

Establishment of Harmonized Policies for the ICT Market in the ACP Countries

Cross-Border Frequency Coordination: A Harmonized Calculation Method for Africa (HCM4A)

**Sub-Saharan Africa
Assessment Report**

HIPSSA

**Harmonization of
ICT Policies in
Sub-Saharan Africa**



Establishment of Harmonized Policies for the ICT Market in the ACP Countries

**Cross-Border Frequency Coordination:
A Harmonized Calculation Method
for Africa (HCM4A)**

**Sub-Saharan Africa
Assessment Report**

HIPSSA

Harmonization of
ICT Policies in
sub-Saharan Africa



Disclaimer

This document has been produced with the financial assistance of the European Union. The views expressed may not necessarily reflect the official opinion of the European Union.

The designations employed and the presentation of material, including maps, do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area, or concerning the delimitations of its frontiers or boundaries. The mention of specific companies or of certain products does not imply that they are endorsed or recommended by ITU in preference to others of a similar nature that are not mentioned.



Please consider the environment before printing this report.

© ITU 2013

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Foreword

Information and communication technologies (ICTs) are shaping the process of globalisation. Recognising their potential to accelerate Africa's economic integration and thereby its greater prosperity and social transformation, Ministers responsible for Communication and Information Technologies meeting under the auspices of the African Union (AU) adopted in May 2008 a reference framework for the harmonization of telecommunications/ICT policies and regulations, an initiative that had become especially necessary with the increasingly widespread adoption of policies to liberalise this sector.

Coordination across the region is essential if the policies, legislation, and practices resulting from each country's liberalization are not to be so various as to constitute an impediment to the development of competitive regional markets.

Our project to 'Support for Harmonization of the ICT Policies in Sub-Sahara Africa' (HIPSSA) has sought to address this potential impediment by bringing together and accompanying all Sub-Saharan countries in the Group of African, Caribbean and Pacific States (ACP) as they formulate and adopt harmonized ICT policies, legislation, and regulatory frameworks. Executed by the International Telecommunication Union (ITU), co-chaired by the AU, the project has been undertaken in close cooperation with the Regional Economic Communities (RECs) and regional associations of regulators which are members of the HIPSSA Steering Committee. A global steering committee composed of the representatives of the ACP Secretariat and the Development and Cooperation – EuropeAid (DEVCO, European Commission) oversees the overall implementation of the project.

This project is taking place within the framework of the ACP Information and Telecommunication Technologies (@CP-ICT) programme and is funded under the 9th European Development Fund (EDF), which is the main instrument for providing European aid for development cooperation in the ACP States, and co-financed by the ITU. The @CP-ICT aims to support ACP governments and institutions in the harmonization of their ICT policies in the sector by providing high-quality, globally-benchmarked but locally-relevant policy advice, training and related capacity building.

All projects that bring together multiple stakeholders face the dual challenge of creating a sense of shared ownership and ensuring optimum outcomes for all parties. HIPSSA has given special consideration to this issue from the very beginning of the project in December 2008. Having agreed upon shared priorities, stakeholder working groups were set up to address them. The specific needs of the regions were then identified and likewise potentially successful regional practices, which were then benchmarked against practices and standards established elsewhere.

These detailed assessments, which reflect sub-regional and country-specific particularities, served as the basis for the model policies and legislative texts that offer the prospect of a legislative landscape for which the whole region can be proud. The project is certain to become an example to follow for the stakeholders who seek to harness the catalytic force of ICTs to accelerate economic integration and social and economic development.

I take this opportunity to thank the European Commission and ACP Secretariat for their financial contribution. I also thank the Economic Community of West African States (ECOWAS), West African Economic and Monetary Union (UEMOA), Economic Community of Central African States (ECCAS), Economic and Monetary Community of Central Africa (CEMAC), East African Community (EAC), Common Market for Eastern and Southern Africa (COMESA), Common Market for Eastern and Southern Africa (COMESA), Southern African Development Community (SADC), Intergovernmental Authority on Development (IGAD), Communication Regulators' Association of Southern Africa (CRASA), Telecommunication Regulators' Association of Central Africa (ARTAC), United Nations Economic Commission for Africa (UNECA), and West Africa Telecommunications Regulators' Association (WATRA), for their contribution to this work. Without political will on the part of beneficiary countries, not much would have been achieved. For that, I express my profound thanks to all the ACP governments for their political will which has made this project a resounding success.



Brahima Sanou
BDT, Director

Acknowledgements

The present document represents an achievement of a global activity carried out under the HIPSSA project (“Support to the Harmonization of ICT Policies in Sub-Saharan Africa”) officially launched in Addis Ababa in December 2008.

In response to both the challenges and the opportunities of information and communication technologies’ (ICTs) contribution to political, social, economic and environmental development, the International Telecommunication Union (ITU) and the European Commission (EC) joined forces and signed an agreement aimed at providing “Support for the Establishment of Harmonized Policies for the ICT market in the ACP”, as a component of the Programme “ACP-Information and Communication Technologies (@CP-ICT)” within the framework of the 9th European Development Fund (EDF). i.e., ITU-EC-ACP Project.

This global ITU-EC-ACP Project is being implemented through three separate sub-projects customized to the specific needs of each region: Sub-Saharan Africa (HIPSSA), the Caribbean (HIPCAR), and the Pacific Island Countries (ICB4PAC).

As members of the HIPSSA Steering Committee co-chaired by the African Union’s Commission (AUC) and the ITU, the African Union’s Commission (AUC) and the African Telecommunication’s Secretariat (ATU) provided guidance and support to the team of consultants, Mr Shola Taylor from Kemilinks Consulting for the Global Report, Mr Zoltan Zsuffa on HCM Europe, Mr Hilaire Mbega for Central Africa, Mr Andrew Kisaka for East Africa, Mr Carlos Alais for Southern Africa and Mr Ahmed Boreau for West Africa, who prepared the draft document. This draft document is to be reviewed, discussed and validated by broad consensus by participants of a workshop to be organised in collaboration with AUC and ATU.

ITU would like to thank the focal point delegates from the member states ICT and telecommunications ministries and regulators, from regional organisations’ commissions and secretariats and regulators associations among them the Association of Regulators of Information and Communications Service of Eastern and Southern Africa (ARICEA), Association of African Telecommunications Regulators (ARTAC), Communication Regulators’ Association of Southern Africa (CRASA), East African Community (EAC), East Africa Communications Organizations (EACO), Economic Community of Central African States (ECCAS), Economic Community of West African Countries (ECOWAS), Southern African Development Community (SADC), and West Africa Telecommunications Regulatory Assembly (WATRA), for their hard work and commitment in contributing to the data collection efforts of this unprecedented study. The contributions from the AUC and ATU are gratefully acknowledged.

Without the active involvement of all of these stakeholders, it would have been impossible to produce a document such as this, reflecting the overall requirements and conditions of Sub Sahara Africa while also representing international best practice.

The activities have been implemented by Ms Ida Jallow, responsible for the coordination of the activities in Sub-Saharan Africa (HIPSSA Senior Project Coordinator), and Mr Sandro Bazzanella, responsible for the management of the whole project covering Sub-Saharan Africa, Caribbean and the Pacific (ITU-EC-ACP Project Manager) with the overall support of Ms Hiwot Mulugeta, HIPSSA Project Assistant, and of Ms Silvia Villar, ITU-EC-ACP Project Assistant. The work was carried out under the overall direction of Mr Cosmas Zavazava, Chief, Project Support and Knowledge Management (PKM) Department. The document was developed under the direct supervision of the then HIPSSA Senior Project Coordinator, Mr Jean-François Le Bihan, and has further benefited from the comments of the ITU Telecommunication Development Bureau’s (BDT) Technology and Network Development (TND) and ITU Radiocommunication Bureau (BR). Support was provided by Mr Andrew Rugege, Regional Director, ITU Regional Office for Africa Region. The team at ITU’s Publication Composition Service was responsible for its publication.

List of Acronyms

List of Acronyms

AM	Amplitude Modulation
ARTAC	Association des Régulateurs des Télécommunications de l’Afrique centrale / Central African Telecommunications Regulators’ Association
BRIFIC	The Radiocommunication Bureau International Frequency Information Circular
BS	Broadcasting Service
BT	Broadcasting Television service
CEMAC	Communauté économique et monétaire de l’Afrique centrale / Central African Economic and Monetary Community
DEM	Digital Elevation Model
DLL	Dynamic-Link Library
DTM	Digital Terrain Model
DVB-H	Digital Video Broadcasting – Handheld
DVD	Digital Video Disc
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States, (ECOWAS)
EIRP	Equivalent Isotropically Radiated Power
FAP	Frequency Allocation Plan
FM	Frequency Modulation
FS	Fixed Service
FTP	File Transfer protocol
FWA	Fixed Wireless Access
GDP	Gross Domestic Product
GE-06	ITU Agreement covering the whole VHF/UHF digital television broadcasting bands in Europe and Africa.
GE84	ITU Agreement covering the sound VHF FM broadcasting bands in Europe and Africa.
GE-89	ITU Agreement covering the whole VHF/UHF television broadcasting bands in African Broadcasting Area and neighbouring countries.
GHz	Gigahertz
GSM	Global System for Mobile Communications
HCM 2008	Harmonised Calculation Method implemented in Europe in 2008

HCM4A	ITU Agreement covering the sound VHF FM broadcasting bands in Europe and Africa.
GE-89	ITU Agreement covering the whole VHF/UHF television broadcasting bands in African Broadcasting Area and neighbouring countries.
GHz	Gigahertz
GSM	Global System for Mobile Communications
HCM 2008	Harmonised Calculation Method implemented in Europe in 2008
HCM4A	Harmonised Calculation Method for Africa
HD	High Definition
HF	High Frequency
HP	Hewlett Packard
HIPSSA	Harmonisation of ICT Policies in Sub Saharan Africa
ICT	Information and Communication Technology
IMF	International Monetary Fund
IMT	International Mobile Telecommunications
IRIS	Spectrum Monitoring and Management System
ISP	Internet Service provider
ITU	International Telecommunications Union
ITU-R	Radiocommunication Sector of the ITU
MHZ	Megahertz
NTFA	National Table of Frequency Allocation
PFD	Phase Frequency Detector
PLM	Public Land Mobile Service
REC	Regional Economic Community
RIO	Regional Integration Organization
TV	Television
UDEAC	Union douanière et économique de l’Afrique centrale/ African Customs and Economic Union
UHF	Ultra High Frequency

List of Acronyms

VHF	Very High Frequency
WAEMU	West African Economic and Monetary Union
WGS1984	World Geodetic System of 1984
WSIS	World Summit on the Information Society
XBFC	Cross-Border Frequency Coordination

Table of contents

	<i>Pages</i>
Foreword	i
Acknowledgements	iii
List of Acronyms	v
Table of contents	ix
SUMMARY	1
INTRODUCTION	5
1 The HIPSSA Project.....	5
2 The HCM4A Feasibility Study	6
3 Study Methodology.....	6
4 Study Report Structure.....	7
4.1 The Central Africa region	8
4.2 The East Africa region	9
4.3 The Southern Africa region	12
4.4 The West Africa region.....	14
REGIONAL COMPARATIVE ANALYSIS	17
1 Regional initiatives towards harmonised cross-border frequency coordination.....	17
2 Regional cross-border frequency coordination agreements	19
3 National and Regional Tables of Frequency Allocation.....	25
4 Interference Challenges	29
5 Data Exchange Format	32
6 Analysis of tools used.....	33
7 Propagation Models.....	34
8 Bilateral and Multilateral Agreements.....	35
EUROPEAN HCM AGREEMENT	37
1 History of the European HCM Agreement	37
2 Structure of the Agreement	37
3 Annexes to the HCM Agreement	44
4 Programs for the different services	47
5 Data assisting the coordination calculations.....	48

GAP ANALYSIS	51
1 Existing multilateral cross-border frequency coordination agreements	51
2 Coordinated needs of Sub-Saharan Africa	52
COST-BENEFIT ANALYSIS	53
1 Purpose of cost-benefit analysis	53
2 Benefits of a Harmonised Calculation Method for Africa	53
3 Estimates of costs and benefits.....	54
OBSERVATIONS	59
1 General observations on the assessment survey.....	59
2 Regional initiatives	59
3 Deficiencies of the existing cross-border frequency coordination frameworks.....	60
CONCLUSIONS AND RECOMMENDATIONS	61
1 Establishment of HCM4A	61
2 Strengthening of regional regulators’ associations with the support of pan-African organisations	61
3 Review of current agreements.....	61
4 Towards convergence for all	62
5 Engagement of countries and consultation with stakeholders.....	62
6 Harmonisation of frequency planning in Sub-Saharan Africa	62
7 Services to be covered by HCM4A	62

List of tables

	<i>Page</i>
Table 1: Frequency coordination agreements needed for Southern Africa- and their respective priority	22
Table 2: Cross-border coordination agreements within West Africa.....	23
Table 3: Agreement in West Africa	24
Table 4: West Africa – Comparison between agreements.....	25
Table 5: National Table of Frequency Allocation in East Africa –.....	26
Table 6: Different spectrum allocations between the SADC FAP 2010 and ITU Region 1 between 80-20 000 MHz.....	27
Table 7: Main characteristics of National frequency band plans of SADC countries.	28
Table 8:NFTA comparison in West Africa.....	29
Table 9: Interference occurrences in Central Africa	29
Table 11: Countries needing coordination in West Africa	31
Table 12: Digital Terrain Characteristics in West Africa	35
Table 13: European HCM	38
Table 14: Difference between the environment in Europe and Sub-Saharan Africa.....	51
Table 15: Cost-benefit analysis	54
Table 16: NPV for group of 10 countries (all costs in US \$).....	56

List of figures

	<i>Page</i>
Figure 1: ECCAS and CEMAC member states	9
Figure 2: East Africa countries.....	10
Figure 2: East Africa countries.....	12
Figure 3: Member States of ECOWAS and UEMOA/WAEMU	14

SUMMARY

Introduction

HIPSSA is a project under an International Telecommunication Union (ITU) and European Commission partnership covering all African, Caribbean and Pacific countries. The program was officially launched in December 2008. Its objectives are:

- To develop and promote ICT market policies and guidelines for individual countries in Sub-Saharan Africa,
- To support the regional organizations and the sub-regional economic groups
- To promote the use of harmonised ICT market policies and regulations in the area concerned and building human as well as institutional capacity in the field of ICT through a range of targeted training, education and knowledge sharing measures.

This agreement is being implemented through three separate sub-projects in order to customize it to specific needs of each region: Sub-Saharan Africa (HIPSSA), the Caribbean (HIPCAR) and the Pacific Island Countries (ICB4PIS).

This project will result in the creation of harmonised regional and national policy, legal and regulatory frameworks conducive to significant investments in the ICT infrastructures and services.

This project covers eight (8) subjects as follows: (i) Licensing (guaranteeing technology neutral licensing), (ii) Universal Service (reviewing best practices for selection and funding of universal access or service providers); (iii) Spectrum management (implementing a Harmonised Calculation Method for Africa for cross-border frequency coordination); (iv) Numbering (setting common principles for the management of these rare resource); (v) Interconnection (defining guidelines for access to submarine cables and cost modeling); (vi) Cybersecurity (to providing model laws on e-commerce, data protection and cyber criminality); (vii) **Statistics** (Monitoring and evaluation) and (viii) Analogue to Digital Broadcasting Migration.

HCM4A Project

This report presents the outcome of a survey carried out in Sub Saharan Africa regarding a Harmonised Calculation Method (HCM) to facilitate cross-border frequency coordination among different countries in the region.

A method of similar characteristics has been implemented successfully in Europe among 17 countries, and based on this; the objective of the survey is to analyse the feasibility of implementing similar methodology in the whole Sub-Saharan Africa.

Four stages have been considered for implementing HCM4A:

- *Assessment Phase*: Review existing bilateral and multilateral cross-border frequency coordination agreements in Sub-Saharan Africa;
- *Multilateral Agreement Proposal*: Technical working group review the results of the assessment and propose a multilateral agreement
- *Validation Workshop*: Adopt the draft agreement in line with the conclusion of the assessment
- *Development of HCM4A Software*: Develop and release software based on HCM4A agreement (if adopted) and propose training workshops on the software

The main objective is to create a cross-border frequency coordination multilateral agreement and tools to:

- Prevent and easily solve radio interference across borders,
- Take account of other neighbouring stations before putting their own stations into operation,
- Set a harmonised standard that all the countries involved accept on a mutually beneficial approach by consensus,
- Provide a solid basis for bilateral and multilateral agreements,
- To enable the creation of bilateral preferential frequency agreements at border zones: who can operate what and with which interference ranges.

The HCM4A software will be a technical tool to:

- Optimise spectrum usage by accurate interference field strength calculations;
- Establish general parameters, improvement and supplementation of technical provisions, individual restrictions;
- Establish models for computer-aided interference range calculations
- Harmonise parameters: objectively predictable towards transparent decisions

This global report thus covers only the assessment phase which analyses the frequency coordination situation across-borders in all the Sub Saharan Africa countries.

Main Findings

The main findings of this study are as follows:

- Most of the countries have established Communication Regulatory Authorities, which oversee Management of the Radio communication frequency spectrum, including cross-border frequency coordination. A few countries have however not liberalized their communications sectors with the same institution playing the role of policy making, regulation and operator.
- The regional regulatory associations, and to a lesser extent, the regional economic communities, have taken some steps in establishing the platform for cross-border frequency coordination, but those steps are not far reaching enough to achieve an effective mechanism for cross-border frequency coordination across Sub Saharan Africa.
- There is currently no effective framework for coordination of frequencies across-borders that addresses administrative procedures and technical provisions. However, CRASA in Southern Africa has coordination framework mainly for GSM, while EACO in Eastern Africa has coordination framework for GSM and digital television broadcasting. The two frameworks do not provide for preferential frequencies, shared frequencies and the register to record the results. These two frameworks address mainly administrative procedures for resolving cross-border interferences.
- The most frequent type of cross-border frequency coordination that have been happening in the recent years are in the broadcasting environment particularly VHF FM with some cases of VHF and UHF TV. There have been as well some frequency coordination cases in the VHF and UHF land mobile radio including some in the 900 MHz GSM band. In some cases microwave frequency coordination between the 6 to 15 GHz bands are carried out. In effect, the main services involved in cross-border interference activities are land mobile and broadcasting.
- There are few frequency coordination agreements (bilateral or multilateral) in Sub Saharan Africa and these are limited to cellular based radiocommunication systems; where they exist like in West Africa and in Central Africa, they need to be reviewed, adapted and harmonised.

Furthermore, there is no harmonized calculation method for Sub Saharan Africa neither is there coordination procedures for predefined frequencies category.

- Majority of the countries do not have a coordination register even to enable reference to coordinated frequencies neither make use of pre-defined frequency/channels category.
- Most countries have their National Table of Frequency Allocation, which is mostly aligned to the ITU Table of Frequency Allocations - although most of them require updating; in some cases, there are deviations from the ITU Table.
- Only SADC in Southern Africa has established a regional frequency allocation plan (SADC FAP 2010) with a view to moving towards a harmonised regional band plan, even though many SADC countries are yet to align to such plan.
- With the exception of Southern Africa, all the other countries experience periodical interference. The most reported radiocommunications services which cause cross-border interference are Broadcasting services (FM radio and analogue television), Fixed Services (HF two ways communication radio) and Mobile Services (GSM and CDMA).
- Very few administrations are involved in concrete approaches aiming at resolving interferences with neighbours due to the inadequacy of professional training and the lack of necessary technical tools. Most of the countries use ITU tools for interference resolutions, coordination and registration. The most preferred tool for spectrum management is SMS4DC.
- Although most of the countries have spectrum management and monitoring systems, most do not have adapted tools especially digital terrain model;
- It is feasible to adapt the European Harmonised Calculation Method to Sub Saharan Africa; it would however be necessary to include FM sound broadcasting and VHF/UHF TV broadcasting.
- There is no common format for the exchange of data and other relevant information, neither for the different bands or radiocommunication services. In addition the majority prefer Internet (e-mail), and CD/DVD as the means for exchanging coordination information.

The study was carried out by a team of experts comprising four regional experts, one international expert and a senior international expert selected by the ITU to conduct an assessment study on existing cross-border frequency coordination and agreement.

INTRODUCTION

1 The HIPSSA Project

HIPSSA is a joint project of the International Telecommunication Union (ITU) and the European Commission. The program was officially launched in December 2008 and it will run until the end of 2013. Its objectives are,

- To develop and promote ICT market policies and guidelines for individual countries in Sub-Saharan Africa,
- To support the regional organizations and the sub-regional economic groups and
- To promote the use of harmonised ICT market policies and regulations in the area concerned and building human as well as institutional capacity in the field of ICT through a range of targeted training, education and knowledge sharing measures.

This project will result in the creation of harmonised regional and national policy, legal and regulatory frameworks conducive to significant investments in the ICT infrastructures and services.

This project covers eight (8) subjects as follows:

- Licensing;
- Universal service;
- Spectrum Management;
- Numbering;
- Interconnection;
- Cyber security;
- Analogue to Digital Broadcasting Migration;
- Statistics.

The European Commission and African Union Commission agreed that HIPSSA was aligned with the EU-Africa Strategic Partnership and it was subsequently proposed to the AUC to co-chair the HIPSSA Steering Committee with ITU.¹

The project for “Harmonisation of ICT Policies in Sub-Saharan Africa” (HIPSSA) is building on the experienced gained with a pilot project funded by European Commission (EC) and ITU that led to the adoption of Supplementary Acts for telecommunications to the ECOWAS Treaty. This project will result in the creation of harmonised regional and national policy, legal and regulatory frameworks conducive to significant investments in the ICT infrastructures and services.²

During the initial phase, the project will support respective countries in their on-going efforts to create harmonised regional telecommunication/ICT markets with possibility for a pan-African market as well as assist member countries without ICT policies to develop them. Countries with ICT policies will be supported in reviewing and up-dating while striving to harmonise them as regional/pan-African ICT policies.

¹ 14th African Union Summit : <http://www.africa-union.org/root/au/Conferences/2010/January/summit/informationSheet/5%20INFORMATION%20SHEET%205%20-%20HARMONISATION%20OF%20ICT%20POLICIES%20IN%20SUB-SAHARA%20AFRICA.pdf> ;

² http://www.itu.int/ITU-D/projects/ITU_EC_ACP/hipssa/tor/G-3/HIPSSA_G-3.5%5BINT%5D.pdf

The project will address the regulatory challenges facing the beneficiary countries with the goal of creating an environment conducive to massive investments in ICT infrastructure and ICT-enabled applications, which the countries will adopt for day to day use in their economic and social activities. This is the overriding objective for the African countries, which is in line with the goals of the WTDC (Doha, 2006) and the WSIS.

The study emphasizes on existing administrative and technical procedures relating to bilateral and multilateral cross-border frequency agreements.

2 The HCM4A Feasibility Study

For spectrum management subject, HIPSSA decided to carry out a feasibility analysis to see if it is possible to implement a Harmonised Calculation Method (HCM) drawing from the experience from Europe through HCM2008.

The final objective is to create a cross-border frequency coordination multilateral agreement and tool to:

- Prevent and easily solve radio interference across borders,
- Take account of other neighbouring stations before putting their own stations into operation,
- Set a harmonised standard that all the countries involved accept on a mutually beneficial approach by consensus,
- Provide a solid basis for bilateral and multilateral agreements,
- Enable the creation of bilateral preferential frequency agreements at border zones and to identify levels of acceptable interference.

3 Study Methodology

The ITU recruited a team of experts to carry out this study.

The methodology used to conduct the survey was through questionnaires which were distributed to all targeted countries. Each country nominated its focal point to fill the questionnaire and follow up questions were asked by telephone, personal contacts and emails.

Although a lot of efforts were devoted to obtain various data from the countries, the data obtained may not be comprehensive but is however sufficient to make some conclusions.

The presentation is divided into two main parts: regional report and national reports.

The questionnaire aimed to obtain the following information:

- Spectrum management framework (legislative basis, responsibilities for frequency coordination in each country particularly frequency coordination across-borders for the different radio communication services).
- Table of frequency allocations (the national and regional frequency allocation band plan as well as alignment with the ITU frequency allocations for ITU Radio Region 1).
- Cross-border frequency coordination (responsibility for cross-border frequency coordination, cross-border frequency coordination framework),
- Bilateral/multilateral agreement,
- Interference problems and cross-border frequency coordination experiences to which the countries were exposed,

- Relevant procedures in place as well as capabilities to handle interference/co-ordinations,
- Coordination agreements required,
- Data exchange formats,
- Tools and databases used.

The study had been conducted in three stages as follows:

- Elaboration of a common template for survey and comparative analysis;
- Establishing a list of focal points and collecting data for a regional survey and comparative analysis;
- Finalization of the study.

4 Study Report Structure

The study led to a report, which is divided in five (5) parts:

- A global report for the whole Sub-Saharan Africa,
- Four (4) Regional Reports as follows:
 - Central Africa covering the following nine (9) countries - Burundi (BDI), Cameroon (CME), Chad (TCD), Central African Republic (CAF), Congo (COG), DR Congo (COD), Equatorial Guinea (GNE), Gabon (GAB), and Sao Tome and Principe (STP).
 - East Africa covering the following eight (8) countries – Kenya (KEN), Uganda (UGA), Tanzania (TZA), Rwanda (RRW), Eritrea (ERI), Djibouti (DJI), Sudan (SDN), Seychelles (SEY) and Mauritius (MAU)
 - Southern Africa, covering the following ten (10) countries - Angola (AGL), Botswana (BOT), Lesotho (LSO), Malawi (MWI), Mozambique (MOZ), Namibia (NMB), South Africa (AFS), Swaziland (SWZ), Zambia (ZMB), Zimbabwe (ZWE) and
 - West Africa covering the following 15 countries – Benin (BEN), Burkina Faso (BFA), Cape Verde (CPV), Cote d'Ivoire (CTI), The Gambia (GMB), Ghana (GHA), Guinea (GUI), Guinea-Bissau (GNB), Liberia (LBR), Mali (MLI), Niger (NGR), Nigeria (NIG), Senegal (SEN), Sierra-Leone (SRL) and Togo (TGO).

This geographical division of countries into four regions in Sub-Saharan Africa corresponds to the one defined by the African Union (AU), which has been used by others to base its Reference Framework for Harmonisation of Telecommunication and ICT Policy and regulation in Africa³.

Each of the four regional reports comprises of two parts

- Part 1, which considers the current regional initiatives towards harmonised cross-border frequency coordination and provides a comparative analysis of the regional survey ending with conclusions and recommendations.
- Part 2 presents the report of each country including a general profile of each of them, the spectrum management framework, the cross-border frequency coordination agreement (structure, coordination procedures, administrative provisions, technical provisions, calculation method, frequency band covered) for each country and investigates the national table of frequency allocations.

³ See Annx 2 : http://www.itu.int/ITU-D/projects/ITU_EC_ACP/hipssa/docs/2_Projet_Rapport_Etude_Politique_Telecom_TIC_31_Mars_08.pdf (accessed on August 2011)

The report presents:

- A comprehensive review of all national cross-border coordination experiences in Sub Saharan Africa;
- A review of regional harmonisation initiatives; and
- A comparative analysis in summary tables or figures.

The report has, under annex and per country, the list of:

- responses to the questionnaire;
- cross-border frequency coordination agreement; and
- national table of frequency allocations.

4.1 The Central Africa region

In Central Africa ECCAS, CEMAC and ARTAC are the main regional organizations considered in the study.

At a summit meeting in December 1981, the leaders of the Central African Customs and Economic Union (UDEAC) agreed on principles to form a wider Economic Community of Central African States (ECCAS). ECCAS was established on 18 October 1983 by the UDEAC members and the members of the Economic Community of the Great Lakes States (CEPGL) (Burundi, Rwanda and then DR Congo) as well as Sao Tomé and Príncipe. Angola remained an observer until 1999, when it became a full member.

ECCAS aims to achieve collective autonomy, raise the standard of living of its populations and maintain economic stability through harmonious cooperation. Its ultimate goal is to establish a Central African Common Market.

At the Malabo Heads of States and Governments Conference in 1999, four priority objectives for the organization were identified:

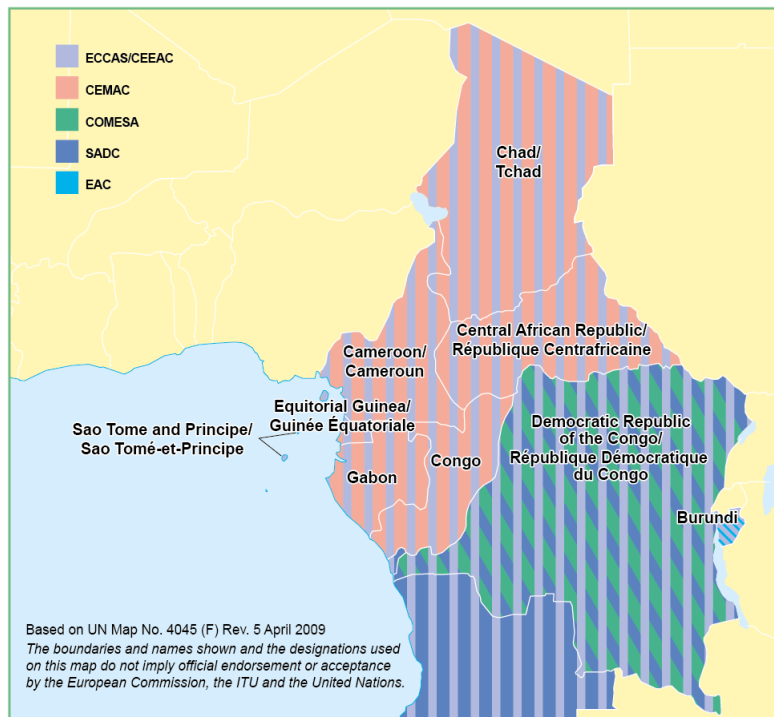
- to develop capacities to maintain peace, security and stability, which are essential prerequisites for economic and social development;
- to develop physical, economic and monetary integration;
- to develop a culture of human integration; and
- to establish an autonomous financing mechanism for ECCAS.

The Economic and Monetary Community of Central African states or CEMAC from its acronym in French, Communauté économique et monétaire de l'Afrique centrale is an organization of 6 states of Central Africa established by Cameroon, Central African Republic, Chad, Republic of Congo, Equatorial Guinea and Gabon to promote economic integration among countries that share a common currency, the CFA franc.

UDEAC was officially superseded by CEMAC in June 1999. CEMAC's objectives are the promotion of trade, the institution of a genuine common market, and greater solidarity among peoples and towards under-privileged countries and regions.

The Central Africa Telecommunications Regulators Assembly (ARTAC-Assemblée des Régulateurs des Télécommunications de l'Afrique centrale) is composed by 5 registered members (Cameroon, Gabon, Central African Republic, Congo, Chad). Though Equatorial Guinea, Sao Tome and Príncipe, Burundi, Rwanda, and Angola are not yet registered as members, they can attend ARTAC meetings. ARTAC focuses on the need for Central Africa to evolve a harmonised regulatory identity to boost investment and investor confidence and to more effectively regulate and monitor telecommunications service.

Figure 1: ECCAS and CEMAC member states



4.2 The East Africa region

The countries of Eastern Africa (defined here as comprising Djibouti, Ethiopia, Eritrea, Kenya, Rwanda, Uganda, Sudan, Somalia, and Tanzania) have a number of features in common. First, most countries were colonies. While Rwanda was colonized by the Germans and then by the Belgians, Kenya, Uganda and Tanzania were British colonial territories (Tanganyika was taken from Germany at the end of the First World War). Ethiopia was colonized by Italy but only for a short while. Eritrea was part of Ethiopia up to 1993. Djibouti was French, Somalia was Italian (though a part of it was colonized by Britain).

Eastern Africa is not a homogenous region in physical, ecological, cultural, or historical terms. But while there are prominent differences there are also many similarities. We bring out two major similarities here:

All of the countries in this region are dependent on their natural resources for national and for household survival. The region has little mineral or manufacturing wealth, and the countries depend on agriculture with wildlife and coastal tourism playing a significant role (in those countries that are stable).

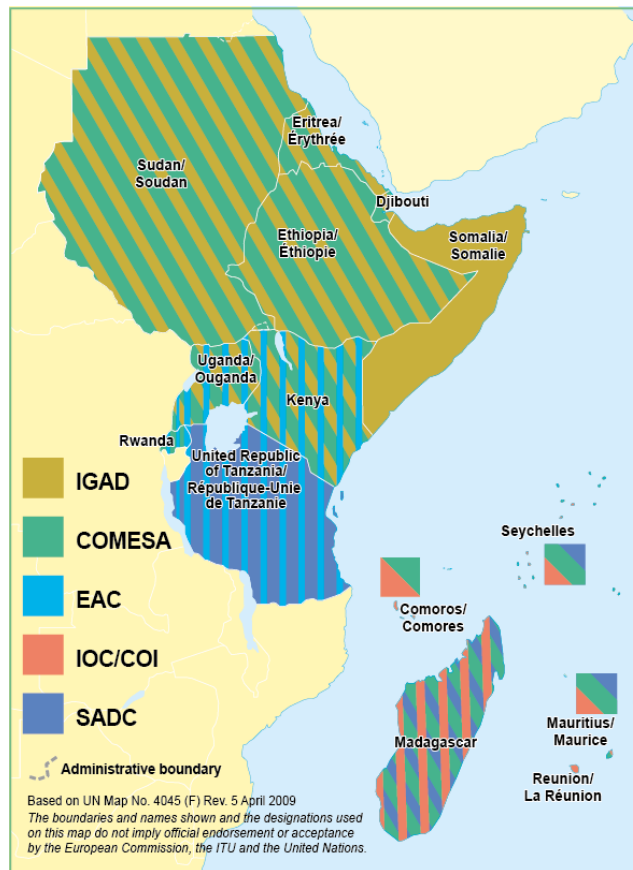
The second common thread, and linked to the first, is that this is a region of relatively high poverty level. Some of the poorest countries of the world are here: Ethiopia, Somalia, Rwanda, Tanzania.

Within the Eastern Africa area there are three distinct groups of countries:

- East Africa – the countries of Kenya, Tanzania, and Uganda, with a common lingua franca, shared colonial history, and consequently similar institutions, policies, and laws.
- The two small countries of Rwanda and Burundi have exceptionally high population densities exerting great pressure on land. The two have similar ethnic composition; share a common heritage of Belgian colonialism, and a recent history of civil war and genocide.

- The Horn of Africa—the arid and largely pastoralist economies of Eritrea, Djibouti, Somalia, and to some extent Ethiopian lowlands. Ethiopia is much larger; it’s a huge population and the central highlands add a great deal of diversity of ecosystems. This sub-region is still dominated by a complex set of conflicts.⁴

Figure 2: East Africa countries



Common Market for Eastern and Southern Africa (COMESA) is a free trade area with nineteen (19) member states stretching from Libya to Zimbabwe. COMESA was formed in December 1994, replacing a Preferential Trade Area which had existed since 1981. Nine of the member states formed a free trade area in 2000 (Djibouti, Egypt, Kenya, Madagascar, Malawi, Mauritius, Sudan, Zambia and Zimbabwe), with Rwanda and Burundi joining the FTA in 2004 and the Comoros and Libya in 2006.

The Treaty for Establishment of the East African Community was signed on 30th November 1999 and entered into force on 7th July 2000 following its ratification by the Original 3 Partner States – Kenya, Uganda and Tanzania. The Republic of Rwanda and the Republic of Burundi acceded to the EAC Treaty on 18th June 2007 and became full Members of the Community with effect from 1st July 2007.⁵ Uganda, Rwanda Burundi and Tanzania are least developing countries while Kenya is classified as a developing nation. Despite this classification, the challenges in the service sector facing the three countries are similar. Some of the challenges include:

⁴ Regional Overview of Transboundary Natural Resource Management in Eastern Africa: <http://www.worldwildlife.org/bsp/publications/africa/121/121/titlepage.HTML>

⁵ http://www.eac.int/about_eac.htm

- Market access restrictions that include nationality requirements, residence and establishment requirements, professional certification, restriction on business structures and legal and administrative barriers.
- Technical and financial challenges in the form of low technological development and infrastructural deficiencies due to inefficiency of state monopolies;
- Complex multilateral and regional trade agreements

The realization of a large regional economic bloc encompassing Burundi, Kenya, Rwanda, Tanzania and Uganda with a combined population of 120 million, land area of 1.85 million square kilometres and a combined gross domestic product of \$ 41 billion, bears great strategic and geopolitical significance and prospects of a renewed and reinvigorated East African Community. East African community has a GDP per capita of US\$ 1,065.

In East Africa, active regional regulators associations are the East Africa Communications Organisation (EACO) which incorporate East Africa Community Member States and Association of Regulators in charge of ICT and Communication of East and southern Africa (ARICEA), which in turn incorporate COMESA countries. Among the objectives of these regulatory associations, are to collaborate on issues pertaining to cross-border frequency coordination

Through ARICEA, COMESA has been very proactive in member state capacity building. It has initiated programs to harmonize ICT policies and attract foreign investment to the region, and drafted model ICT policies, licensing rules, and frameworks. It also established an agenda to stimulate regulatory harmonization.

One of the main concerns for ARICEA is to facilitate proactive solution to issues such as bandwidth and its allocation, interconnection, etc., to co-ordinate the developments of standards and networks. ARICEA has a close relationship with the Communication Regulatory Association of Southern Africa (CRASA). Some CRASA members are also ARICEA members or participate actively in their activities. Given this overlap in membership and the fact that the Southern African Development Community (SADC) and COMESA harmonize their programmes, ARICEA and CRASA have started a process of cooperation. For instance, they have agreed to undertake a number of activities jointly i.e., management of the effect of spillover signals from neighbouring countries (frequency coordination across borders).

The East Africa Community has an association of regulatory authorities called East Africa Regulators Association (EACO). The objectives of the EACO is to harmonise policy and regulatory frameworks in the region; promote the development of broadcasting, postal and telecommunications/ICT services and regulatory matters; and devise ways and means to achieve fast, reliable, secure, affordable and efficient communications services within the Community, with particular focus on:

- Network development and regional inter-connectivity;
- Harmonization of tariff structures and settlement of accounts;
- Policy advice on issues relating to the communications sector;
- Regional projects, and programmes;
- The security of broadcasting, postal and telecommunication/ ICT networks;
- Research and technological development;
- Human resource development;
- Exchange of information;
- Management of radio frequency resource;
- Standards development and promotion of ethical practices;

- Quality of services;
- Ensuring the provision of universal service in the region;
- Promoting the development and application of Information Communication Technologies (ICT);
- Serving as a consultative organization for settlement of matters which are of regional nature, promote the development of technical facilities and their most efficient utilization;
- Harmonizing policies and legislation in the communications sector;
- Promoting the development of local content from the East African Region; and
- Any other objective as may be determined by the Congress from time to time.

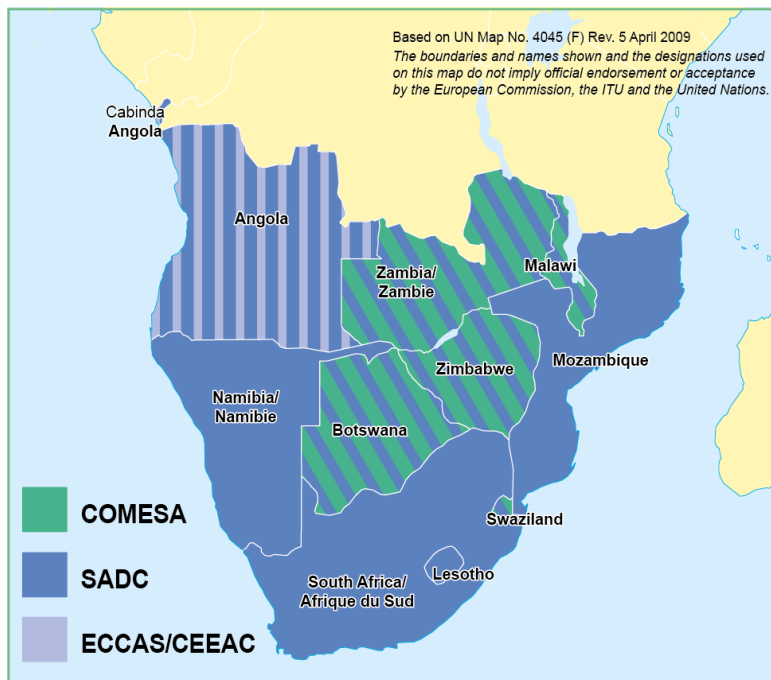
4.3 The Southern Africa region

Southern Africa is the southernmost region of the African continent, comprising the countries of Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe. All these countries are included in this report⁶.

The interior of Southern Africa consists of a series of undulating plateaus that cover most of South Africa, Namibia, and Botswana and extend into central Angola. Contiguous with this are uplands in Zambia and Zimbabwe. Coastal mountains and escarpments, flanking the high ground, are found in northern Mozambique, South Africa, Namibia, Angola, and along the Mozambique-Zimbabwe border. The terrain of Southern Africa is varied, ranging from forest and grasslands to deserts.

The Southern Africa Region is bordered to the northwest by the Republic of Congo (Brazzaville) and the Democratic Republic of Congo. To the northeast it borders with the United Republic of Tanzania. Towards the southwest lies the Atlantic Ocean and the southeast is bathed by the waters of the Indian Ocean.

Figure 2: East Africa countries



⁶ However it must be noted that for the United Nations the Southern Africa Region is only constituted by Botswana, Lesotho, Namibia, South Africa, and Swaziland.

The most common language spoken in the region is English, with the exception of Angola and Mozambique where Portuguese is the main official language.

In terms of natural resources, the region has the world's largest resources of platinum and the platinum group elements chromium, vanadium, and cobalt, as well as uranium, gold, titanium, iron, copper and diamonds.

Consequently its economy depends considerably on the export of such resources.

Fundamentally there is one big regional organization, which addresses telecommunications among many other issues of regional interest. This is the Southern Africa Development Community (SADC). The SADC includes not only the countries covered in this report but additionally the Democratic Republic of Congo, the United Republic of Tanzania and the islands of Madagascar, Mauritius and Seychelles.

The SADC mission is to promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper co-operation and integration, good governance, and durable peace and security, so that the region emerges as a competitive and effective player in international relations and the world economy.

Therefore, the SADC has the widest responsibility on different issues at regional level.

Consequently, at the specific level of Information Communications and Technology (ICT) issues it has one implementing agency. This is the Communication Regulators Association of Southern Africa (CRASA) that groups fundamentally all the ICT regulatory authorities in the region. The Southern Africa Telecommunications Association (SATA) is a consultative member of SADC on telecommunication matters, which groups all the telecommunications operators of the region.

The CRASA mission is to advise policy makers through designing and implementing harmonised ICT policies and regulations thereby contributing to the socio-economic development of the region.

On the other hand the SATA mission is to co-ordinate the development of ICT networks and services of regional nature that are responsive to the diverse needs of commerce and industry in support of the SADC regional socio-economic development programs.

CRASA is the body, which deals with cross-border coordination at regional level.

The telecommunications environment in Southern Africa is under a wave of liberalization and promotion of competition, which for its implementation requires a greater utilization of the radio spectrum, be it for fixed services, mobile services or Internet services. The speed of implementation is variable by which some countries are progressing at a reasonable speed and others do it at a slower pace.

The broadcasting environment seems to be relatively stable in the region; however the big explosion is to come with the introduction of digital television, which will create many situations where frequency coordination will be required, in particular where the same standard is not adopted.

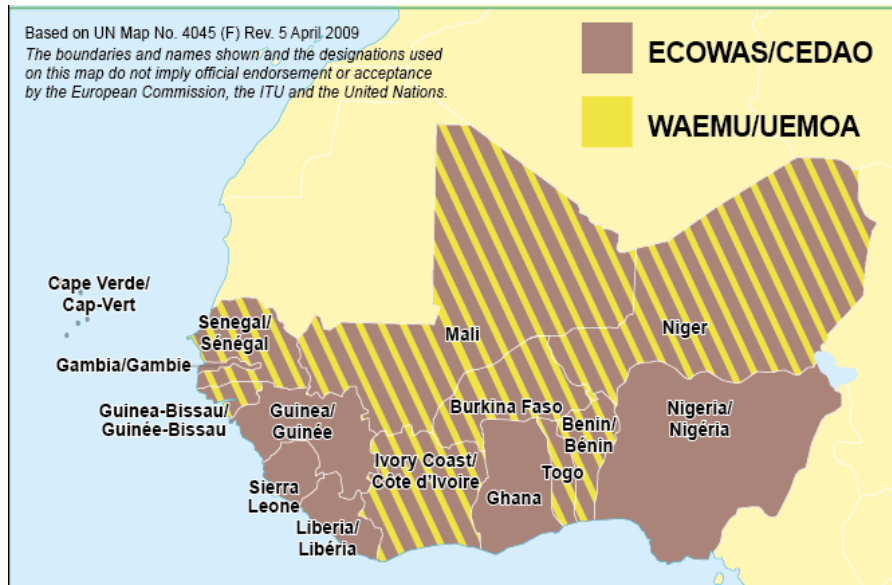
The more important regional broadcasting organisations are the Southern Africa Broadcasting Association (SABA) and the Southern Africa Digital Broadcasting Association (SADIBA).

4.4 The West Africa region

West Africa or Western Africa is the westernmost region of the African continent⁷: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo

With the exception of Mauritania⁸, all of these countries are members of the Economic Community of West African States, (ECOWAS).

Figure 3: Member States of ECOWAS and UEMOA/WAEMU



The Economic Community of West African States (ECOWAS) is a regional group which treaty was signed on May 28, 1975. The protocols launching ECOWAS were signed in Lomé, Togo on November 5, 1976.

Its mission is to promote economic integration in "all fields of economic activity, particularly industry, transport, telecommunications, energy, agriculture, natural resources, commerce, monetary and financial questions, social and cultural matters"⁹.

In telecommunications area, ECOWAS treaty in its article 33 lay out that "Member states shall:

- Develop, modernize, coordinate and standardize their national telecommunications networks in order to provide reliable interconnection among Member States;
- Complete, with dispatch, the section of the pan African telecommunications network situated in West Africa;
- Coordinate their efforts with regard to the operation and maintenance of the West African portion of the pan African telecommunications network and in the mobilization of national and international financial resources".

Apart from ECOWAS, there is another regional economic organization, which gathers eight (8) West Africa French speaking countries (Benin, Burkina-Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo).

⁷ Geopolitically, the UN definition of Western Africa includes the following sixteen (16) countries and an area of approximately 5 million km²

⁸ Mauritania left the ECOWAS Community in 2002

⁹ http://www.comm.ecowas.int/sec/index.php?id=about_a&lang=en

The West African Economic and Monetary Union (WAEMU) was founded on January 10, 1994. The Treaty, in its article 4, mandates WAEMU, among others things, *“to harmonise and coordinate national policies, by the implementation of unified actions and possibly of common policies particular in the following fields: human resources, transport and telecommunications, environment, agriculture, energy, industry and mines”*.

In telecommunications area, ECOWAS and WAEMU have an association of regulator authorities, which are respectively WATRA (West Africa Telecommunications Regulators Assembly) and CRITEL (Comité des Régulateurs de Télécommunications des États membres de l’UEMOA).

WATRA *“focuses on the need for West Africa to evolve a harmonised regulatory identity to boost investment and investor confidence and to more effectively regulate and monitor telecommunications service”*¹⁰. It should be noted that WATRA does not include Togo, an ECOWAS member state, whereas Mauritania, a non ECOWAS Member State is a member of WATRA.

CRITEL supports *“exchanges and cooperation between its members in order to promote regional integration, networks development and intra-community trade”*.

¹⁰ <http://www.watra.org>;

REGIONAL COMPARATIVE ANALYSIS

1 Regional initiatives towards harmonised cross-border frequency coordination

Central Africa

In Central Africa, Central African regional organizations within the framework of their action plan relating to cross-border frequency coordination have organized some activities and initiatives. These include:

- Seminars and Workshops on cross-border frequency management organized by ARTAC and ITU/BDT and attended by ECCAS/CEMAC.
- Missions carried out by experts from Central Africa with the aim to gather information relating to specific bilateral cross-border interferences:
 - Follow up of bilateral GSM cross-border frequency agreement between Cameroon and Chad organizing meetings of relevant committee.
 - Follow up of interference matters in the sub region according to the ARTAC action plan identifying interference areas and organizing meeting of experts.

East Africa

In East Africa, ARICEA has done an effective job of leveraging other initiatives and previous work by others. A case in point is a recent (February 2006) report, “Guidelines on Satellite and Other Wireless Services Regulation” (Adam, 2006).

Through ARICEA, COMESA has been very proactive in member state capacity building. It has initiated programs to harmonise ICT policies and attract foreign investment to the region, and drafted model ICT policies, licensing rules, and frameworks. It also established an agenda to stimulate regulatory harmonisation.

ARICEA is working on identifying clusters of members at the same level of development of policy and regulation matters and continues to develop and update guidelines for member states where necessary.¹¹

One of the main concerns for ARICEA is to facilitate proactive solution to issues such as Bandwidth and allocation, interconnection, co-ordinate the developments of standards and networks. ARICEA has a close relationship with the Communication Regulatory Association of Southern Africa (CRASA).

Some CRASA members are also ARICEA members or participate actively in the activities of ARICEA. Given this overlap in membership and the fact that the Southern African Development Community (SADC) and COMESA harmonise their programmes, ARICEA and CRASA have started a process of cooperation. For instance, they have agreed to undertake a number of activities jointly i.e., management of the effect of spillover signals from neighbouring countries (frequency coordination across borders).

The other regional association of regulators in the region the East Africa Communication Organization (EACO) has formulated draft guidelines on the use of radio systems within border areas, with the aim of resolving signal spill-over’s and interferences along borders of the five East African countries. Members of the EACO are encouraged to carry out bilateral/multilateral coordination for all applicable frequencies. The existing EACO frequency coordination procedures guidelines were reviewed by members with a view to establishing their adequacy for digital broadcasting

¹¹ ARICEA : http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR03/Informal_meeting/ARICEA-ElementsofAction%20Plan.pdf

Southern Africa

In Southern Africa, CRASA has been the only regional organization in Southern Africa that has addressed the issue of frequency coordination across-borders and particularly the spill-over among different cellular operators with base stations close to the borders.

CRASA has issued a document titled: “CRASA, Wireless Technologies, Policies and Regulations”. The purpose of the document is to present guidelines that outline policy and regulatory recommendations for wireless technology deployment in the SADC region. Essentially the guidelines propose recommendations for the removal of structural barriers for the diffusion of wireless communications technologies and services among the SADC countries.

One of the main concerns for CRASA is the management of the effect of spill-over signals from neighbouring countries (frequency coordination across borders). CRASA recognizes that harmonisation of radio frequency spectrum use does facilitate frequency coordination across borders and has the added benefit of allowing regional roaming of certain customer devices (e.g. GSM).

Consequently, one of the most important steps taken by SADC/CRASA was to create a framework for the harmonisation across SADC of the use of the radio frequency spectrum by means of a regional frequency allocation plan. This is considered one of the first steps that will facilitate frequency coordination across-borders.

SADC and CRASA have gone to the extent of harmonising radio frequency channelling plans for various fixed and mobile services in different radio frequency bands throughout SADC. Such harmonisation covers 800 MHz to 38 GHz. CRASA also visualizes that harmonisation is also critical from the economic point of view to build an economy of scale and promote regional cooperation and integration.

CRASA’s guidelines address the problem of frequency coordination across-borders, in a particular section. This section presents possible scenarios and emphasizes the advantages of having harmonised spectrum across-borders, as well as difficulties that can be found when the same spectrum across-borders is exploited in a different way. In line with the guidelines CRASA developed a Memorandum of Understanding (MoU) template on frequency coordination across-borders between telecommunications and broadcasting services that can be adopted between two countries.

The MoU covers Public Land Mobile Radio, Fixed Wireless Access and other radiocommunication systems. It includes very general administrative procedures and does not have much technical provisions other than advisable principles to avoid spill-over and the technical data required for the exchange of information.

The MoU has provisions for the creation of a joint forum for the discussion of cross-border coordination and also creates a joint oversight committee to be the custodian of the MoU with power to amend the terms of the MoU if agreed.

Regarding broadcasting the MoU limits itself to the agreement between the parties to co-ordinate all broadcasting signal distribution activities, which may require such coordination.

To date only one MoU has been duly signed between South Africa and Lesotho.

Complementing the MoU, CRASA has issued a document on GSM spill-over engineering practice and principles; the document mainly addresses the considerations to be taken into account regarding spill-over when installing new radio sites on areas of high site density, low site density, and high lying areas that require special consideration.

West Africa

In West Africa, a number of initiatives to support cross-border frequency coordination have been taken.

For example on March 23th, 2006, WAEMU had taken measures to harmonise laws and regulations and to set up consultation structures for regulators, providers and operators. These measures are composed in six (6) directives called “WAEMU directives”. Article 3 of the Directive n°06/2006/CM/UEMOA recommends that member states should:

- adopt rules for spectrum planning in particular for coherent National Table of Frequency Allocations;
- set up simplified procedures for cross-border frequency coordination between Member States;
- organize mechanism to share spectrum management tools and equipment.

ECOWAS had also examined the issue. In January 19th, 2007, six (6) Supplementary Acts had been signed by member states. The objective is to harmonise Telecommunication/ICT policy and regulatory framework. It’s Supplementary Act A/SA.5/01/07 aims to harmonise regulatory framework on spectrum management for its fifteen (15) countries. This Act is a complete recommendation, which deals with the role of the authority responsible for spectrum, spectrum plan, cross-border frequency coordination and associated tools.

Cross-border frequency coordination is treated at two levels: National and Regional.

At the National level, Article 11 asks *“members states to establish a framework which permits the effective coordination of all spectrum use, at the national, regional and international levels and to promote the merging of separate regulatory bodies dealing with spectrum use in the broadcasting and telecommunications spheres”*.

At the Regional level, Article 14 asks *“Members states to establish a special ECOWAS committee comprising the spectrum management bodies of each ECOWAS Member state with the task of defining common approach to spectrum management”*. This committee shall examine the spectrum assignments and allocations of the ECOWAS countries and recommend a harmonised policy for promoting broadband wireless access service provision across the region.

ITU, through its project on Harmonisation of the ICT Policies in Sub-Saharan Africa (or HIPSSA), is supporting the ECOWAS harmonisation program, including the transposition of the Supplementary Acts.

2 Regional cross-border frequency coordination agreements

Bilateral or Multilateral agreement is an agreement made between two or more countries on how to manage cross-border frequency interference. The agreement covers both administrative and technical aspects.

Central Africa

In Central Africa, some negotiations for cross-border frequency agreements are still on-going. Only one concrete agreement has been signed so far between Cameroon and Chad. This was signed on 3 September 2009 under the aegis of ARTAC.

Other initiatives in the region are as follows:

- Coordination meetings took place between Burundi, Rwanda and Tanzania. Elaboration of agreements is still on-going, initiated by Burundi under the aegis of ARTAC.
- Congo is now working on this matter with colleagues from neighbouring countries.

- An agreement is in the process of elaboration initiated by RD Congo

East Africa

In East Africa, the Regulator’s association namely East African Communication Organization (EACO) has adopted coordination framework for digital television broadcasting and GSM. However the GSM coordination framework was adopted by three members (Kenya, Uganda and Tanzania) when Burundi and Rwanda had not yet joined the membership.

None of the other countries have a framework that covers all range of radio communication services. The following Agreements however exist:

- Tanzania has only three agreements, two being with EAC Member States on GSM and digital television broadcasting while the third one being with CRASA on GSM.
- Uganda has only two agreements one being on GSM and another on digital television broadcasting. The agreements were made with EAC administrations. The GSM agreement was made when Burundi and Rwanda were not yet members of EAC.
- For Rwanda, cross-border frequency coordination agreement for Digital Television with Rwanda neighbouring countries will be done under the framework of EACO.
- For Sudan, any agreement on cross-border frequency coordination agreement will follow ITU frequency coordination framework.
- coordination across their borders about 2-3 times annually on Earth station/VSAT with its neighbour Reunion Island. In Mauritius, Information & Communication Technologies Authority (ICTA) conducts frequency

None of the Agreements mentioned above provide for frequency register to store coordination results, preferential frequencies and sharing of frequencies for cross-border frequency coordination.

Southern Africa

In Southern Africa, none of the countries in the region have a comprehensive coordination framework containing administrative procedures and technical provisions for cross-border frequency coordination.

Lesotho and South Africa make use of the MoU between the countries as a frequency coordination framework between their countries, although it does not have proper technical provisions.

Similarly it has been noted that countries like Zimbabwe use the CRASA MoU and the HF frequencies harmonised in all SADC countries informally, as a framework for frequency coordination across-borders.

The only formalized cross-border frequency coordination agreement in Southern Africa is, as pointed out above, the MoU signed in 2002 between South Africa and Lesotho, on coordination of telecommunications and broadcasting services. The MoU addresses cross-border spill-over of GSM, WLL/FWA and other radiocommunication systems.

The agreement is based on an approach similar to ITU Resolutions. The expressed purpose of the MoU is that both parties promote the co-operation in the regulation of telecommunications and broadcasting on the basis of equality and mutual benefit in accordance with their respective national legislations and the ITU framework.

Among the key issues addressed are:

- The creation of a radio frequency spectrum coordination zone along and overlapping both sides of the borders;

- The prediction of spill-over into the coordination zone with acceptable planning techniques, and the acceptance thereof, in advance of operations commencing, including the calculation of signal strength levels at agreed points;
- The subdivision of the frequency band into preferred and not preferred assignments within the coordination zone;
- Monitoring strength levels at agreed points that trigger the steps to be followed mainly based on a reasonable engineering plan that will resolve the issue in an acceptable way for both parties.

The MoU is based on an administrative approach; since it does not detail how to determine the coordination zone, it refers to acceptable planning techniques without setting the technical conditions for its acceptability and even the calculation methodology is not addressed.

The agreement also considers the creation of a joint forum for cross-border coordination involving all the possible stakeholders that may be affected in both countries by the spill-over.

The primary purpose of the forum is to proactively pre-empt the possibility of the commercial impact of spill-over coverage and frequency interference by means of rules and procedures in such circumstances.

The joint forum is responsible for the creation of such rules, particularly on radio planning and implementation. Also the other important role of the forum is to assist in the resolution of complaints within an environment of cooperative participation.

The data format for the exchange of relevant information during the process of coordination is clearly stated even establishing the process to follow after receiving that type of information.

Broadcasting is addressed at a very high level fundamentally considering broadcasting signal distribution activities, which may require coordination.

Among other issues the MoU touches roaming, interconnections and no-man land services

Finally the parties agree to establish a Joint Oversight Committee in which operators, manufacturers, and service providers may participate together with administrators. This is fundamentally to monitor the modus operandi of the memorandum and see its possible amendments or additions.

The CRASA MoU provides a template that, having very little differences with the AFS LSO MoU, can be used to implement an agreement on frequency coordination across-borders between two regulators. The CRASA MoU is a bit wider than the one signed in 2002, not just considering GSM but extending it to public land mobile systems and dropping the old concept of WLL referring instead to fixed wireless access systems and other radiocommunication systems.

The table in the following page indicates the coordination agreements required in Southern Africa.

Regional comparative analysis

Table 1: Frequency coordination agreements needed for Southern Africa- and their respective priority

Requesting party ↓↓	AFS	AGL	BOT	LSO	MWI	MOZ	NMB	SWZ	ZMB	ZWE	TZA	COD
AFS			BEGHIJK LMNO	BEGHI JKLM NO		BEGHIJK LMNO	BEGHI JKLM NO	BEGHI JKLM NO		BEGHI JKLM NO		
BOT	BE									BE		
LSO	ABCFS											
MWI						ABDGF			ADFG		ADFG	
MOZ	ABEFGHIJ KLMNO				ABEFG HIJKL MNO			ABEFG HIJKL MNO	ABEFG HIJKL MNO	ABEFG HIJKL MNO	ABEFG HIJKL MNO	
NMB#	GHIJKLM N	GHIJK LMN	GHIJKL MN						GHIJK LMN			
SWZ	B					T						
ZMB	ABDFGHI P	ABDF GHIP	ABDFGH IP		ABDF GHIP	ABDFGH IP				ABDF GHIP	ABDF GHIP	ABDFG HIP
ZWE	BGKMR		BGKMR			BGKMR			BGKM R			

Angola did not state any frequency coordination requirement; Priority not specified but considered medium

Key for frequency bands requiring cross-border coordination

- | | | |
|---------------------------------------|--------------------|----------------------------|
| A VHF BS Sound Band | H MS 1710-1785 | O FS MW bands 4 to 13 GHz |
| B MS bands within 137-174 MHz | I MS 1805-1880 MHz | P FS MW bands 4 to 18 GHz |
| C FS 140.5-141 MHz | J MS 1885-2025MHz | Q FS MW bands 7 to 13 GHz |
| D VHF TV band | K MS 2110-2200 MHz | R FS MW bands 6 to 8.5 GHz |
| E MS bands within 401-470 MHz | L MS 2300-2400 MHz | S FS MW bands 8 to 15 GHz |
| F UHF TV band | M MS 2500-2690 MHz | T FS MW band 3534-3940 GHz |
| G MS 790-960 MHz(790-862/862-962 MHz) | N MS 3400-3600 MHz | |

Colour key for the priority level of needed agreements

- Top **RED** High **GREEN** Medium **BLUE** Low **BLACK**

Note that the different frequency bands requested by the different countries have been included into relevant bands as per table of allocations. (I.e. 130-174 MHz or 146-174 MHz included in 137-174 MHz) To see with precision the band requested please consult the relevant country in Part 2 of the Southern African report.

West Africa

In West Africa, cross-border frequency coordination is carried out through bilateral and/or multilateral meetings. These meetings come up either to a formal agreement or to arrangement whose minutes of meeting are acting as agreement.

The minutes of meeting are specific solutions for interferences cases which occur. At the difference of agreement which plan arrangement for a certain number of frequency bands, these minutes take into account only (in general) one frequency band.

The table below shows that except Cote d’Ivoire, Ghana, Liberia, Nigeria and Sierra-Leone, others ECOWAS member states understood the need for cross-border frequency coordination even if they could not have agreement with all of their neighbouring countries.

Table 2: Cross-border coordination agreements within West Africa

	BEN	BFA	CPV	CTI	GMB	GHA	GUI	GNB	LBR	MLI	NGR	NIG	SEN	SRL	TGO
Number of supposed agreement	5	6	2	5	2	4	6	2	3	5	4	3	5	2	4
Number of agreement	3	3	1	0	1	0	1	1	0	3	3	0	1	0	2
Number of country involved	3	3	5	0	5	0	5	5	0	7	3	0	5	0	2

Cross-border frequency coordination agreement are divided into a multilateral agreement between Cape Verde, The Gambia, Guinea, Guinea-Bissau, Mali and Senegal and bilateral agreement between Benin vs. Burkina-Faso, Benin vs. Niger, Benin vs. Togo, Burkina-Faso vs. Mali, Burkina-Faso vs. Niger, Burkina-Faso vs. Togo and Mali vs. Niger.

The multilateral agreement is practically identical to the various bilateral agreements. The essential difference is the “report of harmful interference” which does not exist in the multilateral agreement.

For member states like Benin, Burkina-Faso, Mali and Togo which have several bilateral agreements, an effort of homogenization of their agreements have to be made in order to facilitate the task of spectrum managers.

Table 3: Agreement in West Africa

signed with	BEN	BFA	CPV	CTI	GMB	GHA	GUI	GNB	LBR	MLI	NGR	NIG	SEN	SRL	TGO
BEN															
BFA															
CPV															
CTI															
GMB															
GHA															
GUI															
GNB															
LBR															
MLI															
NGR															
NIG															
SEN															
SRL															
TGO															

Colour key for the status of coordination initiatives

AGREEMENT EXIST	MEETING REPORT AS AGREEMENT	Required AGREEMENT DOESN'T EXIST	AGREEMENT NOT REQUIRED BUT DOES EXIST
-----------------	-----------------------------	----------------------------------	---------------------------------------

Table 4: West Africa – Comparison between agreements

Country	Number of Agreement	Frequency Bands	Agreement Harmonised	Definitions	Administrative Provisions	Technical Provisions	Coordination Procedures	Report of Harmful Interference
BEN	3	0 - 30 GHz	No	Yes	Yes	Yes	No	Yes
BFA	3	0 - 30 GHz	No	Yes	Yes	Yes	No	Yes
CPV	1	0 - 30 GHz	Yes	Yes	Yes	Yes	No	No
CTI	0							
GMB	1	0 - 30 GHz	Yes	Yes	Yes	Yes	No	No
GHA	0							
GUI	1	0 - 30 GHz	Yes	Yes	Yes	Yes	No	No
GNB	1	0 - 30 GHz	Yes	Yes	Yes	Yes	No	No
LBR	0							
MLI	3	0 - 30 GHz	No	Yes	Yes	Yes	No	Yes/No
NGR	3	0 - 30 GHz	Yes	Yes	Yes	Yes	No	Yes
NIG	0							
SEN	1	0 - 30 GHz	Yes	Yes	Yes	Yes	No	No
SRL	0							
TGO	2	0 - 30 GHz	No	Yes	Yes	Yes	No	Yes

The structure of these agreements could be as follows:

- Definitions (must include “Frequency categories” existing in bilateral agreement);
- Technical Provisions;
- Report of harmful interference (must be included in multilateral agreement);
- Administrative provisions (follow-up of the agreement, revision of the agreement, language of the agreement, information of the ITU Secretary General, frequency register and focal point designation).

3 National and Regional Tables of Frequency Allocation

Publication of NFTA provides information to the service providers, radio communication users and manufacturers worldwide. It also reduces the possibilities of cross-border frequency interferences while portraying transparency in assigning the spectrum.

Central Africa

At the Central Africa level, there is no common Regional Table of Frequency Allocations. At the national level:

- ARCT is updating a National Table of Frequency Allocations in Burundi (NTFA). There are no notable differences with the ITU’s Table of Frequency Allocations.
- A project has been launched since 2010 by Ministry of Post and Telecommunication (MINPOSTEL) to acquire a NTFA in Cameroon.
- Central African Republic has a NTFA nearly similar to the ITU’s Table of Frequency Allocations.

- The NTFA is in the process of being elaborated in Chad according to the ITU’s Table of Frequency Allocations.
- The NTFA is in the process of approval by the Government in Congo.
- The NTFA is in the process of elaboration in RD Congo.
- Sao Tome uses ITU table of frequency allocation.

East Africa

In East Africa, Kenya, Rwanda, Sudan and Mauritius have published their National Frequency Table of Allocation (NFTA) on their website. The NFTA has also been customized from ITU plan to the domestic requirements.

DJIBOUTI has no National Frequency Table of Allocation which has been customized to the domestic needs. It is using the ITU table of frequency to plan for the spectrum. The ITU Radio Regulations is used as the tool for the national band plan. Eritrea has a National Table of Frequency Allocations (NTFA) but it needs to be updated some Band and sub-Band which are subject of WRC07 change of regional allocation. The ITU Radio Regulations is used as the tool for the national band plan.

Tanzania and Uganda have planned the NFTA based on ITU and also customized the NFTA but not published their National Frequency Table of Allocation (NFTA) on their website.

Table 5: National Table of Frequency Allocation in East Africa –

Name of the country	Possess NTFA	Customized NTFA	Published NFTA in Websites
Kenya	Yes	Yes	Yes www.cck.go.ke
Tanzania	Yes	Yes	No
Uganda	Yes	Yes	Yes www.ucc.co.ug
Sudan	Yes	Yes	Yes in Arabic www.ntc.gov.sd
Seychelles	Yes	Yes	No
Mauritius	Yes	Yes	Yes www.icta.mu
Eritrea	Yes	No	No
Djibouti	No	No	No
Rwanda	Yes	Yes	Yes www.rura.go.rw

Southern Africa

The Southern Africa region has a common frequency allocation plan known as the SADC Frequency Allocations Plan (SADC FAP 2010) which is a very comprehensive document. It contains the common allocations and proposed common sub-allocations within the SADC and compares them with the allocations for the ITU Region 1. It also indicates the main utilization of the bands as well as many relevant notes.

Based on the provisions of the ITU Radio Regulations, the Table covers from 9 KHz to 100 GHz including the decisions of World Radio Conferences up to 2007.

The purpose of SADC FAP 2010 is to create a framework for the harmonisation across SADC of the use of the radio frequency spectrum. It is however acknowledged that the use of the radio frequency spectrum varies from one SADC country to another due to, amongst others, legacies in system deployments, different time scales for the introduction of new technologies, different services and technology requirements as well as different capacity requirements.

It is therefore not possible to align the use of the radio frequency spectrum over all frequency bands between all countries. It is however evident that a de facto harmonisation already exists in many frequency bands and it could be expected that further harmonisation will occur within the SADC common economic zone.

The SADC-FAP-2010 Plan has numerous annexes particularly important for this project:

- A table indicating all those ITU Radio Regulations footnotes containing references to SADC country names;
- List of SADC country footnotes relevant to SADC FAP 2010, mainly detailing alternative or additional allocations in certain SADC countries;
- SADC harmonised HF cross-border frequencies presenting a list of thirteen (13) HF frequencies harmonised in all SADC countries for mobile communications (e.g. long haul trucks).

In general the table has a high correlation with the ITU Table of frequency allocations although it has some deviations. Table 6 indicates the main different spectrum allocations between the SADC FAP and ITU Region 1 between 80 and 20000 MHz. Not all allocations are recorded

Table 6: Different spectrum allocations between the SADC FAP 2010 and ITU Region 1 between 80-20 000 MHz.

Bands (MHz)	ITU Region 1	Regional Plan (SADC FAP 2010)
138-144	AERONAUTICAL MOBILE (OR)	MOBILE
230-238 and 246-254	FIXED/MOBILE	BROADCASTING
470-790	BROADCASTING	BROADCASTING RADIOASTRONOMY
3400-3600	Mobile	MOBILE except aeronautical mobile
5150-5350	No FIXED	Wireless Access Systems
5470-5725	No FIXED	Wireless Access Systems
17 100-17 300	No FIXED	Wireless Access Systems

Mainly terrestrial allocations have been considered. Obviously many countries still make use of their own frequency allocation plan. Table 7 below shows the actual situation.

Table 7: Main characteristics of National frequency band plans of SADC countries.

Country	Year Plan Issued	Spectrum Covered	Status
Angola	2001	9 KHz to 1000 GHz	Need update
Botswana	2008	9 KHz to 105 GHz	Up to date
Lesotho	2010	9 KHz to 100 GHz	Up to date
Malawi	2010	9 KHz to 100 GHz	Up to date
Mozambique	2011	9 KHz to 400 GHz	Up to date
Namibia	2009	9 KHz to 105 GHz	Up to date but still a draft
South Africa	2010	9KHz to 300 0 GHz	Up to date
Swaziland	2009	9 KHz to 40.5 GHz	Bands Incomplete. Needs revision Partially considers WRC07
Zambia	2009	9 KHz to 1000 GHz	Up to date but still a draft
Zimbabwe	2010	9 KHz to 100 GHz	Does not have a national band plan but uses SADC FAP 2010

West Africa

In West Africa, there is no regional table of frequency allocations. But, supplementary acts article 10 and article 16 obliges member states to establish National Table of Frequency Allocations with respect to ITU allocations.

Mainly, 73% of member States have a National Table of Frequency Allocations. With member States such as Benin, The Gambia and Nigeria whose NTFA are under development added, this ratio could reach 93%. However, only 36% of member States have their NTFA compliant to ITU Region I, 2008 edition table of allocations as it is shown in the table hereafter.

Table 8:NFTA comparison in West Africa

Country	Existence	Edition	Compliant ITU Region I 2008 edition	Spectrum Covered	Observations
BEN	No ¹²				Being edited
BFA	Yes ¹³	2008	Yes	0 - 1000 GHz	
CPV	yes	2008	Yes	9 kHz - 1000 GHz	
CTI	Yes	2006	No	9 kHz - 1000 GHz	need to be updated
GMB	No				Under Development
GHA	Yes			9 kHz - 400 GHz	
GUI	Yes	2005			need to be updated
GNB	No				
LBR	Yes	2010	Yes	9 kHz - 400 GHz	
MLI	Yes	2003	No	9 kHz - 30 GHz	need to be updated
NGR	Yes	2010	Yes	9 kHz - 1000 GHz	
NIG	No				Being edited
SEN	Yes	2006	No	9 kHz - 300 GHz	need to be updated
SRL	Yes			9 kHz - 64 GHz	
TGO	Yes	2006	No	9 kHz - 100 GHz	need to be updated

4 Interference Challenges

Central Africa

In Central Africa, Some cases of interferences had been identified by ARTAC during organized seminars and workshops.

Table 9: Interference occurrences in Central Africa

Interference Area (countries)	Affected Operators	Interfering sources (countries/operators)
Bangui (RCA)	Telecel, Moov, NationLink, Orange	Vodacom et Zain (DRC)
Brazzaville (Congo)	MTN, Zain	Vodacom, Tigo, CCT (DRC)
N'djamena (Tchad)	Zain, Tigo	Orange, MTN (Cameroon)

All countries in the Central Africa sub region experience cases of frequency interferences with neighbours especially in the land mobile and broadcasting services.

Southern Africa

In Southern Africa, the level of cross-border interference does not seem to be high. With the exception of Zimbabwe, no other country has a procedure to handle resolution of interferences and similarly most of the countries do not have proper record of interferences. The time taken to resolve interference is very variable going from a few days to years. The main reasons that delay the resolution of interferences are

¹² Don't Exist ;

¹³ Exist

first of all the lack of a proper procedure in place between the countries. Another reason for delay has been lack of knowledgeable staff in the relevant positions.

There have been some cases where it has been lack of consultation between countries when installing transmitters close to the borders. Additionally, in several cases that lack of proper adherence to ITU frequency plans was the reason for interferences.

On the other hand it was reported by one of the countries that the use of reserved channels helped to minimized interferences. Similarly joint meetings between the countries involved in interference cases have proven to be very effective for their resolution.

VHF FM Sound Broadcasting is the service that experiences the greatest interferences followed by VHF and UHF mobile services including some GSM cases. However the periodicity of occurrence is relatively low.

In general the level of frequency coordination across-borders seems to be more frequent that the cases of interferences between countries in Southern Africa.

Usually submission of technical analysis (field strength, PFD, etc.) showing that the levels are within acceptable values lead towards a successful coordination or interference resolution. Frequently frequency coordination is carried out by making use of alternative channels when there are possibilities of frequency overlaps. Generally, coordination takes about a week or two if all technical parameters requested are available.

The CRASA MoU, which provides fundamentally an administrative framework for coordination across-borders, is on the verge of being formally used by some countries. (Such as Mozambique, South Africa, Malawi, etc.). However many countries make use of the steps pointed out in the MoU without properly formalizing an agreement.

No country is making use of the pre-defined coordination category such as preferential or shared channels. However the CRASA MoU considers the subdivision of the frequency band of interest into preferred and not preferred assignments within the coordination zone.

Regarding the point or line whereof the calculation is made to determine if coordination is required or not, there is no coordination agreement formalized based on a specified point or triggering level. However some countries would prefer the borderline to be the triggering point for coordination. That also may depend on the coverage provided by the digital terrain model into the neighbouring country. The most frequent type of cross-border frequency coordination that have been happening in the recent years are in the broadcasting environment particularly VHF FM with some cases of VHF and UHF TV. There have been as well some frequency coordination cases in the VHF and UHF land mobile radio including some in the 900 MHz GSM band.

In some cases microwave frequency coordination between the 6 to 15 GHz bands are carried out quite often (Up to 15 times a year). That was the case between Lesotho and South Africa.

In global terms the periodicity that frequency coordination across-borders are carried out are relatively low, normally one or two a year but seldom more than 5 a year, with the exception of VHF land mobile radio that in some cases are greater than 10 per year and the already mentioned case on microwave bands.

In many cases frequency coordination across-borders is carried out informally directly between the spectrum management divisions of the countries involved, whenever the circumstances require.

West Africa

In West Africa, majority of member experience interferences at the borders. The table hereafter shows that frequency band allocated to broadcasting service, mobile (2nd and 3rd) service constitute primarily band for which cross-border frequency coordination is required. It should be noted that all these bands had already been subject to meeting or agreement.

Table 10: Frequency band and countries needing coordination in West Africa –

Band	87.5 – 108 MHz	174 – 230 MHz	470 – 862 MHz	GSM	2.1 GHz
Countries	BEN, BFA, CPV, GMB, MLI, NIG, SEN, SRL, TGO	BEN, BFA, GMB, MLI, NIG, SEN, TGO	BEN, BFA, GMB, MLI, NGR, NIG, SEN, TGO	BEN, BFA, GMB, MLI, NGR, NIG, SEN, TGO	BEN, BFA, GMB, MLI, NGR, NIG, SEN, TGO

The table below reveals that all countries need cross-border coordination with neighbouring countries either by anticipation or generally due to the persistence of interference.

Table 11: Countries needing coordination in West Africa

NEED WITH XBFC	BEN	BFA	CPV	CTI	GMB	GHA	GUI	GNB	LBR	MLI	NGR	NIG	SEN	SRL	TGO
BEN		X				X						X			
BFA	X			X		X				X	X				X
CPV													X		
CTI															
GMB													X		
GHA															
GUI															
GNB															
LBR															
MLI		X		X			X				X		X		
NGR	X	X								X		X			
NIG	X										X				
SEN			X		X		X	X		X					
SRL							X		X						
TGO	X	X				X						X			

This problem may be analysed from two perspectives namely the persistence of interferences within agreed frequency bands and interference experience in new frequency bands.

In the first case, the notification of interference in agreed frequency bands means either that the agreement is not respected or the agreement did not take into account adequate technical parameters, calculation method and procedures.

In the second case, the notification of interference means that the authorities responsible of coordination were not able to integrate the frequency band concerned in the agreement.

In general, the resolution of interferences is generally successful but time consuming according to the approach used and can vary between two (2) weeks (Benin and Togo borders) and six (6) months (The Gambia and Senegal borders)

It should be noted that the majority of member states do not have reliable data on interference because, for member states, frequency register to store relative information on coordinated frequencies do not exist.

5 Data Exchange Format

Virtually all countries use email, CD/DVD and internet to exchange data in the course of frequency coordination, but the format of data varies from country to country.

Southern Africa

In Southern Africa, the CRASA MoU details only one data format as follows:

“When requesting coordination, at least the following characteristics of the transmitting station shall be forwarded by the requested Party:

- Frequency in MHz,
- Maximum transmitted bandwidth in MHz
- Name of transmitter station
- Country of location of transmitter station
- Geographical co-ordinates in degrees, minutes and seconds
- Antenna height above ground level
- Height of antenna site above sea level
- Antenna polarization
- Antenna azimuth
- Directivity in antenna systems
- Effective radiated power
- Service Area
- Date of entry into service and
- Mechanical and electrical antenna tilt.

West Africa

In West Africa, the exchange information that is mandatory as per the agreements, both bilateral and multilateral agreements have the same format which fields are:

- Owner;
- Category of the station;

- Type of station (Base or mobile);
- Frequency;
- Longitude and latitude;
- Locality;
- Date of assignment;
- Class of emission;
- Power;
- Antenna Gain;
- Antenna height.

Central Africa

Central African countries use nearly the same data exchange format:

- Internet and on paper confirmation (official letters using post offices) by Cameroon.
- Internet (mail, FTP) by Central African Republic.
- Data exchanges by internet (mail) by Chad.
- CD/DVD, internet, paper by Equatorial Guinea.
- CD, Internet, USB keys by Gabon.
- CD / DVD / internet by Sao Tome.

Common used mandatory parameters for exchanges:

- Antenna azimuth
- Directivity in antenna systems
- Effective radiated power
- Service Area
- Date of entry into service; and
- Mechanical and electrical antenna tilt.

6 Analysis of tools used

Most of the countries have deployed various spectrum management and monitoring systems, but the tools used vary from country to country.

The various tools used for interference resolution, database record keeping and frequency coordination management are as follows:

- Self-developed software called GESREP
- Ellipse by RD Congo.
- ITU SMS4DC
- TEMS Investigation
- Excel and administrative management software to assign frequencies
- TerraNotices and e-Notices

- SRTM-3.
- CCK uses Maps with a resolution of 1:50.
- BRIFIC, MIFR, TerRaQ, TerNotice.
- ITU TerRaSys, WISFAT
- Microsoft Access
- FMS tools
- SPACECAP (and SAM family), GIBC, ITU eNotices Ge-84 (FM) RRC-06 planning interface, GE06 Digital
- Commercially available spectrum management tools from companies such as ATDI,L&S, Tadiran etc.

7 Propagation Models

The propagation models that are used in Sub-Saharan countries vary but are mostly as per ITU Recommendation. They include; Longley Rice, ITU-R.P 370-7, CRC, ITU-R P.526-6, Okumura- Hata, Detvag-90/FOI, ITU-R P. 676-2, ITU-R P.452-9, ITU-R P.619-1., ITU-R P37 and ITU-R P1546. These models are chosen depending on the frequency range, terrain dependence of the analysis, antenna height above ground of the transmitter and the calculation speed of the tools. The type of geographical projection is long.lat – WGS 1984.

In Southern Africa, some countries use maps to determine the appropriate terrestrial profile whilst some do use maps for digital terrain data for interference calculations. The Propagation models used by ICTA Mauritius are as per ITU-R recommendation. The other tools and data used by ICTA are as follows;

- Digital Elevation Model (DEM)- Used for elevation and/or morphological data,
- Lambert and UTM with WGS84 datum- used for geographical projection.

Many countries use digital terrain data, using the same type of geographical projection and, in most cases, morphological data with terrain resolutions between 50x50 meters to 100x100 meters close to borders.

In general the use of paper maps is rare but the scales more frequently used in that type of maps are 1: 250 000 and 1:50 000.

Two countries, namely Malawi and Zambia were not using, at least for now, any propagation method for the theoretical calculations of interferences.

In West Africa, only 20% of the countries (Burkina Faso, Ghana and Senegal) use digital terrain data. Two of them have the same geographical projection system (WGS84) with terrain resolutions between 20 meters to 200 meters. Besides Senegal who announced the line located at the border, most of the countries have, within agreement, the coordination area as the zone whereof interference calculation is made.

Table 12: Digital Terrain Characteristics in West Africa

Country	Elevation / Morphological Data	Geographical projection System	Resolution of Terrain Data	Point / Line whereof calculation is made
BEN	No	No	No	Coordination area
BFA	Yes	WGS 84	90 m	Coordination area
CPV	No	WGS 84	1:10000	
CTI	No	No	No	No
GMB	No	No	No	No
GHA	Elevation and Morphological dots	49 DBMS	90 m	No
GUI	No	No	No	Coordination area
GNB	No	No	No	Coordination area
LBR	No	No	No	No
MLI	No	No	No	Coordination area
NGR	No	No	No	Coordination area
NIG	No	No	No	No
SEN	Yes	WGS 84	200 m v 20 m	Line located @ border
SRL	No	No	No	No
TGO	No	No	No	Coordination area

It must be noticed that some countries use jpg (bmp) maps or map incorporated within SMS4DC.

8 Bilateral and Multilateral Agreements

East Africa

There are only two adopted coordination frameworks for EACO and CRASA, which target two radio communications services, namely GSM and digital television broadcasting. The two frameworks are not comprehensive, as they do not provide for preferential frequencies, shared frequencies and the register to record the results. The framework is basically on administrative procedures for resolving cross-border interferences. CRASA coordination framework actually goes further than coordinating some countries in East Africa since its framework covers all the countries in the SADC region.

West Africa

For West Africa, Article 14 of Supplementary acts obliges “Members states to establish a special ECOWAS committee comprising the spectrum management bodies of each ECOWAS Member state with the task of defining common approach to spectrum management”. This committee is however yet to be constituted.

EUROPEAN HCM AGREEMENT

This part presents the European HCM agreement and components (administrative agreement and procedures for the various radiocommunication services, propagation models and parameters, geographical data including terrain morphology and topology, borders or better called coordination's lines, coordination criteria in terms of power and range, data formats and software).

1 History of the European HCM Agreement

In the context of the European HCM Agreement, the first frequency coordination agreement was created in 1956 in Brussels. This agreement was signed by three countries (Belgium, Federal Republic of Germany and The Netherlands). It was the first agreement that dealt with the Fixed and Mobile Services in border areas in bands 146-156 MHz, 156-174 MHz and 450-470 MHz.

This agreement already covered two different coordination techniques. The band 146-156 MHz was planned in preferential frequencies, the planning method for the bands 156-174 MHz and 450-470 MHz was planned according to geographical lattices.

In order to prepare a common "master register" or reference, there was an exchange of frequency lists between the three countries.

It was the first step that led to the current Agreement signed in Zagreb in 2010.

2 Structure of the Agreement

The Preamble of the agreement summarizes the circumstances and the goal of the agreement, gives a full list of the signatories and the frequencies concerning the agreement. At the end of the preamble there is reference chosen by the signatories, which is usable for referring to this agreement on different forums, like ITU or EC.

After a long evolutionary period the structure and the content of the agreement was resolved. The agreement, which was signed last time in Zagreb in 2010 covers the main text and different sets of annexes for provisions for Land Mobile and for Fixed Services.

The documentation of the agreement contains the following divisions:

Table 13: European HCM

Administrative and procedural conditions and common background for technical working groups for both services	Main text Definitions, general, technical provisions, procedures, report of harmful interference, revision of agreement, accession to agreement, withdrawal from agreement, status of coordinations prior to agreement, languages of the agreement, entry into force of agreement, revocation of agreement agreed by correspondence in 2008	
Technical conditions for Land Mobile Services	Annex 1	Maximum permissible interference field strengths and maximum cross-border ranges of harmful interference for frequencies requiring co-ordination in the Land Mobile Service
	Annex 2A	Data exchange in the Land Mobile Service
	Annex 3A	Determination of the correction factor for the permissible interference field strength at different nominal frequencies in the Land Mobile Service
	Annex 4	Propagation curves in the Land Mobile Service
	Annex 5	Determination of the interference field strength in the Land Mobile Service
	Annex 6	Coding instructions for antenna diagrams in the Land Mobile Service
	Annex 7	Provisions on measurement procedures in the Fixed Service and the Land Mobile Service
	Annex 8A	Method for combining the horizontal and vertical antenna patterns for the Land Mobile Service
Technical conditions for Fixed Services	Annex 2B	Data exchange in the Fixed Service
	Annex 3B	Determination of the Masks Discrimination and the Net Filter Discrimination in the Fixed Service
	Annex 7	Provisions on measurement procedures in the Fixed Service and the Land Mobile Service
	Annex 8B	Method for combining the horizontal and vertical antenna patterns for the Fixed Service
	Annex 9	Threshold Degradation in the Fixed Service
	Annex 10	Determination of the basic transmission loss in the Fixed Service
	Annex 11	Trigger for co-ordination in the Fixed Service

Definitions

The first article of main text gives a full list of terms and definitions used in the agreement, summarizes the goal of the signature of the agreement and lists the actual names of the signatory administrations (Administrations), the sets of the frequency bands (Frequencies) and the special conditions applicable for the Land Mobile and for the Fixed Services in the countries concerned and shall be coordinated under the terms of this agreement.

Also given, is a list of known exceptions, which are not handled by the agreement or give hints for handling them.

- *Frequency categories*

The next section of the first article gives a detailed list and the necessary definition for each frequency category taking into account for coordination. Frequency categories are as follows:

- Frequencies requiring co-ordination
- Preferential frequencies
- Shared frequencies
- Frequencies for planned radio communication networks
- Frequencies used on the basis of geographical network plans
- Frequencies using preferential codes
- Frequencies used on the basis of arrangements between operators

These categories have a special function for determining the appropriate calculation methods and coordination procedures.

The agreement disposes for those cases when bilateral or multilateral agreement was signed out of this agreement. The Managing Administration uploads a copy of each relevant bilateral or multilateral agreement to the server and informs all other signatories.

- *Frequency Register*

The following section of the first article deals with the Frequency register. The unified usage of the Frequency Register is very important as it is also under the umbrella of the ITU-R. It shall be made up of lists set out by every administration indicating the frequency categories. Every administration prepares as many lists as affected countries they have.

All frequency assignments in the Frequency Register shall be protected according to their status of coordination.

The following parts of the first section of the main text give us the definition of harmful interference and affected administrations:

- *Harmful interference*

Harmful interference is construed as any emission, which causes serious degradation in the quality of the traffic of a radio communication service, or disturbs the service by exceeding the maximum permissible interference field strength specified for the Land Mobile Service or in the case of the Fixed Service exceeding the maximum permissible threshold degradation. Calculation methods for these permissible interference field strengths and its descriptions are given in the annexes of the agreement.

- *Affected administration*

For administrative purposes was defined as the affected administration or country, based on the technical conditions of the affected station. Any administration is an affected administration, whose mobile or fixed station could suffer from harmful interference as a result of the planned use of a frequency, or whose mobile or fixed station could cause harmful interference to a planned receiving station of the requesting administration. In this context the usage of the Frequency Register is necessary.

HCM Programs

The signatory administrations established the Technical Working Group HCM (TWG-HCM) for developing calculation method called HCM (Harmonised Calculation Method) and HCM Program for the harmonised application of the calculation methods as provided in the annexes of the agreement.

The TWG-HCM formulated two special sub-working groups, one for developing calculation method for Land Mobile Services (SWG-MS) and the other for the developing calculation method for Fixed Services (SWG-FS). Based on the result and work of these sub-working groups the Sub-Working Group Program (SWG-Program) develops and maintains both HCM Programs for the Mobile Service and the Fixed Service.

The SWG-Program prepares for each 'HCM Program' the source code, the DLL, the test program (*.EXE) and the program documentation. Every administration is free to use the source code, the DLL, or the test program (*.EXE).

Administrations usually develop a surrounding program including and running the official version of the HCM Program (*.DLL) or building and translating the source code into an own developed system in order to prepare a special national administrative and/or technical environment. In case of dispute, the same version of test program (*.EXE) will be used as a reference.

The signatories of the agreement decided to maintain a common home page for the agreement. There are two separate parts of the home page. One is for the public information, which can be accessed by anybody outside of the agreement and the second is the working area accessible by username and password for the members of the groups.

In the public area, one can access the text of the agreement, the results of the groups, the common tools and databases necessary to run the program or develop and build the surround. The existing database and borderlines available on the HCM-server and further described in the user manual are a basis for bilateral or multilateral agreements. In the protected area, one can access the working documents and detailed information of the groups. The Managing Administration¹⁴ is responsible for the maintenance and registration of the HCM server. (<http://www.hcm-agreement.net/>)

All the provisions of this agreement will apply, making use of the HCM program for the respective service, using a topographical database and border lines. If Administrations decide to use more detailed topographical database and/or border line data, they shall be mutually agreed between Administrations carrying out co-ordinations with each other.

Putting into practice at the same time is critical. A new version of a HCM program has to be implemented by all Administrations at the same point in time to avoid using different versions for different neighbouring Administrations/countries.

¹⁴ Currently the German national regulatory authority, BNetzA.

General

This article summarizes the legal background, conditions of usage of the agreement and discusses the international and inter-governmental provisions, the conditions of putting into operation of stations and conditions that are different from or supplementary to the provisions of the agreement. It proposes solutions for handling services in the cases when the Administration has no responsibility for providing the information and proposes to apply self-modesty instead of using excessive antenna heights and transmitter outputs for both services.

Technical Provisions

This article gives solutions for cases in Land Mobile and Fixed Services for handling the coordination requests and calculating the interference field strength in accordance with the technical provisions. There is a possibility for the Administrations to apply parameters other than the set values.

Procedures

This article summarizes the different cases when the frequency utilization shall be coordinated.

- *Frequencies requiring co-ordination*

For determining the cases of coordination, this section gives cases for the Mobile and the Fixed Services. The necessary calculation method for Land Mobile Service is in Annex 1 and for Fixed Services, Annex 11.

It is strongly recommended to coordinate the receiving frequency if it requires protection in the Land Mobile Service and the radio-relay links in the Fixed Service if the conditions are so.

The next part of this section describes the administrative and technical procedures, the timeframe of the coordination and the flow of putting into or out of operation the coordinated stations. It also gives a procedure to handle accordingly the entries of the Frequency Register.

The following sections of this article give a complete definition and view how to handle the coordination procedures in cases of:

- *Preferential Frequencies*

Definition: Frequencies in the frequency bands defined by prior bilateral or multilateral agreements concluded in the framework of this agreement as preferential frequencies for given administrations.

Using this right the Administration which has been granted a preferential right may put stations operating within the terms of the relevant bilateral or multilateral agreements into use without prior co-ordination.

The detailed technical procedure for applying this condition can be found in Annex 1 and Annex 2A or Annex 2B of the agreement.

- *Frequencies for planned radio communication networks*

Definition: Stations or networks shall be consulted on a technical basis prior to the coordination.

Prior to the coordination of a planned radio communication network, the administrations may embark on a consultative procedure in order to facilitate the taking into operation of this new network. The request for consultation shall include the planning criteria as well as the following data:

- Planned frequencies (transmitting and receiving frequency of the station);
- Coverage area of the entire radio communication network;

- Class of the station;
- Effective radiated power;
- Maximum effective antenna height;
- Designation of the emission;
- Network development plan;
- Antenna characteristics for stations belonging to the network.

The section gives a complete flow and timeframe for the coordination.

- *Frequencies used on the basis of geographical network plans*

Definition: Administrations can prepare and agree on the usage of frequencies based on geographical network plans. These frequencies and their technical parameters shall be entered into the Frequency Register. The procedure of putting into service on the basis of these plans is described in this section.

- *Frequencies using preferential codes*

Definition: Administrations can prepare and agree on the usage of frequencies based on the preferential code groups or preferential code group blocks where the centre frequencies are aligned between the administrations. These frequencies and their technical parameters shall be entered into the Frequency Register.

The procedure of putting into service on the basis of these plans is described in this section. This section tries to handle the exceptions as well.

- *Frequencies used on the basis of assignments between operators*

Definition: Operators in neighbouring countries are allowed to conclude mutual arrangements on the conditions that the Administrations concerned have signed an agreement authorizing such arrangements.

These arrangements between operators may deviate from the technical parameters or other conditions laid down in the annexes of this Agreement or in the relevant bilateral or multilateral agreements between the Administrations concerned.

Evaluation of requests for coordination

Definition: In evaluating the requests for co-ordination, the Administration affected shall take into account the following frequencies:

- Frequencies entered in the Frequency Register;
- Frequencies used on the basis of bilateral or multilateral agreements;
- Frequencies awaiting an answer to a co-ordination request (in chronological order of requests).

This section gives a complete description of the procedure and flow and how to use them based on the methods described in Annex 1 and Annex 2A to the agreement in case of Land Mobile Services, and based on the Annex 9 and Annex 2B to the agreement in case of Fixed Services.

Evaluation in connection with tests

Definition: Administrations can agree on a trial period in case of different evaluation results. They can agree to open the service on a trial basis.

The procedure described in this section can help to increase the efficient use of the radio spectrum and to avoid possible harmful interference.

Additionally the administrations can use the provisions on measurement procedures given in Annex 7 to the agreement.

Exchange of Lists

Definition: Under the provisions of the agreement each Administration shall prepare an up-to-date Frequency Register. The Frequency Register contains lists corresponding to each affected Administration. The Frequency Register shall be exchanged bilaterally at least once every six months.

Report of Harmful Interferences

This article gives a short description of the procedures used in case of observing harmful interference.

Any harmful interference shall be reported to the administration of the country in which the interfering station is located, in accordance with Annex 7 to the agreement. There is a different procedure defined if harmful interference occurs on frequencies entered in the Frequency Register. In this case the administrations concerned shall endeavour to achieve a mutually satisfactory solution as soon as possible.

Revision of the Agreement

This article summarizes the conditions and procedure of expanding or amending the agreement.

Accession to the Agreement

This article gives a short description of the procedure accessioning an administration to the agreement.

Withdrawal from the Agreement

This article gives a short description of the procedure withdrawing an administration from the agreement.

Status of coordinations prior to Agreement

This article describes the statuses of the frequency utilizations for Land Mobile and Fixed Services already agreed between Administrations prior to this agreement being concluded. These frequencies shall be recorded in the Frequency Register.

Languages of the Agreement

In this article, it is declared that the original agreement exists in the English language and will be translated into French and German, each version being equally authentic.

Entry into force of the Agreement

This article contains the time of entering into force of the agreement.

Revocation of the Agreement agreed by correspondence in 2008

This article overrules the previous version of the agreement and declares that the bilateral and multilateral agreements concluded within the framework of previous versions of the agreement remain valid.

3 Annexes to the HCM Agreement

The annexes for the Land Mobile and the Fixed Services contain the technical provisions necessary to use for determining the interference field strength and the triggers for coordination. A short summary of the annexes relevant for the Land Mobile and the Fixed Services are as follows.

Annexes related to the Land Mobile Service

Annex 1 Maximum permissible interference field strengths and maximum cross-border ranges of harmful interference for frequencies requiring co-ordination in the Land Mobile Service

Definitions, conditions and the tools are given in Annex 1 for determining the maximum permissible interference field strengths and maximum cross-border ranges of harmful interference for frequencies requiring co-ordination in the Land Mobile Service. These tools help to determine the cross-border range of harmful interference, the limitation of the interference caused by transmitters, and the limitation of protection of receivers.

Annex 2A Data exchange in the Land Mobile Service

Media and data storage method, transmission media and definition of the fields are given in the first part of Annex 2A. The next section of Annex 2A contains different appendices for defining, determining and describing the follows:

- File structure
- Record description file header for Land Mobile Service
- Data table description
- Frequency categories
- Class of station
- Nature of service
- Category of use
- Abbreviations and codes normally used when the name of the station exceeds 20 characters
- Status of coordination
- Polarization symbols used to indicate polarization

Annex 3A Determination of the correction factor for the permissible interference field strength at different nominal frequencies in the Land Mobile Service

In Annex 3 the correction factor for the permissible interfering field strength causing the interference and the receiving channel experiencing is determined by means of tables and curves.

Annex 4 Propagation curves in the Land Mobile Service

In calculating the interfering field strength at the receiving site, the propagation curves used are in accordance with Recommendation ITU-R P.1546.

The propagation curves represent the interfering field strength values for 50 % of the locations and for 50 %, 10 % and 1 % of the time for different propagation paths and for a receiving antenna height h_2 of 10 m. The curves are given for values of h_1 of 10, 20, 37.5, 75, 150, 300, 600 and 1200 m.

The propagation curves for the frequency 100 MHz shall be applied if frequencies between 29.7 and 300 MHz are concerned. The propagation curves for the frequency 600 MHz shall be applied if frequencies between 300 and 1000 MHz are concerned. The propagation curves for the frequency 2000 MHz shall be applied if frequencies between 1000 and 3000 MHz are concerned.

Annex 5 Determination of the interference field strength in the Land Mobile Service

In Annex 5 is described a complete set of definitions and methods for determining the interference field strength in the Land Mobile Service considering the frequency, distance, antenna height, terrain irregularity, terrain clearance, different interference situations, the factors which are necessary for the calculations (h_{eff} , Δh , terrain clearance angle, mixed path propagation model, Fresnel ellipsoid, free space field strength, antenna diagrams, correction factors, inter and extrapolation techniques.

Annex 6 Coding instructions for antenna diagrams in the Land Mobile Service

In Annex 6 for the describing of the characteristics of antenna diagrams for the co-ordination procedure a character string was defined. This character string (000XX00) gives description for the following cases:

- For the antenna diagrams of groups EA, EB, EC, DE and LA
- For the antenna diagrams of groups CA, CB, CC and KA,
- For the antenna diagrams of group TA,
- And for the antenna diagrams of group Px.

The diagrams are in the appendices of the Annex 6 to the agreement.

Annex 7 Provisions on measurement procedures in the Fixed Service and the Land Mobile Service

In Annex 7 are defined the provisions on measurement procedures and three different cases were defined for measurement:

- in cases of disagreement concerning the results of evaluation related to a specific coordination request
- to facilitate the enhancement of existing networks
- in cases of harmful interference between coordinated links

The Monitoring Services have to work closely together on the basis of internationally agreed measurement procedures and the measurements shall be made according to the latest version of the relevant CEPT/ECC/ERC Recommendation.

Annex 8A Method for combining the horizontal and vertical antenna patterns for the Land Mobile Service

In Annex 8A there is a description of how to calculate the 3-D antenna radiation pattern from the following input data of the Tx and Rx antennas. In cases of using antennas having additional electrical tilt, it can simply be applied to the resulting vertical offset. The resulting horizontal and vertical offset, the values for horizontal and vertical attenuation can be calculated according to the relevant antenna codes.

Annexes related to the Fixed Service

Annex 2B Data exchange in the Fixed Service

Media and data storage method, formats, transmission methods (e-mail, FTP, HTTPS), transmission media and definition of the fields are given in the first part of Annex 2B. The next section of Annex 2B contains different appendices for defining, determining and describing the following:

- File structure
- Record description file header for the Fixed Service
- Data table description
- Frequency categories
- Class of station
- Nature of service
- Category of use
- Abbreviations and codes normally used when the name of the station exceeds 20 characters
- Status of co-ordination
- Polarization symbols used to indicate polarization
- Maximum capacity of the link
- Table of default values of transmitter spectrum masks and receiver selectivity masks
- Table of default values for co-polar and cross-polar antenna radiation pattern

Annex 3B Determination of the Masks Discrimination and the Net Filter Discrimination in the Fixed Service

In Annex 3B there is a description of the calculation of the Masks Discrimination and the Net Filter Discrimination for the Fixed Service which are based on the relation of two powers. Only the areas are taken into account for the determination of the Masks Discrimination and the Net Filter Discrimination because these powers are represented by areas.

The Masks Discrimination expresses the reduction of the interference power caused by the filter shape of the Transmitter Spectrum Density Mask and the Receiver Selectivity Mask.

The Net Filter Discrimination (NFD) expresses the reduction of the interference power if the transmitter and receiver frequencies are different.

Annex 7 Provisions on measurement procedures in the Fixed Service and the Land Mobile Service

In Annex 7 are defined the provisions on measurement procedures and three different cases were defined for measurement:

- In cases of disagreement concerning the results of evaluation related to a specific coordination request
- To facilitate the enhancement of existing networks
- In cases of harmful interference between coordinated links

The Monitoring Services have to work closely together on the basis of internationally agreed measurement procedures and the measurements shall be made according to the latest version of the relevant CEPT/ECC/ERC Recommendation.

Annex 8B Method for combining the horizontal and vertical antenna patterns for the Fixed Service

In Annex 8B was given a calculation method for combining horizontal and vertical antenna patterns for the Fixed Services considering the line of sight and trans-horizon path parameters.

Annex 9 Threshold Degradation in the Fixed Service

In Annex 9 was defined the threshold of a radio receiver as a level of the wanted signal received for a given Bit Error Rate (BER). In presence of an interfering signal, the level of the received wanted signal must be increased to preserve the same BER.

For a given BER, the difference between the increased threshold level value due to interference and the threshold value without interference is the Threshold Degradation (TD).

Using these definitions in Annex 9 calculation methods were given for determining the Permissible Threshold Degradation and the Threshold Degradation.

Annex 10 Determination of the basic transmission loss in the Fixed Service

In Annex 10 was given the calculation method for determining the basic transmission loss in Fixed Services.

The prediction method provided in this chapter is based on the Recommendation ITU-R P.452-13. The procedure is appropriate to radio relay links operating in the frequency range of about 0.7 GHz to 50 GHz.

Annex 11 Trigger for co-ordination in the Fixed Service

In Annex 11 was given a prediction method for determining the coordination distance as a trigger for coordination in the Fixed Service.

4 Programs for the different services

For both services, Land Mobile and Fixed, a separate calculation program is developed.

As it is described in the agreement the SWG-Program prepares for each ‘HCM Program’ the source code, the *.DLL, the test program (*.EXE) and the program documentation. Every administration is free to use these outputs.

On the home page of the agreement both programs have a separate directory structure containing the following information:

HCM-MS program

- HCM program versions (official, old and test versions)
- Tools
- Known errors
- Special table, containing the history of the versions
 - Program version
 - Solved problem(s) or new features

- Date of the test phase (start and end)
- Date of the official use (start and end)
- Program documentation
 - HCM-MS User Guide (basic information for installing the program and using the different calculation methods, Questions and Answers, special cases, etc.)
 - HCM-MS program documentation (description of calculation methods, common subroutines, storage formats for height, morphological and line data, error codes, etc.)
 - Revision history of different parts of the program (DLL, interface to the HCMMS DLL, etc.)
 - List of error codes and Info
 - Test program (*.EXE)
- Source code

HCM-FS program

- HCM program versions (official and old versions, DLL)
- Tools
- HCM_FS_Versions.doc
- Program documentation
 - HCM-FS program documentation (basic information for installing the program, the information for Windows and Linux version, definition of different data types, directory structure, flowcharts of calculation methods, error codes, storage formats for height, morphological and borderline data,...)
- Source code

The HCM-MS was made on the FORTRAN platform, the HCM-FS was developed on FORTRAN and also on Linux platform.

5 Data assisting the coordination calculations

Three sets of data required for the interference calculations.

Terrain height data

The height data comes from different sources possibly from military sources and some data from national geographic institutes. As a common possibility standardizing the source is to get terrain height data from GTOPO30. This data is free and available at the Internet, but the resolution is 30 seconds (approximately 1 km). GTOPO30 data converted to the HCM format are available at the Internet site of the HCM Agreement (<http://hcm.bundesnetzagentur.de>).

A second possibility is to use the SRTM3 topo data, converted to HCM format. This data has a resolution of 3 seconds by 3 seconds but it is only available for latitudes from 61S to 61N. This data is measured from the space and therefore all heights are not the heights above sea level, but the heights include the morphology (e.g. heights of buildings, forests, etc.). This data is also available on the Internet site of the HCM Agreement.

The HCM terrain height data has a resolution of 3 seconds in the North - South direction and 3 or 6 seconds in the East – West direction (depending on the latitude). If the latitude is less than 50 degrees (North or South), the resolution is 3 seconds. If the latitude is greater or equal to 50 degrees, the resolution is 6 seconds. All source data has to be converted to WGS84 format and to the above-mentioned resolution. Data from different sources needs to be combined to a common database covering all HCM Agreement Signatory countries (plus an additional range of approximately 100 km). (The storage format of the height data can be found in the document of HCMMS_V7_Rev3b.doc on the website of the agreement).

Morphological data

The morphological data required for the HCM programs is provided by the TWG-HCM SWG-Program (Technical Working Group Harmonised Calculation Method Sub-Working Group Program) and is available at the Internet site of the HCM Agreement (<http://hcm.bundesnetzagentur.de>). The data is elaborated using GTOPO30 data (see Chapter 6 of HCMMS_V7_Rev3b.doc).

The morphological database is a raster database with the same grid and structure as the terrain height database (see Chapter 6 of HCMMS_V7_Rev3b.doc). Each entry consists of two bytes, one for the predominant height of the surface (trees, buildings) and one for the class of the morphology information.

Because each grid point represents an area of 3 x 3 (3 x 6) seconds, more than one class of morphology is possible, e.g. a part is buildings, and another part is trees. In those cases there are different heights for this area. It is possible to define more than one class, but only one height. (The storage format of the morphological data can be found in the document of HCMMS_V7_Rev3b.doc on the web site of the agreement).

The class of morphology consists of one byte. Therefore 8 different classes (bits) are possible. For the Fixed Service land, sea and coastal area are required, for the Land Mobile Service only land and sea are required.

Line data

For distance calculations, field strength predictions and calculation of the position of a mobile, the following geographical data are required:

- Borderlines to involved countries,
- Cross-border lines according to the Annex 1 of the agreement,
- X-km lines for preferential frequencies (for own and foreign preferential frequencies).
- Closed borderlines of the own and of the involved countries (for calculation of the position of mobiles).

(The cases and the storage formats of the line data and the calculation methods can be found in the document of HCMMS_V7_Rev3b.doc on the web site of the agreement).

GAP ANALYSIS

1 Existing multilateral cross-border frequency coordination agreements

The study carried out in the four regions demonstrates clearly that there are hardly any comprehensive multilateral cross-border frequency coordination agreements in Sub-Saharan Africa. The few existing ones are limited to a few countries in West Africa, one in Central Africa between Cameroon and Chad and the MoU in the SADC region.

There are significant differences between the existing multilateral cross-border frequency coordination agreements in Africa - where they exist – and the framework in Europe. Table 14 below shows the difference between the existing framework in Sub-Saharan Africa and Europe.

The situation in Sub-Saharan Africa is characterized by the absence of a uniform model of an agreement. As previously pointed out, the only agreements that exist are the ones in West Africa and the MoU in SADC. In contrast the HCM for Europe creates an attractive framework for effective cross-border frequency coordination.

Moreover, the current agreement in Europe has evolved with time and a lot of experience has been gained amongst the users of the system.

The table below shows the difference between the environment in Europe and Sub-Saharan Africa.

Table 14: Difference between the environment in Europe and Sub-Saharan Africa

Item	HCM Europe	Sub-Saharan Africa
Framework for cross-border frequency coordination	Exists within the HCM for Europe	No comprehensive framework within Sub-Saharan Africa
Type and level of cross-border interference	Limited and low level interference due to mechanism for interference resolution in place	High level in some countries particularly in Central Africa; low in some cases because of frequency channelling arrangements
Interference Measurement	Set of Definitions exist for determining interference field strength	No such definitions exist
Administrative Procedures	Common Administrative Procedures exist within the HCM for Europe	Individual administrative procedures exist in most countries but vary from country to country. Exception is SADC where there is limited common administrative procedures within the region
Technical Procedures	Exists within framework of HCM	None existing
Technical parameters e.g Interference level permissible, correction factor, trigger for coordination	All defined within framework of HCM for Europe	Depends solely on ITU
Coordination Agreements	HCM Agreement in place	None in place, except in Southern Africa where the CRASA MoU exists
Coordination Register	Exists	Non existing in most countries
NTFA	All have published NTFA	Most have but some needs updating
Regional Table	Exists	Only SADC has a regional Table but most SADC countries are yet to adhere to this

Item	HCM Europe	Sub-Saharan Africa
Data exchange	Uniform format used in the context of HCM for Europe – see Annex 2A of HCM	No standardised format
Propagation Model	Propagation Curves standardized according to ITU Rec ITU-R P.1546	Not standardised
Measurement procedures	Provisions for measurement clearly stipulated in the HCM	No uniform provisions applicable
Types of services covered in the Agreement	Land Mobile and Fixed Service	no agreement yet, except in SADC which addresses cross-border spill-over of public land mobile (PLM) systems, fixed wireless access (FWA) systems and other radiocommunication systems
Frequency Register	Exist	Does not exist
Capacity to manage	Capacity exists	Inadequate capacity

2 Coordinated needs of Sub-Saharan Africa

In order for Sub-Saharan Africa to adopt a Harmonised Calculation Method, it is necessary to ensure a high level commitment by all the concerned countries and a suitable platform established to manage the system.

The first step that would need to be taken would be to present the results of the study to the countries concerned for validation. This validation process would also be used to update any further developments on cross-border initiatives within the region as well as updating of the data used as raw inputs for the study.

As soon as the study report is validated, it would be necessary to create a special technical working group to prepare the draft Agreement as well as the modalities for implementation and the financing mechanism. The working group will need to prepare the legislative framework, the model Agreement taking a cue from the experience from Europe and adapting it to Africa. For example, the need to include broadcasting services must be taken into account.

Given the leading role that the regional regulatory agencies have played in promoting initiatives to achieve effective cross-border frequency coordination, it would be essential that they constitute the key driver for this initiative and that adequate resources are deployed for the successful execution of the project. However their action would greatly benefit from the support and legitimacy of a pan-African organisation with a mandate in telecommunication policies and regulation coordination and harmonisation like the AU Commission ATU and the African Broadcasting Union (ABU). Working under the aegis of one or more of these two organisations would ensure that ministries in charge of telecommunication, ICT and broadcasting are also dedicated to the implementation of such project and are committed to provide the backing administrations in charge of spectrum management may need in establishing contacts with their neighbours...

COST-BENEFIT ANALYSIS

1 Purpose of cost-benefit analysis

This section of the report provides a cost-benefit analysis for the introduction of a pan-African agreement on administrative and technical procedures for cross-border frequency coordination in Sub-Saharan Africa using the HCM agreement as a potential solution to be adapted to the needs of the region

The purpose of the cost-benefit analysis is to provide the basis for a decision making by the countries

For the purpose of conducting the cost-benefit analysis, two scenarios are considered:

- Scenario A – the current situation where no HCM4A exists
- Scenario B – the situation where HCM4A is implemented in Sub Saharan Africa

This analysis is based on the cost of acquiring the HCM4A tools and software for the various countries and the benefits to the countries (Government, regulators, and operators).

2 Benefits of a Harmonised Calculation Method for Africa

The benefits of using a Harmonised Calculation Method in Africa can be summarised as follows:

- Common, harmonised administrative procedures for all the countries/administrations involved,
- Common calculation flows, tools and procedures for the most part of the frequency bands and services,
- Not necessary to develop and maintain different technical procedures and parameters,
- Collective work with neighbouring countries on developing and implementing the harmonised policies, common methods, structures, tools, databases and procedures,
- No need for each country to convert between the data provided by neighbouring countries to its own data because the data format would be uniform,
- The time of putting a station or service into operation would be much shorter than currently the case
- The results of the procedures can easily be calculated.
- A common legal framework for cross-border frequency coordination would be created,
- The training provided within the framework of HCM4A would be the same for all participating countries and of course less costly when aggregated over Sub Saharan Africa,
- The efficiency and the security of the management of the spectrum for all participating countries would be higher using the well-defined and developed common tools,
- The aggregated efforts required for developing a common set of tools and procedures for the region would be much less than the aggregated efforts required to develop different tools and different sets of procedures for different countries.
- Better spectrum usage
- Preferential frequencies assigned quickly
- Transparent decisions through mutually agreed assessment procedures
- Quicker interference assessment.

The above benefits are taken into account to the extent possible in the cost-benefit analysis.

3 Estimates of costs and benefits

The Table below identifies the cost components used in carrying out the cost-benefit analysis under the two different scenarios described above. The costs elements have been given for a worst case scenario with the following assumptions which are based on practical experience:

- only 10 participating countries;
- discount of 5% per annum;
- a period of 10 years duration is used for the analysis.

Table 15: Cost-benefit analysis

Item	Without HCM4A	With HCM4A	Without HCM4A	WithHCM4A
Administrative procedures for notification of stations, services and frequencies for different directions, countries or administrations and legal framework	Every country has to prepare build and develop	A common platform	US \$10,000 per country = US\$100,000 for 10 countries and reducing progressively with time	Global cost of \$25,000 for the one group of 10 countries = US\$25,000 and reducing progressively with time
Technical tools and procedures required for calculating for different directions, countries or administrations	Every country has to prepare build and develop	A common platform	US \$10,000 per country = US\$100,000 for 10 countries and reducing progressively with time	Global cost of \$25,000 for the one group of 10 countries = US\$25,000 and reducing progressively with time
Training	Each country will have to prepare its own training module and conduct yearly training on its own	A common set of training Modules and training programme	US\$50,000 per country. For 10 countries = US\$500,000 and reducing progressively with time	One uniform Training programme for all 10 countries = US\$50,000 reducing progressively with time
Experience	Sharing of experience is limited	Sharing of experience is maximised	Not quantifiable	Not quantifiable
Conversion of data formats	This requires efforts in converting data	Practically no effort since data format are same	\$10,000 per year per country	0
Time to install a station	The time of putting into operation a station or service could be much shorter than earlier.	Typical time for putting a station in operation is shortest	3 months	1 month
Efficiency factor in managing spectrum	Relatively inefficient management of spectrum	A more efficient management of spectrum	Not quantifiable	Not quantifiable

It is also assumed that the cost of acquiring the HCM4A software is in the region of US\$25,000 taking into account that the same software would be used by the 10 countries. It may be noted that the second version of SMS4DC (Version 3 Edition 2009) is priced at US\$10,000

SMS4DC is a harmonised, efficient, automated technical administrative tool for spectrum management in developing countries under the brand name SMS4DC (Spectrum Management System for Developing Countries). SMS4DC is a practical, user-friendly tool that is a great advance on the previous ITU spectrum planning product WinBASMS, offering more advanced and powerful functions.

This second version of SMS4DC covers terrestrial fixed, mobile, sound and television broadcasting services in the bands above 30 MHz, including GE-06 as well as satellite Earth stations in space service.

SMS4DC is sold as an integrated software package on CD-ROM, containing the software, a user manual and a digital terrain map of the world.

- Environmental effects,
- Non quantifiable benefits e.g. better service provided to members of the public as a result of limiting interference to acceptable limits and others previously mentioned,
- The possibility of getting the software free of charge from Europe.

Cost Benefit Analysis

Table 16: NPV for group of 10 countries (all costs in US \$)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Preparation/Management of Admin Procedures (without HCM4A)	200,000.00	100,000.00	90,000.00	80,000.00	70,000.00	60,000.00	50,000.00	40,000.00	30,000.00	20,000.00
Preparation/Management of Admin Procedures (with HCM4A)	25,000.00	10,000.00	9,500.00	9,000.00	8,500.00	8,000.00	7,500.00	7,000.00	6,500.00	6,000.00
Preparation of Technical Procedures (without HCM4A)	200,000.00	100,000.00	95,000.00	90,000.00	85,000.00	80,000.00	75,000.00	70,000.00	65,000.00	60,000.00
Preparation of Technical Procedures (with HCM4A)	25,000.00	10,000.00	9,500.00	9,000.00	8,500.00	8,000.00	7,500.00	7,000.00	6,500.00	6,000.00
Training (without HCM4A)	500,000.00	480,000.00	460,000.00	440,000.00	420,000.00	400,000.00	380,000.00	360,000.00	320,000.00	300,000.00
Training (with HCM4A)	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00
Conversion of data format (without HCM4A)	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00
Conversion of data format (with HCM4A)	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00
Procurement of software (without HCM4A)	100,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00
Procurement of software (with HCM4A)	25,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00
Net Cash flow	930,000.00	650,000.00	616,000.00	582,000.00	548,000.00	514,000.00	480,000.00	446,000.00	392,000.00	358,000.00
Discount rate	0.05									
NPV	4,635,342.95									

The cost-benefit analysis has been built using an Excel spread sheet model which shows the input variables (estimated costs and benefits) in the year when they will occur. All estimates are in real terms. It has been assumed that the system will be in place in the year 2013, the earliest year in which it was considered possible to commence the HCM4A leaving one year for Agreement to be reached amongst countries as well as the preparation of the required documentation and development of tools and other materials.

The model discounts all figures back to 2013 (i.e. converts them to Present Value) using the discount rate of 5% per annum which is a conservative figure

All benefits are summed and costs subtracted to arrive at an estimate of Net Present Value (NPV). The input estimates can be varied to test the effect on the NPV in sensitivity analysis. The worst case analysis is presented in this report.

The period over which costs and benefits are estimated and compared is from the end of 2013 to the end of 2022

Because we are comparing Scenario 1 (without HCM4A) and Scenario 2 (with HCM4A), the estimates of costs and benefits used in the cost and benefit analysis are of the difference between the two scenarios.

The costs and benefits which would be the same in both scenarios are excluded from the cost and benefit analysis. As is normal in cost-benefit analysis, “sunk costs” such as the cost of this study and the validation stages are also excluded. For this purpose, the counting of costs will start from 1 January 2013, where a decision would be possible to proceed or not to proceed.

OBSERVATIONS

1 General observations on the assessment survey

The survey has been quite successful in general even if some responses are not complete; the data obtained enabled the study to come out with a concrete representation of the current situation on cross-border frequency coordination in Sub-Saharan Africa.

2 Regional initiatives

ARICEA and CRASA have started a process of cooperation. For instance, they have agreed to undertake a number of activities jointly i.e., management of the effect of spillover signals from neighbouring countries (frequency coordination across borders). CRASA recognizes that harmonisation of radio frequency spectrum use does facilitate frequency coordination across borders and has the added benefit of allowing regional roaming of certain customer devices (e.g. GSM).

SADC and CRASA have gone to the extent of harmonising radio frequency channelling plans for various fixed and mobile services in different radio frequency bands throughout SADC. Such harmonisation covers 800 MHz to 38 GHz. CRASA also visualizes that harmonisation is also critical from the economic point of view to build an economy of scale and promote regional cooperation and integration. It was found that in the region there is no comprehensive coordination framework that is to say containing administrative procedures and technical considerations.

In general the level of interference experienced by countries in Southern Africa does not seem to be high. That could be the reason why there are no proper procedures in place to address the resolution of interference.

Some examples of successful and unsuccessful approaches to handle coordination or interference cases were obtained although the actual information and the number of examples are not significant. However some do and don'ts can be extrapolated from the interferences and coordination experiences.

With the exception of Angola, all the remaining countries clearly have indicated the bands that they require to coordinate with their different neighbouring countries. Possible one of the most important responses since in certain way it constitute the heart of the specifications for the HCM4A.

The responses showed that the majority of the countries do not have a coordination register nor make use of pre-defined frequencies or channels category. Nevertheless, the CRASA MoU divides the bands under consideration into preferred and not preferred assignments

Practically no country has differing data formats for the exchange of relevant information, neither for the different bands or radiocommunication services. In addition the majority have responded that they prefer Internet (email), and CD/DVD as the means to exchange coordination information.

Most of the countries are reasonably equipped to handle interference and frequency coordination cases, although the actual capability of the tools varies from very basic to sophisticated.

Although the process for coordination and resolution of interference exists in the different ITU Broadcasting agreements, it has been found that many countries report interference or spill-over cases between them. Many countries consequently have been requesting that the HCM4A include as well broadcasting. Therefore, it is advisable that ITU considers investigating the reasons why interferences or spillover are occurring and the possible way to sort it out.

In some cases it has not been possible to obtain all the information required but in the next phases of the HCM4A project based on the outcome of this survey it should be possible to confirm or enhance some of the responses.

The **Central African** region suffers from lack of:

- Specialized and active regional cross-border frequency coordination framework.
- Common regional table of frequency allocations.
- Training relating to the mastering of spectrum management software tools.

3 Deficiencies of the existing cross-border frequency coordination frameworks

A number of countries have cross-border frequency coordination frameworks. For example, in East Africa, for the GSM and television digital broadcasting which is applicable among the EAC member states. Tanzania Mauritius and Seychelles use the CRASA agreement for resolving GSM interferences across the border through the adopted framework. However the entire adopted framework do not provide for preferential frequencies, shared frequencies and the register to record the results. The framework focuses mainly on administrative procedures for resolving cross-border interferences.

A number of countries like Sudan, Djibouti, and Eritrea rely on the ITU framework to resolve any interference complaints with the neighbouring countries. This process can be very lengthy and even more challenging particularly when the frequencies in question may not have been registered in the ITU Master Frequency Register

CONCLUSIONS AND RECOMMENDATIONS

1 Establishment of HCM4A

The study has established the need for Sub-Saharan Africa to proceed towards the establishment of a Harmonised Calculation Method for Africa similar to the existing framework in Europe but extended to broadcasting services. The cost-benefit analysis is supportive of this conclusion. This will be beneficial for the countries with advanced tools and experienced staff, but at the same time will raise the know-how of those countries short of staff and capabilities.

2 Strengthening of regional regulators' associations with the support of pan-African organisations

Each of the countries in Sub-Saharan Africa belongs to one or more regional regulators' associations. Among the objectives of these associations are to collaborate on issues pertaining to spectrum management and by extension, cross-border frequency management.

These associations are most relevant in developing coordination frameworks, agreements and harmonised calculations methods. It is therefore recommended that these organizations should play a key role in coordinating the efforts so that each of these regulatory organizations adequately support the individual countries and take into account existing resources

Discussions with these organizations were initiated on how to establish the coordination framework and agreements which will take into account and address issues of preferential frequencies, shared frequencies, frequency register and data exchange format. The framework shall cover Fixed Services, Broadcasting frequency ranges for TV, FM radio and GSM/CDMA frequency ranges.

Nevertheless, tackling these issues on a regional basis will not provide for similar challenges at the borders of these regions. It is therefore advisable to have these regional regulators' associations working on the forefront with the support of an organisation with a pan-African mandate on telecommunication and more specifically on radiocommunication and spectrum management issues. They could benefit from the backing of the Africa Union's Commission and its specialized body the African Telecommunication Union.

3 Review of current agreements

A number of coordination agreements exist within Sub-Saharan Africa. Although they all have practically the same structure, they are not comprehensive enough to ensure effective coordination. They do however present an opportunity for a model Agreement to be developed for the region.

- Definitions;
- Technical provisions;
- Report of Harmful Interference;
- Administrative provisions;
- Coordination Procedures.

4 Towards convergence for all

Most of the countries have a converged regulator (telecommunication and broadcasting) which provide effective management of the frequency spectrum. However, a number of countries are yet to establish a converged regulatory environment. In a few cases, there is an overlap of responsibilities for managing the radio frequency spectrum, which create room for potential conflicts.

It is therefore recommended that those countries that are yet to do so, should take urgent steps to adopt a convergent regulatory framework

5 Engagement of countries and consultation with stakeholders

It is recommended that before the HCM4A is implemented, the results of the study be shared amongst the constituent countries so that their inputs may be further obtained and the results of the study validated to ensure a good basis for decision making.

6 Harmonisation of frequency planning in Sub-Saharan Africa

Harmonisation of frequency allocation across Sub-Saharan Africa has many socio-economic benefits for the region and would bring about economies of scale which would eventually translate to reduced costs of customer devices. It would also promote regional integration. SADC and CRASA have gone to the extent of harmonising radio frequency channelling plans for various fixed and mobile services in different radio frequency bands throughout SADC. Such harmonisation covers 800 MHz to 38 GHz

Efforts should therefore be deployed to achieve a harmonised frequency plan for the whole continent in the short term.

7 Services to be covered by HCM4A

The survey indicates that, the highly recommended radio communication services for cross-border frequency coordination are Fixed Services, Broadcasting for TV and FM radio and GSM/CDMA frequency ranges. The project may start to support developing a pan African agreement on these mentioned services and the corresponding Harmonised Calculation Method,

International Telecommunication Union
Telecommunication Development Bureau (BDT)
Place des Nations
CH-1211 Geneva

E-mail: bdtmail@itu.int
www.itu.int/ITU-D/projects/ITU_EC_ACP/

Geneva, 2013