively in environments where electricity is unreliable, with lithium batteries providing the processing power even when power outages occur. A personal computer with a UPS is the standard solution to unreliable electricity supplies.

Another potential solution is the use of low-power computers with solar power backup, such as an Inveneo system (as shown in Figure 7). This could also bring electricity cost savings.

Figure 7: Typical Inveneo solar power configuration





6.5.2 Computers of recent vintage

Ideally, up-to-date computers and laptops should be included in the list of equipment for all health facilities. Laptops can work effectively in environments with unreliable electricity supplies. Laptops that are equipped with lithium batteries can provide facilities with IT infrastructure, even in the event of power outages. In cases where it is not feasible to furnish facilities with computers, tablets and cellular phones can be used to capture patient data, perform remote diagnosis and monitor pharmacy stock controls, for example.

6.5.3 Accessories

Accessories such as printers, barcode scanners and facilities for identifying individuals are also needed. These and other hardware elements should form part of a broader appropriate information system that includes patient record, pharmacy inventory control, patient drug dispensing, laboratory information, and reporting systems. In order to protect the systems, it is important that adequate antivirus software be installed.

6.6 Early warning system

Key to the establishment of early warning systems is the adequate registration of all citizens from SADC Member States in their respective national health systems. Patient tracking supplements the actions described earlier.

One approach is for national systems to enable the tracking of citizens who are receiving treatment at any facility. This would be linked to a regional SADC data warehouse, enabling the exchange of data and tracking of patients who cross into neighbouring SADC countries to receive treatment.

Other mechanisms that support early warning are briefly described below.

Heat scanners at border crossings: Entry points into countries could be equipped with heat scanners, which will facilitate the identification of persons who might harbour communicable diseases, especially influenza. Quarantine facilities should be available at border posts, so people who exhibit symptoms can be tested and relevant data can be transmitted to the Ministry of Health, and to the SADC Secretariat.

X-ray detection: Teleradiology can be used to screen patients and confirm cases of TB. This can be used for all visitors entering a country. Laboratory test results currently are time consuming and the communication of results is a problem. The TNDS could be used to relay such data.

Tele-epidemiology and early warning: Tele-epidemiology is a natural complement to a SADC TNDS that is equipped to use satellite technology. The Telehealth system can include remote sensing devices—since most vectors, hosts and pathogens are commonly tied to the landscape, with environmental factors determining their distribution and abundance.[8] For example, an increase in mosquitoes in a particular area could signal a high risk of an outbreak of Malaria.[9]

Environmental parameters derived from meteorological satellites (particularly NDVI) serve as indicators for early warning systems for Malaria. Coupled with GIS, statistical analysis and a sound knowledge of the ecology of mosquito vector populations, remote sensing can play a key role in the macro-stratification of vast malarious areas in order to prioritise control measures in cost-effective ways. This should occur alongside continued diagnosis of local communities that harbour parasites which may trigger unexplained local transmission. Similar systems have been proposed for early warning for various types of virus-borne influenza, such as Avian influenza (H5N1).[10]

8 *Pavlovsky EN. Natural nidality of transmissible diseases, with special reference to the landscape epidemiology of zooanthroponse. Urbana, Ill.: University of Illinois Press; 1966.*
9 *Dhiman RC. Remote sensing: a visionary tool in Malaria epidemiology. Indian Council of Medical Research (ICMR) Bulletin. 2000;30(11).*
10 *Marius Gilbert et al. Mapping H5N1 highly pathogenic avian influenza risk in Southeast Asia. Available at www.pnas.org*

Satellites carry various types of sensors (including panchromatic, multispectral, infrared and thermal ones) that have applications in disaster mitigation. Depending on the electromagnetic characteristics of the objects and the nature of the disaster, satellites and sensors are suitable to different types of natural disasters. For example, thermal sensors capture fire hazards, while infrared sensors are more suitable for floods and microwave sensors can record soil moisture. Through the work of Action Team 6 of the UN Office of Outer Space Affairs, some countries have started programmes on landscape epidemiology by using Global Navigation Satellite System technologies.

6.6.1 ICT equipment required across all ADF countries and at the SADC Secretariat to establish a fully functional Telehealth system

Using the network for telemedicine purposes, such as remote consultations and second opinions, can support the disease surveillance objectives. Proper application of telemedicine can reduce referrals of patients in and between Member States. However, without the procurement and implementation of Telehealth systems, and without appropriate training and incentives, it will be difficult to realise such benefits.

Linking tertiary hospitals

All SADC and ADF Member States need to upgrade Internet connectivity at the tertiary hospital level, with adequate bandwidth to enable more Telehealth modalities. Information systems in hospitals need to be harmonised. Ideally there should be only one comprehensive information system in a hospital, and it should bring together systems for hospital administration, patient information, human resources information, pharmacy inventory control, patient drug dispensing etc. In order to protect the systems, it is important that adequate antivirus software be installed on all systems. User-friendly systems can be used for all of the above requirements and these can be based on medical records system, such as OpenClinic and OpenMRS.

Patient identification cards should be introduced. If this takes the form of plastic identification cards, the equipment for electronically tagging as well as printing those cards should introduced and linked to the relevant Government department. If the cards are printed on cardboard, then barcode printers need to be installed, and scanners should be linked to registration computers for speedy patient identification and medical record entry.

Accessories such as printers, barcode scanners and identity facilities also need to be introduced to constitute a useful and e-ready system.

6.7 Geographic Information System

A Geographic Information System (GIS) has various potential uses in the health sector, including:

- Determining geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping populations at risk;
- Stratifying risk factors;
- Assessing resource allocation;
- Planning and targeting interventions; and
- Monitoring diseases and interventions over time.

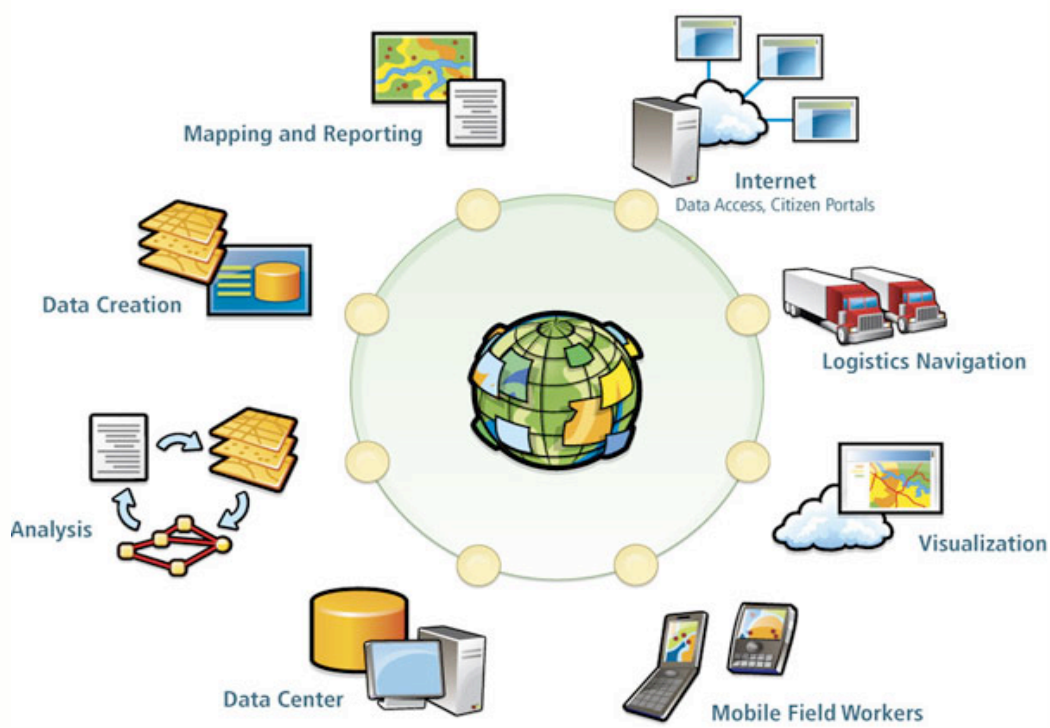
More specifically, the system allows users to:

- Perform advanced GIS data analysis and modelling;
- Take advantage of tools designed for overlay, proximity and surface analysis, and for raster processing and conversion;
- Publish and convert data in many formats;
- Create and manage personal geo-databases, multi-user geo-databases, and feature datasets;
- Use high-end cartography tools to generate professional-quality, publication-ready maps; and
- Design customised symbols and place sophisticated annotation and labels on maps.

ESRI is a key provider of GIS platforms and services, and its ArcView GIS is widely used in the SADC region. WHO also provides the HealthMapper, although it is being phased out.

An enterprise-wide GIS system would resemble that shown in Figure 8.

Figure 8: ESRI enterprise license agreement coverage



DHIS v2, the web-based open source version of the district health information system used in several SADC Member States (including Botswana, Malawi, South Africa and Tanzania) includes a basic mapping function. However, this would be too basic to cover all the functionalities discussed earlier. The two main GIS options are WHO's HealthMapper GIS and ESRI's ArcView GIS.

WHO can provide technical assistance for:

- Country assessments of national GIS data and resources;
- Organising and facilitating global positioning system surveys to map communities, health care and other core baseline data;
- Designing and developing national level, core geographic databases; and
- Developing national plans of action for the implementation of GIS.

WHO also provides training in the following areas:

- Introduction to basic mapping concepts and training;
- Overview of the current and potential uses of GIS for public health;
- Database design and assistance in integrating public health datasets into GIS;
- Hands-on training on GIS/mapping for creation of maps and integration of data results; and
- Hands-on training on HealthMapper.

6.7.1 ArcGIS

ArcGIS software is an open and interoperable technology platform that provides advanced visualisation and cartographic capabilities, spatial analysis and geographic data management. It is a complete system to author, serve and use geographic information, and it can serve analysts, decision makers, field staff and the public through mobile, web and desktop clients. The server can run any of ArcInfo, ArcEditor, ArcView GIS and their extensions.

6.7.2 Printers and scanners

In addition, accessories such as printers and scanners are needed at each node of the SADC TNDS:

- Laser colour printer;
- Large format inkjet plotter for final maps;
- Flat bed A4 colour scanner; and
- Large format map scanner.

7. Implementation Mechanisms and Institutional Arrangements

In order to successfully implement the TNDS, all stakeholders need to fulfil their responsibilities. The roles and responsibilities of key stakeholders are discussed in this sub-section.

7.1 SADC Secretariat

The SADC Secretariat has to manage the process of selecting, in a timely manner, providers for the required equipment and services in the proposed network solution. It also needs to make funds available for the procurement and installation of the items, and for the necessary capacity building activities.

In addition, the SADC Secretariat needs to develop the structure for monitoring and evaluating the project (along the lines described later), as well as ensure that Ministries of Health put in place their various necessary structures in countries.

7.2 Ministries of Health

Ministries of Health need to designate and provide space for the installation of the equipment in three sites in each country, namely:

- At the Ministry itself or at another designated central node;
- At a referral hospital; and
- At a reference laboratory.

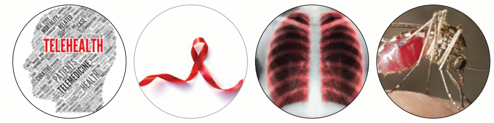
At each of these three nodes, a responsible officer should be identified, along with an overall project lead for the country. The project lead could be the SADC Coordinator in the Ministry of Health.

Ministries of Health should also identify and provide appropriate space for training activities during installation, and for specialised training on specific aspects of the project (such as GIS).

7.3 WHO and other development partners

WHO and other development partners should be urged to support the project with additional funding, for instance, to support candidates to the telemedicine training course offered at the Medical Research Council in Tygerberg, South Africa. In particular, it would be important for SADC Member States to work with WHO to promote the use of GIS tools such as AccessMod. The latter is used to determine population coverage of health services from existing facilities, or conversely, to identify where new facilities should be located to provide maximum coverage of the target populations.

A regional resource that should be tapped is the telemedicine lead programme of the Medical Research Council in South Africa. The Council offers training courses on telemedicine free of charge to SADC countries.



7.4 Project participants

The benefits of Telehealth for disease surveillance, and for eHealth generally, would be enhanced greatly by the creation of a professional society for eHealth in Member States. This could be the responsibility of the Community of Practice (CoP) in each Member State. The International Society for Telemedicine and eHealth could support such efforts by providing templates for setting up civil society professional associations.

South Africa already has two professional societies in the eHealth space that can serve as examples: the South African Telemedicine Association (www.satelemedicine.org) and the South African Health Informatics Association *(www.sahia.org.za).*

8. Monitoring and Evaluation of the Telehealth Network for Disease Surveillance

M&E is an essential aspect of every project. The SADC Secretariat should provide support in developing M&E indicators, as well as for implementing them. Evaluation should be conducted periodically, starting with a baseline at the beginning of the project, and annually thereafter. The architecture of the system and its data gathering potential facilitate the collection of M&E indicators and the sharing of such information to improve overall productivity of the network.

The CoP should facilitate sharing of learning via discussion groups and other electronic networking tools. SADC and health sector development partners should assist Ministries of Health in regular M&E of implementation and of the impact on surveillance of the three target diseases. They should also propose appropriate adjustments to project implementation.

8.1 Critical factors for success

Successful implementation of the TNDS will depend, among other things, on long-term political commitment, the establishment of solid conditions for ownership within Member States, continued availability of a critical mass of trained technical personnel, effective resource mobilisation and adequate budget provision.

An enabling environment for the project includes the commitment of SADC Member States and other partners to health sector development—including Telehealth—as an integral component of socioeconomic and human development, and the expressed will to improve the health status of the population in Member States through better use of ICT.

References

1. Mitchell J. From Telehealth to e-health: the unstoppable rise of e-health. Department of Communications, Information Technology and the Arts; 1999.

2. Office for the Advancement of Telehealth. 2001 Telemedicine Report to Congress. Washington D.C: U.S. Department of Health and Human Services, Health Resources and Service Administration, Jan 2001.

3. Oh H, Rizo C, Enkin M, Jadad A. What Is eHealth? A systematic review of published definition., J Med Internet Res. 2005;7(1):e1: http://www.jmir.org/2005/1/e1/

4. WHO. Global observatory for eHealth 2005. Geneva: WHO; 2005.

5. Eysenbach G. What is e-health? J Med Internet Res. 2001;3(2):e20 http://www.jmir.org/2001/2/e20/

6. Istepanian R, Lacal J. Emerging mobile communication technologies for health: Some imperative notes on m health. In: IEEE (Ed.), The 25th Silver 59 Anniversary International Conference of the IEEE Engineering in Medicine and Biology Society. Cancun, Mexico: IEEE; 2003.

7. SADC Treaty

8. SADC Protocol on Health, 1999

9. SADC ICT Strategy

10. Department of Health (South Africa). Epidemiological comments. Notifiable medical condition surveillance system Vol. 2 No. 2. Pretoria: Department of Health; 2010.

11. Ayyagari A, Bhargava A, Agarwal R, Mishra SK, Mishra AK, Das SR et al. Use of telemedicine in evading cholera outbreak in Mahakumbh Mela, Prayag, UP, India: an encouraging experience. Telemed J E Health. 2003 Spring;9(1):89-94.

12. Moore K. Real-time syndrome surveillance in Ontario, Canada: the potential use of emergency departments and Telehealth. Eur J Emerg Med. 2004 Feb;11(1):3-11.

13. Moss WJ, Hamapumbu H, Kobayashi T, Shields T, Kamanga A, Clennon J et al. Use of remote sensing to identify spatial risk factors for Malaria in a region of declining transmission: a cross-sectional and longitudinal community survey. Malar J. 2011 Jun 10;10:163.

14. Chanda KL & Shaw JG. The development of Telehealth as a strategy to improve health care services in Zambia. Health Info Libr J. 2010 Jun;27(2):133-9.

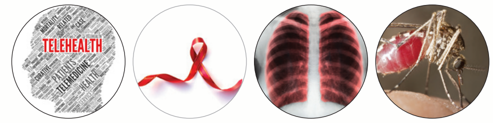
15. Mahmud N, Rodriguez J, Nesbit J. A text message-based intervention to bridge the healthcare communication gap in the rural developing world. Technol Health Care. 2010;18(2):137-44.

16. Fischer MK, Kavember MK, Scheer AJ, Introcaso, CE, Binder SW, Kovarik CL. Establishing telepathology in Africa: Lessons from Botswana, Journal of the American Academy of Dermatology. 2011 May;64(5):986-7.

17. Zimic M, Coronel J, Gilman RH, Luna GC, Curioso WH, Moore DAJ. Can the power of mobile phones be used to improve tuberculosis diagnosis in developing countries? Transactions of the Royal Society of Tropical Medicine and Hygiene. 2009;103:638-640.

18. Suhanic W, Crandall I, Pennefather P. An informatics model for guiding assembly of telemicrobiology workstations for Malaria collaborative diagnostics using commodity products and open-source software. Malar J. 2009 Jul 17;8:164.

19. WHO/RBM. A framework for field research in Africa: Malaria early warning systems—concepts, indicators and partners. Geneva: WHO, Rollback Malaria; 2001.



20. WHO Global Outbreak Alert and Response (GOARN) website (http://www.who.int/csr/labepidemiology/projects/earlywarnsystem/en/)

21. WHO. Weekly Epidemiological Record. 2004;16:153–160

22. Rolland E, Moore KM, Robinson VA, McGuinness D. Using Ontario's "Telehealth" health telephone helpline as an early-warning system: a study protocol. BMC Health Serv Res. 2006 Feb 15;6:10.

23. Grover-Kopec EK, Blumenthal MB, Ceccato P, Dinku T, Omumbo JA, Connor SJ. Web-based climate information resources for Malaria control in Africa. Malaria J. 2006;5:38.

24. See: http://www.smartglobalhealth.org/blog/entry/disease-early-warning-systems-key-aspects-of-the-2010-pakistan-flood-respon/ (accessed February 23, 2012)

25. Mars M. Health capacity development through telemedicine in Africa. Year Med Inform. 2010:87-93.

26. e-SADC policy. See www.uneca.org/istd/news/istd-dna-2010051301-en.asp for announcement and www.uneca.org/aisi/nici/e-SADC_StrategyFramework.pdf for copy.

Additional documents

1. Documents available from SADC Secretariat, such as the ADB Appraisal Report for the Control of Communicable Diseases Project
2. The SADC Harmonised Surveillance Framework for HIV and AIDS, Malaria and TB
3. The SADC HIV and AIDS Harmonised Framework; SADC HIV and AIDS Database and Information Portal documentation
4. SADC HIV and AIDS Management Information Guidelines
5. Reports on development and evaluations of Telehealth systems, etc.
6. Documents available from HIV/AIDS, Malaria and Tuberculosis programmes from SADC countries
7. Relevant scientific literature in the fields of disease surveillance and Telehealth
8. E-Health Strategies and policies
9. ICT Strategies and policies
10. Country Health Matrix Network Assessment reports
11. The ADB Appraisal Report for the Control of Communicable Diseases Project
12. The SADC Harmonised Surveillance Framework for HIV and AIDS, Malaria and TB
13. The SADC HIV and AIDS Harmonised Framework
14. SADC HIV and AIDS Database and Information Portal documentation
15. SADC HIV and AIDS Management Information guidelines
16. The e-SADC Strategy in general and the Telehealth component of the e-SADC Strategy in particular reports on development and evaluations of Telehealth systems, etc.
17. Policy Framework for Population Mobility and Communicable Diseases in the SADC Region (draft)
18. World Health Statistics (2009) (WHO)
19. The State of the World's children (UNICEF)
20. Levels & Trends in Child Mortality Report 2010 (UNICEF, WHO, World Bank, UN DESA/Population division
21. Global Tuberculosis Control 2009 Epidemiology Strategy Financing
22. UNAIDS HIV/AIDS Update
23. Technical guidelines for integrated disease surveillance and response in the African region
24. Towards Universal Access: Scaling up Priority HIV/AIDS Interventions in the Health S—Progress Report 2009

    a. SADC Health Indicator Report
    b. SADC Member States MDG Country reports 2010
    c. Strategic Plan for the Control of Tuberculosis in the South African Development Community 2007-2015 (May 2007)
    d. SADC HIV and AIDS Strategic Framework 2010-2015 (SADC)
    e. Minutes of Meeting of SADC Ministers of Health and Ministers Responsible for HIV and AIDS (11-12 Nov 2009) Swaziland
    f. eHealth Tools & Services, Needs of the Member States, Report of the WHO Global Observatory for eHealth (WHO)

ANNEX 1: Added Value of the Project—Networking of Disease Surveillance

Facilitating the transfer of aggregated country data between a national data bank and a SADC Secretariat database will serve SADC Secretariat needs for timely data from countries. However, if the data are of poor quality, they will be of questionable use. Even when data are of high quality and are available in a timely manner, there are potential limits to the added value of the data analysis for the Secretariat, compared to the benefits Member States themselves can derive from such a network.

Indeed, during the assessment, several informants posed a significant question: “So aggregated data are transferred from countries to SADC Secretariat, which then does further analysis of the data—but so what?” This underlines the issue of how data are used and how that use relates to the quality and reliability of the data. It also speaks to the purpose of networks.

The issue of data quality has been addressed in the earlier discussion of Option 1, based on new thinking about health information system architecture. It should therefore be emphasised that, Member States are not simply transferring data to the SADC Secretariat without locally analysing and using them—which after all should be the primary purpose of data collection at the Member State level.

However, in line with the SADC Protocol on Health, the issue of disease preparedness can be effectively tackled if a sufficiently detailed, objective regional picture can be achieved. Furthermore, if there is a disease outbreak, the SADC Secretariat can react quickly. The analysis at the regional level therefore provides the regional picture, while that at the Member State level presents the national picture. In this context, the importance of referrals to reference laboratories for disease confirmation and medical consultations, and the referral of affected patients to specialist hospitals for treatment cannot be overemphasised.

The added value of the SADC TNDS is to connect people, not only databases. This, in turn, will strengthen country ownership of the network, making the network an enabler of activities for those who collect the data. It then functions not only as a network for data, but as a communications link among those whose work and lives are affected by the data.

A1.1 Networking the users of the Telehealth network for disease surveillance

Given the identified need for the SADC TNDS, it is useful to examine the specifics of networking in the Internet era. The term “networking” is often used along with the word “social”, as in “social networking”. But networks existed long before that, including in business circles. Neural networks are an example.

Neural networks comprise a large number of highly interconnected processing elements (neurones) that work in unison to solve specific problems. Like people, neural networks learn by example. They have remarkable abilities to derive meaning from complicated or imprecise data; to the point of acting as “experts” in the category of information that is being analysed. The “expert” could then be used to provide projections given new situations of interest, and answer “what if” questions. This is not unlike what we expect from the nodes of the networked Human Resources for Health Observatory. A neural network also has the capability of adaptive learning and self-organisation.

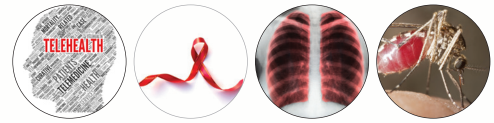
Added value of the SADC TNDS

“Never doubt that a small group of thoughtful, committed people can change the world. Indeed, it is the only thing that ever has.”—Margaret Mead (cultural anthropologist)

A network involves the technology for connecting its nodes and the content that enables people to interact in meaningful ways. It also involves a common agenda for research, using common platforms for studying DS issues, and thus creating a community of practitioners. A major added value of such a network would be the opportunity it offers to strengthen newer disease surveillance centres, thereby helping new operations overcome teething problems.

The SADC TNDS can also serve as a mechanism for recognising good practices, for identifying practices that should be avoided, and for disseminating those lessons. This would be a learning environment similar to the virtual campus in public health, with its website serving as a learning resource.

A TNDS can also strengthen the ability to raise resources for the nodes, by harnessing collective efforts, with the prospect of attracting major donor support for large-scale projects.



A1.2 Additional functions and tangible products of the human network

We therefore can identify four initial functions for the human network:

- Develop common practices for disease surveillance through consensus-building actions on a wide scale;
- Support and strengthen member institutions (especially newer ones), and learn from the successes and failures of others by identifying and disseminating good and poor practices;
- Collaboratively address disease surveillance issues of a regional nature that transcend national boundaries; and
- Assist with fundraising for network-wide activities, as well as those of sub-networks and individual institutions.

A1.3 Structure and other aspects of the network

There are three main possibilities for structuring the "people network" for disease surveillance:

- A formally created SADC entity;
- A formal collaboration among country nodes; or
- A self-organising informal collaboration among network users.

In the case of the first two options, the structure could be based on proven models for a formal or informal entity, consisting of three levels:

- A steering or advisory committee;
- A secretariat; and
- Individual institutions that constitute the nodes of the network.

Terms of reference would need to be approved, perhaps by the Executive Secretary, and membership of the steering committee would follow existing SADC guidelines. The steering committee would have statutory meetings at least once a year. Table 6 outlines the main features of each of the three types of structure.

Table 6: Possible structure for various network types

Network type	Advisory group type	Secretariat	Costs
Formally created entity	• Board or steering committee	• 1 professional staff • 1 support staff	• Highest—staff salaries + operational costs
Formal collaboration	• Advisory committee	• 1 part-time professional staff • 1 support staff	• Moderate—staff salaries + operating costs
Self-organising informal collaboration	• None or one which evolves organically	• Voluntary	• Lowest—no staff salaries + operational costs borne by network users

The main differences would be in the attributes of each of the organs in the structure. Whereas the members of the steering committee of the formal entity might be appointed by an Executive Secretary, those of an advisory committee for formal collaboration could be selected by the network nodes themselves.

Similarly, the level at which approval is given for the terms of reference could range from the Executive Secretary and/or a SADC statutory organ for the most formal structure, to programme manager endorsement for the informal collaboration.

The advantages and drawbacks associated with each type of structure are shown in Table 7.

Table 7: Comparison of network types

Network type	Advantages	Drawbacks
Formally created entity	• Formal recognition • Higher profile • Significant autonomy	• Approval of terms of reference by the Executive Secretary or SADC statutory body • Significant resources for staff and operations and meetings
Formal collaboration	• Formal recognition • Higher profile • Some autonomy	• Approval of terms of reference by the SADC programme manager • Moderate resources for staff and meetings
Informal collaboration	• Nimble/flexible structure • No need for approval • Low overhead costs	• Lower profile • Limited influence with partners

The recommended option is a flexible model that is not too hierarchical or rigid: i.e. informal collaboration.

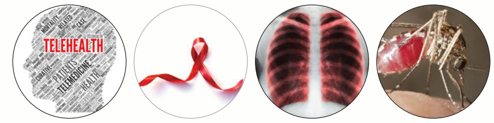
A1.4 Tools for networking people in the SADC TNDS

Whatever the forms of the networks, they can be enabled by the plethora of tools for social/business networking that are now available to anyone with Internet connectivity.

Table 8 shows some of the more commonly used tools for social networking. It excludes routine tools such as email systems, web browsers and presentation tools, but indicates how useful these might be in a regional network of disease surveillance units.

Table 8: Social networking tools and their value to a SADC TNDS

Category	Tools	Value to SADC TNDS
Blogging tool	Wordpress, Blogger	High
RSS/Feed reader	Google Reader, Bloglines	High
Micro-blogging tool	Twitter, Tweetdeck	Moderate
Instant messaging	Skype	High
Mind mapping	Freemind, Bubbl.us	High
Presentation sharing tool	Slideshare, Voice Thread	High
Web conferencing	Elluminate	High
Course authoring tool	Articulate, Lectora	Low
Web authoring	Dreamweaver, GoogleSites	High
Wiki tool	Pbworks, Wikispaces	High
Image/photo tools	Flickr, Adobe Photoshop	Moderate
Audio/podcasting tools	Audacity, iTunes	High
Video tools	YouTube, Flip	Low
Course management system	Moodle	Low
Social networking	Ning, LinkedIn, Facebook	High



A1.5 Further description of networking

The concept—variations on the networking theme

The network, when fully developed, will not be a single, monolithic maze of interrelationships among all the national participants. If the concept were to be adopted by all 14 SADC Member States, a maze of links between every pair of nodes in the network would be too unwieldy to manage. Indeed, most nodes would spend inordinate effort maintaining some form of activity with this level of interconnectivity, making the links the primary focus of the node's work. Any benefits derived would be a by-product rather than a direct output from the network. A network of networks is more likely to emerge and would be more useful—along the lines described below.

Networking models[11]

Network typologies for a global network of HRH Observatories would probably span four typologies:

- Highly structured entities such as the European Commission's Networks of Excellence;
- Loosely coupled networks of networks, such as the World Bank's Network of Networks for Impact Evaluation, and UNESCO's Culturelink network;
- Collaborations built around specific projects, such as the Integrated Projects, which were part of the Sixth Framework Programme of the European Commission; and
- Networks based on a technological platform, such as the recently launched Medpedia.

Highly structured networks are multi-partner endeavours aimed at strengthening scientific and technological excellence in specific research areas by integrating, on a large scale, the critical mass of resources and expertise that is needed to provide leadership in a given domain.

The European Commission's Networks of Excellence are tools for overcoming the fragmentation of the European research landscape in a given area and for removing barriers to integration. Their purpose is to reach a durable restructuring and integration of efforts and institutions or parts of institutions. The success of such networks is not measured in terms of scientific results but rather by the extent to which the social fabric for researchers and research institutions in a field has changed, and by the extent to which the existing capacities become more competitive as a result of that change. A neural network falls in this category.

The Regional East African Community Health Policy Initiative is designed to strengthen health systems and address cross-border health concerns, such as avian flu and Ebola. Its primary function is "to synthesise, package and distribute health policy options and information to policy makers, so that they are able to undertake more evidence-informed planning and policy-making". Its structure will see individual country nodes (in Burundi, Kenya, Rwanda, Tanzania and Uganda) linked to a single regional hub at the East African Community level. Requests for information will filter upward from the country levels, so that regional staff can prepare confidential briefings to inform politicians and bureaucrats on which policy directions the current evidence suggest.[12]

The EVIPNet aims to provide access to the best available scientific evidence that it regards as fundamental to an informed policy-making process. EVIPNet's social network is dedicated to identifying high-quality systematic reviews and other relevant research results that are useful to help address each policy issue chosen as a priority.[13]

11 Adapted from a report for WHO prepared by Global eHealth Consultants in September 2009, which in turn was based on an unpublished work done by Global eHealth Consultants in collaboration with Prof. Andy Marsh of HOIP-CIC, a Community Interest Company acting as an enabler of community-generated personalised self-care and health care technologies for Web 3.0

12 See http://www.idrc.ca/en/ev-123538-201-1-DO_TOPIC.html

13 See http://www.homolog.evipnet.org/php/level.php?lang=en&component=101&item=20

The key characteristic of both networks is the integration of end-users of the products into the network activities.

Loosely coupled networks: An example of a network of networks model is the Network of Networks for Impact Evaluation (NONIE), which comprises the Organization for Economic Co-operation and Development's Development Assistance Committee Evaluation Network, the UN Evaluation Group, the Evaluation Cooperation Group, and the International Organization for Cooperation in Evaluation—a network drawn from the regional evaluation associations. NONIE was formed to promote quality impact evaluation, and is aimed at:

- Building an international collaborative research effort for high-quality and useful impact evaluations as a means to improving development effectiveness; and
- Providing its members with opportunities for learning, collaboration, guidance and support, leading to commissioning and carrying out impact evaluations.

Collaboratives built around specific projects: The European Commission's Integrated Projects are multi-partner projects to support objective-driven research, where the primary aim is to generate knowledge for implementing the thematic priorities. The Integrated Projects bring together a critical mass of resources to reach ambitious goals, and are aimed either at increasing Europe's competitiveness or at addressing major societal needs.

They contain a research component and may also contain technological development and demonstration components, as well as a training component. A project may exist at any point in a broad research spectrum or a single project may span large parts of such a spectrum (i.e. from basic to applied research). Integration within an Integrated Project may take several forms:

- Vertical integration of the full "value chain" of stakeholders, from those involved in knowledge production to technology development and transfer;
- Horizontal integration of a range of multidisciplinary activities;
- Activity integration: integrating various research activities from fundamental to applied research, as well as with other types of activities that can include take-up activities, protection and dissemination of knowledge, training and more; and
- Sectoral integration of actors from private and public sector research organisations, and particularly between academia and industry (including small and medium-sized enterprises).

An Integrated Project comprises a coherent set of activities and an appropriate management structure. Activities in an Integrated Project may cover research and technology development activities, as well as demonstration, technology transfer or take-up, training, dissemination, knowledge management and exploitation, and consortium management activities.

Networks built around a platform: This type of network is built on a technology platform. An example is the recently launched Medpedia Project, a long-term, worldwide project to evolve a new model for sharing and advancing knowledge about health, medicine and the body among medical professionals and the general public. The Project provides a free online technology platform to any individual or organisation, and is available at www.medpedia.com.

Application of this model to the SADC TNDS would focus on technological platforms for collaboration, for use by the nodes of the network. An example is the use of the Elluminate platform, in the PAHO network of HROs. The fundamental difference, however, is that the network did not grow around the use of the platform; rather the tool was chosen to serve the needs of an existing network. A global network of HROs based on the "platform" typology could still evolve if a collaborative tool were to be developed that disease surveillance programmes found particularly useful and around which a community of users could grow.

ANNEX 2: GAP ANALYSIS—EQUIPMENT FOR THE TNDS

Summary gap analysis

This section examines SADC ADF Member States in two respects. Firstly, the assessment has shown that, with the exception of Swaziland, SADC non-ADF Member States meet the basic requirements for Telehealth for disease surveillance and GIS. Secondly, and more importantly, the SADC Secretariat is expected to assist SADC ADF Member States in acquiring the equipment and systems they need to set up and run the TNDS.

In each summary table, the required equipment is shown in the second column from the left, under the appropriate column heading, with each item assigned a letter code. Available equipment in the appropriate programme in each SADC ADF Member State is shown by the corresponding letter code in the row representing the Member State. Thus, for example, the HIV and AIDS surveillance programme in Angola has a server, a LAN/WAN, UPS and Internet connectivity. However, it still requires the items that are indicated in the right-hand column—namely, a backup server, laptop and printer.

Table 9: Database equipment and connectivity—HIV and AIDS

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
Angola	A: Server	A, D, E, F, G	B, C, F
DRC	B Backup server	A, D, G	B, C, E, F
Lesotho	C: Laptop	D, F, G	A, B, C, E
Malawi	D: LAN/WAN	A, D, G	B, C, E, F
Mozambique	E: UPS	A, D, G	B, C, E, F
Tanzania	F Printer	A, B, D, G	B, E
Zambia	G: Internet	D, G	A, B, C, E, F
Zimbabwe		A, D, G	B, C, E, F

Table 10: Database equipment and connectivity—TB

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
Angola	A: Server	A, D, E, F, G	B, C, F
DRC	B: Backup server	A, D, G	B, C, E, F
Lesotho	C: Laptop	D, F, G	A, B, C, E
Malawi	D: LAN/WAN	A, D, G	B, C, E, F
Mozambique	E: UPS	A, D, G	B, C, E, F
Tanzania	F: Printer	A, B, D, G	C, E, F
Zambia	G: Internet	D, G	A, B, C, E, F
Zimbabwe		A, D, G	B, C, E, F

Table 11: Database equipment and connectivity—Malaria

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
Angola	A: Server	A, D, E, F, G	B, C, F
DRC	B: Backup server	A, D, G	B, C, E, F
Lesotho	C: Laptop	D, F, G	B, C
Malawi	D: LAN/WAN	A, D, G	B, C, E, F
Mozambique	E: UPS	A, D, G	B, C, E, F
Tanzania	F: Printer	A, B, D, G	C, E, F
Zambia	G: Internet	D, G	A, B, C, E, F
Zimbabwe		A, D, G	B, C, E, F

Table 12: GIS Equipment

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
Angola	A: GIS server	B, C, D	A, E
DRC	B: A1 plotter	C, D	A, B, E
Lesotho	C: Printer	-	A, B, C, D, E
Malawi	D: Software	-	A, B, C, D, E
Mozambique	E: A3 scanner	-	A, B, C, D, E
Tanzania		C, D	A, B, E
Zambia		-	A, B, C, D, E
Zimbabwe		D*	A, B, C, D, E

** = Custom software*

Table 13: Summary table: Additional equipment for fully functional Telehealth for disease surveillance and early warning—HIV and AIDS programmes

Country	Ideal equipment required for Level III Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Equipment currently in place	Equipment to be purchased
Angola	A: Application server linked to the Internet	-	A, B, C, D
DRC	B: Appropriate devices at health facilities	-	A, B, C, D
Lesotho	C: Software for application server and for devices	-	A, B, C, D
Malawi	D: Hosting services by provider of system	-	A, B, C, D
Mozambique		-	A, B, C, D
Tanzania		-	A, B, C, D
Zambia		-	A, B, C, D
Zimbabwe		-	A, B, C, D

Table 14: Summary table: Additional equipment for fully functional Telehealth for disease surveillance and early warning—TB programmes

Country	Ideal equipment required for Level III Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Equipment currently in place	Equipment to be purchased
Angola	A: Application server linked to the Internet	-	A, B, C, D
DRC	B: Appropriate devices at health facilities	-	A, B, C, D
Lesotho	C: Software for application server and for devices	-	A, B, C, D
Malawi		-	A, B, C, D
Mozambique	D: Hosting services by provider of system	-	A, B, C, D
Tanzania		-	A, B, C, D
Zambia		-	A, B, C, D
Zimbabwe		-	A, B, C, D

Table 15: Summary table: Additional equipment for fully functional Telehealth for disease surveillance and early warning—Malaria programmes

Country	Ideal equipment required for Level III Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Equipment currently in place	Equipment to be purchased
Angola	A: Application server linked to the Internet	-	A, B, C, D
DRC	B: Appropriate devices at health facilities	-	A, B, C, D
Lesotho	C: Software for application server and for devices	-	A, B, C, D
Malawi		-	A, B, C, D
Mozambique	D: Hosting services by provider of system	-	A, B, C, D
Tanzania		-	A, B, C, D
Zambia		-	A, B, C, D
Zimbabwe		-	A, B, C, D

Table 16: Summary table: Additional equipment for Telehealth at referral hospitals

Country	Ideal equipment required for Level I Communication between referring and receiving hospital without imaging	Equipment currently in place	Equipment to be purchased
Angola	A: Voice communication—phone or Skype	A, B, C	
DRC	B: Official email service with file attachment	A, B, C	
Lesotho	C: Internet bandwidth > 128 Kbps	A, B	C
Malawi		A, B, C	
Mozambique		A, B, C	
Tanzania		A, B, C	
Zambia		A, B, C	
Zimbabwe		A, B, C	
Country	**Ideal equipment required** **for Level II** **Communication between referring and receiving hospital fully supported by imaging studies**	**Equipment currently in place**	**Equipment that to be purchased**
Angola	A: Picture Archiving Communications System	B	A,
DRC	B: Higher bandwidth—256 Kbps or more	B	A,
Lesotho		-	A, B
Malawi		B	A,
Mozambique		B	A
Tanzania		B	A
Zambia		-	A, B
Zimbabwe		-	A, B
Country	**Ideal equipment required** **for Level III** **Full video-conferencing for real-time Teleconsultations**	**Equipment currently in place**	**Equipment to be purchased**
Angola	A: Videoconferencing system	-	A, B, C, D
DRC	B: Large screen displays	-	A, B, C, D
Lesotho	C: Image server for storage and sharing	-	A, B, C, D
Malawi	D: Higher bandwidth—1.5 Mbps or greater	-	A, B, C, D
Mozambique		-	A, B, C, D
Tanzania		-	A, B, C, D
Zambia		-	A, B, C, D
Zimbabwe		-	A, B, C, D

Table 17: Summary table: Additional equipment for Telehealth at reference laboratories

Country	Ideal equipment required for Level I Telepathology with store-and-forward technology	Equipment currently in place	Equipment to be purchased
Angola	A: Digital imaging capability B: Internet bandwidth of 128 Kbps or greater	B	A
DRC		B	A
Lesotho		-	A, B
Malawi		B	A
Mozambique		B	A
Tanzania		B	A
Zambia		B	A
Zimbabwe		B	A
Country	**Ideal equipment required for Level II Telepathology with remote reading of locally prepared and stored slides**	**Equipment currently in place**	**Equipment that to be purchased**
Angola	A: Reference laboratory server B: Sending laboratory server C: Internet bandwidth—256 Kbps or more	C	A, B
DRC		C	A, B
Lesotho		C	A, B, C
Malawi		C	A, B
Mozambique		C	A, B
Tanzania		C	A, B
Zambia		C	A, B, C
Zimbabwe		C	A, B, C
Country	**Ideal equipment required for Level III Real-time Telepathology with remote handling of slides from reference laboratory**	**Equipment currently in place**	**Equipment to be purchased**
Angola	A: Automated microscope at sending site B: Viewer software at reference laboratory C: Internet bandwidth—1 Mbps or more	C	A, B
DRC		-	A, B, C
Lesotho		-	A, B, C
Malawi		-	A, B, C
Mozambique		-	A, B, C
Tanzania		-	A, B, C
Zambia		-	A, B, C
Zimbabwe		-	A, B, C

The summary tables are followed by country-specific gap analysis tables.

ANGOLA

Table 18: Database equipment and connectivity needs for Angola—HIV and AIDS programme

Database equipment		
Ideal equipment required	**Equipment currently in place**	**Equipment that needs to be purchased**
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	Available	-
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 19: Database equipment and connectivity needs for Angola—TB programme

Database equipment		
Ideal equipment required	**Equipment currently in place**	**Equipment that needs to be purchased**
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	Available	-
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 20: Database equipment and Connectivity needs for Angola—Malaria programme

Database equipment		
Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	Available	-
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

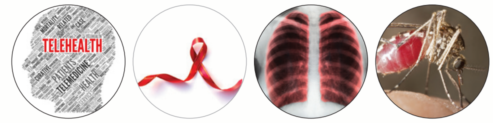


Table 21: GIS equipment needs for Angola

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	Available	-
C: Printer	Available	-
D: Software	Available	-
E: A3 scanner	-	Yes
F: Other (specify)		

Table 22: Additional equipment for a fully functional Telehealth system for disease surveillance—Angola

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 23: Additional equipment for Telehealth at referral hospital—Angola

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	Yes	No
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 24: Additional equipment for Telehealth at reference laboratory—Angola

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	Yes	No
	Higher Internet bandwidth—256 Kbps or more	No	Yes
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes

DRC

Table 25: Database equipment and connectivity needs for DRC—HIV and AIDS programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 26: Database equipment and connectivity needs for DRC—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 27: Database equipment and connectivity needs for DRC—Malaria programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 28: GIS equipment needs for DRC

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	Available	-
D: Software	Available	-
E: A3 scanner	-	Yes
F: Other (Specify)		

Table 29: Additional equipment for a fully functional Telehealth system for disease surveillance—DRC

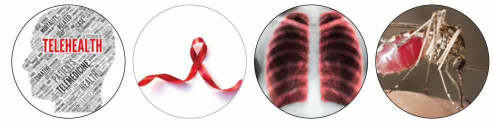
Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 30: Additional equipment for Telehealth at referral hospital—DRC

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	Yes	No
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 31: Additional equipment for Telehealth at reference laboratory—DRC

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes



LESOTHO

Table 32: Database equipment and connectivity needs for Lesotho—HIV and AIDS programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	-	Yes
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	Available	-
G: Internet	Available	-
H: Other (specify)		

Table 33: Database equipment and connectivity needs for Lesotho—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	-	Yes
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	Available	-
F: Printer	Available	-
G: Internet	Available	-
H: Other (Specify)		

Table 34: GIS equipment needs for Lesotho

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	-	Yes
D: Software	-	Yes
E: A3 scanner	-	Yes
F: Other (Specify)		

Table 35: Additional equipment for a fully functional Telehealth system for disease surveillance—Lesotho

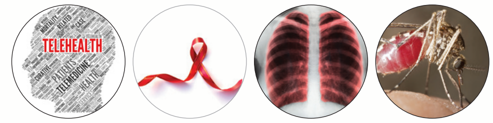
Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 36: Additional equipment for Telehealth at referral hospital—Lesotho

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication–phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	No	Yes
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	No	Yes
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 37: Additional equipment for Telehealth at reference laboratory—Lesotho

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	No	Yes
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes



MALAWI

Table 38: Database equipment and connectivity needs for Malawi—HIV and AIDS programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 39: Database equipment and connectivity needs for Lesotho—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 40: Database equipment and connectivity needs for Lesotho—Malaria programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	*Available*	-
B: Backup server	-	*Yes*
C: Laptop	-	*Yes*
D: LAN/WAN	*Available*	-
E: UPS	-	*Yes*
F: Printer	-	*Yes*
G: Internet	*Available*	-
H: Other (specify)		

Table 41: GIS equipment needs for Malawi

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	-	Yes
D: Software	-	Yes
E: A3 scanner	-	Yes
F: Other (Specify)		

Table 42: Additional equipment for a fully functional Telehealth system for disease surveillance—Malawi

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 43: Additional equipment for Telehealth at referral hospital—Malawi

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	Yes	No
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

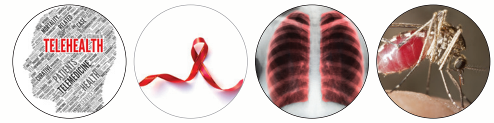


Table 44: Additional equipment for Telehealth at reference laboratory—Malawi

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes

MOZAMBIQUE

Table 45: Database equipment and connectivity needs for Mozambique—HIV and AIDS programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 46: Database equipment and connectivity needs for Mozambique—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 47: Database equipment and connectivity needs for Mozambique—Malaria programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 48: GIS equipment needs for Mozambique

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	-	Yes
D: Software	-	Yes
E: A3 scanner	-	Yes
F: Other (specify)		

Table 49: Additional equipment for a fully functional Telehealth system for disease surveillance—Mozambique

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based, full early-warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

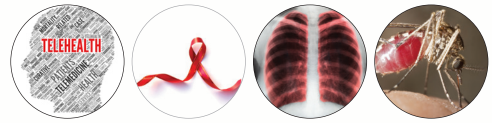


Table 50: Additional equipment for Telehealth at referral hospital—Mozambique

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture archiving communications system	No	Yes
	Higher bandwidth—256 Kbps or greater	Yes	No
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 51: Additional equipment for Telehealth at reference laboratory—Mozambique

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	No	Yes
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes

TANZANIA

Table 53: Database equipment and connectivity needs for Tanzania—HIV and AIDS programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	Available	-
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	Available	-
G: Internet	Available	-
H: Other (specify)		

Table 53: Database equipment and connectivity needs for Tanzania—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	Available	-
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 55: Database equipment and connectivity needs for Tanzania—Malaria programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	Available	-
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 55: GIS equipment needs for Tanzania

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	Available	-
D: Software	Available	-
E: A3 scanner	-	Yes
F: Other (specify)		

Table 56: Additional equipment for a fully functional Telehealth system for disease surveillance—Tanzania

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based full early warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 57: Additional equipment for Telehealth at referral hospital—Tanzania

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	Yes	No
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 58: Additional equipment for Telehealth at reference laboratory—Tanzania

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	No	Yes
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes

ZAMBIA

Table 59: Database equipment and connectivity needs for Zambia—HIV and AIDS programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	-	Yes
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 60: Database equipment and connectivity needs for Zambia—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	-	Yes
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 61: Database equipment and connectivity needs for Zambia—Malaria programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	-	Yes
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 62: GIS equipment needs for Zambia

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	-	Yes
D: Software	-	Yes
E: A3 scanner	-	Yes
F: Other (specify)		

Table 63: Additional equipment for a fully functional Telehealth system for disease surveillance—Zambia

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based full early warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 64: Additional equipment for Telehealth at referral hospital—Zambia

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	No	Yes

III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 65: Additional equipment for Telehealth at reference laboratory—Zambia

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	No	Yes
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes

ZIMBABWE

Table 66: Database equipment and connectivity needs for Zimbabwe—HIV and AIDS programme

Database equipment		
Ideal equipment required	**Equipment currently in place**	**Equipment that needs to be purchased**
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

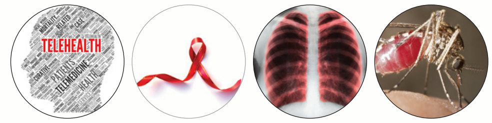


Table 67: Database equipment and connectivity needs for Zimbabwe—TB programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 68: Database equipment and connectivity needs for Zimbabwe—Malaria programme

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: Server	Available	-
B: Backup server	-	Yes
C: Laptop	-	Yes
D: LAN/WAN	Available	-
E: UPS	-	Yes
F: Printer	-	Yes
G: Internet	Available	-
H: Other (specify)		

Table 69: GIS equipment needs for Zimbabwe

Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased
A: GIS server	-	Yes
B: A1 plotter	-	Yes
C: Printer	-	Yes
D: Software	Available (custom made)	Yes
E: A3 scanner	-	Yes
F: Other (specify)		

Table 70: Additional equipment for a fully functional Telehealth system for disease surveillance—Zimbabwe

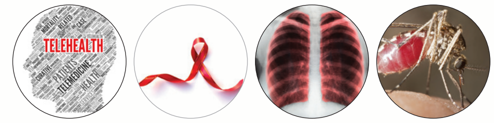
Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
III: Data collection, storage and analysis with automatic updating and reporting (web-based full early warning system)	Application server linked to the Internet	No	Yes
	Appropriate devices at health facilities	No	Yes
	Software for application server and devices	No	Yes
	Hosting services by provider of system	No	Yes

Table 71: Additional equipment for Telehealth at referral hospital—Zimbabwe

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Communication between referring and receiving hospital without imaging	Voice communication—phone or Skype	Yes	No
	Official email service with file attachment	Yes	No
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Communication between referring and receiving hospital fully supported by imaging studies	Picture Archiving Communications System	No	Yes
	Higher bandwidth—256 Kbps or greater	No	Yes
III: Full video-conferencing for real-time Teleconsultations	Videoconferencing system	No	Yes
	Large screen displays	No	Yes
	Image server for storage and sharing	No	Yes
	Higher bandwidth—1.5 Mbps or greater	No	Yes

Table 72: Additional equipment for Telehealth at reference laboratory—Zimbabwe

Level: Function	Ideal equipment required	Equipment in place	Equipment to be purchased
I: Telepathology with store-and-forward technology	Digital imaging capability at sending laboratory	No	Yes
	Internet bandwidth of 128 Kbps or greater	Yes	No
II: Telepathology with remote reading of locally prepared and stored slides	Reference laboratory server	No	Yes
	Sending laboratory server	No	Yes
	Higher Internet bandwidth—256 Kbps or more	Yes	No
III: Real-time Telepathology with remote handling of slides from reference laboratory	Automated microscope at sending site	No	Yes
	Viewer software at reference laboratory	No	Yes
	Higher Internet bandwidth—256 Kbps or more	No	Yes



ANNEX 3: BROAD FUNCTIONS OF EHEALTH STAFF

Staff	Broad functions
eHealth Manager	1. Lead the development of policy and strategy on use of ICT in the health sector 2. Lead the development of a regulatory environment for introducing ICT into the health sector 3. Manage policy and strategy implementation, as well as eHealth staff 4. Provide technical advice to health services on adoption and use of eHealth tools and services 5. Develop plans for capacity building to use ICT in the health sector
eHealth Officer	1. Support the development of policy and strategy on use of ICT in the health sector 2. Support the development of a regulatory environment for introducing ICT into the health sector 3. Provide technical advice to health services on adoption and use of eHealth tools and services 4. Develop plans for capacity building to use ICT in the health sector 5. Design and develop training programmes for ICT staff, and courses for training various cadres of health workers in the use of ICT 6. Train the health work force in the use of eHealth tools and services 7. Introduce international standards on eHealth and select technology solutions appropriate to local needs and context 8. Specify hardware and software for use in various eHealth applications, such as Telehealth, electronic health records, PACS, etc. 9. Maintain ICT systems (various types of equipment, computer hardware, software, etc.) used in the health sector, through in-house expertise or through outsourcing 10. Supervise technician-level staff
eHealth Technician	1. Specify hardware and software for use in various eHealth applications such as Telehealth, electronic health records, PACS, etc. 2. Maintain ICT systems (various types of equipment, computer hardware, software, etc.) used in the health sector, through in-house expertise or through outsourcing 3. Support the training of the health work force in the use of eHealth tools and services

NB: The designation of Senior eHealth Officer or Senior eHealth Technician could be based on years of experience within the cadre.

ANNEX 4: EQUIPMENT FOR THE SADC TELEHEALTH NETWORK FOR DISEASES SURVEILLANCE

This Annex provides specifications for the equipment required for a fully functional TNDS and the associated costing. It covers equipment for the database of the three main communicable diseases, namely HIV and AIDS, TB and Malaria, as well as equipment for GIS.

Table 73: Database server specifications (same for GIS server)

Component	Specification
Processor	AMD Opteron Model 8439 SE (6 cores, 2.8 GHz, 6MB L3, 105W)
Number of processors	4
Processor core available	6-core
Memory slots	32 DIMM slots
Memory	PC2-6400 DDR2
Expansion slots	9
Network controller	(2) 1GbE NC371i Multifunction 2 Ports
Power supply type	Redundant standard on performance models
Storage controller	(1) Smart Array P410/512MB BBWC
Internal mass storage	4.0 TB
Management software	HP Insight Control software 24x7 Support
Optical drive type	Slimline DVD/CD-RW
Form factor (fully configured)	4U
Remote management software	Insight Control with iLO Advanced
Approximate cost: US$ 33,000	

e.g. HP ProLiant DL585 G6 8439SE

Table 74: Back-up database server specifications

Component	Specification	Extra
Processor	2 Quad-core 2.4Ghz or higher	64-bit support
Motherboard	4 DIMM slots per processor	2 processor slots
Memory	16GB DDR2 ECC RAM; upgradable to 64GB	DDR3/FBDIMM
HDD	2 * 146GB 10k RPM SAS drives	Expandable to 4 drives
Networking features	Dual Gigabit Network Adapters	Embedded or slot-based
USB	Minimum 4 USB slots	USB 2.0 / 3.0
OS	64-bit Operating System	Linux or Windows
Software	Java, PostgreSQL and Apache Tomcat	64-bit versions
Approximate cost: US$ 15,000		

Table 75: Laptop specifications

Component	Specification
Processor	Intel Mobile HM65 Express chipset Intel Core i5 Sandy Bridge Dual Core i5-2430M 2.4Ghz 3MB L3 Cache Processor
Motherboard	4 DIMM slots per processor
Memory	4096MB DDR3-1333 SO-Dimm Memory (1x4096); upgradable to 8GB
HDD	640GB 5400rpm
DVD	Super Multi Writer optical drive
Screen	17.3" WXGA HD+ (1600 x 900 resolution) Non Gloss Type LED Backlit Display
	Full Size Keyboard with Numeric keypad
Graphics	AMD Radeon HD 6490M with 1GB dedicated graphics, or equivalent
Wireless connectivity	802.11b/g/n Wireless LAN 10/100/1000 Gigabit Ethernet LAN Bluetooth 3.0
Webcam	HD Webcam
USB	Minimum 2 USB slots
Touchpad	With Fingerprint Reader
Software	Microsoft Windows 7 Professional Edition 64bit Microsoft Windows 7 Professional Edition 64bit
Carrying case	Carrying case
Approximate cost: US$ 1,300	

e.g. HP Probook 4730s Series A1D61EA

Table 76: Uninterruptible power supply (UPS) specifications

Component	Specification
Class	Line Interactive UPS with automatic voltage regulation (AVR)—incl. Software
Output	1080Watt - 1x DB9/USB
AC input	1x AC in
Outputs	4x AC out
Others	2 x RJ-45
Cables	DB9/USB cable 2 x Power external cables
Software	Included
Approximate cost: US$ 200	

e.g. Proline 2000VA

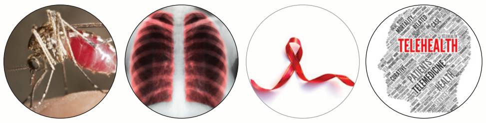


Table 77: Printer specifications

Component	Specification
Class	Mid Level Multifunction Printer (Print, Scan, Copy, Fax)
DPI	9600 x 2400
ADF	35 Page automatic document feeder (ADF)
Display	2.5" TFT Display
Network capability	WiFi, Network, Duplex
Display	Dot LCD Display
Print speed	PPM Black: 8.4 ipm PPM Colour: 5.6 ipm
Copy speed	27 seconds.
Other	Scan to USB
Approximate cost: US$ 300	

e.g. Canon PIXMA MX870 4-in-1 Printer

Table 78: A3 scanner specifications

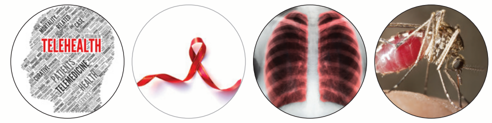
Component	Specification
Class	High performance
DPI	2400 dpi
Image resolution	2400 x 4800 dpi
Colour resolution	48-bit colour
Format	Up to A3
Connectivity	Hi-Speed USB 2.0 and FireWire® (IEEE 1394)
Other	Batch scanning
Approximate cost: US$ 300	

e.g. Epson EXP10000XL

Table 79: A1 plotter specifications

Component	Specification
Class	24-inch
Print resolution	2,400 x 1,200 dpi
Minimal line width	0.02mm (Theoretical value)
Line accuracy	+/- 0.1% or less
Print speed	A1 Roll, Full Colour Image; Plain Paper: 0:33 (Fast-CAD); Coated Paper: 1:19 (Standard-CAD); Photo Glossy Paper: 2:44 (Standard-Full Colour Image)
Media size	Roll paper (width): ISO: A3, A2, A1
Interface	USB2.0 Hi-Speed: Type: Built-in; Mode: FullSpeed (12 Mbit/sec), High Speed (480 Mbit/sec), Bulk transfer; Connector type: Series B (4 pins)
Connectivity	Type: Built-in; Standard: IEEE 802.3 10base-T; IEEE 802.3u 100base-TX/Auto-Negotiation; IEEE 802.3 x Full Duplex
Protocol	IPX/SPX (Netware 4.2(J), 5.0(J), 6.0(J)); SNMP (Canon-MIB), HTTP, TCP/IP, AppleTalk
Print head	6 colours integrated type (6 ships per print head)
Approximate cost: US$ 3,000	

e.g. Canon imagePROGRAF IPF 605



ANNEX 5: SUMMARY OF TNDS EQUIPMENT LIST—SADC ADF Member States

Table 80: Summary of database equipment—HIV and AIDS

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased	Cost of equipment to be purchased (US$)
Angola	A: Server	A, D, E, F, G	B, C, F	$ 16,600
DRC	B: Backup server	A, D, G	B, C, E, F	$ 16,800
Lesotho		D, F, G	A, B, C, E	$ 49,600
Malawi	C: Laptop	A, D, G	B, C, E, F	$ 16,800
Mozambique		A, D, G	B, C, E, F	$ 16,800
Tanzania	D: LAN/WAN	A, B, D, G	B, E	$ 15,200
Zambia	E: UPS	D, G	A, B, C, E, F	$ 49,800
Zimbabwe		A, D, G	B, C, E, F	$ 16,800
Total	F: Printer			$ 198 400
	G: Internet			

Table 81: Summary of database equipment—TB

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased	Cost of equipment to be purchased (US$)
Angola	A: Server	A, D, E, F, G	B, C, F	$ 16,600
DRC	B: Backup server	A, D, G	B, C, E, F	$ 16,800
Lesotho		D, F, G	A, B, C, E	$ 49,600
Malawi	C: Laptop	A, D, G	B, C, E, F	$ 16,800
Mozambique		A, D, G	B, C, E, F	$ 16,800
Tanzania	D: LAN/WAN	A, B, D, G	C, E, F	$ 1,800
Zambia	E: UPS	D, G	A, B, C, E, F	$ 49,800
Zimbabwe		A, D, G	B, C, E, F	$ 16,800
Total	F: Printer			$ 185 000
	G: Internet			

Table 82: Summary of database equipment—Malaria

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased	Cost of equipment to be purchased (US$)
Angola	A: Server B: Backup server C: Laptop D: LAN/WAN E: UPS F: Printer G: Internet	A, D, E, F, G	B, C, F	$ 16,600
DRC		A, D, G	B, C, E, F	$ 16,800
Lesotho		D, F, G	B, C	$ 16,300
Malawi		A, D, G	B, C, E, F	$ 16,800
Mozambique		A, D, G	B, C, E, F	$ 16,800
Tanzania		A, B, D, G	C, E, F	$ 1,800
Zambia		D, G	A, B, C, E, F	$ 49,800
Zimbabwe		A, D, G	B, C, E, F	$ 16,800
Total				$ 151 700

Table 83: Summary of GIS equipment

Country	Ideal equipment required	Equipment currently in place	Equipment that needs to be purchased	Cost of equipment to be purchased (US$)
Angola	A: GIS server B: A1 plotter C: Printer D: Software E: A3 scanner	B, C, D	A, E	$ 16,200
DRC		C, D	A, B, E	$ 19,200
Lesotho		-	A, B, C, D, E	$ 20,500
Malawi		-	A, B, C, D, E	$ 20,500
Mozambique		-	A, B, C, D, E	$ 20,500
Tanzania		C, D	A, B, E	$ 19,200
Zambia		-	A, B, C, D, E	$ 20,500
Zimbabwe		D*	A, B, C, D, E	$ 20,500
Total				$ 157 100

** = Custom software*

Table 84: Costing for database equipment

Database Equipment				
Item	Description	Quantity	Unit cost (US$)	Total cost (US$)
A	Server	1	$ 33,000	$ 33,000
B	Backup server	1	$ 15,000	$ 15,000
C	Laptop	1	$ 1,300	$ 1,300
D	LAN/WAN	1		$ 0
E	UPS	1	$ 200	$ 200
F	Printer	1	$ 300	$ 300
G	Internet			
Grand Total				$ 49,800

Table 85: Costing for FIS equipment

GIS Equipment				
Item	Description	Quantity	Unit cost (US$)	Total cost (US$)
A	GIS Server	1	$ 15,000	$ 15,000
B	A1 plotter	1	$ 3,000	$ 3,000
C	Printer	1	$ 300	$ 300
D	Software	1		$ 1,000
E	A3 scanner	1	$ 1,200	$ 1,200
Grand Total				$ 20,500

Table 86: Use of Geographic Information system

Geographic Information system (GIS)			
Country	Have GIS?	Number of trained users	Installed software
Angola	Yes	18	Grafo Win, Kosmo, Epi-Info
DRC	Yes	19	ArcView GIS 9.3, QUANTUM GIS
Lesotho [(a)]	No	N/A	N/A
Malawi [(a)]	No	N/A	N/A
Mozambique	No	N/A	N/A
Tanzania	Yes	5	Health Mapper, Google
Zambia	No	N/A	N/A
Zimbabwe [(a)]	Yes	1	Custom software

Key:

** = 1 in Dec 2010 and 25 in June 2011*

[(a)] *Data not validated at consensus meeting*

Table 87: Server for diseases surveillance and Internet connectivity

Server for diseases surveillance and Internet connectivity				
Country	Server adequate? [a]	Backup type	Internet connectivity type	Internet speed
Angola	Yes	External drive	ADSL- fibre optic	2-4 M bps
DRC	Yes	External drive	VSAT	Average
Lesotho [b]	Yes	None	DSL	No data
Malawi	Yes	None	Yes	No data
Mozambique	Yes	None	Wireless	2 Mbps+
Tanzania	Yes	Backup server	DSL	1 Mbps
Zambia	No server	External drive	DSL – Fibre optic	1 Mbps
Zimbabwe [b]	No	No	VSAT and DSL	128 KBPS

Key:
(a) Meets or exceeds specifications shown in Table xx
(b) Data not validated at Consensus workshop
** = Moving towards back up server*
+ = To be confirmed

Directorate of Social & Human Development & Special Programs SADC Secretariat

Private Bag 0095
Gaborone, Botswana
Tel: (267) 395 1863
Fax: (267) 397 2848
Email: registry@sadc.int
Website: www.sadc.int

ISBN: **978-99968-402-7-2**