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AFRIMETS
Intra-Africa Metrology System
Système Intra-Africain de Métrologie

Strategic Roadmap 2012-2016

Contributing to Pan-African Quality Infrastructure

FINAL DRAFT

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SADCMET/MEL	NEWMET	EAMET	MAGMET	CEMAC	SOAMET
Mr Donald Masuku (KEN)	Dr Ahmed El Sayed (EGY)	Mr Joel Kioko (KEN)	Dr Berrada (MAR)	Mr Ndingatoloum Fiacre (CMR)	Mr Salifou Issoufou (BFA)
Mr Katima Temba (RSA)	Dr Ali Abuelezz	Mr Dennis Moturi (KEN)	Mr Mourad Ben-Hassine (TUN)	Mr Henri Mitio (GAB)	Mr Immanuel Deza Zabo (CIV)
Mr Geraldo Albazini (MOZ)	Dr Adel Shehata	Mr John Paul Musimami (UGA)			
Mr Stuart Carstens (RSA)	Mr Paul Date (GHA)	Mr Salesio Njiru (KEN)			
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We are confident that similar exercises can be envisaged periodically to revise, update and adapt the strategy set out in the Roadmap to meet the global changing environment. This will add further value to AFRIMETS' activities and advance metrology in Africa.

Foreword

Measurement is fundamental to practically all the processes we carry out, both large and small, from commodity trading, manufacturing, environmental monitoring, health diagnostics, medical treatment, global navigation, public safety and law enforcement to just about every daily activity we perform. The African continent, however, faces considerable challenges in this area. Although Africa has an ancient history of accurate measurement, by the 1990s it had only a few pockets of measurement excellence, and just a few bi-lateral measurement arrangements. This challenge was taken up by a group of individuals and experts who recognised the importance of harmonizing measurement on the African continent, and in 2007 the nations and sub-regions of Africa came together to form AFRIMETS, the Intra-Africa Metrology System. AFRIMETS aims to overcome the metrology deficit in Africa by establishing communication channels, enhancing legal frameworks, fostering technical capabilities and connecting the continent to the international measurement system.

Such a momentous task has to be a global effort, and various major players have been instrumental in establishing AFRIMETS. By the end of 2008, the basic structuse of AFRIMETS was well established and had official international recognition; however, the institutional infrastructure still needed to be enhanced and a clear future direction defined.

It was in light of this that individuals from the BIPM, OIML and African countries approached UNIDO for assistance in strengthening AFRIMETS. A project was set up, with financial assistance from NORAD, to assist AFRIMETS achieve these goals. One of the first ideas was the publication of a roadmap that would provide a snapshot of the current situation and identify future directions.

The AFRIMETS Roadmap is not intended to provide detail on all the measurement capabilities of the AFRIMETS member institutes, but rather to give a broad overview of the regional metrology situation and identify specific interventions that could improve capabilities over a relatively short period of time. The Roadmap thus aims to provide guidance to countries on how to establish a metrology infrastructure, identify approaches to pooling scarce resources and indicate what projects could be supported by prospective donors.

The Roadmap provides a comprehensive picture of the current status of metrology on the continent and gives a clear indication of what is needed to elevate accurate measurement and testing to a fit-for-purpose level so that Africa can take its rightful place in the international measurement community and effectively support the development of the continent as a whole. It is hoped that prospective donors will find the Roadmap a valuable tool for deciding how to meaningfully support metrology in Africa.

However, for the information contained in the Roadmap to remain current and for metrology activities to adapt to new developments, politically and otherwise, the Roadmap and its proposals will need to be continuously updated and refined. The reader is thus advised to refer regularly to future publications on this subject as these are added to the AFRIMETS website, www.afrimets.org.

Mr. Mourad Ben Hassine
Chairperson of AFRIMETS

CONTENTS **Page**

1. DEFINITIONS

Accreditation	-	Procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks
AEC	-	African Economic Community established in 1991 by the Organization of African Unity heads of state and government
AFRAC	-	African Cooperation in Accreditation
AMU	-	Arab Maghreb Union
ARSO	-	African Regional Organization for Standardization
AU	-	African Union
AUC	-	AU Commission
BIML	-	*Bureau International de Métrologie Légale* – the International Bureau of Legal Metrology
BIPM	-	*Bureau International des Poidet Mesures* – the International Bureau of Weights and Measures
Calibration	-	Set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measurement
CEMAC	-	*Commission de la Communaute Economique et Monetaire de l'Afrique Central* – the Economic and Monetary Community of Central Africa
CEMACMET	-	CEMAC Metrology Cooperation, the SRMO for CEMAC
Certification	-	Any activity concerned with determining, directly or indirectly, that relevant requirements are fulfilled *Note: Typical examples of conformity assessment activities are sampling, testing, and inspection; evaluation, verification and assurance of conformity (supplier's declaration, certification) registration, and approval as well as their combination*
CGPM	-	*Conférence Générale des Poids et Mesures* – the General Conference on Weights and Measures
CIML	-	*Comité International de Métrologie Légale* – the International Committee of Legal Metrology
CIPM	-	*Comité International des Poid et Mesures,* – the International Committee of Weights and Measures
CIPM MRA	-	CIPM Mutual Recognition Arrangement
CMC		Calibration and measurement capabilities
Conformity assessment	-	Relevant combination of inspection, testing and certification concerned with determining, directly or indirectly, that relevant requirements are fulfilled

DRC		Democratic Republic of the Congo
EAC	-	East African Community
EAMET	-	EAC Sub-committee on metrology cooperation, the SRMO for the EAC
ECOWAS	-	The Economic Community of West African States
Harmonized standards	-	Equivalent standards: standards on the same subject approved by different standardizing bodies that establish interchangeability of products, processes and services, or mutual understanding of test results or information provided according to these standards
ILAC	-	International Laboratory Accreditation Cooperation
Inspection	-	Examination of a product design, product, service, process or plant, and determination of their conformity with specific requirements or, on the basis of professional judgement, with general requirements
ISO	-	International Organization for Standardization
JCRB		Joint Committee of the RMOs and the BIPM
KCDB	-	Key Comparison Database (maintained by the BIPM)
LDCs	-	Least Developed Countries (countries that, according to the World Bank, exhibit the lowest socio-economic development)
LM	-	Legal metrology: comprising all the activities for which legal requirements are prescribed on measurement, units of measurement, measuring instruments and methods of measurement, these activities being performed by or on behalf of governmental authorities, in order to ensure an appropriate level of credibility of measurement results in the national regulatory environment
Maghreb	-	Region of North-west Africa, west of Egypt, that includes Morocco, Algeria, Tunisia, Libya and Mauritania
MAGMET	-	Maghreb metrology mooperation, the SRMO for the AMU
Member	-	A member economy of the BIPM, OIML, AFRIMETS or an SRMO as defined in the context
MERCOSUR	-	Common Market of the South (South-America)
Metre Convention	-	(*Convention du Mètre*): The treaty that created the BIPM, an intergovernmental organization under the authority of the CGPM and the supervision of the CIPM. *Note: the Metre Convention established a permanent organizational structure for member governments to act in common accord on all matters relating to units of measurement. This led to the introduction of the SI system.*
MOU	-	Memorandum of Understanding
NAB	-	National Accreditation Body

National measurement standard	-	A standard recognized by a national decision that it should serve, in that country, as the basis for assigning values to other standards of the quantity concerned
National Legal Metrology Body (NLMB)	-	A body appointed by a national government to be responsible for legal metrology or any specified part of legal metrology in that country
National standard	-	A standard that is adopted by a national standards body and made available to the public
National Metrology institute (NMI)	-	A measurement institute recognized at the national level that is eligible to be the national member of the corresponding international and regional metrology organizations
NEPAD	-	New Partnership for Africa's Development
NEWMET	-	North-Eastern and Western Africa metrology organization National legal metrology body (see above)
NLMB	-	National Legal Metrology Body
NMI	-	National Metrology institute
NRCS	-	National Regulator for Compulsory Specifications
NSB	-	National standards body
NTB	-	Non-tariff barrier
OIML	-	*Organisation Internationale de Métrologie Légale* – the International Organization of legal Metrology Persistent organic pollutants
PPP	-	Purchasing Power Parity
PTB	-	PhysikalischTechnischeBundesanstalt, (Germany's national institute for natural and engineering sciences, and the highest technical authority for metrology and physical safety engineering in Germany)
Quality	-	The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs
Quality assurance	-	All those planned and systematic actions necessary to provide adequate assurance that a product or service will satisfy given requirements for quality
Quality infrastructure (QI)	-	All fields of standardization, metrology and testing, quality management and conformity assessment, including certification and accreditation. In this document it has the same meaning as SQMT.
Quality system (QS)	-	The system in place to achieve quality
Region	-	The African region unless stated otherwise
REC	-	Regional Economic Community (or block)
Regional metrology organization (RMO)	-	The regional body officially recognized by the CIPM to represent the region in matters related to the CIPM MRA

Rules of Procedure	-	A set of formally adopted rules and/or guidelines for activities undertaken by constituted committees, subcommittees or working groups
SADC	-	Southern African Development Community
SADCMEL	-	SADC Cooperation in Legal Metrology
SADCMET	-	SADC Cooperation in Measurement Traceability
SADCMET/MEL	-	The SRMO representing SADC in AFRIMETS
Sanitary and Phytosanitary measures	-	Measures necessary to protect human, animal or plant life or health, subject to the requirement that these measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between members of the WTO where the same conditions prevail or a disguised restriction on international trade
Secondary (or transfer) Standard	-	A measurement standard that is not a primary realization of the SI, but is traceable to a primary (or fit-for-purpose secondary) measurement standard at another NMI or the BIPM, or, in the case of least developed country NMIs, to accredited laboratories with fit-for-purpose artefact measurement standards traceable to an NMI or the BIPM
Scoping Study	-	A preliminary study to define the scope of a project
Scientific and industrial (S&I) metrology	-	As defined for this Roadmap, the metrology activities at an NMI (or body responsible for metrology) to establish traceability to the SI and/or determine degrees of equivalence to other national and international standards and disseminate this traceability to calibration laboratories and/or industry, and its application in industry
SI units	-	*Le Système International d'Unités* – a universal, practical system of units of measurement adopted by the General Conference on Weights and Measures
SOAMET	-	*Système Ouest-Africain de Métrologie* – the Secretariat for Metrology of the Economic Community of West African States, representing the SRMO for UEMOA
SQAM and SQMT	-	Standardization, quality assurance, accreditation and metrology. In this document it is also abbreviated as SQMT, where T stands for Testing
SRMO		Sub-regional metrology organization (see below)
Standard	-	A document that provides for common and repeated use, rules, guidelines or characteristics for products, services, or processes and production methods, including terminology, symbols, packaging, marking or labelling requirements as they apply to a product, service, process or production method
Standardization	-	To compare with, test by or adjust to a standard, the level of which is judged by the condition in which a standard has been

		successfully established
Standards Body	-	A standardizing body recognized at national, regional or international level that has as a principal function, by virtue of its statutes, the preparation, approval or adoption of standards that are made available to the public
Sub-regional metrology organization (SRMO)	-	A metrology body based on a regional economic community in Africa, representing the members of the economic community in AFRIMETS. The SRMO is a Principal member of AFRIMETS
Supplier	-	Any organization or person that brings a product or a service into circulation or onto the market place, irrespective of who the manufacturer is
TBT	-	Technical barrier to trade
Technical Regulation	-	A document which lays down product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory. It may also include or deal exclusively with terminology, symbols, packaging, and marking or labelling requirements as they apply to a product, process or production method
Testing	-	A technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure
Top-level measurement standard	-	A measurement standard of the highest metrological quality available for a quantity in a particular country which does not have an official national measurement standard for that quantity
Traceability	-	The property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties
UEMOA	-	*Union Economique et Monétaire Ouest Africaine*, – the West African Economic and Monetary Union
UNIDO	-	United Nations Industrial Development Organization
WTO	-	World Trade Organization

2. INTRODUCTION

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For many decades, Africa has been at a disadvantage with its trading partners. One of the reasons is its lack of a proper quality infrastructure, without which it is difficult to manufacture to international specifications and tolerances, to ensure the integrity of export commodities, to apply quality control for the acceptance of fresh produce at the port of arrival, to lock out unsafe imports, to ensure the health and safety of the population, and to effectively prevent crime and enforce the law.

The pillars of a quality infrastructure, namely standards, accreditation, metrology, conformance testing and quality assurance, are equally important and essential if African products and services are to be competitive. Products and services that conform to documentary standards (voluntary or compulsory) are more efficient, safer, cleaner and can be compared, and are thus nationally and internationally more acceptable. Accreditation is needed to ensure consistency in conformance to the standards, to monitor competency and, in general, to ensure repeatability. Metrology (the measurement infrastructure) is the cornerstone pillar since it underpins conformance testing and is crucial for competitive manufacturing and trade, effective health and environmental monitoring, and law enforcement. The term 'quality assurance' summarises the results of the applied processes described above, as well as any other action that improves the product or service.

Various programmes have been launched to develop quality infrastructures in the countries of Africa, but prior to 2007 there was no pan-African project to improve the accuracy of measurement and the international acceptance of measurement results generated in Africa. Calibration and testing services from outside the continent had to be used, with the associated high costs and the inability to effectively monitor the processes that led up to the final export product.

This changed with the establishment of the Intra-Africa Metrology System (AFRIMETS). At its inception, more than 70% of the nations of Africa joined a figure that has since grown to over 90%. The effect on accurate measurement could be far reaching, from the benefits to be derived by manufacturing in the more developed countries of the region, such as South Africa, Egypt, Kenya and Tunisia, to the most basic measurement functions in countries classified by the World Bank as "least developed countries" (LDCs), of which most are in Africa (see Figure 1).

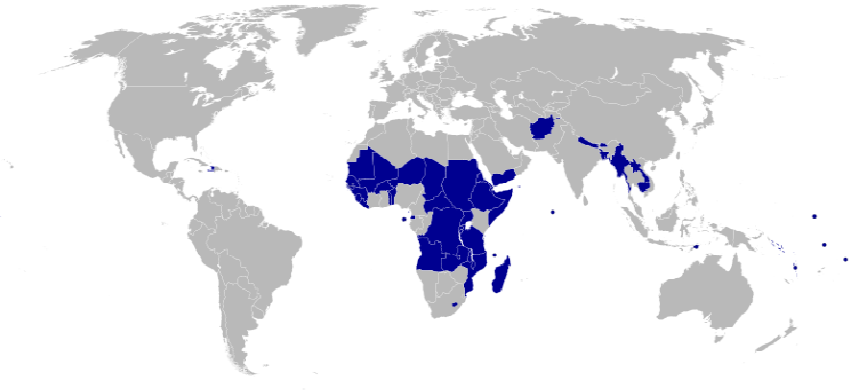

Figure 1: Least Developed Countries in the world [1]

The international linkages that AFRIMETS can provide to the measurement community are of inestimable value, and its impact on increasing trade and improving energy efficiency, and ultimately to poverty reduction, could be huge.

Metrology may be categorized as scientific and industrial (S&I) metrology (the process to establish measurement and metrological traceability to fundamental units through the realization and maintenance of primary standards and their dissemination to Industry) and legal metrology (LM) (relating to activities which result from statutory requirements, including the measurement and measuring instruments). The AFRIMETS membership includes both.

This publication, 'AFRIMETS Roadmap', was commissioned as part of the UNIDO project to strengthen AFRIMETS. The aim is to provide a snapshot of the status of scientific and industrial and legal metrology in Africa at the start of the project, to analyse the gaps in the measurement standards and legal metrology structures in the regional economic communities (RECs) of Africa, to set goals for metrology in the continent, to provide a policy statement on the approach that should be followed, to define strategies to reach the goals, and to propose a model for a sustainable organization.

The Roadmap focuses on the provision of traceability to the calibration and measurement capabilities in Africa and the harmonization of legal metrology activities. Although it identifies and comments on measurement and testing gaps, the establishment of a comprehensive testing infrastructure for Africa is beyond the scope of this study.

The Roadmap thus includes:

A. An introduction to the history, infrastructure and membership of AFRIMETS;
B. A summary of the sub-regional metrology organizations (SRMOs) and their technical and capability needs;
C. A policy statement on how to approach the needs, followed by infrastructure and skills development strategies;
D. Proposals for ensuring the sustainability of AFRIMETS;
E. Recommendations for future projects.

It is assumed that the reader has knowledge of metrology and related concepts, such as accreditation, standardization and quality. References are given if basic concepts need to be understood before the Roadmap is read, and readers are encouraged to visit the websites of the BIPM, OIML, AFRIMETS, the other RMOs and RLMOs such as EURAMET, WELMEC, APMP, APLMF SIM and COOMET, as well as the websites of the SRMOs in Africa, such as SADCMET/MEL and EAMET, for background information.


B1

3. STRENGTHENING AFRIMETS' INFRASTRUCTURAL CAPACITY

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The lack or inadequateness of any of the pillars of a quality infrastructure (but especially of metrology as the cornerstone of a quality infrastructure), can lead to an uncompetitive manufacturing industry and limited access to export markets, the inability to protect against unsafe local or imported products, ineffective environmental monitoring, and the failure of a national health or law enforcement system.

Accurate measurement and the acceptance of measurement results internationally can only be achieved through a proper, benchmarked national measurement system (supported by accreditation). This process, known as ***scientific metrology,*** concerns the establishment of quantity and unit systems, units of measurement, the development of new measurement methods, the realization of measurement standards, the process to determine the equivalence of national measurement standards to those of other nations and the transfer of traceability from these standards to users in society. ***Industrial metrology*** concerns the application of scientific metrology to manufacturing and other processes and their use in society, ensuring the suitability of measurement instruments, their calibration and the quality control of measurements. ***Legal metrology*** concerns measurements and measuring instruments for the protection of health, public safety and the environment, for enabling taxation, and for the protection of consumers and fair trade (applied through type testing of measuring instruments, verification and inspection). Collectively this system is known as a ***national metrology system.***

This Roadmap deals with both scientific and industrial and legal metrology on the African continent.

3.1 The establishment of AFRIMETS

During 2005, a group of delegates from the Southern African Development Community Cooperation in Measurement Traceability (SADCMET), the National Metrology Institute of South Africa (NMISA), the PhysikalischTechnischeBundesanstalt of Germany (PTB), the Legal Metrology Department at the National Regulator for Compulsory Specifications (NRCS), and the New Partnership for Africa's Development (NEPAD) came together to discuss the formation of an umbrella body to further metrology in Africa, and the idea of an "intra-Africa metrology system" was born [2].

The first Intra-Africa Metrology System (AFRIMETS) workshop was held in March 2006 [3] and was attended by delegates from more than 25 African countries. A draft Memorandum of Understanding (MOU) was prepared and a second workshop was held in September 2006. The first General Assembly (GA) was held in July 2007 at the premises of NEPAD at Midrand, South Africa. The MOU was finalized and signed by five groupings based on regional economic communities- which were either established as sub-regional metrology organizations (SRMOs) or were in the process of being established, namely: (i) the Southern African Development Community (SADC) Cooperation in Measurement Traceability and the SADC Cooperation in Legal Metrology (SADCMET/MEL); (ii) the East African Community sub-committee on metrology cooperation (EAMET); (iii) the Economic and Monetary Community of Central Africa Metrology Cooperation (CEMACMET); (iv) the Secretariat for Metrology of the Economic Community of West African States (SOAMET); and (v) the Maghreb Metrology Cooperation (MAGMET). These SRMOs represent 36 countries in Southern, Eastern,

Central, Western and North-Western Africa, respectively. Four countries signed on as members in their individual capacity (Ordinary members). During 2009, Egypt united with these four Ordinary members as well as Libya and Sudan in a sixth SRMO in North-Eastern and Western Africa (NEWMET). NEWMET officially joined AFRIMETS in July 2009, Mauritania then joined MAGMET, and Sierra Leone joined AFRIMETS as an Ordinary member, increasing the membership of AFRIMETS to 44 countries (as at June 2011).

3.2 AFRIMETS mission and vision

Africa faces a huge challenge to stay abreast of technological developments, to be able to prove measurement equivalence, to provide accurate and internationally acceptable analysis results for export products and to ensure an appropriate level of credibility of measurement results in the national regulatory environment. Its economy is resource- and commodity-based and relies heavily on mineral, oil, diamond and agricultural exports. As market access encompasses: (i) intra-African trade; (ii) Africa's trade with other countries and regions; and (iii) the diversification of exports, the international linkages that AFRIMETS could provide to the analytical community is of inestimable value, and its impact on increasing trade could be huge.

AFRIMETS primary aim is to harmonise scientific, industrial and legal metrology issues across Africa and to operate as a fully fledged RMO, fulfilling the obligations stipulated in the Mutual Recognition Arrangement of the International Committee for Weights and Measures, the CIPM MRA. This leads to AFRIMETS' secondary aim of fostering trade between African states and the rest of the world through the negation of technical barriers to trade.

AFRIMETS' mission statement is to:

"Promote metrology and related activities in Africa with the view of facilitating intra–African and international trade and to ensure the safety, health, and consumer and environmental protection of its citizens"

Leading to its vision of:

"Providing fit for purpose, comparable and internationally accepted metrology facilities in Africa"

The long term vision, as approved at the 3rd AFRIMETS GA (2009), includes:

- The establishment of all the structures within the organization of AFRIMETS that are necessary to fulfill its aims as set out in the MOU;
- AFRIMETS eventually becoming financially independent of sources outside Africa for its administration, thus ensuring its continued existence;
- Elevation of AFRIMETS' status so that it is fully accepted within the folds of the AU;
- The leverage of national and donor funding towards AFRIMETS' goals;
- The establishment of legal metrology and basic S&I metrology structures in all members;
- The use of these structures to improve the measurement capabilities and harmonization of administrative and technical regulations in all member countries, with the aim of facilitating their participation in intra-Africa and international trade.

The long term vision is reviewed annually at the AFRIMETS General Assembly meeting.

3.3 Objectives

AFRIMETS' overall objectives are to:

a) Create awareness of metrology in Africa at all levels of society and government;
b) Assist in the development and/or strengthening of the metrology infrastructure in each country and/or SRMO - on the continent;
c) Contribute to the development of a conformity assessment and regulatory infrastructure as required and promote equity in trade;
d) Foster competitiveness and quality in the manufacturing sector in order to promote trade and commerce;
e) Contribute to the development of the metrological infrastructure required to protect the environment and to promote the general well-being of the population, including its health and safety and the protection of consumers from fraudulent dealings where measurements are used as the basis for the transaction;
f) Develop a closer collaboration between members;
g) Improve the level of metrology and assist members in gaining international recognition;
h) Improve the traceability of measurement standards within Africa to international standards as defined in the international system of units (SI) and generally promote the CIPM MRA and the objectives of the Metre Convention;
i) Encourage measurement traceability in Africa through recognized calibration services;
j) Promote the adoption of International Organization of Legal Metrology (OIML) technical recommendations or other relevant international standards as technical regulations wherever possible and harmonize technical regulations in Africa in order to minimise technical barriers to trade.

From these come the objectives of this Roadmap, namely to:

a) Provide a snapshot of current metrological capabilities;
b) Determine the metrological needs of the continent;
c) Define how these needs will be best met;
d) Define policies and strategies to establish the necessary metrological infrastructure;
e) Define policies and strategies for the strengthening of infrastructural capacity;
f) Design models for a sustainable AFRIMETS.

3.4 Current Infrastructural arrangements and membership

The structure of AFRIMETS with SRMOs as the Principal members (see Figure 2) has been designed with reference to the geographic spread, regional economic communities and the languages used. Since it is difficult to transport artefacts or samples for comparisons or proficiency testing schemes (PTs) between custom zones in Africa, the countries were asked to organize in SRMOs that closely resemble the regional economic communities or unions (AMU, CEMAC, EAC, UEMOA/ECOWAS and SADC). The exception is NEWMET which spans three economic blocks (ECOWAS, AMU and COMESA), where language and trading partners were the overriding consideration.

The SRMOs have three main functions:

1) To establish confidence in measurements between neighbouring trading partners in RECs in support of intra-REC trade;
2) To participate in the activities of AFRIMETS to establish confidence in measurements at the international level;
3) To adopt, establish and harmonise legal metrology laws and regulations.

Secondary functions include the sharing of expertise, assistance with the establishment of a metrology infrastructure in the region, assistance with type testing and verification, training, and the creation of awareness of metrology at all levels of society.

The AFRIMETS infrastructural arrangements, including the Secretariat, were defined in the original MoU signed in July 2007 (See Appendix A). The main structures are summarized below:

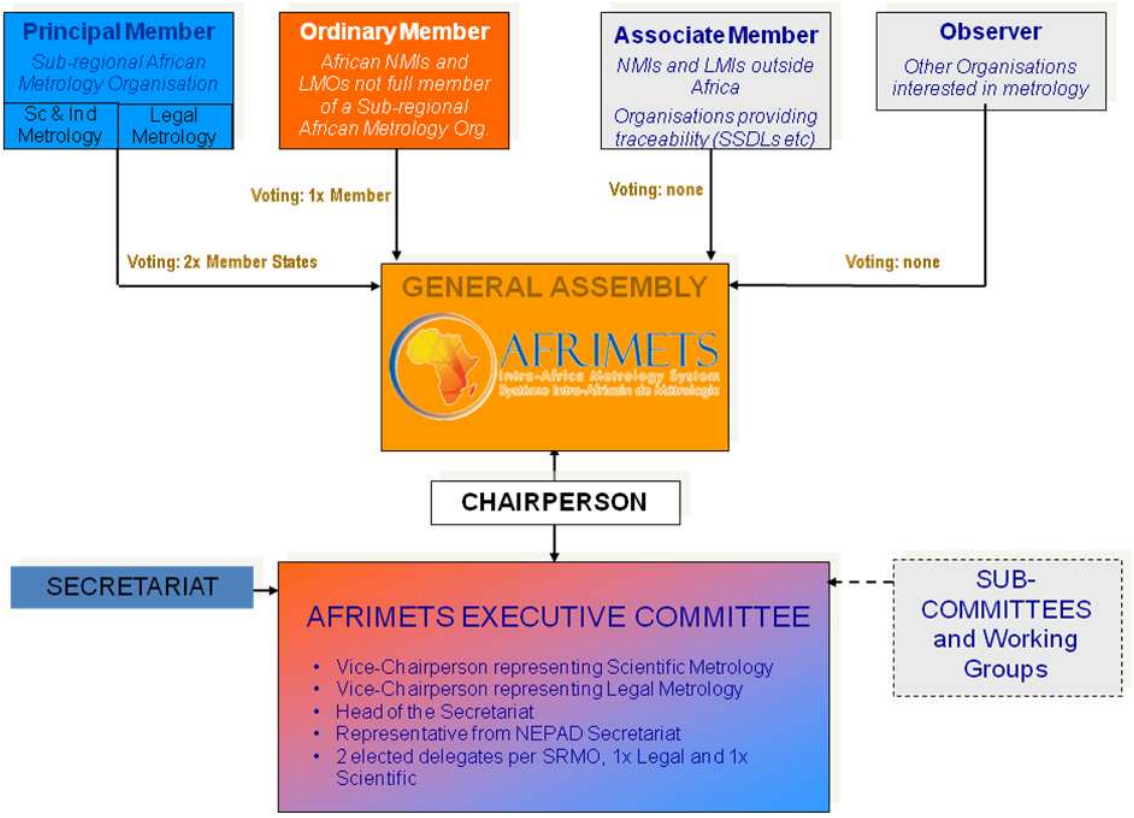

Figure 2. The structure of AFRIMETS

3.4.1 Membership of AFRIMETS

There are four categories of membership, namely:

a) Principal members: Countries that are members of SRMOs in Africa;
b) Ordinary members: Countries/institutes responsible for metrology in Africa who are not full members of an SRMO;
c) Associate members: Institutes responsible for metrology outside Africa, or institutes in Africa designated by the national metrology institute as responsible for specific parameter(s), for example atomic energy institutes responsible for ionizing radiation;
d) Observer members: Other organizations interested in metrology in Africa.

Only one category of membership is allowed.

At the inauguration of AFRIMETS, 36 countries signed the MOU as members of an SRMO, and 4 countries became Ordinary members (Egypt, Ethiopia, Nigeria and Ghana). In 2009 the Ordinary members formed NEWMET and were joined by Libya and Sudan. There were thus no Ordinary members left. Prospective new members were encouraged to join through an SRMO to ensure that the first objective of advancing intra-REC trade is met, and in 2009 Mauritania joined MAGMET. In 2010, Sierra Leone joined as an Ordinary member since the SRMO structures in ECOWAS – the REC Sierra Leone is a member of – are still in a developmental phase. It is envisaged that in the future SOAMET will expand to include all ECOWAS countries, and Sierra Leone can then join this new grouping. It must be noted that the rules of AFRIMETS do not allow for interference with national decisions, and it is up to the members to decide how to join AFRIMETS. But, since donor funding is focused on assistance to RECs, it will be to the advantage of members to join within a regional economic community.

CEMACMET only existed by name in 2007 and no formal SRMO structures were in place. There are no well-established metrology institutes in any of the member countries, and although there was individual representation at the AFRIMETS founding GA in 2007, there was no attendance from CEMACMET at the 2nd and 3rd AFRIMETS GAs and limited attendance at the 4th. The AFRIMETS Executive committee (EXCOM) initiated a process to engage the Republic of the Congo, and an EXCOM member (from the DRC) visited Brazzaville in December 2009 and made contact with the staff in government responsible for metrology. In 2010, the PTB reported that a process had started in CEMACMET to establish an official SRMO structure. Consequently, individuals from three CEMACMET member countries attended the annual GA in July 2011 and reported some progress. This is encouraging, and future developments will be eagerly anticipated (and actively supported).

AFRIMETS now spans the continent with 44 members, as shown in Table 1 and Figure 3. Only Cape Verde, Comoros, Djibouti, Eritrea, Gambia, Guinea, Liberia, Somalia and São Tomé and Principe, most without any mentionable metrology infrastructure, have not yet joined AFRIMETS.

Table 1. The countries which are members of AFRIMETS through an SRMO, and the Ordinary members

SADCMET/ MEL	SOAMET	CEMACMET	EAMET	MAGMET	NEWMET	Ordinary members
Angola Botswana DRC Lesotho Madagascar Malawi Mauritius Mozambique Namibia Seychelles South Africa Swaziland Tanzania Zambia Zimbabwe	Benin Burkina-Faso Côte- d'Ivoire Guinea-Bissau Mali Niger Senegal Togo	Cameroon Central African Republic (CAR) Chad Republic of the Congo Equatorial-Guinea Gabon	Kenya Uganda Rwanda Burundi	Morocco Algeria Tunisia Mauritania	Egypt Ethiopia Ghana Libya Nigeria Sudan	Sierra Leone

*Although Sudan is indicated as a member of NEWMET, Sudan has not officially signed the MoU

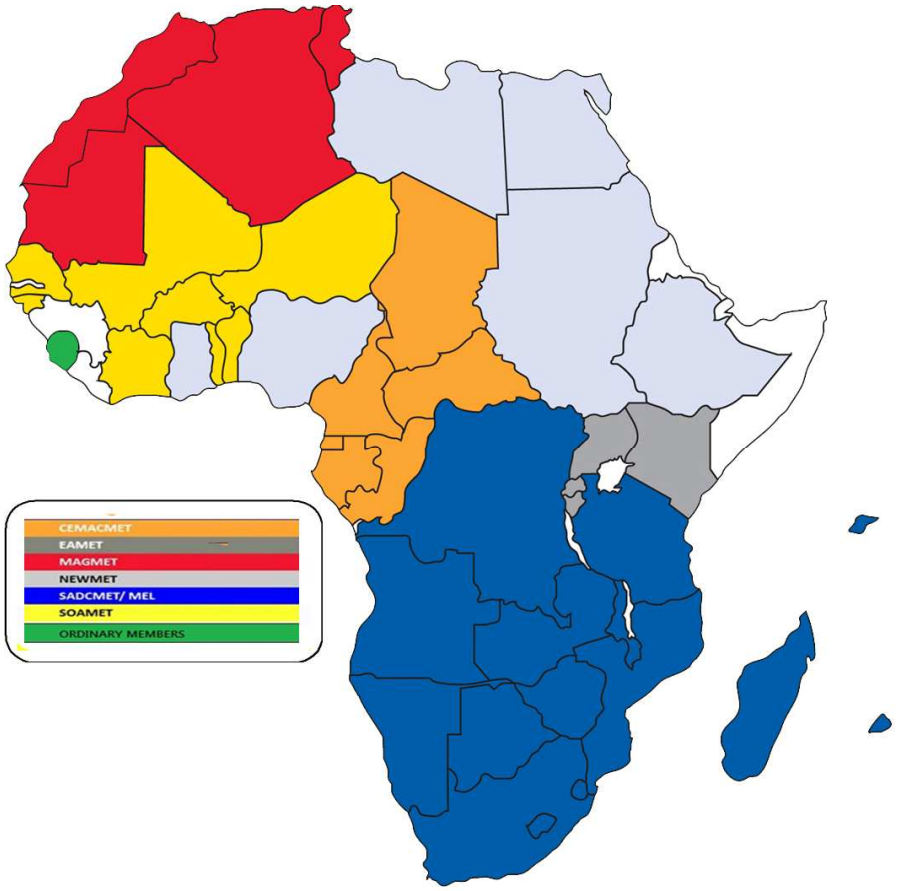

Figure 3. The Members of AFRIMETS

3.4.2 Membership of the BIPM and the OIML

One of the aims of AFRIMETS is to increase the number of Member States of the International Bureau of Weights and Measures (BIPM) [4] and of Associates of the General Conference on Weights and Measures (CGPM), and Member States and Corresponding Members of the International Organization of Legal Metrology (OIML) [5].

Scientific and industrial metrology

At the inception of AFRIMETS in 2007 only two countries (Egypt and South Africa) were Member States of the BIPM (and thus were signatories to the Metre Convention) and Kenya was an Associate of the CGPM. Cameroon is a signatory to the Metre Convention, but is currently suspended as a Member due to its membership fees being in arrears. As of 23 October 2007, the Republic of Tunisia and, as of 17 September 2009, Ghana are Associates of the CGPM [6]. Kenya acceded to the BIPM on 1 January 2010 and became a Member State. In 2010 Seychelles, Mauritius, Zambia and Zimbabwe applied to become Associates of the CGPM [7] and all were accepted by early 2011. This brought the number of Members of the BIPM in Africa to three, and of Associates to the CGPM to six. Morocco and Botswana indicated that their applications to become Associates will be submitted by the end of 2011. Tunisia indicated that its application to become a full member is in progress.

The distribution of the Member States and Associates across the Continent is shown in Figure 4.

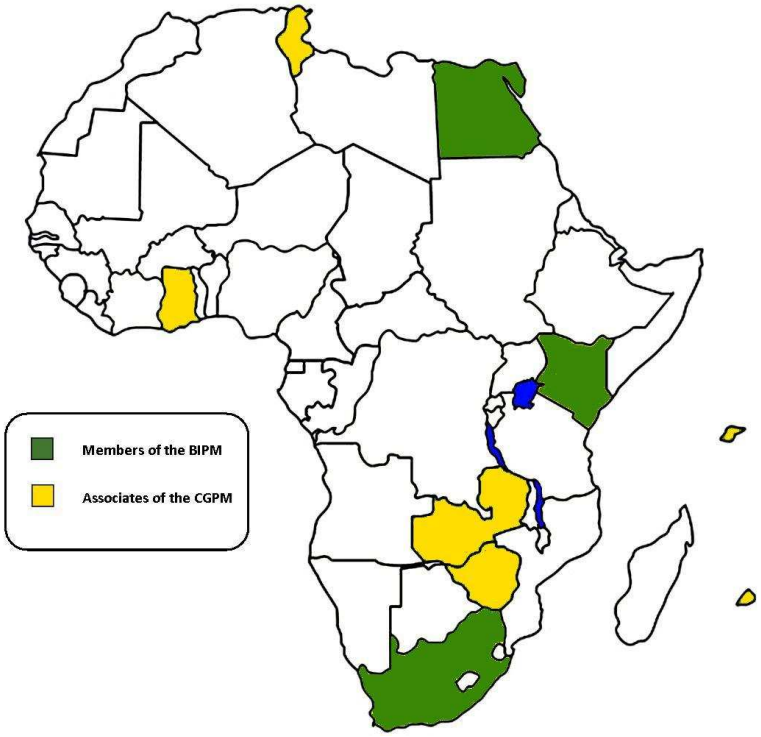

Figure 4. Member States of the BIPM and Associates of the CGPM

Legal metrology

By July 2011, there were 7 Member States and 19 Corresponding Members of the OIML in Africa [5]. The membership is well distributed across the SRMOs with Member States (MS) or Corresponding Members (CM) in SADCMET/MEL (2 MS, 6 CM), EAMET (1 MS, 1 CM), NEWMET (1 MS, 3 CM), SOAMET (UEMOA has membership as a block, thus 8 CM, and Benin and Burkina Faso have individual membership as well) and MAGMET (3 MS). CEMACMET has one Corresponding Member (Gabon). The distribution of the membership is shown in Figure 5.

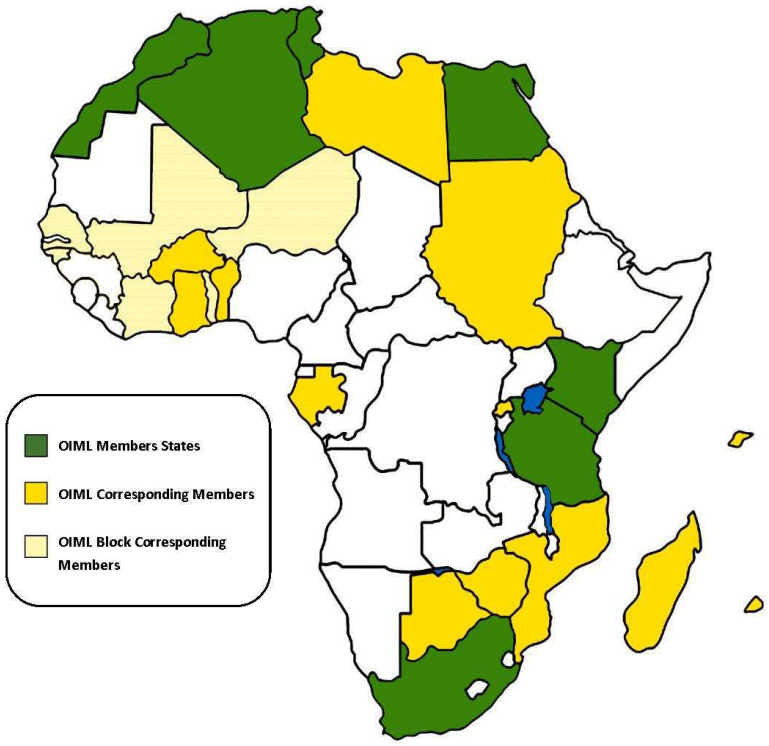

Figure 5. Member States and Corresponding Members of the OIML

3.4.3 The rights and obligations of Members, the General Assembly and Office Bearers

The rights and obligations of members, the operation of the General Assembly, and the definition and duties of the office bearers are described in Article 5 and 7 of the MOU (Appendix A).

3.4.4 The Secretariat

The structure of the Secretariat and its relationship to the Technical Committee structures are shown in Figure 6. All positions are non-paid voluntary positions elected from nominees or volunteers from the member states. One support person (sponsored by the PTB) is appointed on a yearly contract basis.

The scientific and industrial and legal metrology coordinating roles are not positions but functions that are provided by the country hosting the Secretariat.

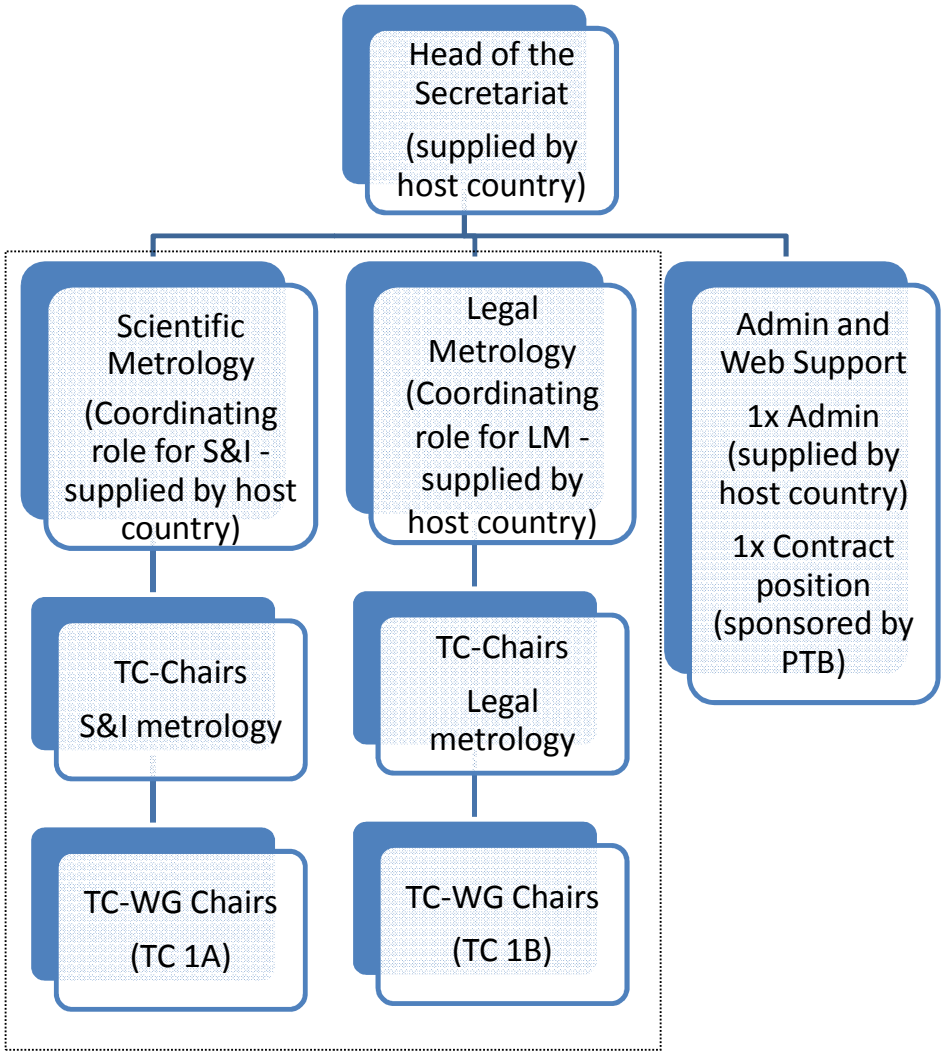

Figure 6: Structure of the AFRIMETS Secretariat

The Rules for the Secretariat are described in detail in section 7 of the MoU (Appendix A).

The Secretariat for AFRIMETS is provided by a member of an SRMO volunteering to host it at its own cost. If members from two or more SRMOs volunteer to host the Secretariat, an election is held in the GA. The Secretariat assists the Chairperson and the EXCOM in the administration of AFRIMETS and ensures that details of collaborations are circulated to all Representatives. The Secretariat maintains a complete set of AFRIMETS publications and AFRIMETS member details, and each retiring Secretariat needs to ensure the efficient transfer of AFRIMETS material to the succeeding Secretariat. The term of the Secretariat is three years and renewable, and the country hosting the Secretariat should preferably not provide the Chairperson of AFRIMETS (this condition was wavered at the inception of AFRIMETS, and for the first four years both the Secretariat and Chair were provided by South Africa).

One of the aims of this Roadmap is to propose a sustainable model for a Secretariat. This is discussed in section 5.5.

3.4.5 The roles of the RMO and the SRMOs

Due to the size of the continent and the difference in levels of development of the national metrology institutes (NMIs), AFRIMETS was designed in such a way that technical work (comparisons, proficiency testing, etc.) can be conducted at two levels:

1) Key, subsequent and supplementary comparisons and other international benchmarking activities, as well as the harmonization of legal metrology regulations (where applicable) and overall legal metrology strategizing are conducted at the RMO (AFRIMETS) level. The SRMOs assist the process by co-ordinating the participation of the institutes or laboratories from their members.
2) Other comparisons, pilot studies, proficiency testing activities and the harmonization of regulations within RECs and the establishment of basic verification and testing facilities are conducted within the SRMOs.

The SRMO structures do not need to "mirror" the structure of AFRIMETS, but must rather complement it. The main roles and responsibilities of the RMO as different from those of the SRMO can be summarized as follows:

<u>AFRIMETS as the RMO for AFRICA:</u>

- It represents the continent at the BIPM and in its relationship with other RMOs (through participation in the Joint Committee of the RMOs and the BIPM (JCRB) and at the OIML (where applicable, as legal metrology at international level does not currently have an equivalent of the JCRB);
- Regarding the CIPM MRA, it is reponsible for all activities associated with the international benchmarking of the calibration and measurement capabilities (CMCs) of countries in Africa;
- It therefore handles the CMC submission process. This entails:
    1) Approval of the quality systems of NMIs as stipulated by the CIPM MRA;
    2) The intra-regional peer review of CMCs;
    3) The submission of CMCs to the JCRB for inter-regional review.
- All official key, subsequent and supplementary comparisons conducted in Africa will be registered as "AFRIMETS" comparisons in the Key Comparison Data Base (KCDB) of the BIPM. Such comparisons will be piloted by an NMI in a SRMO, for example KEBS (EAMET), NMISA (SADCMET) or NIS (NEWMET), but need to be registered as AFRIMETS comparisons.
- The adoption of international laws and regulations by members and legal metrology strategy on the continent is co-ordinated by the Technical Committee - Legal Metrology.

<u>Sub-regional metrology organizations within AFRIMETS</u>

- Represent AFRIMETS in the RECs of Africa;
- Promote metrology within the RECs of Africa;
- Assist country member NMIs and NLMBs with methodology, training, etc.;
- Organise intra-REC benchmarking exercises and the harmonization of technical regulations within an SRMO to assist intra-REC trade;
- Conduct fit-for-purpose proficiency testing within SRMOs to improve the measurement capabilities and methodology;

- Generally assist their member countries with advice and training in metrology;
- Assist with the distribution of samples and artefacts within the SRMO during AFRIMETS benchmarking exercises.

4. TECHNICAL AND CAPABILITY NEEDS

4. TECHNICAL AND CAPABILITY NEEDS

4.1 Profile of Africa, the RECs and the associated SRMOs

To aid understanding of Africa's basic metrology requirements, a short background summary of the continent's financial and industrial activities and its RECs is provided below, with a brief introduction to its SRMOs.

Statistics given are in 2009/2010 values sourced in October 2010. More detail on the economic activities of the members is available in Appendix B.

4.1.1 The continent

Africa has a total GDP (purchasing power parity -PPP) of US$2,200 trillion (2009 est.) and a total population of just over 1 billion (est. in 2011) living in 54 countries. 36.2% of its population lives on less than US$1 per day. According to the United Nations Development Report of 2003, 25 sub-Saharan African nations ranked amongst the 31 lowest developed countries in the world. During the past decade, some positive signs have emerged, and the World Bank has reported that the economy of Sub-Saharan African countries grew at rates that match global rates (end of 2007), with the economies of the fastest growing African nations experiencing growth above the global average, for example Mauritania (19,8%), Angola (17,6%), Mozambique (7,9%) and Malawi 7,8%) [8].

The recession of 2008-2009 resulted in a sharp decline in the export of commodities, the mainstay of the African export trade, but increased oil production and relatively high global food prices offset the negative effects to a certain extent. Manufacturing growth comes from a low base and even though global markets are depressed, the expectation of further growth is not unrealistic, especially in processed foods.

The depressed global market does, however, mean stiffer competition for African food exports, and accurate, traceable measurement is even more important in such a climate, as some market protection by importers may be expected. Metrology is therefore becoming of increasing importance to Africa. It is here that AFRIMETS, through its members, plays an ever increasing role.

4.1.2 CEMAC and CEMACMET

<u>Important statistics</u>

Total population:	41 million
Gross domestic product (PPP):	US$123 billion
Main products and industries:	Oil, diamonds, cotton, agro-food products, logs and timber, cassava, coffee, cocoa and minerals (manganese)
Main exports:	Oil, diamonds and cotton

CEMAC (from its name in French: Communauté Économique et Monétaire de l'Afrique Centrale) is an organization of states of Central Africa established to promote economic integration among

countries that share a common currency, the CFA franc. CEMAC is the successor to the Customs and Economic Union of Central Africa (UDEAC), which it completely superseded in June 1999 (through an agreement in 1994). Its member states are Cameroon, the Central African Republic, Chad, the Republic of the Congo (Brazzaville), Equatorial-Guinea and Gabon. The region shares a high dependence on oil and forestry, volatile economic growth patterns, weak intra-REC linkages and a lack of transportation infrastructure. It is dominated by Cameroon and Gabon, whose economies account for more than two-thirds of the region's GDP. The main export products are oil, diamonds and cotton, with oil contributing 45% of GDP [9].

CEMAC's objectives are the promotion of trade, the institution of a genuine common market, and greater solidarity among peoples. Currently, CEMAC countries share a common financial, regulatory, and legal structure, and maintain a common external tariff on imports from non-CEMAC countries. In theory, tariffs have been eliminated on trade within CEMAC, but full implementation of this has been delayed [5] and trade is hampered by a large number of unharmonized policies in the REC. Traditionally, the CEMAC markets have been sheltered from competition with high tariff and non-tariff barriers in all sectors other than unprocessed raw material [10]. CEMAC's intra-REC trade is relatively low (an estimated 3 % of total trade), and, for example, trade between France and CEMAC is more than 10 times the intra-REC trade.

Metrology infrastructure is weak in the REC and although the Metrology Cooperation of the Economic Community of Central African States (CEMACMET) was established (in name) in 2007, no formal SRMO structures exist. In 2010/11 the PTB re-initialized initiatives to formalise the SRMO structures and some progress has been reported. The presence of a delegation from CEMACMET at the 5th AFRIMETS GA in July 2011 is a good start towards future positive developments. In addition, CEMACMET held its first general assembly on the 6 octobre 2011 in Bangui and signed the MoU.

4.1.3 The EAC and EAMET

Total combined population (excl. Tanzania):	94 million
Gross domestic product (PPP):	US$120 billion
Main products and industries:	Coffee, tea, fruit and flowers, cotton, sugarcane, dairy and meat products
Main exports:	Coffee, tea, bananas, cotton, sugarcane, dairy and meat products, and horticultural products (e.g. cut flowers, etc.)

The economy of the EAC, whose members are Burundi, Kenya, Tanzania, Uganda and Rwanda, is heavily dependent on agricultural and horticultural exports, and most industries either support agriculture or are involved in value addition or food processing. Tourism is also a substantial contributor to the economies of Kenya and Tanzania, and to a lesser extent of Rwanda and Uganda.

The EAC Protocol on Standardization, Quality Assurance, Metrology and Testing (2001) has mandated the East African Standards Committee to coordinate regional SQAM activities. Four technical sub-committees have been created under the EAC SQMT Act, one being the Sub-

committee on Metrology Cooperation (EAMET and NLMBs), which is responsible for coordinating metrological activities in the REC and assuring traceability to the SI. The Chair and Secretariat are held by one of the partner states on a rotational basis [12].

A metrology infrastructure is thus well established under EAMET, its members (NMIs and NLMBs) being Burundi (BBS), Kenya (KEBS and Kenya Weights and Measures), Rwanda (RBS) and Uganda (UNBS). Although a member of the EAC, Tanzania chose to participate in AFRIMETS through SADCMET/MEL, as it is also a member of SADC. Where EAMET is discussed in this document, it thus excludes Tanzania, although Tanzania is also participating in EAMET activities as an Associate member.

4.1.4 The AMU and MAGMET

Total combined population:	80 million
Gross domestic product (PPP):	US$427 billion
Main products and industries:	Agricultural (dairy and meat products, olive oil, vegetables, textiles), oil and gas, fish products, automotive, minerals, services
Main exports:	Oil and gas, agro-food and fish products (Mauritania), manufacturing (automotive, electronic), services (call centres, etc.)

The Arab states of North Africa established the Arab Maghreb Union (AMU) in 1989 to promote cooperation and economic integration. Its members are Morocco, Algeria, Tunisia, Libya and Mauritania [13]. MAGMET was established in 2007/8. Its membership does not include Libya, as Libya chose to participate in AFRIMETS through NEWMET.

Algeria's economy is mostly reliant on petroleum and natural gas, whilst Morocco and Tunisia rely on Atlantic fisheries, textiles, fruit and vegetables, manufacturing and services. Morocco and Mauritania have thriving mining industries.

With a relatively large and well trained working force, nearly 50 % of exports from Morocco and Tunisia are intermediate and finished manufacture. Their destination is mostly the EU, with the USA second.

Tunisia and to a lesser extent Morocco have well established metrology infrastructures, although they not yet internationally recognized. The SRMO structures of MAGMET are well established with Tunisia and Morocco as the main contributors, and an annual GA is held. Algeria has a measurement infrastructure, mostly based on legal metrology. Mauritania recently joined MAGMET and not much is known about its capabilities. MAGMET started a project in 2010 to assist Mauritania's metrology infrastructure and the situation is expected to improve.

4.1.5 The Countries constituting NEWMET

Total combined population: 391 million

Gross domestic product (2009 est.): US$1129 billion

Main products and industries: Resources and commodities (oil and natural gas, potash, salt, gold, platinum, copper, manganese, iron ore, phosphates, limestone, gypsum, talk, asbestos, timber, bauxite, and diamonds), agricultural (cotton, rice, onions, beans, citrus fruits, wheat, corn, barley, sugar, sesame, ground nuts, coffee, cereals, pulses, oilseeds, khat, meat, and hides and skins), and construction.

Main exports: Oil and natural gas, textiles, coffee, processed foods, cement and hydroelectric power

NEWMET is not based on a single economic block and thus no summary is provided.
During 2009, Egypt was instrumental in the establishment of a sixth SRMO amongst the ordinary members of AFRIMETS, mostly English/Arabic speaking countries in North-Eastern Africa and the English speaking countries in the Economic Community of West African States (ECOWAS). In June 2009, the NMIs of five African countries, namely the National Institute for Standards of Egypt (NIS), the Standards Organization of Nigeria (SON), the Ghana Standards Bureau (GSB), the Quality and Standards Authority of Ethiopia (QSAE) and the Libyan National Centre for Standardization and Metrology (LNCSM), signed an MoU and officially establishing “NEWMET”, and in August 2009, the Sudanese Standards and Metrology Organization (SSMO) agreed to join.

A first general assembly was held at the NIS (Egypt) on 21 June 2009, and the delegates selected office bearers to take care of NEWMET affairs. The structures now include technical working groups, and some benchmarking activities are already underway.

4.1.6 SADC and SADCMET/MEL

Total combined population (incl. Tanzania): 267 million

Gross domestic product (PPP): US$827 billion

Main products and industries: Agricultural (fruit, table grapes, vegetable products, maize, wheat, meat, hides and skins), fish, prepared foodstuffs (beverages, spirits and vinegar, tobacco), mineral products (salt, sulphur, stone, lime and cement, mineral fuels, oil), precious metals (platinum, gold, silver), base metals and articles made from base metals (iron and steel, copper, nickel, aluminium, lead, zinc, tin), natural and cultured pearls and precious and semi-precious stones, wood pulp and wood articles, chemicals, manufactured goods (automotive units and components, and aircraft, vessels and textile articles).

Main exports: Mineral products (mineral fuels, oils), pearls and precious stones, metal products, agricultural (vegetable products, beverages, tobacco), prepared foodstuffs, chemical products, paper products, machinery, vehicles, textile products.

SADC was formed in 1992. It currently has fifteen member states: Angola, Botswana, Democratic Republic of the Congo (DRC), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, the Seychelles and Zimbabwe. SADC's objective include achieving active development and economic growth; alleviating poverty; enhancing the standard and quality of life of the people of Southern Africa. Intra-SADC, intra-African and African global trade are well established, with South Africa leading the way. Exports by most countries focus on agricultural goods and commodities, with South Africa also exporting manufactured goods and services. SADC launched a free trade area in August 2008 [17]. This also paved the way for entry into the more competitive global market. While growing, intra-SADC trade is still low at around 25% of total SADC trade and is concentrated in the Southern African Customs Union (SACU) [14].

A SADC SQAM programme was established to progressively eliminate technical barriers to trade (TBTs) in the REC, as well as between SADC and other regions in the world. This programme is overseen by the SADC Directorate of Trade, Finance, Industry and Investment.

The SADC quality infrastructure was formed at the same time as SADC and includes several formal entities, established to perform specific functions of the SQAM program, including SADCMET and SADCMEL. It includes technical committees and working group structures [15].

The NMISA is the most prominent NMI in SADC [16] and provides traceability to a large part of sub-Saharan Africa.

4.1.7 UEMOA and SOAMET

Total combined population: 97.8 million

Gross domestic product (PPP): US$122.4 billion

Main products and industries: Oil and natural gas, uranium, gold, other minerals, cocoa, coffee, fish products and cotton.

Main exports: Coffee, cocoa, cotton, gold and phosphate by-products, petroleum products, food commodities (rice, fruit) and fish products.

The UEMOA member countries are Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. They account for only 0.1 % of global trade in manufactured goods, and intra-REC trade is only 6 % of total trade. Their main exports are agro-food products, fish products and cotton, and their main export market is the EU [18]. In September 2001, the EU, the United Nations Industrial Development Organization (UNIDO) and UEMOA launched a Quality Programme as part of the UNIDO Trade Capacity Building Initiative to enhance the participation of the UEMOA countries in regional and international trade. The Programme assisted with the establishment and/or strengthening of institutional and human capacities in laboratory accreditation; the development of

product and material testing laboratories (chemical, microbiology, etc.) according to international standards; the formulation, adoption and dissemination of standards; the development and implementation of quality policies; the institution of quality awards; and the development of consumer protection laws and associations. In 2009, an ambitious strategy was implemented to pursue bio-energy in five areas, namely sustainable wood fuels, bio-ethanol, biodiesel, power generation and biogas [19].

UEMOA countries have realized for many years that it will be interesting to get a "common" view to deal with some fields of metrology and to be able to face the great challenges of supporting industries in the REC. This was strongly supported by UNIDO and the PTB, which proposed different programmes to implement this approach. In 2005 the Secretariat for Metrology of the Economic Community of West African States (SOAMET) was established as part of the UNIDO and PTB cooperation programmes. SOAMET's goals are to determine the main metrology priorities for the REC, to develop a common approach to regulations, standardization, accreditation and quality insurance in a REC quality infrastructure, and to strengthen industries in the REC to participate in regional and international markets.

Although SOAMET's official structures are in place, intra-REC activities are still limited and mostly focus on the coordination and accreditation of calibration facilities at NMIs in UEMOA member countries.

4.2 Snapshot of the metrology infrastructures in the SRMOs

Obtaining a clear and comprehensive picture of the metrology infrastructure in Africa is a major task. The technologically more advanced countries have well-described formal structures for SQAM, and information on their capabilities is available from the internet. The smaller, less developed countries have some SQAM structures, but in most cases these are not well described or, when they are part of a standards body (less than 50% of the countries in Africa), only the testing laboratories are explained on websites. In some cases, for the LDCs, there is no mention of industrial or legal metrology, and correct information can only be gathered through country visits.

The information supplied in the Roadmap has been gathered through a combination of website searches, the assistance of individuals from institutes or SRMOs, presentations at meetings and conferences, a workshop with the regional coordinators of the International Technical Cooperation of the PTB, discussions with UNIDO officials responsible for projects in Africa, attendance of SRMO meetings and visits to members. It is not claimed to be 100% correct or comprehensive, but it can be used as an indication of the capabilities and status of metrology in each country as of early 2011.

A short summary of the infrastructure in each SRMO is provided below. Tables summarizing the capabilities for each parameter by SRMO and member country are included in Appendix B, and a graphic summary of metrological capabilities is provided in section 4.3. A table listing recent quality Infrastructure projects in Africa is also supplied in Appendix B.

4.2.1 The metrology infrastructure in CEMACMET

CEMACMET's metrology infrastructure is extremely limited. Gabon and Cameroon have a basic legal metrology infrastructure and Gabon is a Corresponding Member of the OIML. Cameroon has three private measurement laboratories and is in the process of becoming accredited to ISO/IEC 17025, while Gabon has a private laboratory that provides calibration for mass, temperature and pressure. None of the other countries has identifiable legal or S&I metrology activities.

The PTB and UNIDO are active in programmes to establish a quality infrastructure in the REC [11], with a focus on the establishment of basic testing facilities and their accreditation. The establishment of a metrology secretariat for CEMACMET is also being addressed, and a number of awareness campaigns have been conducted. A reference measurement laboratory is planned. More information can be obtained from www.cemac-qualite.org.

In summary

- Legal metrology:
  - Gabon is a Corresponding Member of OIML, and the legal basis for trade metrology is in place;
  - Cameroon has a very basic legal metrology infrastructure;
  - The necessary equipment and requirements for an efficient metrology infrastructure are lacking;
  - Chad has verification activities for legal metrology.
- Scientific and industrial metrology:
  - Cameroon is a Member State of the BIPM (although currently suspended), and has no scientific/industrial activity in metrology (at reference level);
  - There are no official NMIs in the region (that could be identified during this study);
  - No national or REC accreditation body is active and internationally recognized (for calibration services);
  - Gabon and Cameroon have some industrial metrology activities in private laboratories that are in the process of becoming accredited.

4.2.2 The metrology infrastructure in EAMET

EAMET is well covered in both S&I and legal metrology. Legal metrology mostly comes under the government ministries in each country, and S&I metrology is part of the bureaus of standards.

Legal metrology is fairly well established and every country except Burundi (where it is in progress) has a legal metrology act in place.

In S&I metrology, the provision of traceability for all basic parameters is in place in Kenya (KEBS), to a lesser degree in Uganda (UBS) and Rwanda (RBS), and at a basic level in Burundi (BBS). KEBS is improving its traceability route with a development programme to replace secondary standards with primary standards, for example in mass and temperature.

There are still gaps, though, and the region needs to expand its metrology infrastructure, especially in chemistry (MiC), to fully support intra-REC and international trade in foodstuffs, environmental monitoring and manufacturing. Kenya recently opened an expanded capability in MiC in upgraded buildings. For physical metrology, some laboratories in the region still only have traceability to accredited laboratories in developed countries, and the traceability chain needs to be improved (to NMIs) to shorten the traceability route and to improve uncertainty of measurement.

KEBS is the driving force behind most of the metrology programmes in the EAC and undertakes activities such as managing the comparison measurements, hosting workshops and providing expertise in training and consultancy. It is well supported by the Kenyan government and has made a substantial contribution to the increase in trade of Kenyan and other EAC products through the provision of internationally recognized measurement standards and accredited testing facilities.

In summary

- Legal metrology
  - Kenya is a full Member State and Rwanda a Corresponding Member of OIML;
  - There are technical regulations and laws on legal metrology in Kenya and Uganda and to a lesser extent in Rwanda, but these are still limited in Burundi;
  - Kenya has a well-equipped legal metrology facility, but in general the SRMO is planning to improve its legal metrology infrastructure and harmonize regulations.
- Scientific and industrial metrology
  - Kenya is a Member State of the BIPM and a signatory to the CIPM MRA. It has good basic facilities, most of which are accredited by internationally recognized accreditation bodies, and is in the process of establishing primary standards, starting with mass, temperature and time & frequency;
  - Uganda and Rwanda have some accredited facilities and deliver recognized calibration and testing services;
  - Burundi's S&I capabilities are very limited;
  - Kenya has established a national accreditation body and are in the process to obtain full recognition by ILAC and IAF;
  - Comparisons in mass, pressure and temperature have been conducted in the SRMO;
  - Kenya is participating in AFRIMETS comparisons, and CMCs are expected in the near future.

4.2.3 The metrology infrastructure in MAGMET

Since the inception of AFRIMETS, the metrology infrastructures in the member countries of MAGMENT have become more organized. Tunisia is moving towards international recognition of its measurement standards and services. It has a distributed system for metrology overseen by a public entity agency (the Tunisian National Agency for Metrology (ANM), created in 2008 under the responsibility of the Ministry in charge of commerce. ANM manages scientific, industrial and legal metrology. The main reference laboratories are LCAE (mass, pressure, length, temperature), DEFNAT (electricity and time and frequency), INRAP for MiC and ANM for mass and volume. Both are

accredited for these quantities by internationally recognized national accreditation bodies (NABs) (COFRAC and the Tunisia National Accreditation Council (TUNAC).

In Morocco, industrial, scientific and legal metrology is the responsibility of the Standardization and Promotion of Quality Department of the Ministry of Industry, Commerce and New Technologies. For S&I metrology, the national metrology laboratory in Morocco is *Le Laboratoire National de Metrologie* (LNM) at *Laboratoire Public d'Essaiset d'Etudes* (LPEE). LNM is in charge of the metrology references in Morocco for temperature, humidity, electricity, dimensional, force, torque, volume, pressure, mass weighing and density. It has lengthy experience in metrology, has participated in many programmes in the frame of EU contracts, and has organized some comparisons at regional level. There is some activity in the field of chemistry, though at the present time it does not really deal with metrology, but it has the potential to expand into metrology.

Morocco achieved accreditation for most of its metrology laboratories from the national accreditation system (that is currently not a signatory of the ILAC MRA).

In Algeria, metrology comes under the responsibility of the *National Legal Metrology Organization* (ONML). ONML was created in 1986 (decree no. 86-250) as a public administrative institute under the responsibility of the Ministry of Industry, Small and Medium Enterprises and Promotion of Investment. ONML deals mainly with legal metrology – there are no recognized scientific metrology facilities, although one private company (Metrocal Algérie) has been accredited for industrial metrology in the fields of pressure, mass and non-automatic weighing instruments.

In Mauritania, metrology falls under the responsibility of the Ministry of Mines and Industry. A dedicated service of technology and intellectual property is in charge of standardization, metrology, the promotion of quality and technological innovation. A recent law (April 2010) further formalized metrology in Mauritania. Its main objective is to define the context of legal metrology (verification, repairing, utilization) and to define the legal units which should be used. In the latter half of 2011 Mauritania will receive precision instrumentation for the calibration and verification of weighing instruments in the fields of mass, volume and temperature measurement through the UNIDO West Africa Quality Programme, which provides support to the competitiveness and harmonization of TBT and SPS [36]. The country currently has no S&I metrology capability.

<u>In summary</u>:

- Legal metrology:
    - Tunisia, Algeria and Morocco are Member States of OIML and have well established facilities;
    - Mauritania has one legal metrology function in a government ministry.
- Scientific and industrial metrology:
    - Tunisia is an Associate of the CGPM and has signed the CIPM MRA. The process to become a Member State of the BIPM was started in 2011. The ANM, LCAE, DEFNAT and the INRAP are its main "reference laboratories" for metrology, and most of their capabilities (CMCs) are accredited by an internationally recognized NAB;
    - The National Metrology Laboratory (LNM) at the Laboratoire public d'essais et d'etudes (LPEE) is the national metrology laboratory and is accredited for calibration services by the Moroccan accreditation body;

- Tunisia and Morocco participate in AFRIMETS comparisons, and CMCs are expected from Tunisia in the near future.

4.2.4 The metrology infrastructure in NEWMET

The original Ordinary members of AFRIMETS in North-Eastern and Western Africa already had an established metrology infrastructure (both S&I and legal metrology) when AFRIMETS was established. With the inception of NEWMET, they became more organized, and Libya and Sudan joined. The heightened awareness of metrology benefitted Libya and Sudan and both have indicated that they will soon establish S&I metrology facilities, though it is assumed that, with the hostilities in Libya, this process has not commenced there. Ghana and Ethiopia are improving their established facilities and traceability, and, with the exception of Sudan, the members have established legal metrology.

In Egypt, legal metrology is the responsibility of the National Legal Metrology Authority within the Egyptian Organization for Standards and Quality (EOS). EOS also includes an industrial metrology section with accredited laboratories for most physical metrology parameters. Traceability is obtained from the National Institute of Standards (NIS), which has responsible for primary standards. NIS provides traceability for all basic parameters through primary standards and, in some cases, traceable secondary standards. It currently (August 2011) has 24 CMCs accepted in the international key comparison database (KCDB). NIS can therefore assist the other SRMO members with traceability to the SI or internationally stated references.

In Ethiopia, legal and S&I metrology used to be the responsibility of the Quality and Standards Authority of Ethiopia (QSAE). Recently, QSAE has been re-organized into four different institutes, each responsible for one part of the quality infrastructure. The Ethiopian National Metrology Institute (NMIE) is responsible for establishing and maintaining Ethiopian measurement standards and ensuring that the national calibration service is used by the manufacturing industry. It is also responsible for providing independent evidence that testing and calibration laboratories, inspection agencies, and certification bodies are technically competent. It has good basic industrial metrology facilities, but for scientific metrology, traceability is sourced from other NMIs (NIS, NMISA, KEBS and NMIs outside Africa).

In Ghana, both legal and S&I metrology are the responsibility of the Ghana Standards Board (GSB) and both are well established. Legal metrology focuses on oil marketing companies (service and fuel stations and weighing instruments for the cocoa and other industries), while industrial metrology focuses on mass, flow/volume and force measurements. Scientific metrology undertakes the calibration of laboratory, medicine and other equipment. The temperature, mass and pressure laboratories are accredited. Scientific metrology is also responsible for the certification of all new weighing and measuring equipment in Ghana. Traceability is sourced from other NMIs (NIS, KEBS, NMISA and from Europe).

In Libya, metrology is the responsibility of the Libyan National Centre for Standardization and Metrology (LNCSM). Libya is participating in the activities of NEWMET but a full picture of their capabilities is not available. Due to the hostilities in 2011, the current status of LNCSM is also not known.

In Sudan, metrology is the responsibility of the Sudanese Standards and Metrology Organization (SSMO), which has 13 laboratories. Metrology activities are limited to the unification of

measurement units in the country, the issue of measuring specifications, the national distribution of international measurement information and the technical supervision of scales. A new scientific metrology laboratory is envisaged.

In Nigeria, metrology is the responsibility of the Standards Organization of Nigeria (SON) and has well established industrial metrology laboratories focusing on mass, volume, dimensional, force, temperature and torque. The facility calibrates equipment. Traceability is sourced from other NMIs in NEWMET or SADCMET/MEL. A scientific metrology facility is planned.

In summary:

- Legal metrology:
    - Egypt is a full member and Ghana, Libya and Sudan are Associate Members of the OIML;
    - Egypt, Ghana, Ethiopia and Nigeria have well established structures for legal metrology, but want to improve their physical facilities;
    - Libya and Sudan have organizations responsible for legal metrology, but limited laboratory facilities.
- Scientific and industrial metrology:
    - Egypt is a Member State of the BIPM, is a signatory to the CIPM MRA and has CMCs in the international database;
    - Ethiopia and Ghana have industrial metrology facilities and some scientific metrology facilities;
    - Nigeria has industrial metrology facilities and limited scientific metrology facilities;
    - Libya and Sudan have organizations responsible for industrial metrology, but no identifiable scientific metrology activities.

4.2.5 The metrology infrastructure in SADCMET/MEL

Both the S&I and legal metrology infrastructures are well established in the SRMO. A contact list of the institutes responsible for metrology is provided in Appendix D.

All the countries in SADC have legal metrology capabilities, or at least an identifiable entity or group within a government department responsible for legal metrology. A group of countries (South Africa, Tanzania, Zimbabwe, Zambia, Seychelles, Mauritius and Botswana.) have relatively extensive facilities, although many gaps have been identified through the SADC EU Project.

The S&I infrastructure closely follows the intra-African and global trade patterns, with those countries with limited global, but increasing intra-REC trade, focusing on basic metrology parameters, such as mass, volume and temperature (for example Swaziland, Zambia and Namibia). Those participating more extensively in global trade have established more advanced metrology and technical infrastructures (such as Botswana, Tanzania, South Africa and Zimbabwe) and are expanding into metrology in chemistry.

Some level of S&I metrology is established in all the countries except Angola and Lesotho, but only South Africa performs primary realization of units, while the rest of the region obtains traceability for their secondary standards from the NMISA. There was an extensive drive, as part of the SADC EU Project, to accredit the basic parameter facilities (mass and related quantities, volume, temperature, etc.) at NMIs in SADC, and the laboratories of a group of members (Seychelles, Mauritius, Tanzania, Zimbabwe, Zambia and Botswana) have been accredited. Most of the other NMIs have at least one

or two facilities accredited. These laboratories provide calibration or analysis at a national level. Another project under the SADC EU Project improved traceability with the calibration of the basic parameter secondary standards at the NMISA.

Even though the NMISA has CMCs accepted for most parameters in the KCDB, and the REC is relatively advanced in metrology for a developing region, challenges remain as primary traceability is still needed for some parameters, for example electricity (energy, power, resistance) and flow (large diameter/volume). There is also a programme to develop reference materials and reference methods for specialized chemical analysis, such as dioxins and mycotoxins.

There are challenges to better harmonizing legal metrology in the REC and to establishing fit-for purpose facilities in countries such as Angola, Swaziland and Lesotho.

In summary:

- Legal metrology :
    - South Africa and Tanzania are Member States of the OIML, and Botswana, Madagascar, Mauritius, Seychelles and Zimbabwe are Corresponding Members of the OIML;
    - South Africa has well established laboratory facilities and the rest (except Lesotho) have some facilities, although not fit-for-purpose in all the countries;
    - SADCMEL is active in harmonizing technical regulations in the REC and providing training and general assistance to member LMIs.
- Scientific and industrial metrology:
    - South Africa is a Member State of the BIPM, and Mauritius, Seychelles, Zambia and Zimbabwe are Associates of the CGPM. All 5 are signatories to the CIPM MRA.
    - South Africa has 334 CMCs in the KCDB in general physics and ionising radiation, and 22 in chemistry (June 2011);
    - Most countries (except DRC, Lesotho, Angola and Namibia) have S&I metrology facilities (for the basic parameters);
    - Traceability is sourced mostly from South Africa, in accordance with SADCMET/MEL strategies that not all countries need to maintain primary standards.

4.2.6 The metrology infrastructure in SOAMET

Since the establishment of SOAMET as the secretariat for metrology in UEMOA , the organization of metrology has improved substantially. SOAMET supports members with equipment and training to strengthen the capacities of their metrology structures, which, when it was created, had mostly only legal metrology structures and facilities, with S&I metrology facilities limited to a few countries, such as Benin and Burkina Faso. Senegal had a very basic industrial metrology capability within a government department but it is currently not providing a calibration service. Côte d'Ivoire had an S&I facility but it was destroyed during the hostilities in 2011. There are now plans to re-build the institute.

The increased organization of UEMOA and the emphasis placed on quality infrastructure should accelerate the improvement of metrology infrastructures in the region. The possible future incorporation of all the ECOWAS countries into SOAMET could give the metrology activities in the REC a further boost.

SOAMET has an interesting strategy for S&I metrology as it plans to spread the responsibility for traceability between the member countries. As an example, Benin has been earmarked to provide traceability to the members for mass, and the laboratory received assistance to become accredited, which it obtained in 2011, while Burkina Faso will provide traceability for temperature and Côte d'Ivoire for pressure. Five working groups are in place, namely mass, temperature, pressure, volume and legal metrology, but not all are active.

A regional law on metrology (legal) is in the process of adoption by the UEMOA Commission, and, since 2009, SOAMET has been a Corresponding member of the OIML through the UEMOA Commission as an economic entity.

Benin also individually holds Corresponding membership of the OIML, with one laboratory in charge of legal metrology and industrial metrology in a department under the responsibility of the ministry in charge of industry and trade *(Agence Béninoise de la Métrologie et du Contrôle de la Qualité).*

Burkina Faso, likewise, individually holds Corresponding membership of the OIML, with one laboratory in charge of legal metrology and industrial metrology in a department under the responsibility of the ministry in charge of industry and trade (*Direction Général de la Qualitéet de la Métrologie*). This laboratory has capabilities in the field of mass.

In Côte d'Ivoire, one laboratory, LANEMA (*Laboratoire National d'Essais de Qualitéde Métrologique et d'Analyses*), is in charge of S&I metrology. This laboratory is a public institute with commercial activities under the responsibility of the ministry in charge of industry. LANEMA gives support to companies/laboratories for the industrial development, protection and security of consumers in the country. It performs calibration services, testing and analysis (chemical analysis). In the last ten years, it has faced several difficulties, in particular the lack of qualified staff due to a high turnover of personnel. During the hostilities in 2010/11, the institute was totally destroyed. As mentioned above, the institute will be re-built, and the existing expertise should still be available. Basic capabilities in mass, pressure, temperature, humidity, electrical metrology and volume are planned.

Legal metrology in Côte d'Ivoire comes under the Ministry of Trade (*Direction de la Métrologie et du Contrôle de la Qualité).* This department, however, lacks the working standards for its main purpose of trade regulation.

Around 2005, Guinea-Bissau planned to create a department in charge of standardization and metrology under the responsibility of the ministry in charge of commerce and industry but no information is, as yet, available on the project.

In Mali a new project was proposed in 2010 to examine the impact of measuring instruments in the competitiveness of industries, in international commerce and trade, in the development of new technologies, and in commercial innovation. The Department of Commerce and Competitiveness (*DNCC: Direction Nationale du Commerce et de la Concurrence*) is in charge of regulation (for commerce and trade), metrology, consumer protection and commercial innovation within the ministry in charge of industry. The DNCC has a laboratory in charge of legal metrology, which is responsible for verifying measuring instruments (mainly for mass, weighing instruments and volume). It is the official NMI for the country, but there is also a project to build new facilities for theNMI.

In Niger, a new project was similarly proposed to examine the impact of measuring instruments in the competitiveness of industries, in international trade, in the development of new technologies and in commercial innovation. The Department of Domestic Trade and Competitivness (*DCIC: Direction du Commerce Intérieure et de la Concurrence*) within the ministry of industry is in charge of

regulation (for commerce and trade), metrology, consumer protection and commercial innovation. Since 2010 the DCIC has had a laboratory in charge of legal metrology, which is responsible for verifying measuring instruments (mainly for mass, weighing instruments, volume). It is the official NMI for the country.

In Senegal, one laboratory in the Ministry of Commerce, Consumption and Handicraft is in charge of legal and industrial metrology. This laboratory is essentially focused on regulation and operates as a fraud squad. In 2005, it was also the NMI, but was not able to provide calibration services and is currently not the official NMI. A private company has developed some activity in metrology to provide traceability to other private or public companies. This company, the LAME (*Laboratoire Africain de Métrologie et d'Essais*), has implemented calibration services in mass, pressure, temperature and liquid flow, and also provides testing activities and training. It should be noted that this laboratory was accredited for mass by COFRAC (French NAB).

In Togo, The Ministry of Trade and Private Sector Promotion is in charge of legal metrology. A new law project was elaborated in 2009 which proposed the creation of a national legal metrology council in charge of the regulation and application of the law (including legal metrology linked to the environment). A legal metrology laboratory (*Laboratorie National de Métrologie et d'Essais*) is being developed within the ministry.

In summary:

- Legal metrology:
  - Benin and Burkina Faso are Corresponding Members of OIML;
  - The other countries are Corresponding Members of OIML through UEMOA;
  - Many countries have a law on legal metrology (mostly trade metrology), but without regulations and laboratories sufficient to meet their industrial and trade requirements;
  - A regional metrology law is in process for adoption by the UEMOA Commission.

- Scientific and industrial metrology :
  - There are no Member States of the BIPM or Associates of the CGPM in the SRMO;
  - One laboratory in the NMI of Benin is accredited for calibration services for mass, and one private laboratory in Senegal is accredited for some calibration;
  - A regional accreditation body was established, called SOAC (Système Ouest Africain d'Accréditation) and is in the process to implement an accreditation process in the region;
  - Not many companies /laboratories are able to perform calibration services.

4.3 Graphic presentation of the metrology infrastructure in Africa

The status of metrology in Africa is summarized below in three maps, which show:

A. The metrology infrastructure through the formal institutes or bodies for scientific and industrial and legal metrology. The criteria are shown in Table 2A and the classification in Table 2B. The map is shown in Figure 7.
B. S&I metrology capabilities, presented in five categories of capabilities. The criteria are shown in Table 3A and the classification in Table 3B. The map is shown in Figure 8.
C. Legal metrology capabilities, presented in five categories of capabilities. The criteria are shown in Table 4A and the classification in Table 4B. The map is shown in Figure 9.

Table 2A: Classification criteria for metrology institutes in AFRIMETS Member Countries

Category	Criteria
1-Gold (Internationally recognized metrology infrastructure)	-Official institutes responsible for S&I and legal metrology -Member State of BIPM/OIML -Capabilities in most areas of metrology, or in those critical for the country
2-Silver (Regionally recognized metrology infrastructure)	-Official institutes responsible for S&I and legal metrology -Associate of CGPM or Corresponding Member of the OIML -Capabilities in most areas of metrology, or those critical for the country
3-Green (Established national metrology infrastructure)	- Official institutes responsible for S&I and legal metrology -Associate/Corresponding Member of CGPM/OIML or plans to become one in the next 5 years -Capabilities in basic areas of metrology, or in those critical for the country
4-Yellow (Basic metrology infrastructure)	-Official institutes or at least an identifiable section with basic facilities within a government department or other institute responsible for S&I and/or legal metrology -Capabilities in basic areas of metrology or in those critical for the country
5-Red (Limited or no metrology infrastructure)	-No official institutes or identifiable bodies responsible for S&I and/or legal metrology -Very basic facilities in other institute not uniquely identified for metrology but performing some functions, or no capabilities at all

According to the criteria the countries are classified in table 2B (July 2011). Countries that are establishing facilities, or at least have designated contact points (even for one of the metrologies) and have identified the need to establish facilities, have been classified as yellow. It is debatable if Cameroon and Gabon should not be red, but at least there are identifiable institutes and contact points have been established.

Table 2B: Classification of members in terms of the presence of metrology institutes/contact points

Category	Criteria
1-Gold	Egypt, Kenya, South Africa
2-Silver	Ghana, Tunisia, Seychelles, Mauritius, Zimbabwe
3-Green	Benin, Botswana, Ethiopia, Morocco, Rwanda, Tanzania, Uganda, Zambia
4-Yellow	Algeria, Angola, Burkina Faso, Burundi, Cameroon, Côte d'Ivoire, DRC, Gabon, Libya, Madagascar, Malawi, Mauritania, Mozambique, Namibia, Nigeria, Senegal, Sudan, Swaziland, Sierra Leone
5-Red	CAR, Chad, Equatorial-Guinea, Guinea-Bissau, Lesotho, Mali, Niger, Republic of the Congo, Togo

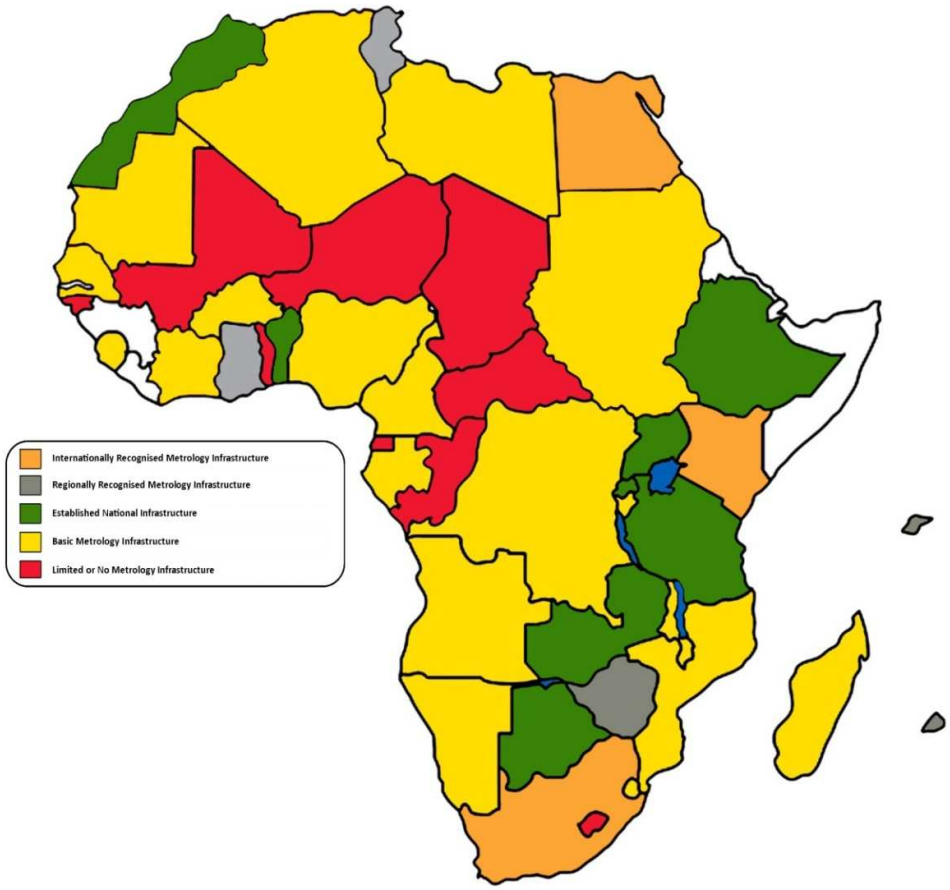

Figure 7: Indication of the presence of metrology institutes in AFRIMETS member countries

Table 3A: Classification criteria for S&I metrology capabilities in AFRIMETS member countries

Category	Criteria
1-Gold (NMIs participating in the CIPM MRA)	-Official institutes responsible for S&I metrology -Member State of BIPM -Capabilities in most areas of metrology, or those critical for the country -At least some in-house realization of the SI -International traceability in place for all national standards -AFRIMETS (or EURAMET)-approved quality system in place -Most laboratories accredited or peer reviewed -CMC entries in KCDB, or imminent
2-Silver (NMIs participating in RMO activities)	-Official institutes responsible for S&I metrology - Associate of CGPM -Capabilities in most areas of metrology, or those critical for the country -International traceability in place for all or critical national standards -AFRIMETS (or EURAMET)-approved quality system in place, or imminent -Most laboratories accredited or peer reviewed
3-Green (NMIs providing national traceability)	- Official institutes responsible for S&I metrology -Associate of CGPM, or plans to become one in next 5 years -Capabilities in basic areas of metrology, or those critical for the country -Traceability in place for critical national standards -Quality system in place -Critical laboratories accredited or peer reviewed
4-Yellow (Basic scientific metrology infrastructure)	- Official institutes responsible for S&I metrology -Capabilities in basic areas of metrology, or those critical for the country -Traceability in place for some parameters -Quality system in place or being developed
5-Red (Limited or no scientific metrology infrastructure)	-No official institute responsible for S&I metrology -Very basic facilities in a government department or related institute

Although the membership of AFRIMETS (44 members) suggests that the continent is covered by at least a basic metrology infrastructure, the classification (Table 3B) and map (Figure 8) shows that a large part of the continent has no or very limited S&I metrology facilities. Also, it is debatable if the Democratic Republic of the Congo (DRC) should not also be classified as red.

At least with the renewed activities in the SRMOs, up to seven countries are in the process of establishing S&I metrology facilities, and the situation should improve in the near future.

Table 3B: Classification of S&I metrology capabilities in AFRIMETS member countries

Category	Criteria
1-Gold	Egypt, Kenya, South Africa
2-Silver	Tunisia, Ghana
3-Green	Benin, Botswana, Ethiopia, Mauritius, Morocco, Tanzania, Uganda, Zimbabwe
4-Yellow	Burkina Faso, Burundi, Cameroon, Côte d'Ivoire, DRC, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Seychelles, Zambia, Swaziland
5-Red	Algeria, Angola, CAR, Chad, Equatorial-Guinea, Gabon, Guinea-Bissau, Lesotho, Libya, Mali, Mauritania, Niger, Republic of the Congo, Senegal, Sierra Leone, Sudan, Togo

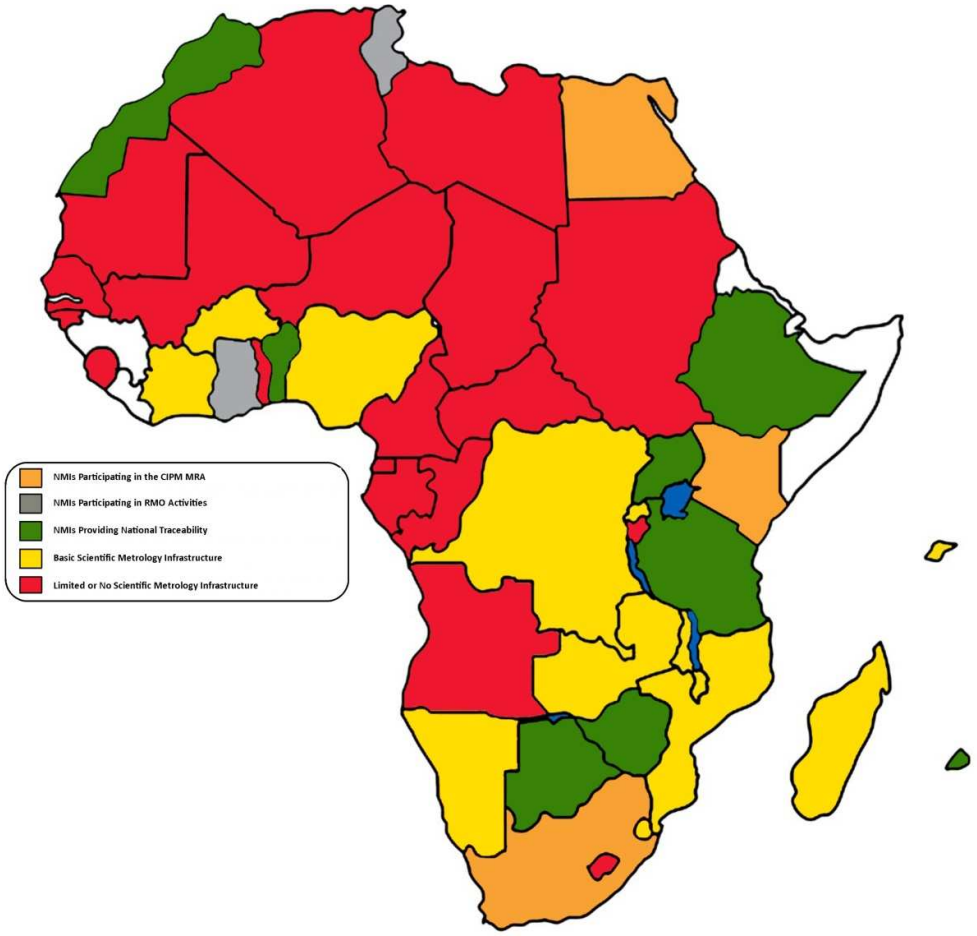

Figure 8: S&I Metrology infrastructure in AFRIMETS member countries

Table 4A: Classification criteria for legal metrology capabilities of AFRIMETS member countries

Category	Criteria
1-Gold (Recognized LM system at national, regional and international levels)	-Official institute responsible for legal metrology -Member State of the OIML -OIML MAA (Mutual Acceptance Arrangement) signatory -Legal metrology Act (including or with plans to include health, safety, environment and trade) -Facilities to carry out technical activities -Competent staff -Prepackages -Participation in OIML technical committees -Categories of measuring instruments that fully support the scope of the Legal Metrology Act -Approved quality system in place, accreditation or certification
2-Silver (Imbedded LM system with regional and international participation)	-Official institute responsible for legal metrology -Member State of the OIML -Legal system in place for weights and measures and plans for Legal Metrology Act to include health, safety, environment and trade -Facilities to carry out technical activities -Competent staff -Prepackages -Participation in OIML technical committees -Categories of measuring instruments that fully support the scope of the Legal Metrology Act. -Approved quality system in place, accreditation or certification
3-Green (Organized LM system with SRMO participation	-Official institute responsible for legal metrology -Corresponding Member of OIML -Legal system in place for weights and easures -Facilities to carry out technical activities -Competent staff -Prepackages -Categories that fully support the scope of the Legal Metrology Act -Participation in SRMO technical activities
4-Yellow (LM existence at National level with limited resources)	- Legal system in place, with at least fit-for-purpose regulations for main national issues -Some facilities to carry out technical activities -Trained staff to support technical activities -REC participation -Technical instructions
5-Red (No official LM)	-No facility and/or Act/regulations

Table 4B: Classification of legal metrology capabilities of AFRIMETS member countries

Category	Criteria
1-Gold	None
2-Silver	South Africa, Tunisia
3-Green	Algeria, Benin, Egypt, Kenya, Morocco
4-Yellow	Angola, Botswana, Burkina Faso, Burundi, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Gabon, Ghana, Libya, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, Republic of the Congo, Rwanda, Senegal, Seychelles, Swaziland, Sudan, Uganda, Tanzania, Togo, Zimbabwe, Zambia
5-Red	CAR, Chad, Equatorial-Guinea, Guinea-Bissau, Lesotho *, Mali*, Niger*

***Mali and Niger have basic trade metrology acts in place and have plans to establish facilities but are still classified as red for the moment. Lesotho has a basic trade metrology act with some regulations and equipment to calibrate mass and volume but is also still classified as red**

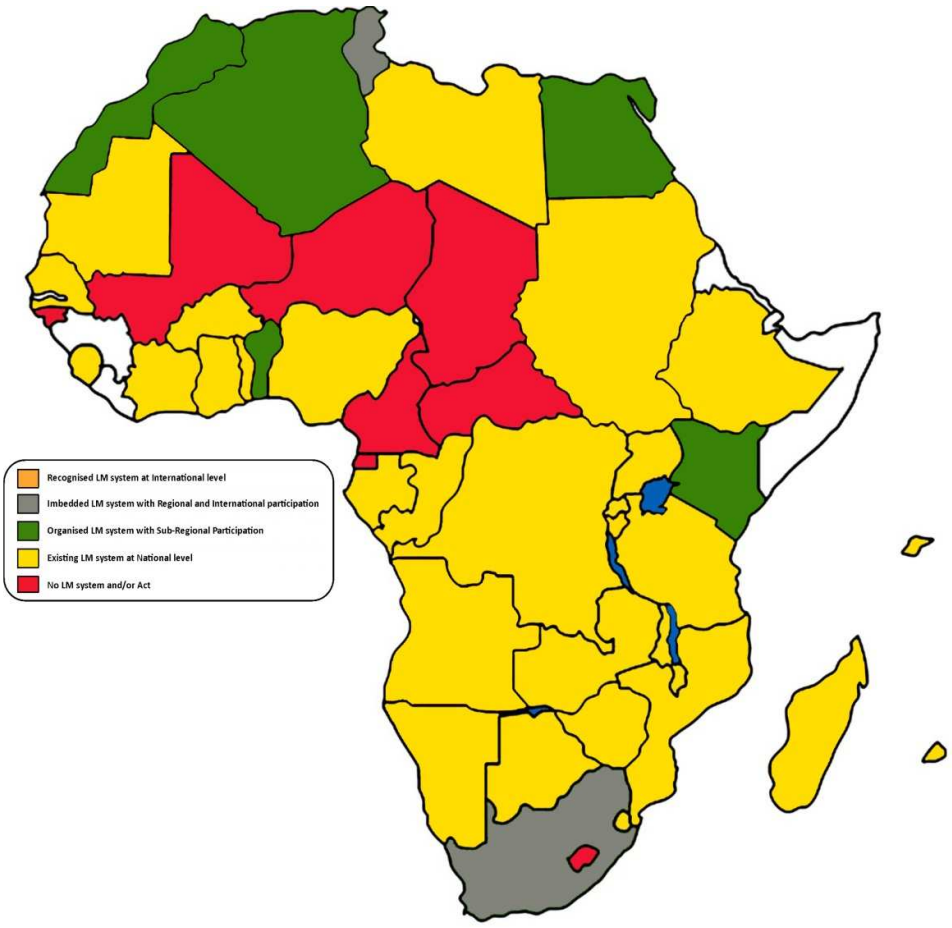

Figure 9: The level of legal metrology infrastructure in member countries

Figure 9 shows that although a large part of the continent is covered for legal metrology, the level of the infrastructure is a concern, as well as the lack of infrastructure in CEMACMET and parts of SOAMET. Many countries classified as "yellow" only perform 10-20% of the required activities.

The infrastructure maps can now be used to visually track the development of metrology in Africa.

4.4 Market trends, projections and associated future metrology traceability needs

To properly identify the current metrology infrastructure gaps in member countries and, even more importantly, the infrastructure needed to meet future demands, a comprehensive study of the industry, industry projections and current analytical capabilities of each member country is needed. Only a preliminary investigation was done for the Roadmap and only a summary of future trends is provided. It is one of the recommendations of this Roadmap that a comprehensive study be undertaken, especially for those SRMOs with less developed metrology infrastructures, such as CEMACMET and SOAMET.

Weak infrastructure, poor transport systems, unreliable electricity supply and protracted customs procedures are some of the common challenges faced by companies in Africa, but the lack of quality information is arguably the biggest obstacle to doing business on the continent, especially in its poorest economies [20]. The same was found to be true during the process to identify the status of legal metrology, analytical capabilities and metrological traceability. More success was had with obtaining information on the market trends and projections of future industries and economic activity, since these studies are being compiled by international companies and entities interested in doing business with Africa.

A summary of macro-trends for the continent and RECs is provided below as an indicator as to what metrology infrastructures need to be developed.

4.4.1 The continent

From 1995 to 2005, there were indications that many African economies appeared to have turned the corner and moved to a path of faster and steadier economic growth, with growth figures following those of the developed world [21]. This trend continued to 2007/2008, with growth rates above 5%, fuelled by high commodity prices (oil, minerals and food). The effects of the economic recession then led to a severe slowdown as commodity prices came under pressure. However, there are some less negative indications for the economies of developing countries than for those of the developed world – it appears that the extent of the downturn is less severe. This can be attributed to a combination of factors: the African financial markets are relatively weakly integrated into global markets, thus the direct negative effects of the global financial crisis are moderate; the African economy is only lightly dependent on the export of manufactured or high technology goods that showed the biggest decline globally; oil production and export is on the increase and offset the decline in trade in other commodities; and food prices have increased worldwide (one of the main reasons being the increase in bio-fuel production in the USA). Some sectors, such as minerals, did experience a severe decline in exports and, in the case of one or two more developed countries (such as South-Africa and Tunisia), automotive and automotive component exports declined. In Southern Africa, the decline in income was offset to a certain extent by the increased tourism associated with South-Africa hosting the 2010 FIFA World Cup.

So what does the future hold for the continental economy? The market potential is there, especially in the energy, consumer goods, telecommunication, industrial equipment, logistics and services sectors [22]. Oil exports are on the increase, especially from countries such as Angola and Libya, and (relative) newcomers Equatorial-Guinea, Cameroon, Sao Tome, Uganda, DRC, Tunisia, Egypt and Mauritania [23]. Commodity exports, however, are under pressure and will remain so until the developed world comes out of the recession that started in 2009. Coming from a very low base, there is a slow but steady increase in the export of some manufactured goods, especially processed foods. If world food prices remain high, this may have a positive effect on some African economies, although it may lead to instability in domestic markets.

An increase in stability in some countries (Sudan, the DRC, Zimbabwe, etc.) could also lead to substantial future economic growth (coming from a very low base).

Africa can also benefit from participation in a few niche markets. Domestic production of organic products is expected to rise within the next few years (there is usually a time-lag of three years between conversion and production of certified organic produce), but it is unlikely to meet demand for most products. Consumers' preference for locally or regionally produced organic fruit and vegetables indicates that the best opportunities are in counter-seasonal fresh organic temperate zone produce and non-temperate zone products. In particular, the countries along the Mediterranean, such as Morocco and Egypt, could benefit [24].

There may also be some opportunities in seasonal produce which is in short supply and in processed fruit and vegetables. This would benefit economic blocks such as the EAC, UEMOA, CEMAC and the AMU.

In SADC, South-Africa has embarked on an ambitious Industrial Policy Action Plan (IPAP) with the aim of creating jobs through increased industrialization and value addition to commodities. This will be achieved through the development of specific industry sectors (automotive, metal beneficiation, chemicals, agro-processing, advanced technologies – bio and nano, etc.). This will create an increased demand for metrology to provide traceability for measurements and analysis in the manufacturing process and acceptable certificates of analysis and testing for export products.

The African Union has formed the African Economic Community (AEC) which is endeavouring to promote cooperation and integration among African countries and RECs [25]. In future this may be a further stimulus to trade on the continent.

Although the global recession has had a severe negative effect on the economies of poorer countries in Africa, there are thus some positive drivers and, should the political situation allow stability, growth rates may constantly outstrip those of the developed world.

4.4.2 The SRMOs

To identify the metrology traceability that will be needed in future, the main future trends in each SRMO have to be estimated. These trends can then be used to suggest future metrology needs. What follows is not a comprehensive analysis of the future metrology needs, but rather a high level indication of what could be needed in each SRMO. To obtain the full picture, each SRMO will have to perform a proper future needs study (such studies are proposed for the SRMOs in the final recommendations in this document). The level of infrastructure needed in each member country must also be decided, and what can be shared or provided by the leading NMIs in the SRMO.

The following abbreviations are used in the tables below:

T	-	The need to be traceable to the SI at NMI level, suitable for CMC submission
t	-	The need to be traceable at least to an internationally recognized source of traceability; this can be to an accredited laboratory at appropriate level
nt	-	The need for in-house traceability only

4.4.2.1 CEMACMET

Oil production will increase, with a resultant increase in the export of petroleum products. An increase in the manufacturing of processed foods is also foreseen. The anticipated future metrology needs are shown in Table 5:

Table 5: Future metrology needs in CEMACMET

Main products and exports (CEMACMET)	Future industries	Current metrology offerings	Future anticipated metrology needs
oil agro-food products logs and timber cassava cotton coffee cocoa diamonds minerals (manganese) gold cement palm oil	petroleum products, processed foods, furniture	mass (nt) temperature (nt) pressure (nt)	mass and volume (t) pressure (t) flow (t) length (dimensional) (t) temperature (t) electrical (t) MiC (t) - inorganic, organic, bio, gas

4.4.2.2 EAMET

The EAC mainly exports agricultural products and to a lesser extend manufactured goods and needs the measurement infrastructure for traceable certificates of analysis. In turn, it imports manufactured goods and needs a measurement infrastructure to support compliance testing.

The export of processed chemicals and food products is on the increase, with Kenya the main supplier. The basic measurement traceability infrastructure is in place to support this industry. Although accredited chemical testing or analysis facilities are in place, traceability is lacking and needs attention. Metrology in chemistry (MiC) is being established in Kenya and to a lesser degree in Uganda. It is expected that the major export growth in Kenya will be in the processed foods and horticultural sectors, and in the export of manufactured goods to neighbouring RECs.

Future manufacturing will include composite materials and plastics. Uganda and Rwanda are the largest intra-COMESA exporters of plastic and its products, whilst Kenya is the largest intra-importer [26]. Kenya and Uganda are the major exporters of agricultural products in the region. Exports to outside the EAC and COMESA are limited but expected to grow.

Oil explotation is on the increase in Uganda, a relative newcomer to the oil producing countries in Africa. This could in future lead to a petroleum-based industry.

Regular technical metrology sub-committee meetings are held. At the 13th meeting of the sub-committee in Arusha, Tanzania on 4-5 May 2009 [12], it was noted that the Tanzania Bureau of Standards (TBS) received additional equipment in the areas of electricity, and dimensional and pressure measurements, and these areas submitted formal applications for accreditation. Kenya

reported that it was in the process to have all its laboratories accredited to ISO/EIC 17025, while Uganda reported that it has earmarked accreditation in the mass area – that has since been achieved. Rwanda reported that it has earmarked accreditation in mass and temperature – staff had been trained but the quality manuals and other documents had still to be prepared.

Table 6 gives an indication of the future needs in EAMET. All the highest current metrology offering traceability status is in Kenya, although some of the other NMIs do have (T) traceability for some parameters.

Table 6: Future metrology needs in EAMET

Main products and exports (EAMET)	Future industries and exports	Current metrology offerings	Future anticipated metrology needs
horticultural products coffee tea bananas cotton sugarcane dairy and meat products limited steel products chemicals pharmaceuticals	composite materials pyrethrum products garments processed foods: - dairy - fruit juice - beer manufactured products: - soap - plastics/rubber - petroleum - textiles and fibres	mass (T -Kenya) volume/flow (T) density (t) temperature (T) dimensional (length – t) pressure (T) force (T) ionising radiation (dosimetry - T) MiC (t) time (T) density/viscosity (t) photometry (t) acoustics/vibration (t) electrical (ac/dc -T)	photometry (T) acoustics/vibration (T) length (T) ionising radiation (T) density/viscosity (T) MiC (T): - inorganic - organic - bio - gas

4.4.2.3 NEWMET

The countries in NEWMET span three major RECs in Africa (AMU, ECOWAS and COMESA). Libya is a member of the AMU, Ethiopia of COMESA and Nigeria and Ghana of ECOWAS. Sudan and Egypt do not belong to well-defined RECs or trade areas within Africa, but Egypt has close ties with the AMU. ECOWAS is a member of the AEC and has signed a free trade agreement with MERCOSUR [27]. Southern Sudan has indicated that it wants to join the EAC [28].

The AMU, including Libya, exports mainly to Europe, with very little intra-trade. In fact, internal exchanges constitute only 3% of total local exports [22]. Libya, Egypt and Nigeria rely on oil and gas production, and Sudan is also increasingly doing so. One can therefore expect that petroleum products will play a bigger role in future in these economies, resulting in the need for specialized metrology. The Egyptian furniture industry is showing a rapid growth and is in fact one of the country's fastest growing and most promising industries [29].

In Ethiopia the major export products include coffee, livestock products (leather, live animals and meat), oil seeds and pulses, fruits, vegetables and flowers, textiles, natural gum, spices and mineral products. In addition to the efforts underway to increase the export of these products and to improve their quality, investments in other currently unexploited, higher value-added export sectors is strongly encouraged (such as the pharmaceutical sector). Other products where export is on the

increase are fruit, vegetables and flowers, and mineral products such as granite and marble. This will place additional demands on MiC, mass and dimensional metrology.

In Ghana, traditional exports such as Bolga baskets are re-capturing markets in Europe [30], and the export of hand-woven textiles is also on the increase. The industries that would require advances in metrology in the future are the growing oil exports, food processing (value addition to cocoa and coffee products, as well as fruit juices, etc.), wood products, horticulture and the ailing cotton industry if it could be revived.

The SRMO has primary traceability in place for most parameters through Egypt. There are many gaps in individual countries at secondary standard level, and, as they are not neighbouring or part of the same economic block, it will logistically be more difficult to get secondary standards calibrated, and primary traceability may be needed in some. The main anticipated needs in the other countries are therefore as shown Table 7.

Table 7: Future metrology needs in the countries of NEWMET

Main products and exports (NEWMET)	Future industries and exports	Current metrology offerings	Future anticipated metrology needs
resources and commodities: - oil and natural gas - minerals - gold - diamonds agriculture: - cotton, rice, onions, beans, citrus fruits, wheat, corn, barley, sugar, sesame, ground nuts, coffee, cereals, pulses, oilseeds, khat, meat, hides and skins industry: - textiles - processed foods - construction - cement - hydroelectric power	petroleum products, furniture and wood products, pharmaceutical, food processing, horticulture, textiles	mass (T) volume (T) density (T) pressure (T) force (T) dimensional (T) temperature (T) ionising radiation (T) electricity)T) MIC (t) (Most of these are in Egypt, which could provide traceability to the SRMO members, but selected offerings will have to be established in countries such as Nigeria, Ethiopia, Sudan and Ghana)	Egypt: Flow (T) MiC: Gas, Inorganic, Organic (T) Ghana: Needs are known and basic parameters are in place; expanding into MiC-inorganic, organic (t) Nigeria: proper needs analysis should be conducted, but probably mass, volume, density, flow, voltage, temperature, MIC: gas, inorganic, organic Libya and Sudan: Proper needs analysis should be conducted. Ethiopia: Basic parameters in place; need to improve traceability route and establish MiC

4.4.2.4 MAGMET

The AMU is a leading REC in Africa. Its proximity to Europe across the Mediterranean Sea and to Asia with the common border with the Middle East area, endows the community with many strategic advantages. GDP per capita varies across the MAGMET member countries with Algeria in the lead, thanks to its energy reserves. Mauritania has one of the fastest growing economies in Africa, Morocco has signed a free trade agreement with the US (2004), and Tunisia signed the first total free trade area agreement with the EU in 2008.

With a growing population and rising GDP, there are opportunities for growing intra-trade in numerous sectors, such as consumer goods, healthcare, transport, construction and telecommunications. This would place an increased demand on mechanical and electromagnetic metrology. Organic agriculture production is expected to increase, both for local consumption and export, increasing the importance of MiC.

Table 8: Future metrology needs in MAGMET

Main products and exports (MAGMET)	Future industries and exports	Current metrology offerings	Future metrology needs (T level)
resources and commodities: - oil and natural gas - minerals agriculture: - textiles, vegetables, olive oil	refined energy products, food processing, construction, pharmaceuticals, organic agriculture	mass (t) volume (t) density (t) humidity (t) pressure (t) force (t) torque (t) dimensional (t) temperature (t) Time & Frequency (t) ionising radiation (t) electricity (t) MIC (t) (Most of these are in Tunisia and Morocco and could provide traceability to the SRMO members, but selected offerings will have to be established in Algeria and Mauritania)	Algeria: Basic parameters such as mass and related quantities (t), pressure (t) flow (t) electrical (t) MIC: Gas, organic, inorganic (t) Morocco: Convert (t) level traceability for some basic parameters to (T) level, add MiC. Mauritania: To be explored Tunisia: Mass and related quantities (T) electricity (T), Temperature (T), Time & Frequency (T), MiC: gas, organic, inorganic (T)

4.4.2.5 SADCMET/MEL

The main market driver for the future will be increased oil and gas production in the al REC (especially in Angola and Mozambique), increased food production and fish exports. An increase in industrial projects in the aluminium, gas, titanium and coal industries in Mozambique is foreseen, and, if stability improves in the Democratic Republic of the Congo (DRC), the export of its natural resources will increase too. An increase in manufacturing output from South Africa is also anticipated, due to the IPAP. High-technology projects such as the Square Kilometre Array Project [31], micro satellite production, solar energy generation, nano-technology projects and bio-fuel production will also exert pressure to improve the existing metrology infrastructure in Southern Africa.

Future metrology needs can be divided into two groups:
A: The improvement of the basic metrology infrastructure in the SADC countries, excluding South Africa;
B: Primary metrology facilities in South Africa.

Table 9: Future metrology needs in SADCMET/MEL

Main products and exports (SADCMET/MEL)	Future industries and exports	Current metrology offerings	Future metrology needs (T level)
resources and commodities: - oil and natural gas - coal - mineral products (salt, sulphur, stone, lime and cement, mineral fuels) - precious metals (platinum, gold, silver) - base metals (iron and steel, copper, nickel, aluminium, lead, zinc, tin) - natural and cultured pearls - precious and semi-precious stones - wood pulp agriculture; - coffee, cocoa, cotton, gold and phosphate by-products, petroleum products, food commodities (rice, fruit), fish products	pharmaceuticals, organic agriculture, bio-fuels, value added mineral/metal products, high technology products (solar energy, satellites, products enhanced by nano-technology, automotive and aviation components)	mass (T) volume (T) density (T) pressure (T) force (t) dimensional (T) temperature (T) ionising radiation (t) radioactivity Standards (T) electricity (T,t) MiC (T) (All the (T) level is in South Africa. Selected offerings at (t) level exist at other institutes. SADCMET did a comprehensive study of the S&I capabilities and SADCMEL the legal metrology capabilities that need to be established in individual member countries)	South Africa: force (T), ionising radiation (T), resistance, power and energy (T), large flow(T), MiC; high resolution MS facility for POPs (dioxin/furan) analysis and CRMs, food matrix CRMs. Other countries: basic fit for purpose metrology parameters as identified by SADCMET/MEL (see Appendix B)

4.4.2.6 SOAMET

In addition to the efforts at national level to improve the metrology infrastructure, members of UEMOA have opted for a common strategy in order to capitalise on the synergy arising from the national potential to better promote the productive sector, derive benefits from the opportunities offered by the world economy and achieve a high standard of living for their citizens. The bedrock of this common strategy is the enhancement of the economic integration process initiated within UEMOA since 1994 [32]. In the industrial sector, a Common Industrial Policy (CIP) has been adopted to pool resources in the REC with the aim of increasing industrial output. The Union's Agricultural Policy (UAP) tends to increase cash crop production. Growth is not currently following the predictions or targets, in part due to the global recession. Specific economic development strategies to make the vision of the future a reality include the processing of cotton fibre, the development of the textile industry, fish farming and a programme to improve the competitiveness of small and medium industry (SMEs, etc.).

An average GDP growth of 6% is forecast for Côte d'Ivoire until 2013 [33]. This growth is based (in part) on the active promotion of exports. Specific sectors mentioned are food production, export agriculture (cocoa, cotton) and oil and gas exploration. Mining is also expected to increase (iron ore, nickel, bauxite, gold). Recent hostilities have severely impacted on the economic growth prospects, but outside donor assistance could restore the development plans.

Table 10: Future metrology needs in SOAMET

Main products and exports (SOAMET)	Future industries and exports	Current metrology offerings	Future metrology needs (T level)
resources and commodities: - oil and natural gas, uranium, gold, other minerals, agriculture: - cocoa, coffee, fish products and cotton - food commodities (fruit et légumes) - wood	textile industry, processed cotton fibre, fish farming, mineral beneficiated products, petroleum products, processed foods	mass (t) volume (nt) density (nt) temperature (nt) electricity (nt) pressure (t)	mass (T) length (T) volume (t) density (t) temperature (T) electricity (t) pressure (T) MiC (t)

5. THE WAY FORWARD

5. THE WAY FORWARD

5.1 Policy and strategies to advance metrology in Africa

The establishment of fit-for-purpose metrology in Africa is a momentous task. It not only involves the provision of traceability for existing analytical, measurement and calibration services but, in many cases, the establishment of a measurement infrastructure at all levels (weights and measures, testing, calibration, traceability, accreditation, international benchmarking) in each member country. In Section 4, the gaps in the current infrastructure and the future requirements were highlighted and it is clear that a concerted effort is necessary to address the issues.

The goal is to establish a fit-for-purpose accurate measurement system for Africa that supports intra-REC trade, improves the competitiveness of the manufacturing industries, ensures internationally recognized calibration and analysis certificates for export commodities and products and that provides a legal metrology framework in support of local, regional and international trade, health and safety and environmental issues.

It is proposed (by the members, stakeholders and other interested parties) that the goals and objectives should be met within a policy of developing a metrology infrastructure in an integrated manner between S&I and legal metrology. Scarce resources should be optimized through the sharing of facilities between S&I and legal metrology, the strengthening of metrology hubs in the SRMOs and the establishment of centres of excellence at a pan-African level. The intention is to establish fit-for-purpose basic legal and S&I systems and facilities in member countries, but not to duplicate facilities for the establishment of traceability in every country in Africa. The responsibility for national measurement standards (mostly at secondary standard level) could be shared amongst member countries in a SRMO. Traceability to primary standards could be provided by metrology hubs in the SRMOs or the most developed NMIs on the continent. The focus should always be to determine the level of infrastructure needed in each member and SRMO and develop only a fit-for-purpose infrastructure.

The snapshot of the status of metrology in Africa, the status of the economies and future trends then defines the strategies to reach these objectives. Three strategies are proposed, the first on how to develop the technical infrastructure, the second on how to strengthen the AFRIMETS institution and make it sustainable, and the third on skills development on the continent. A fourth strategy on how to attain political recognition is only briefly mentioned as the process is already well underway.

The infrastructure can be developed at three distinct levels, namely national (basic infrastructure), SRMO (hubs to provide fit-for-purpose traceability and harmonization of regulations for REC trade) and continental (a few advanced NMIs and LMIs that could provide linkage to the international systems) by:

A. Establishing fit-for-purpose basic legal and industrial metrology in the least-developed countries;
B. Strengthening existing legal and S&I metrology capabilities in developing countries in the SRMOs to provide for the needs of intra-REC trade; and finally:

C. Elevating the level of metrology in more technologically advanced countries to an internationally acceptable level.

A skills development strategy is crucial for the effective implementation of the infrastructure strategy. It is acknowledged that many training exercises have been conducted previously as part of individual member or REC donor projects, and the strategy will focus on generic training at a pan-African level through metrology schools.

An integral part of the first three strategies is the role that should be played by the SRMO. As explained in section 3.4.5, the SRMO should foster development in metrology at the REC level and co-ordinate AFRIMETS activities amongst the SRMO members. The SRMO structures should be developed according to a clear understanding of the role and responsibilities of the SRMO (metrology development, coordination of activities and harmonization of regulations within RECs) so as not to duplicate activities that should be conducted at the RMO level (international representation, international benchmarking, quality system approval, CMC issues, etc.).

The political recognition of AFRIMETS by the AU is covered by the Pan-African Quality Infrastructure Project sponsored by the PTB. This process has been continuing since 2009, when a quality infrastructure representative was sponsored by the PTB to assist the process through NEPAD. In April 2011, with the help of NEPAD and coordinated between the pan-African structures representing standardization (ARSO and AFSEC), metrology (AFRIMETS) and accreditation (AFRAC), an official request was submitted to the AU Commission (AUC) for the recognition of the four bodies as representing the pillars of the quality infrastructure in Africa. Subsequently, a request for information on the structures was received from the AUC. AFRIMETS forwarded its constituting MoU and information on its membership as contained in this Roadmap. A representative of the AU was also invited to attend the AFRIMETS GA. The process to receive recognition will continue under the guidance of the PTB pan-African project and with assistance from UNIDO. This strategy is thus in progress and will not be discussed further in the Roadmap.

A technology development strategy for Africa will be developed later to lessen future dependence on NMIs in other RMOs and to develop more fit-for-purpose measurement standards for the continent.

The process is graphically depicted in Figure 10.

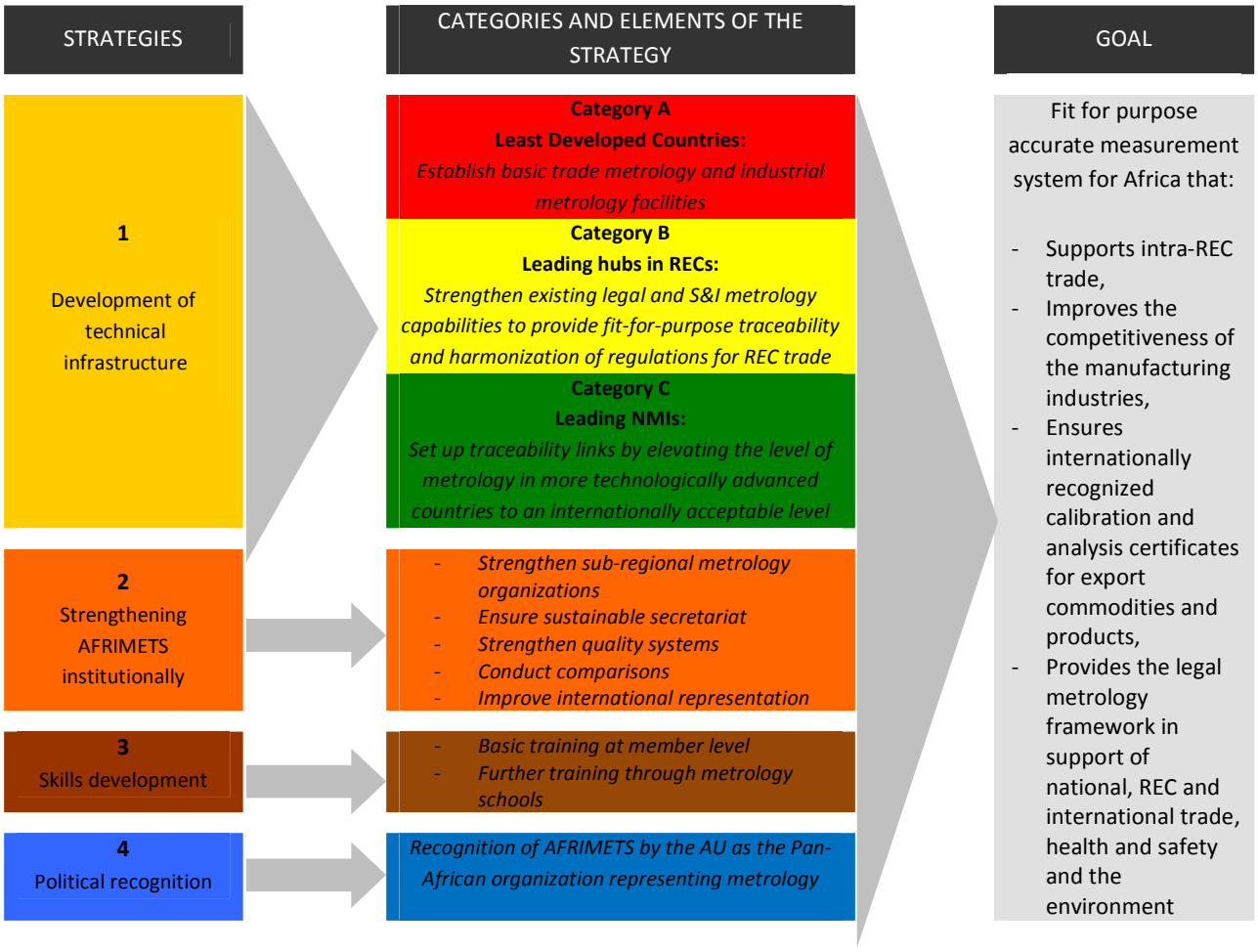

Figure 10: Infrastructure development strategies

5.2 Implementation of the strategies

5.2.1 Steps to implement the infrastructure development strategy

Category A: Least Developed Countries

Establish basic weights and measures (legal metrology) and fit-for-purpose industrial metrology, with the option of expanding to scientific metrology with mostly secondary measurement standards. In parallel, develop some SRMO institutional structures and improve the overall level of awareness of metrology at the REC level. The following approach is proposed:

a. Obtain the political buy-in at national and/or REC level;
b. Strengthen the SRMO institutional metrology infrastructure;
c. Motivate and assist members to adopt metrology legislation at national level, and technical regulations, at least, for the most important national/REC issues;
d. Develop fit-for-purpose training programmes and provide basic training in metrology (the programmes implemented in SADCMET/MEL as part of the SADC EU Project can be used as examples [35];
e. Develop fit-for-purpose basic weights and measures metrology infrastructures in member countries. This should include the establishment of enforcement capabilities and a basic calibration infrastructure. (The UNIDO document [36] detailing technical specifications for equipment for calibration and legal metrology can be used as a basic guide);
f. Develop fit-for-purpose industrial metrology laboratories for the basic parameters that can later be improved to include scientific metrology. This must include a list and costing of equipment, staff requirements, a training and skills plan and operational funding requirements. The focus should be on providing traceability to existing measurement capabilities in the country in support of weights and measures or, where very little exists, to operate as an accredited measurement facility for the country. This could either be at national level or, as in the case of SOAMET, could be shared amongst the members. Where very little measurement infrastructure currently exists, as in CEMACMET, it is an advisable option;
g. Obtain third party accreditation for the laboratories.

The steps below can be followed for implementation:

Step 1: Make contact with the local government and get approval to perform a comprehensive study of the measurement needs in the country. This should include:

- the measurements and traceability needed for weights and measures;
- the main local and export industries and their measurement needs;
- health and environmental measurement and monitoring needs;
- measurement needed in support of law enforcement;
- future economic and market trends and associated measurement needs;
- the existing measurement infrastructure, including testing and calibration laboratories (private and public) and the tests/analysis/calibrations performed;
- the accreditation status;
- the level of traceability needed.

Step 2: Get the approval of local government on the best model to achieve the required basic measurement infrastructure, and consensus from the REC on the sub-regional approach. This should include decisions on:

- what level of traceability will be established nationally and what will be sourced sub-regionally (SRMO), regionally (Africa) and internationally;
- whether applicable legislation is in place and if not, the process to establish it;
- where the capability should be established;
- future sustainability support from the national government and the REC.

Step 3: Establish an SRMO institutional structure to assist the process in the REC and act as a contact point.

Step 4: Develop a detailed plan with costing of how to develop the infrastructure. This should include:

- the main parameters to be established;
- whether the parameter must be established for national or REC needs;
- future parameters that provision must be made for;
- the building infrastructure with a specific focus on environmental conditions;
- a list and costing of equipment;
- staff requirements;
- a training and skills plan;
- operational funding requirements;
- a schedule for accreditation.

Step 5: Obtain funding from a combination of national, REC, regional (AU) or donor sources for implementation.

This category applies to CEMACMET and, from step 4, to most countries in SOAMET, Mauritania in MAGMET, Sudan and Libya in NEWMET and Burundi in EAMET. Steps 1- 4 have been completed in SADCMET/MEL and EAMET and their models of how it was done could be adopted by the other SRMOs.

<u>Category B: Leading REC hubs</u>

For this category, the basic principles of a metrological infrastructure are understood, but the basic metrological infrastructure in member countries needs to be improved. The focus should be on formalizing the methodology for a sub-regional (REC) approach. The requirements for elevating legal metrology to the desired level in the sub–region and individual member countries need to be identified. For S&I metrology, identify the parameters and level of traceability that must be established at sub-regional hubs and in individual member countries.

Where possible, leading NMIs in the REC/SRMO can provide fit-for-purpose traceability to member country NMIs, or assist national institutes to obtain traceability to the SI from leading international NMIs. This process should be overseen by a SRMO metrology infrastructure that will harmonise legal

metrology issues and organise and manage benchmarking exercises. The following approach can be followed:

a. Improve the status of the NLMBs (national legal metrology bodies) in each country to a fit-for-purpose level;
b. Establish S&I metrology at a fit-for-purpose (national) level that is at least recognized in the SRMO;
c. Assist the leading institution(s) in SRMOs to provide leadership in legal metrology issues and a traceability link to members;
d. Assist the leading institutions to pilot benchmarking exercises in the SRMO.

The steps below can be followed for implementation:

Step 1: Obtain consensus on the sub-regional approach from the SRMO Secretariats and structures within the RECs (for example UEMOA, ECOWAS, EAC, AMU).

Step 2: Perform a comprehensive study of the measurement needs in the REC. The RECs with an established SRMO secretariat structure will have such information available, but it may entail Category A studies for individual countries (for example MAGMET: Mauritania; SOAMET: Guinea-Bissau, Mali, Niger and Togo; EAMET: Burundi; NEWMET: Libya, Sudan).

Step 3: At the national level, obtain approval from local government on the best model to achieve the required basic measurement infrastructure, as in Category A. This should include agreement on:

- what level of legal metrology and traceability will be established nationally and what will be sourced sub-regionally (REC), regionally (Africa) and internationally;
- whether applicable legislation is in place and, if not, the process to establish it;
- where the capability should be established;
- future sustainability and government support.

Step 4: Prioritise and divide into individual projects to establish the required parameters and levels of traceability at individual NMIs or LMIs.

This category includes SOAMET and, to a certain extent, MAGMET and NEWMET. The process is already advanced in EAMET and has been finalized in SADCMET/MEL.

<u>Category C: Leading NMIs and NLMBs</u>

In support of all trade and measurement issues of continental and international concern, improve the adoption and implementation of international legal metrology standards at SRMO level and obtain international recognition for CMCs. It is proposed that this category be designed on the basis of a network of higher level NMIs and NLMBs in Africa that could provide internationally benchmarked traceability to the continent, hence the strengthening of regional centres of

excellence. For scientific and industrial metrology, this will be for secondary measurement standards as established at the sub-regional (REC) hubs or individual member NMIs. For legal metrology, the NLMBs would be able to provide guidance and assistance to member countries on how to establish fit-for-purpose legal metrology structures and with the development of regulations, and would assist with training inspectors. The following approach can be followed:

a. Establish which parameters should be elevated to international recognition level (taking into account the needs of legal metrology as well), and in which member countries this should be done; sharing of this responsibility amongst SRMO members is highly recommended;
b. Assist leading NLMBs with linkages to international legal metrology structures and to obtain membership of the OIML;
c. Assist leading NMIs to provide and improve the traceability route through the membership (or Associates) of the BIPM, accreditation and/or peer review of facilities and the approval of quality systems;
d. Initiate a process of harmonization of legal metrology legislation and ensure that the regulatory control and trade relevant measurement capacity of NLMBs are upgraded according to international standards;
e. Get CMCs accepted in the international key comparisons database for all parameters critical for the SRMO;
f. Assist AFRIMETS with liaison with international organizations such as OIML/CIML, BIPM/CIPM, RMOs, the JCRB and technical interactions such as with legal metrology forums and consultative committee meetings and workshops;

The steps below can be followed for implementation:

Step 1: Obtain a detailed picture of what the leading NLMBs and NMIs offer, including the level, the uncertainty of measurement and the status of international acceptance; identify the gaps; and reach consensus with the SRMOs on which leading NMIs will focus on primary realization of which units.

Step 2: Prepare a schedule of which parameters will be established where and when; and obtain a full costing to improve/establish the parameter. This should include equipment, staff, training, participation in benchmarking exercises (pilot studies, comparisons) and operational costs.

Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website. Donors can then assist with individual projects

This category includes Egypt, South-Africa, Kenya and, in the future, Tunisia, Ghana, Ethiopia, Seychelles, Zambia, Zimbabwe and Mauritius. The methodology is to identify what gaps exist in the provision of internationally benchmarked traceability to the REC/SRMO, and which parameters must be strengthened to improve the level of traceability. The basic information is available in this Roadmap but needs to be investigated in more detail.

It must be stressed that this category is one of the most important for the advancement of AFRIMETS. In the past, donor agencies were inclined towards assistance to Least Developed countries. The risks associated with the establishment of basic metrological infrastructures in these countries are huge. The projects must be planned thoroughly, with the sustainability issue properly addressed. Even then an inadequate local infrastructure, the loss of key personnel, political instability and, in general, isolation can easily render investments useless. Investments in more developed and politically stable countries that can assist neighbouring countries with metrology issues are thus an important part of the strategy.

To achieve the proposed strategy to develop the metrological infrastructure in the countries and RECs, specific projects are proposed for each category (A, B and C). Interested donors can then choose the appropriate project to get involved in. The proposed projects are summarized in Table 11 and the detail is given in section 5.4.

5.2.2 Best practice to establish basic legal metrology (weights and measures) and S&I facilities

There are many different models to establish measurement and testing facilities. In Africa, the largest number of NLMBs is within government departments. A few of the more developed countries have separate, dedicated NLMBs. Most NMIs is within national standards bodies. A few more economically advanced countries have dedicated NMIs (for example, South Africa, Egypt and Ethiopia) and a few countries have designated a group of government measurement institutes and/or industrial metrology laboratories at private companies as NMIs (for example Tunisia). Some countries have one institute responsible for both legal and S&I metrology.
The advantages and disadvantages of the three models that are summarized below can be used as an initial input when a decision is to be taken on how the infrastructure is to be organized.

NLMB within a government department

Most NLMBs in Africa were created as a function of or branch within a government department.

Advantages	Disadvantages
The legal framework provided by the department	Red tape and slow processes
The backup and support from the department	A low national profile
A small initial financial outlay	Insufficient funding for inspection and for testing facilities
Governance provided by the department	Corruption

NMI within a standards body (SB)

Advantages	Disadvantages
Normally formed from a calibration and/or testing facility within the SB	Can have a low profile within the SB
Draws on experience of seasoned calibration and/or testing staff	Has to compete for funding with the standards activities, in many cases resulting in not enough dedicated funding for metrology
Governance is in place	May have to compete for time with commercial activities, e.g. metrologists are required to do routine work for external compensation
No need for a substantial initial financial outlay	Low national profile
The backup and support of the larger organization	Focus can be on calibration and testing with little scientific metrology activities
In many instances the laboratories are already accredited to ISO/IEC 17025	Governance and management structures do not understand the activities and do not support functions crucial for metrology

Designated NLMBs or NMIs

Advantages	Disadvantages
Normally an existing calibration and/or testing facility is designated for a specific set of parameters	Can have a low profile within the country
Can draw from experience of seasoned calibration and/or testing staff	Impartiality could be compromized
Governance is in place	Metrology can be a low priority within the organization
Does not need a substantial initial financial outlay	Metrology does not have a unique identity in the country and thus has a low profile nationally
Has the backup and support of the larger organization	Has to compete for funding with the other commercial activities, in many cases resulting in not enough dedicated funding for metrology
The existing institute can have a good national or even international profile	Low national profile
In many instances the laboratories are already accredited to ISO/IEC 17025	May have to compete for time with commercial activities, e.g. metrologists are required to do routine work for external compensation
	Focus can be on calibration and testing with little scientific metrology activities
	Governance and management structures do not understand the activities and do not support functions crucial for metrology

Single institute responsible for both metrologies

Advantages	Disadvantages
A single governance and management structure, less duplication in country;	If not correctly set up, the two metrologies can have to compete for resources
Sharing of facilities; in most cases facilities are developed for conformance testing and can later be expanded to include first industrial and then scientific metrology	Governance and/or management could have a preference for one of the two
In general, resources can be shared	Routine weights and measures functions (conformance testing) can result in very little time available for the maintenance of measurement standards and traceability issues
More critical mass	Each branch of metrology does not have a unique identity in the country and thus has a low profile nationally

Separate, individual NLMBs and NMIs

Advantages	Disadvantages
A single governance and management structure dedicated to and focusing on only one branch of metrology	High initial cost
High national profile	High cost of governance, management and support services
Single entry point for branch of metrology in country; high international profile	Can struggle to reach critical mass
No competing for resources with other priorities	No backup from larger institute
Priorities understood by governance and management	
Structures and support can be designed to best serve the specific branch of metrology	

The most appropriate model depends on the development level of the country, the level of support received from government, and historical factors. For a specific country, a comprehensive study is necessary to identify the best approach. A comprehensive guide on how to establish an NLMB and an NMI and what each should include will be developed as one of the proposed future projects for AFRIMETS.

5.3 Barriers to implementation of the strategies

The barriers to establishing a metrology infrastructure are well known. The main factors are:

- Political instability
- Lack of political support for metrology
- Lack of regional/national infrastructure
- Lack of proper buildings, poor environmental conditions
- Lack of artefacts/instrumentation
- Lack of trained personnel/metrologists/scientists
- Lack of services (electricity, water, gas, liquid nitrogen/helium, consumables)
- Lack of technical support for instrumentation – most of the time this must be sourced from overseas

It is beyond the scope of this Roadmap to comment on the barriers per member or to suggest solutions for the barriers. It is sufficient to state that strategies for the institutional strengthening and to improve the metrological infrastructure in Africa should take cognisance of the barriers. Where specific barriers are identified in a REC, this is stated in the final recommendation of a strategy to improve metrological infrastructure in the SRMO.

5.4 The implementation of the Infrastructure development strategy in the SRMOs

The information already gathered in this Roadmap can be used as the basis for the studies proposed for the SRMOs. It is, however, important that comprehensive, in-depth studies be conducted per member country where the information is not available. For EAMET and SADCMET/MEL, most of the information is already available.

The studies should take cognisance of the findings in the report from the UNIDO Expert Group on "Standards Compliance and Conformity Assessment for the Development of Sustainable Trade in Africa" on "Assessing the Specific Needs of African Countries in the Field of Quality Infrastructure with a Focus on Key Export Sectors". It is important that the investment in metrology infrastructure supports the key export sectors.

As an output of all the studies, a comprehensive list of S&I capabilities to be established will be developed according to three distinct levels of sophistication. It will be summarized as high level capabilities at CMC level, medium level capabilities per SRMO and fit-for-purpose capabilities per country.

It is also proposed that each SRMO develops a 3-5 year work plan detailing training, infrastructure development, quality system development, proficiency testing and other benchmark activities. SADCMET/MEL, EAMET and MAGMET have such work plans in place for at least the next year or two (see Appendix D). A summary of the work programmes for 2012-2013 for S&I and legal metrology at an AFRIMETS level is provided in Appendix C.

5.4.1 CEMACMET

It is proposed that a Category A study be conducted for CEMACMET, including the establishment of a SRMO structure. This should be followed by some elements of a Category B study.
Three distinct projects are proposed:

First project (C 1): Basic scoping study

Step 1: Make contact with national governments in the REC and get approval to perform a comprehensive study of the measurement needs in the countries of CEMAC and conduct the study;

Step 2: Get the approval of local governments on the best model to achieve the required basic measurement infrastructure and consensus from CEMAC on the SRMO approach;

Step 3: Establish an SRMO institutional structure for CEMACMET to assist the process in the region, and act as a contact point. It must again be emphasized that the SRMO structure only needs to be a central contact point or points for scientific and industrial and legal metrology and, when more mature, can assist with coordination of metrology activities in the -REC.

The cost of the study should be based on the appointment of three experts (economic/market studies and metrology – both legal and S&I) for 15-20 working days each, visits to the 8 member countries and a comprehensive report.

Second Project (C2): Detailed infrastructure costing

Step 4: Develop a detailed plan with costing of how to develop the infrastructure, including the sequence in which it will be implemented in the member countries;

Step 5: Motivate a combination of national, REC, regional or donor sources to fund implementation.

The cost of such a study should be based on the appointment of two metrology experts (legal and S&I) for at least 25-30 workdays each, with provision for 2-3 follow-up visits to some members,

Third Project (C3): Infrastructure development

Step 6: Develop technical infrastructures in members starting with the most developed countries in CEMAC. From this point, the establishment of facilities in each member country will be a project on its own, although it will follow the strategic plan as defined in step 4.

5.4.2 EAMET

It is proposed that a category A study be conducted for Burundi, elements of a category B study for Rwanda and a category C study for Uganda and Kenya. As the SRMO is well established, most information is already available. It is also recommended that the projects be conducted either by or under the supervision of the EAMET Executive.

Three projects are proposed:

First Project: (E 1): Scoping study, Burundi

Step 1: Perform a comprehensive study of the measurement traceability needs (legal metrology is already established) and perform the study;

Step 2: Reach consensus with BBN on the best model to achieve the required basic S&I measurement infrastructure and to improve the legal metrology infrastructure, in consensus with EAMET as a REC approach;
Step 3: Develop a detailed plan with costing of how to develop the S&I infrastructure and to improve the legal metrology infrastructure in Burundi;
Step 4: Motivate a combination of national, REC, regional or donor sources to fund implementation.

The cost of the study should be estimated on the basis of the appointment of two experts from EAMET for 15-20 working days each, and at least three visits to Burundi.

Second Project (E2): S&I Infrastructure development, Rwanda
Step 1: Conduct a study of the traceability needs of Rwanda;
Step 2: Develop a detailed plan with costing of how to further develop the S&I infrastructure in Rwanda;
Step 3: Motivate a combination of national, REC, regional or donor sources to fund implementation.

The cost of the study should be estimated on the basis of the appointment of one expert from EAMET and two visits. The next step will be to develop an S&I technical infrastructure in Rwanda, with the cost as determined in Step 2.

Third Project (E3): Infrastructure improvement at UNBS and KEBS
Step 1: Update the details of what is offered (including uncertainty of measurement) at UNBS, KEBS and Kenya Weights and Measures and reach consensus on who will focus on primary realization of which units, including agreement at the EAMET Executive level;
Step 2: Prepare a schedule of which parameters will be established where and when;
Step 3: Prepare proposals for individual projects and publish these in a schedule on the AFRIMETS website. Donors can then assist with individual projects.

The cost of the study will be estimated on the basis of the appointment of two experts from EAMET and two visits.

5.4.3 MAGMET

It is proposed that a Category A study be conducted for Mauritania, a Category B study for Algeria and a Category C study for Morocco and Tunisia.

Three distinct projects are proposed:

First Project: (M1): Scoping study, Mauritania
(It is proposed that the projects be conducted under the guidance of and through the MAGMET Executive):
Step 1: Make contact with the Mauritanian government and get approval to perform a comprehensive study of the measurement needs in Mauritania and perform the study;
Step 2: Get approval from the Mauritanian government on the best model to achieve the required basic measurement infrastructure, in consensus with MAGMET on the REC approach;

Step 3: Develop a detailed plan with costing of how to develop the infrastructure in Mauritania;
Step 4: Motivate a combination of national, REC, regional or donor sources to fund implementation.

The costing should be estimated on the basis of the appointment of two metrology experts for 10-15 working days each and two visits.

Second Project (M 2): Infrastructure development, Algeria

Step 1: Obtain approval from the Algerian government to conduct a study of the traceability needs of Algeria and conduct the study;
Step 2: Develop a detailed plan with costing of how to develop the infrastructure in Algeria;
Step 3: Motivate a combination of national, REC, regional or donor sources to fund implementation.

The costing should be estimated on the basis of the appointment of one metrology expert for 20-25 working days and two visits.

Third Project (M3): Infrastructure development, Morocco and Tunisia

Step 1: Obtain a detailed picture of what is offered at the individual NMIs in Morocco and Tunisia and reach consensus on which NMIs will focus on the primary realization of which units, including agreement at the national government and MAGMET executive level;
Step 2: Prepare a schedule of which parameters will be established where and when;
Step 3: Prepare proposals for individual projects and publish these in a schedule on the AFRIMETS website. Donors can then assist with individual projects.

The costing should be estimated on the basis of the appointment of one metrology expert for 20-25 working days and two visits.

5.4.4 NEWMET

It is proposed that a Category A study be conducted for Sudan, a Category B study for Nigeria, a verification of activities in Libya and a Category C study for the rest of the SRMO, and that the projects be conducted under the guidance of and through the NEWMET Executive.

For Sudan, it is proposed that a Category A study be undertaken once the political situation has stabilized and the secession of South-Sudan has been finalized. The first step should then be to confirm the participation of both North Sudan and South Sudan in NEWMET. If South Sudan chooses to participate in EAMET, the study can be conducted under the auspices of the EAMET executive.

Three distinct projects are proposed:

First Project (N 1): Scoping study, Sudan

Step 1: Make contact with both Sudanese governments and get approval to perform a comprehensive study of the measurement needs in Sudan and South Sudan and perform the study;
Step 2: Get approval from the Sudanese governments on the best model to achieve the required basic measurement infrastructure, in consensus with EAMET on the REC approach;

Step 3: Develop a detailed plan with costing of how to develop the infrastructure in North and South Sudan;
Step 4: Motivate a combination of national, REC, regional or donor sources to fund implementation.

The cost should be estimated on the basis of the appointment of four experts (two from NEWMET and two from EAMET) for 15-20 days each, and four visits.

SecondProject (N 2): Infrastructure development, Nigeria

Step 1: Assist SON to conduct a study of the traceability needs of Nigeria;
Step 2: In partnership with SON, develop a detailed plan with costing of how to develop the S&I infrastructure in Nigeria;
Step 3: Motivate a combination of national, REC, regional or donor sources to fund implementation.

Most of the information should be available from SON. It is envisaged that one expert from NEWMET could assist SON with the study and the costs should be based on one expert for 10-15 days and one visit.

Third Project: (N3): Infrastructure development, Libya

The Libyan National Centre for Standardization and Metrology (LNCSM) is well known to NEWMET, but the institute has had very little interaction with AFRIMETS. It is proposed that once the political situation has stabilized, NEWMET conduct a study to determine the metrology offered in LNCSM and to identify any future projects in the country. The costs can be based on the appointment of an S&I expert and will include a visit to Libya by the NEWMET Secretariat.

Fourth Project (N 4): Infrastructure development in Ethiopia, Ghana and Egypt

Step 1: Update the picture of what is offered at the individual NMIs in Ethiopia, Ghana and Egypt, and reach consensus on which NMIs will focus on primary realization of which units, including agreement at the national government and NEWMET executive level;
Step 2: Prepare a schedule of which parameters will be established where and when;
Step 3: Prepare proposals for individual projects and publish these in a schedule on the AFRIMETS website. Donors can then assist with individual projects.

Due to the level of development of NEWMET, the cost should be minimal, although it could include a joint meeting of the three institutes to finalise the proposal. The cost can be estimated as assistance for the meeting (travel of at least four individuals, intra-REC).

Projects already identified:

Egypt

1) The expansion of the metrology in chemistry (MiC) section to include the preparation of primary gas mixtures and an organic and bio-analysis section;
2) Improvement of the traceability chain for time and frequency, temperature, pressure, dosimetry, etc. Project proposals will be invited from NIS.

5.4.5 SADCMET/MEL

SADCMET/MEL has a comprehensive strategy to develop metrology at a basic level in the REC, as defined in the SADC EU Project and SADC-PTB interactions.

As part of the SADC EU Project, SADCMEL conducted a legal metrology landscape study for seven countries [35]. SADCMET performed measurement needs studies in most of SADC and has a comprehensive database of what is currently offered at NMIs and the future needs for traceability.

Current or recent activities include a measurement needs study completed for Swaziland and one in progress for Namibia. UNIDO-sponsored quality system projects are currently being conducted in Mozambique and Zambia.

The only country in SADC with no metrology infrastructure is Lesotho. Due to the small size of its economy and its proximity to the NMISA, from where it can source traceability, the proposed strategy is to update the measurement needs and investigate the option of a mobile metrology laboratory (MML). Maintenance and calibration of equipment can be performed in South Africa.

Madagascar is currently excluded from activities in SADC due to the political situation. Most information regarding its measurement and metrology needs are known, and it is possible to design a strategy to establish missing parameters without a comprehensive study.

Although some information is available for the Democratic Republic of the Congo (DRC), it needs to be updated and a study may be necessary. This could be performed as part of the extension of the SADC EU Project (anticipated for 2012 onwards).

The SADCMET/MEL strategy does not include a Category C intervention, and the recommendation is to focus on a Category C study for the more advanced NMIs and NLMBs in SADC. An overarching project is thus proposed specifically to improve the international standing of the leading NLMBs and NMIs:

<u>First Project (SD1): Infrastructure development at sub-REC level</u>

Step 1: Update the picture of the status of the NLMBs and NMIs in South Africa, Mauritius, Seychelles, Zambia and Zimbabwe. Reach consensus on which NMIs will focus on primary realization of which units, including agreement at the national government and SADCMET/MEL Executive level. For NLMBs, reach consensus on what interventions are needed to fill the gaps as identified in Table 4, and elevate the member countries to a higher level.

Step 2: Prepare a schedule of which parameters will be established where and when, and what interventions are necessary.

Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website.

Donors can then assist with individual projects.

The study could be conducted by the SADCMET and SADCMEL Secretariat, and the cost based on four visits and one joint meeting.

Projects already identified:

SD2.1: Establishment of a REC reference facility for (persistent organic pollutants) POPs analysis

Establish a regional (Africa) POPs laboratory in organic chemistry, with the focus on performing dioxin screening for exports from the region. The idea is to establish this laboratory in South Africa at the highest level possible, with state-of-the art equipment rendering internationally recognized environmental analysis, and then to provide assistance to a network of lower level POPs laboratories at the leading SRMO NMIs – Kenya, Egypt, Ghana, Tunisia and later, Cote d'Ivoire. The cost of this project is estimated at € 3,5 million.

SD2.2: Shorten the traceability route for electrical parameters

Shorten the traceability chain for electrical parameters with the establishment of primary systems for resistance, AC power and capacitance (quadrature bridge). The realization will be implemented in the countries as identified in SD 2.1.

SD2.3: Equip established NLMBs in SADC with fit-for-purpose equipment.

Build on the successes of the SADC EU Project and equip well established NLMBs with the necessary equipment as identified in the Project. It is proposed to start with Mauritius, Seychelles and Zimbabwe. Bi-lateral programmes are running in Mozambique, Namibia and Zambia.

5.4.6 SOAMET

It is recommended that Category A studies be conducted for Guinea-Bissau, Mali, Niger, Senegal and Togo, A Category B study for Benin, Côte d'Ivoire and Burkina Faso, and a Category B study for these countries.

The studies could be conducted under the auspices of the SOAMET Secretariat with external expert input.

In summary:

First project (S 1): Scoping study SOAMET

Step 1: Make contact with local governments in Guinea-Bissau, Mali, Niger and Togo and get approval to perform a comprehensive study of the measurement needs;
Step 2: Update the metrology offered by Benin, Burkina-Faso, Côte d'Ivoire and Senegal and confirm gaps;
Step 3: Get the approval of local governments on the best model to achieve the required basic measurement infrastructure and consensus from the SOAMET Secretariat on the REC approach.

The cost should be based on two experts for 30-40 days each and eight visits. This study could be combined with the CEMACMET study and the studies for Mauritania and Burundi (all French speaking).

Second Project (S2): Infrastructure development at national level

Step 4: Develop a detailed plan with costing of how to develop the basic infrastructure, including training metrologists and the sequence in which it will be implemented in the member countries;

Step 5: Motivate a combination of national, REC, regional or donor sources to fund implementation.

Third Project (S 3): Infrastructure development at SRMO level

Step 6: Improve the traceability link in members, starting with the most developed metrology institutes (Benin, Burkina Faso and Côte d'Ivoire). From this point, the establishment of facilities in each member country will be a project on its own, although it will follow the strategic plan as defined in step 4.

The summary of the SRMO projects is given in Table 11.

Table 11: Summary of proposed projects in SRMOs

No	Sub-RMO	Category	Project Description	Cost to be Based On
C1	**CEMACMET**	**A**	Basic scoping study	3 Experts - 15-20 days each, 8 visits each for 3 experts = 24
C2		**A**	Infrastructure costing	2 Experts – 25-30 days each, 4-6 visits to members
C3		**A**	Infrastructure development	As per recommendation from C1-2
E1	**EAMET**	**A**	Scoping study, Burundi	2 Experts – 15-20 days each, 3-4 visits to Burundi
E2		**B**	Infrastructure development, Rwanda	2 Experts – 15-20 days each, 2 visits to Rwanda
E3		**C**	Infrastructure Improvement, Uganda and Kenya	2 Experts – 15-20 days each, 2 intra-REC visits
M1	**MAGMET**	**A**	Basic scoping study, Mauritania	2 Experts – 15-20 days each, 2 intra-REC visits
M2		**B**	Infrastructure development, Algeria	1 Expert – 20-25 days, 2 intra-REC visits
M3		**C**	Infrastructure development, Morocco and Tunisia	2 Experts – 15-20 days each, 2 visits
N1	**NEWMET**	**A**	Scoping study, Sudan	2 Experts – 15-20 days each, 4 intra-REC visits
N2		**B**	Infrastructure development, Nigeria	1 Expert – 5 days, 1 visit
N3		**B**	Infrastructure development, Libya	2 Experts – 10 days each, 2 visits
N4		**C**	Infrastructure development, Ethiopia, Ghana, Egypt	4 visits (joint meeting for 2 days)
SD1	**SADCMET**	**C**	Infrastructure development at sub-REC level.	4 visits and one joint meeting
SD2.1		**C**	Develop POPs REC (and regional) facility.	To be costed. Will be published on website.
SD2.2		**C**	Develop primary traceability for electrical quantities.	To be costed. Will be published on website.
SD2.3		**C**	Equip NLMBs in SADC with fit-for-purpose equipment.	To be costed. Will be published on website.
S1	**SOAMET**	**A**	Scoping study, Guinea-Bissau, Mali, Niger, Senegal and Togo	2 Experts – 30-40 days each, 8 visits
S2		**B**	Infrastructure development at national level for Burkina Faso, Benin and Côte d'Ivoire	To be estimated from study S1.
S3		**C**	Infrastructure development at REC level	To be estimated from study S2.
G1	**All SRMOs**		Develop work plans for the next 3-5 years.	


The 5th AFRIMETS General Assembly
18 - 22 July 2011
Nairobi, Kenya

5.5 Strengthening AFRIMETS' institutional infrastructure

Since the inception of AFRIMETS in 2007, the institutional arrangements (and meetings) as well as marketing material have been sponsored by the PTB, NMISA and, to a lesser extent, the NCRS. S&I metrology benchmarking exercises are mostly sponsored by the NMISA and the PTB. NEPAD assisted with the first GA. The SADC EU Project also contributed to AFRIMETS through sponsorships to SADCMET and SADCMEL, and the PTB and UNIDO contribute to the general activities of the SRMOs through individual projects in support of economic blocks or individual countries. Since the start of the UNIDO/AFRIMETS Project in 2009, UNIDO has been assisting with training, attendance at some meetings, marketing, a metrology school and assistance with benchmarking exercises.

The NMISA, NRCS and PTB contribute to the Secretariat. PTB sponsors a contract administrative person and provide funding for ad-hoc projects and marketing material. The NMISA and NRCS provide all further secretariat functions.

Technical activities such as comparisons and proficiency testing schemes are funded mostly by the pilot laboratory (up to now NMISA , NIS and KEBS), with assistance from the PTB for the transport of artefacts and evaluation meetings. UNIDO, through the UNIDO/AFRIMETS Project, also assists with the purchasing of artefacts needed for benchmarking exercises.

Projects to strengthen the institutional infrastructure and to ensure a more effective system are proposed below. A summary of the projects is given in Table 16.

5.5.1 The Secretariat and ensuring a sustainable AFRIMETS

Various models for an AFRIMETS Secretariat were investigated. Most RMOs follow a rotation system where members host the Secretariat for defined periods, with most of the costs funded by the host institution. Most RMOs charge a membership fee and contribute a certain amount to the Secretariat for the travel expenses of Secretariat members for RMO activities, for marketing and to manage information systems.

The exception is the European Association of National Metrology Institutes (EURAMET). What sets EURAMET apart from the other RMOs is that funding from the EU that can be accessed by NMIs on a 50/50 basis for joint research projects in metrology. It is called the European Metrology Research Programme (EMRP). EURAMET was established as a legal entity from its predecessor, EUROMET.

The EURAMET Secretariat is still hosted by an NMI (currently PTB), but most of the Secretariat personnel is appointed by the RMO and funded from a combination of membership fees and a participation fee in the EMRP. In practice, some of the costs are still shared by the host NMI.

A full cost analysis was done for

1) A "permanent", fully sponsored secretariat;
2) A secretariat hosted by a member country with partial funding from membership fees or donors;
3) A secretariat hosted and sponsored by a member country.

After much deliberation and discussion with role players, it was decided that, due to the RMO's role as defined internationally and the associated skills base needed, a "permanent" fully paid secretariat

is not an option. A secretariat hosted and fully sponsored by a host country can become a financial burden to such an extent that member countries will be reluctant to host the secretariat.

For AFRIMETS, a secretariat hosted by a member country with partial funding from membership fees or donors is thus proposed. The activities for which funding is needed are shown in Table 12.

Table 12: Activities to be sponsored for a partially sponsored Secretariat

Topic	Description	Cost Issues
Accommodation and services	Currently provided by the NMISA	To be provided by the host
Head of the Secretariat	Currently provided by the NRCS	To be provided by the host
Technical human resources	Currently provided by the NRCS (legal) and the NMISA (S&I)	To be provided by the host and members
Resource person -Admin -ICT	Currently sponsored by PTB for a half day. A full-day person is recommended. It is assumed that further resources would be provided by the host country.	Depends on host country
Travel of executive members -EXCOM meetings (2-3 p/a) -JCRB meetings (2 p/a) -RMO meetings (2-3 p/a) -Miscellaneous (CIML?)	The PTB is currently assisting with travel to executive committee meetings, and UNIDO sponsored 2 RMO GA attendants.	Level of assistance to be determined by donor
Upkeep of website	Currently jointly provided by NMISA and the PTB.	Not defined
Promotional material and marketing	Currently provided by PTB, NMISA and UNIDO.	As needs arise

There are two models to obtain the funding:

1) Sponsorship by a donor;
2) Membership fees.

It is not recommended at this stage to introduce a membership fee for AFRIMETS, as it could provide an entry barrier to the remaining countries which have not engaged in AFRIMETS. It can also not be recovered from non-active members at the moment, for example all members of CEMACMET and some members of SOAMET. The issue of membership fees to the SRMO versus membership fees to AFRIMETS will also have to be resolved first.

It is recommended that this issue be thoroughly discussed and planned over the next three to five years. A membership fee could be introduced once all SRMOs are fully in operation. It is envisaged that a five-tier membership fee could then be levied:

Table 13: Possible future membership fees (Based on classification in Table 2)

Category	Examples with numbers	Possible fees (€ p/a)	Total estimated income (€ p/a)
A. Top level NMIs/NLMBs participating at International Level	4	5 000	20 000
B. Middle level NMIs/NLMBs leading in SRMOs	6	2 500	15 000
C. Other well established NMIs/NLMBs	8	1 500	12 000
D. NMIs/NLMBs from LDCs participating at SRMO level only	14	1 000	14 000
E. Observers (aspiring members)	4	500	2 000
		Total	**63 000**

It is questionable if the full amount could be recovered for the first 1-3 years, and some external sponsorship will be needed in the interim. The fees could then be increased over a five-year period, until the costs are fully covered. It is also envisaged that the active membership will increase with the implementation of the strategy for CEMACMET and SOAMET.

The phased possible income from membership fees are then:

Table 14: Possible phased income from membership fees

Year (starting 2011)	Membership fee (€)
2011	0
2012	0
2013	0
2014	0
2015	(30 000)* 0
2016	52 000
2017	70 000

*This is the 1st year that a fee could be levied, but it is rather envisaged from 2016

5.5.2 Approval of quality systems and assistance to benchmarking exercises

The CIPM MRA stipulates that RMOs must have a process in place to approve the quality systems of the member NMIs as a pre-requisite for the acceptance of CMCs into the KCDB. In AFRIMETS, the responsibility is delegated to the TC-QS (Technical Committee for Quality). The procedure stipulates an on-site visit. The cost associated with the time spent at the NMI is absorbed by the host NMI, but the preparation by the TC-QS and flights to the host country are not covered. In other RMOs there are enough high level NMIs that the cost can be shared between a large number of members.

In AFRIMETS, technical experts were trained (by UNIDO) to assist with peer-review, but only the NMISA and NIS currently have the capability to oversee the approval of the quality systems. This places a financial burden on the two institutes, and the travel costs of the technical assessors (only for parameters not third party accredited) must be covered.

One of the most important activities of an RMO is conducting benchmarking exercises. In AFRIMETS, these exercises are conducted at two distinct levels:

1) SRMO pilot studies and proficiency testing;
2) AFRIMETS pilot studies, proficiency testing, and supplementary and key comparisons.

The costs of SRMO exercises will be borne by the members. Funding is requested for AFRIMETS studies, with, as a priority, supplementary and key comparisons to support CMC claims.

A schedule of benchmarking exercises (2011-2012) is attached in Appendix C. The schedule will be expanded to 2013-2015 as benchmarking needs are identified through the proposed studies. The cost of each benchmarking exercise depends on the parameter, the need for a workshop to finalise the protocols, the number of participants, and the SRMOs to which the artefacts must be distributed, as well as the manner of their transportation.

5.6 Strategies for alternative technologies and skills development

5.6.1 Alternative technologies and measurement standards

Some of the oldest examples of accurate measurement standards were found in Africa, but the development of modern day measurement standards and measurement technologies originates from Europe, the United States and Asia Pacific (Japan), and the recent development of scientific metrology in Africa has followed the example set by the developed world. The advantage is that resources do not need to be spent on re-inventing the wheel, and technologies and standards can be imported from developing countries. The disadvantage is that the technologies in many cases are not suited to African conditions.

Also, the methods prescribed in European Union regulations are often not readily available or accessible in Africa, due to the high cost of the equipment, the cost and availability of reference materials for the methods, or the high level of specialization required to operate these.

It is planned to form a metrology interest group amongst the more advanced NMIs and NLMBs in Africa to develop robust, fit-for-purpose measurement standards and methods based on technologies adapted to Africa.

South Africa and Tunisia are already conducting research into a robust optical clock that could form the backbone of an African time network. To comply with European Union regulations in Africa, the organic group at NMISA is developing and validating equivalent methods for POPs analysis on instruments widely available in laboratories in South Africa and at NMIs in Africa.

It is proposed that initially South Africa, Egypt, Kenya and Tunisia form the interest group (with observer status for any other interested party) to formulate future projects for the development of measurement standards and methods for Africa.

5.6.2 Skills development

Various REC and bilateral quality system development programmes and donor projects in Africa had general training as a main area of activity. It is therefore acknowledged that basic training in quality systems and specifically in metrology will be conducted at the SRMO level, including scholarships sponsored through REC donor programmes. Metrology e-learning capacity will be developed to meet the large demand of the Least Developed Countries.

For AFRIMETS, it is proposed that the skills development strategy revolves around pan-African events such as the Metrology School and AFRIMETS General Assembly. The Metrology School can be held every second or third year, and specific technical training programmes organized to coincide with the annual General Assembly and associated technical working group meetings (TC-WGs). The TC-WGs will be tasked with developing schedules of technical training.

For legal metrology, it is proposed that the training strategy of the SADC EU Project be adopted for AFRIMETS. The main components of the Project were:

- Theoretical and practical training was provided at different levels. The institutions used to provide the training were carefully selected and the courses were performed in different countries of SADC where it was possible to gain first-hand experience of the relevant trade

metrology issues. National experts from SADC and international experts from Europe worked together with the participants from SADC.

- A number of participants were selected to receive additional "train the trainer" instruction in presentation skills and related issues, so that they could be available to meet future requests for training in SADC.
- The technical training courses covered such areas as:
  - typical non compliances
  - labelling and accuracy of packing of products
  - automatic and non-automatic weighing instruments
  - automatic weighing instruments
  - calibration of mass, length and volume standards
  - dynamic measuring systems
  - uncertainty of measurement
  - verification of fuel dispensers
  - beam balances and mechanical counter scales

- Specific coaching was provided in:
  - length (taximeter)
  - mass (hopper and belt weighers)
  - gravimetric filling instruments

It is proposed that such programmes be conducted in each SRMO.

Table 15: Proposed schedule for metrology schools

No	PARAMETER	Year	Project Description
MiC1	**Metrology in chemistry**	2012	Hold metrology school aimed at metrology in chemistry
LM1	**Legal metrology**	2013	Hold metrology school for legal metrology
Ph 1	**Electromagnetic parameters: photometry and radiometry, time and frequency, radio frequency, electricity, ionising radiation**	2014	Hold metrology school aimed at electromagnetic metrology and Ionising radiation
Ph 2	**Mechanical and basic parameters: mass and related quantities, length, temperature.**	2015	Key, supplementary and subsequent comparisons: -Development of scopes (comparisons p/a) -Provision of artefacts -Logistics (movement of artefacts)
	Start to repeat cycle	2016	

Table 16: Summary of Infrastructure improvement projects at AFRIMETS level

No	AREA	Project Description	Cost Issues
A1	**Secretariat**	Support a secretariat hosted by a member country	Activities will be planned according to funding available from donor.
A2	**Quality systems**	Perform peer review evaluation of quality systems of NMIs ready to submit CMCs	Funding depends on number of peer review visits. The cost is estimated at €13-20 per full assessment.
A3	**Technical comparisons** (see Appendix C)	Supplementary and key comparisons: -Development of scopes (comparisons p/a) -Provision of artefacts -Logistics (movement of artefacts between participating laboratories)	The cost depends on the specific comparison and the number of participants and will be cost per comparison
SK1	**Skills development**	Metrology schools	To be costed by donor To be costed by donor
SK2	**Skills development (legal metrology)**	Legal metrology training strategy	To be costed by donor To be costed by donor
TI 1	**Technical infrastructure**	Develop comprehensive guide on how to establish an NLMB and an NMI	To be costed by donor To be costed by donor

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