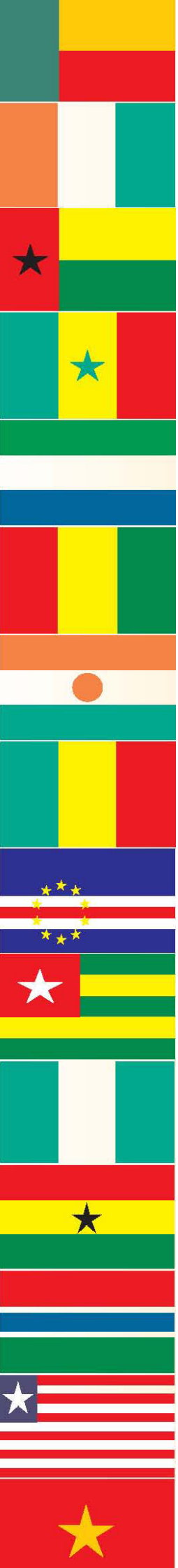
International Telecommunication Union



West African Common Market Project:

Harmonization of Policies Governing the ICT Market in the UEMOA-ECOWAS Space

Radio Spectrum Management

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Radio Spectrum Management

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Foreword

The International Telecommunication Union (ITU) launched a regional project, in cooperation with the European Union, to support the establishment of an integrated ICT Market in West Africa.

The project takes account of the UEMOA and ECOWAS vision for the telecommunications sector, shared by National Regulatory Authorities throughout the region, which is *"to have a single liberalized telecommunications market in the Community, following on the adoption of uniform legislative and regulatory frameworks, and the interconnection and integration of national networks."*

The project was designed based on several Government requests for assistance on Regulatory Reform aiming to harmonize the development of the telecommunications sector in West Africa. As such, it aims to build on existing initiatives and projects from other national, regional and international organizations such as UEMOA, ECOWAS and the World Bank, where applicable. Thus, the project will specifically take into account recent studies and recommendations such as the draft UEMOA Directives and the World Bank−ECOWAS Study on the Harmonization of Telecommunications Policies in ECOWAS. It also aims to build human and institutional capacity in the field of ICT through a range of targeted training, education and knowledge sharing measures.

The project focuses on a number of urgent regulatory issues of concern to the beneficiary countries. It recognizes that some of the constraints towards the objective of a common market are related to telecommunications regulations, but that other social and economic constraints to investment such as lack of information or of appropriate regulations or indeed lack of regulatory certainty also play a role.

The project has five components, namely: interconnection, licensing, management of scarce resources (numbering plan and frequency spectrum management), universal access and model policy and legislation.

Within the framework of the project, best practices and guidelines on various regulatory aspects of ICTs were identified and developed. In the first phase, validation workshops were organized in 2004 on the following regulatory aspects: interconnection, licensing, numbering, spectrum management and universal access/service. Following these workshops, the comments of the participants were incorporated and the documents were revised in order for ECOWAS-UEMOA to have at their disposal a regulatory framework best tailored to their member countries in the era of the Information Society.

The first version of the report on spectrum management was developed by Michel Schaar and presented at the Validation Workshop on spectrum management in Ouagadougou, Burkina Faso, 14-16 December 2004. The report was revised and updated by Dr. Chris Doyle. The present document will be presented to ECOWAS/UEMOA member countries for final approval.[1]

[1] In preparing this report on radio spectrum management, the author benefited from discussions with Professor Martin Cave of Warwick Business School, and Eric Lie and Susan Schorr of the ITU. All opinion expressed is that of the author.

1 Introduction

This EC-ITU report sets out the analysis and policy Guidelines of a review of radio spectrum management in the West Africa ECOWAS/UEMOA region. Spectrum is a limited and valuable resource and is used for all forms of wireless communication, including mobile telephony, radio and television broadcasts, broadband links, aeronautical and maritime navigation, and satellite command, control and communications. Spectrum is used to support a wide variety of commercial and public sector uses and because it cannot support all of these uses simultaneously to an unlimited extent, its use must be managed or coordinated to prevent signal interference.

It is the management of interference that primarily calls for government oversight of spectrum's use. In addition to managing interference, government may also manage radio spectrum through economic regulation, ensuring that supply meets demand and the resource is put to its most effective use.

The total supply of spectrum is fixed, but technology affects the extent to which it can be utilized. Radio spectrum is the portion of electromagnetic spectrum that carries radio waves. The boundaries of radio spectrum are defined by the frequencies of the transmitted signals, and are usually considered to range from 9 kiloHertz (thousand cycles per second) up to 3000 GHz (billion cycles per second).

Electromagnetic Spectrum

Frequency lower bound	Band	Example use
9 kHz	Very Low Frequency	**Long distance radio**
30 kHz	Low Frequency	**Naval broadcast**
300 kHz	Medium Frequency	**Aeronautical communications**
3000 kHz	High Frequency	**Sound broadcasting**
30 MHz	Very High Frequency	**Private business radio**
300 MHz	Ultra High Frequency	**TV broadcasting**
3000 MHz	Super High Frequency	**Radar**
30 GHz	Extremely High Frequency	**Broadband wireless access**
300 GHz	**Not designated**	

The key characteristics of spectrum are the propagation features and the amount of information which signals can carry. In general, the higher the frequency, the lower the propagation distance, but the higher the data-carrying capacity of the signal. These physical characteristics of the spectrum limit the range of applications for which any particular band is suitable, although some spectrum (such as in the UHF band, 300-3000 MHz) is suitable for a wide variety of services and is thus in great demand, such as cellular mobile telephony.

1.1 Spectrum demand in the ECOWAS/UEMOA region

Demand for radio spectrum in the ECOWAS/UEMOA region has grown markedly over the last decade, notably in those frequency bands supporting wireless communications (microwave links,

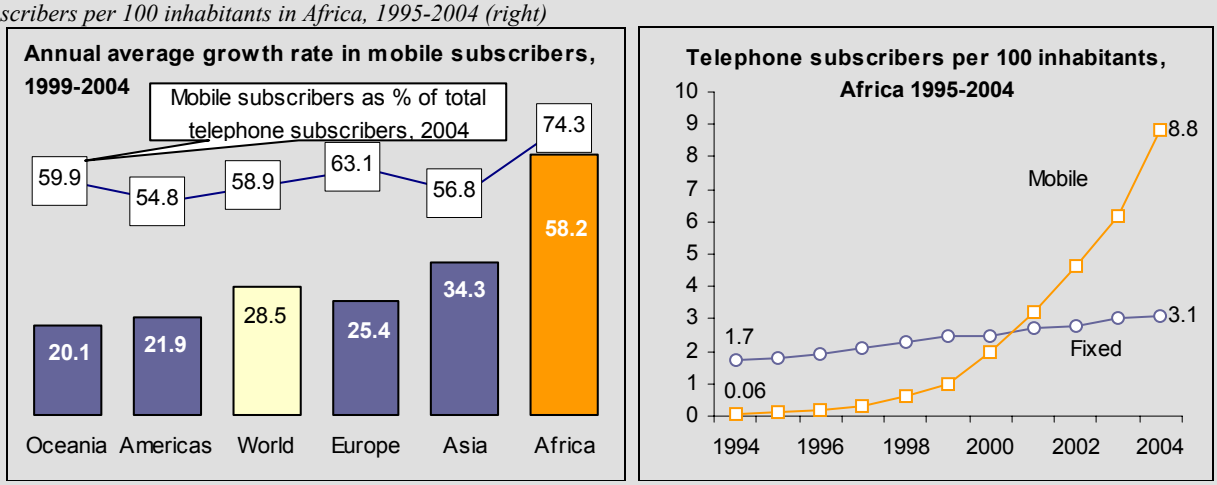
cellular telephony, fixed wireless access, etc.). This is illustrated in Figure 1.1 illustrating the growth in mobile telephony in Africa.[2] As Hamadoun I. Touré, ITU, has stated:

"The growth in telephone access in Africa has been largely fuelled by mobile cellular communications. The change has been so rapid that it has caught many by surprise. From just two countries in 1999, there were 33 African countries that had more mobile than fixed-line telephone subscribers in 2004, more than any other region. The wireless boom has been caused by the combination of sector liberalization—which has seen the licensing of multiple cellular operators in most African markets—and service innovation in the form of pre-paid cards. Africa's challenge is to sustain this high mobile growth and extend it to other sectors such as the Internet."[3]

However, while the growth in radio spectrum usage has been spectacular of late in Africa, and especially in the ECOWAS/UEMOA region, it remains the case that current and foreseeable demands for radio spectrum are unlikely to exhaust available spectrum. The absence of a supply constraint on radio spectrum should enable the countries in the region to foster much needed further developments in the ICT sector. These developments can be further enhanced by promoting a harmonized approach to radio spectrum management.

Figure 1.1: Mobile in Africa

Annual average percentage growth in mobile network subscribers, 1999-2004, world regions (left) and mobile and fixed telephone subscribers per 100 inhabitants in Africa, 1995-2004 (right)



Source: ITU World Telecommunication Indicators Database.

1.2 Managing interference

The majority of countries in the ECOWAS/UEMOA region have in place an apparatus to oversee the management of interference between radio spectrum users and different services. However, a number of countries face major practical challenges in this important area of spectrum management. In some countries the regulation of spectrum use is overly prescriptive and gives rise to inflexibility which can hinder the development of new services which could bolster development. In other countries there is little effective monitoring in practice, even though a framework exists in principle.

2 *African Telecommunication Indicators* 2004, p.1, May 2004.

3 *African Telecommunication Indicators* 2004, p.iii, May 2004.

1.3 Striking the right balance

A challenge for the countries in the region is to move in a direction where government is involved in spectrum use only to the extent necessary. To foster continued investment in new ICT infrastructure, it is necessary for the governments to build credible financial environments, and refrain from appropriation, including where certain users of radio spectrum have been 'taxed' via changed licence terms. Governments can exercise restraint in this area, which would lead to an enhanced environment for investment and stimulate the development of the ICT sectors.

2 Promoting efficient and innovative spectrum use

The principles of regulating access to radio spectrum have remained essentially the same during the history of radio. Spectrum blocks are allocated, through international agreement, to services broadly defined. National regulatory authorities (NRAs) then assign licences for use of specific frequencies within these allocations within their jurisdictions.

Regulation of spectrum is a complex balancing act and there are many conflicting considerations. Key factors include:

- Interference. Transmissions interfere unless sufficiently separated in terms of frequency, geography or time. Regulators must strike a balance between reducing the extent of harmful interference, through careful planning, and enabling new and potentially valuable new services to enter the market.
- International co-ordination. The effective use of radio spectrum in any single country in the ECOWAS region will typically require careful co-ordination with neighbouring countries, to mitigate the extent of harmful interference. Governments must weigh up the benefits of co-coordinated and harmonized use of spectrum across the region against the constraints which this imposes on spectrum management in an individual member state.
- Investment in equipment. Most radio equipment can operate over only a limited range of frequencies, and so relies on predictable access over time to defined frequency bands. Stability in spectrum assignments to encourage investment in equipment can slow the pace of spectrum re-use. Increasingly, technical specifications are determined internationally to reap economies of scale in production. National regulators need to balance stability and international harmonization with responsiveness to new technologies.

Technological developments have opened up the range of useable radio spectrum, so enabling ever-greater access to new allocations and assignments. In the ECOWAS region demand for radio spectrum has changed markedly in recent years with the expansion in wireless communications and is expected to continue. The change in the market place is often outpacing the ability of NRAs to respond.

In high-income countries spectrum managers are being called upon to devise procedures to ration current and future demand for radio spectrum between competing commercial and public service users. To do this centrally requires detailed knowledge of supply and demand trends, technology developments, and the relative value to society of alternative services. This represents a formidable central planning task, which is now growing beyond the scope of any regulatory body, no matter how well staffed and managed. As a result, in high income countries NRAs are becoming less able to accumulate and assimilate sufficient information to make a correct assignment of spectrum to optimise use over time.

2.1 The objectives of radio spectrum management

Spectrum is a finite but non-exhaustible resource which is a vital input into an ever widening range of services. The utility of the resource depends crucially on the management of interference from

competing users. This has been, and will continue to be, the primary role of the agencies responsible for national spectrum management authorities in the ECOWAS/UEMOA states. But the value derived from the use of radio spectrum also depends on the ability of the system to accommodate shifting demands for spectrum use driven by market changes in technology and consumer preferences.

3 International regulatory framework

The very nature of radio spectrum, the pervasive and trans-national nature of radio signals, demands that, in the first instance, its use is considered at an international level. The regulation of radio spectrum has evolved within an increasingly involved international framework, operating on several multilateral and bilateral dimensions.

3.1 Global and regional regulatory framework

The global regulatory framework is provided by the International Telecommunication Union (ITU). In some parts of the world regional bodies also play a role. In Europe the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) provides the regulatory framework, which in many ways reflects the role of the ITU. Within the European Union, the European Commission also has an increasingly significant regulatory influence. In addition to governmental organizations, the European Telecommunications Standards Institute (ETSI), an industry-led organization, plays an important role in developing European standards for telecommunications (including radio) services and equipment.

The main priorities of the ITU's regulation of radio spectrum are:

- to protect against harmful interference;
- to allocate radio services to the various radio frequency bands in the radio spectrum (including globally harmonized allocations for systems used in international air and sea travel), taking account of sharing and compatibility studies; and
- to promote the effective use of the spectrum and the geostationary orbit.

An important way in which the ITU facilitates the avoidance of harmful interference between countries is by a system of registration and co-ordination for notified stations and/or radio systems by member states.

The radio spectrum is used for a variety of radio communications applications. It is used for terrestrial based services as well as satellite applications. These involve a variety of configurations: for example, point to area configurations such as mobile, fixed wireless access and broadcasting, and point to point configurations such as radio relay and fixed satellite systems. Some of these systems are constrained to certain parts of the spectrum, because of the different propagation characteristics of signals at different parts of the spectrum. For example, land mobile applications at present are best suited to the spectrum below around 3 GHz.

In carrying out its remit, the ITU has, over a number of decades, developed:

- definitions of various discrete radio communications services, such as mobile, fixed, fixed-satellite, mobile-satellite;
- a table of allocations identifying one or more radio services (typically two to four) to each frequency band; and
- regulations and recommendations outlining the broad conditions under which NRAs should plan the deployments of these services in their jurisdictions.

Services are allocated on a primary or secondary basis, which in turn confers a certain hierarchy. Current systems in a primary service will be protected from interference from subsequently implemented (registered) systems using primary allocations. Systems operating in a secondary allocation must not cause interference to, and will not be protected from, interference from, current or future primary services, but can claim protection from future secondary services.

4 Interference management

4.1 Introduction

The main motivation for managing radio spectrum has been interference oriented. To minimize interference across different applications, most frequency bands have in all countries been allocated to certain uses (e.g. aeronautical, maritime, defence, broadcasting, etc.). Much of spectrum management involves overseeing that frequencies are being used by the correct applications. Additionally, interference between different users within a frequency band also needs to be managed. There is also an international dimension to interference management, as radio waves do not respect national boundaries.

For interference management to be effective, it may be necessary for a regulatory agency to deploy considerable resources for monitoring purposes. In West Africa, human resources trained in spectrum management are currently scarce, interference management could therefore be a potential costly activity. This naturally raises questions about the scale of interference management required, and whether interference management could be delegated to users of radio of spectrum.

Experience in other countries suggests that interference management of radio spectrum should allow for greater flexibility in use and permit more customer led innovation.

4.2 Interference issues

Radio-based communications systems, unlike wired communications, involve signals being transmitted and received that travel at least a significant portion of their path in free space. This is clearly an essential characteristic in certain applications such as mobile phones, satellite communications, and broadcasting. The main disadvantage however is that transmission over free space means that stray signals from one radio communications system can easily interfere with the proper reception of another.

Interference is unavoidable and ever present. The impact of excessive interference ranges from simple inconvenience to individual users to, on occasions, the undermining of the commercial viability of networks suffering interference. At the very extreme, it can have ‘safety of life’ implications, for example where radio systems used by the emergency services suffer interference. Furthermore radio signals do not respect national borders. Thus, if not properly managed, signals emanating from one country can unduly interfere with systems in other countries.

Interference, whether local, regional or international, is a key factor rendering the radio spectrum a scarce resource. NRAs throughout the world have therefore regarded it as one of their central duties to ensure both an acceptable interference environment as well as maximizing the (technically) efficient use of the available spectrum. This has resulted in a significantly regulated environment in radiocommunications, with the vast majority of NRAs in the world retaining close control on deciding both the type of permitted services and which organizations should be licensed to operate in a given frequency range. While this has undoubtedly resulted in a well managed environment, the drawback is a general lack of speed in the licensing of systems and refarming of spectrum from one use to another to respond to technological and market developments. Thus it could be argued that some of the technical efficiencies gained in spectrum utilization as a result of careful and lengthy planning are offset by the economic costs of ‘downtime’ in the planning process.

It is the job of radio planners, both at the regulatory and individual operator level, to ensure that the radio systems are properly planned so that the interference levels are within acceptable limits. In simple terms, interference management entails ensuring that the received signal strength from the wanted transmitter exceeds the aggregate of the incident interfering signal strength from other transmitters and noise, by at least a predefined margin. This can be achieved by separating the system in question from other potentially interfering systems. This separation can be achieved in one or more dimensions: frequency, spatial, time and signal separation.

The trend in some countries, notably Australia, Guatemala, New Zealand, UK and the US, has been towards an approach permitting greater flexibility and market orientation of spectrum management by shifting the balance of the responsibilities for interference management further towards users. In achieving this, there are three important prerequisites:

- public availability of a core set of technical and locational information about all other systems sharing a given frequency band;
- a common understanding, or set of criteria, relating to interference thresholds (acceptable levels of interference) and the calculation of interference; and
- a system for resolving interference problems, which includes monitoring and enforcement arrangements.

4.3 Coordination of radio spectrum use

There are three main aspects to coordination of radio spectrum use: intra-service co-ordination, inter-service coordination and international coordination.

4.3.1 Intra-service coordination

This involves the planning of different systems in the same service category sharing frequencies in the same band. NRAs tend to use a combination of two basic approaches in their frequency assignment and licensing activities: central management, and self-management by operators.

The central management approach involves the NRA directly managing a central pool of spectrum. Operators apply to the NRA for a frequency assignment and licence on case by case, geographical or ‘first come, first served’ bases. This method of management is common for certain types of radio systems (e.g. fixed links, fixed satellite earth stations). It has the advantage that a central body is able to facilitate the re-use of frequency channels by licensing individual channels to multiple operators, by careful central planning of the spectrum resource. However, disadvantages include the loss in spectral efficiency due to the need to use generic technical information which is applicable to all users, and the rigidities inherent in any central regulatory system.

Under a self-management approach, the NRA packages a number of frequency blocks by detailed pre-planning of the overall frequency band. These frequency blocks are then offered to potential users, via comparative selection (‘beauty contests’), auctions or on a first-come first-served basis by the NRA. This approach is often adopted for services which entail area coverage (e.g. cellular and broadcasting systems). NRAs may sacrifice some spectrum efficiency, initially in their pre-planning work (due to the need for planning margins). However, this method allows operators to maximize the utilization of their individual licensed spectrum by using equipment-specific information from their own suppliers. Also, managing their own spectrum offers operators the advantage of speedy rollout of networks.

4.3.2 Intra-service coordination

In some cases operators are licensed in frequencies which are shared with other services. For example, fixed services (e.g. fixed point to point links and fixed wireless access) often share spectrum with fixed satellite services. Such inter-service co-ordination can be expedited centrally or

via delegated means. Where the spectrum for both services requiring co-ordination is managed by the NRA, the necessary work can be carried out by the regulator. Less formal bilateral co-ordination between third parties can also occur, which often helps to speed up proceedings in formal processes.

4.3.3 International coordination

Interference management between systems in different countries is handled via two related routes: ITU initiated co-ordination and direct bilateral (or multilateral) co-ordination between countries. WATRA provides a forum to facilitate multilateral coordination of spectrum use.

The ITU route entails a procedure whereby all Member States register the details of the systems they have licensed with the Radiocommunication Bureau (BR) of the ITU. The BR collates these details and circulates the details to all the other NRAs who may be affected. It is the duty of the individual NRAs to examine these details and submit a request to co-ordinate with any other NRAs which have submitted systems which are likely to interfere with any of their own currently licensed systems.

Such a request to co-ordinate leads to bilateral (or multi-lateral) co-ordinations between the interested parties. At this stage, it is customary for the NRAs to involve the individual users in their jurisdiction who will participate in detailed technical negotiations with their foreign counterparts. It is also possible for individual NRAs to engage in direct bilateral discussions prior to the registration procedure with the ITU.

In performing interference calculations, in any of the above scenarios, planners should endeavour to use system-specific technical information whenever this is available. This invariably produces the most spectrally efficient solution. Where this is not possible, however, more generic information is used. In Europe, performance limits specified in ETSI standards often tend to be used for this purpose. These standards are however a trade-off between spectral efficiency/technical interests, which favour higher performance specifications, and commercial/economic considerations which may imply the reverse. Insufficient consideration to either priority, on the part of standards-making organizations, will undermine the careful balance on which many of the decisions of NRAs are made.

4.4 Challenges for Interference management in the ECOWAS/UEMOA region

The scarcity of skilled personnel to oversee radio spectrum use in the region suggests that interference management should rely on appropriate self-management where possible. The NRAs can concentrate in the short-term on the development of national frequency tables.

The issue of who has jurisdiction over the management of radio spectrum also needs to be addressed in the region. The emergence of independent regulatory authorities overseeing telecommunications is to be welcomed, and it seems appropriate that radio spectrum management powers should be vested in such authorities. As the trend globally is towards regulatory authorities that embrace technological neutrality, it would also seem desirable to broaden the remit of the relevant authorities to include electronic communications broadly defined.

In the short term the management of radio spectrum can be coordinated through the new independent NRAs (see the next chapter for further details).

5 National spectrum management policies

5.1 Introduction

In this chapter national spectrum management policies are outlined for each country. Much of the chapter is derived from ITU survey responses, and from regulators' websites.

5.2 National spectrum management practices

Spectrum management in the region is in different phases of development, with some countries advancing towards international best practice and others struggling to establish a basic framework for policy. The following paragraphs give an overview of the situation of each country in the region as regards the management of radio spectrum and summarize the major issues as identified during the analysis.[4]

BENIN

Governance: Spectrum is allocated by the Ministry (Ministère de la Communication et de la Promotion des Technologies Nouvelles), and day to day oversight is conducted by the newly established ARPT (l'autorité de régulation des postes et télécommunications). At present a frequency band distribution table database appears not to exist. It is unclear who is responsible for the use of spectrum in broadcasting.

Fees: Information about spectrum fees is limited. It is understood that GSM operators pay fees, but information about other users is not known.[5] How fees are levied and collected is not known.

Priorities: Spectrum scarcity is not an issue in Benin. The key priority for the new regulator is to establish a database of spectrum usage.

BURKINA FASO

Governance: ARTEL (Autorité Nationale de Régulation des Télécommunications) is responsible for spectrum management. It is not known to what extent a frequency band distribution table database exists. Spectrum is assigned to large users by auction. Allocation and licensing is the responsibility of the Ministry (Le Ministère chargé des telecommunications). The use of spectrum for broadcasting is managed by ARTEL.

Fees: Spectrum fees account for 45% of the ARTEL's budget.[6]

Priorities: Spectrum scarcity is not an issue in Burkina Faso. A key priority for ARTEL is to establish a database of spectrum usage and to establish principles for setting spectrum fees.

CAPE VERDE

Governance: The regulator, ICTI, (Instituto das Comunicações e das Tecnologias de Informação) is responsible for spectrum management. ICTI is also responsible for broadband spectrum allocation and monitoring.

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4 Information on each of the countries' radio spectrum management regime has not been readily available.

5 There are three GSM operators in Benin (Office des Poste et Telecommunications Benin, SpaceTel Benin, Telecel Benin Ltd) and a fourth that was planned to become operational in 2002 (Bell Benin). Coverage is provided mainly in Porto Novo and along the coastal region. There is some coverage in country as far as Zagnanado, about 100km from Porto Novo.

6 There are two cellular operators in Burkina Faso: Onatel and Celtel. Coverage is largely in towns and the capital Ouagadougou.

Within the framework of spectrum management, ICTI is in charge of:

1. National radio spectrum planning within the framework of international agreements;
2. Frequency assignment;
3. Licensing of all radio communication means, according to Decree-Law nº 71/95, 20 November;
4. Monitor spectrum usage conditions, of licensed activities as well as monitor and fine abusive uses and radio electrical interferences, when necessary;
5. Definition of the legal framework;
6. Coordinate with national and international entities

Fees: Fees are calculated based on power, bandwidth and occupied band. Calculation varies for each type of service, for example, for mobile services the end user terminal number is taken into account. The calculation methodology is set the *Arrêté* nº39/99 of 3o August, Official Gazette nº 31, III Serie, available at: http://www.icti.cv/secteuertelecom.html

Priorities: There is a national frequency band distribution table for the range 27 MHz – 3 Ghz band. It is not known whether spectrum scarcity is an issue.[7]

CÔTE D'IVOIRE:

Governance: The regulator ATCI (Agence des Télécommunications de Côte d'Ivoire) has considerable powers and is responsible for allocating and managing spectrum. Almost 70% of the ATCI budget derives from spectrum fees, and a further 9% from auction fees applied on mobile licences.[8] Broadcasting spectrum is managed by CNCA (Le Conseil National de la Communication Audiovisuelle).

Fees: Spectrum fees are levied. Spectrum is awarded on demand.

Priorities: It is not known whether spectrum scarcity is an issue.

THE GAMBIA

Governance: The regulator PURA (Public Utility Regulatory Authority) was established in 2004 and derives its funding from a 1.5% levy on the turnover of operators. It is jointly responsible for spectrum allocation with the ministry (Department of State for Communications, Information and Technology). Broadcasting spectrum appears to be managed by the ministry.

Fees: It appears that spectrum fees are not levied.[9]

Priorities: It is not known whether spectrum scarcity is an issue.

GHANA

Governance: The regulator NCA (National Communications Authority) is responsible for spectrum allocation, and it derives 46% of its funding from spectrum fees. It is also responsible for overseeing broadcasting spectrum. Spectrum is assigned on a first come, first served basis. NCA

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7 There is a state owned cellular operator called Cabo Verde Telecom, which provides coverage to towns on the inhabited islands.

8 There are two cellular operators: Loteny and Orange CI, using the 900 MHz frequency range. Coverage is mainly provided in urban districts and some coastal areas.

9 There are two cellular operators Africell and Gamcell, providing good coverage in Banjul and in towns inland. Various licenses have also been granted to ISPs and to certain entities for the use of VSATs.

has a well organized and clear website outlining its spectrum management policies and providing access to application forms for spectrum licences. There is also information available about spectrum assignment in key bands, such as cellular telephony and VHF broadcasting.

The mission of the NCA in spectrum management is stated as:[10]

- Long-term spectrum management policy and planning to determine and periodically update the existing and future requirements for the various radio communications services. It is on the basis of this that long-term national policies are established and necessary studies in the field conducted, bearing in mind the national priorities.
- To assign, allocate and regulate the use of frequencies for operations in land Mobile, Marine, Aeronautics, Terrestrial, Satellite Broadcasting and all related services, in conformity with international requirements, pursuant to any relevant treaties, protocols or conventions to which Ghana is a signatory, and also ensure electromagnetic compatibility of all proposed or requested assignments with regard to existing assignments on a national or international basis. It is also responsible for related actions necessary to protect the country's radio communication systems from potential interference from another country's assignments. Once a frequency has been assigned to a transmitting or a receiving station, all the technical and operating data indicating the spectrum space occupied by this assignment is entered in the national frequency register. This register not only serves as a reference when subsequently selecting other usable frequencies but also provides the basic material for taking effective measures required to adapt national planning.
- Impose fines, penalties and sanctions for any violation of spectrum rules in order to maintain discipline in the use of the spectrum.
- Record-keeping activities are involved in almost all functions of frequency management. Accurate and up-to-date records are of utmost importance for effective national and international coordination, licensing and enforcement activities, policy formulation, investigations on interference and resolution, and financial considerations.
- Radio monitoring. The Authority carries out inspection of installations to ensure that stations and companies comply with the relevant provisions of the NCA Act 524, NCA Regulations, and Ghana Telecommunication policy those of the national legislation, which are indicated in the terms of the licence. It also checks technical equipment to ensure that they are operated in conformity with the required standards and conditions.

Fees: Spectrum fees are levied, though their structure is not known.[11]

Priorities: It is not known whether spectrum scarcity is an issue.

GUINEA

Governance: The regulator DNPT (Direction Nationale des Postes et Télécommunications) is jointly responsible for spectrum allocation with the ministry (Ministère de la Communication).

Fees: It is not known whether spectrum fees are levied.[12]

Priorities: It is not known whether spectrum scarcity is an issue.

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[10] Source: http://www.nca.org.gh/ncatemp/spectrum_freq_mana.asp.

[11] There are three cellular operators Ghana Telecom, Millicom and Scancom, all operating in the GSM 900 MHz range. Coverage is good in Accra and the coastal areas, and in some towns.

[12] There are three cellular operators in Guinea: Lagui, Spacetel and Telecel all operating in the 900 MHz frequency range.

GUINEA BISSAU

Governance: The regulator ICGB (Institut des Communications de la Guinée-Bissau) is responsible for spectrum allocation. It derives 62% of its funding from the application of spectrum fees. Broadcasting spectrum is managed jointly with the Ministry (Ministère de la Communication Sociale). Spectrum is assigned via public agreement and on a first-come, first-served basis.

Fees: Spectrum fees are levied.[13]

Priorities: It is not known whether spectrum scarcity is an issue.

LIBERIA

Governance: The Ministry of Posts and Telecommunications regulates spectrum, though plans are in place for an independent regulator.

Fees: It is possible that spectrum fees will be levied on GSM licence holders.[14]

Priorities: It is not known whether spectrum scarcity is an issue.

MALI

Governance: The regulator CRT (Comité de Régulation des Télécommunications) oversees spectrum management, and derives 49% of its income from spectrum fees. Broadcasting spectrum is regulated by the ORTM (Office de Radiodiffusion et de Télévision du Mali).

Fees: Spectrum fees are levied.[15]

Priorities: It is not known whether spectrum scarcity is an issue.

NIGER

Governance: The ministry DRPT (Direction de la Réglementation des Postes et Télécommunications) is understood to regulate spectrum, in conjunction with the ARM (Autorité de Régulation Multisectorielle).

Fees: It is not clear whether spectrum fees are levied.[16]

Priorities: It is not known whether spectrum scarcity is an issue.

NIGERIA

Governance: The regulator NCC (Nigerian Communications Commission) oversees spectrum management. The regulator has articulated detailed plans for spectrum management, and overseen auctions of spectrum for cellular telephony and fixed wireless access. It is unclear who has jurisdiction over broadcasting spectrum.

As part of continuing efforts to provide efficient management of the radiofrequency spectrum in Nigeria, the NCC is currently putting in place a modern Spectrum Management and Monitoring

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13 There are two cellular operators in Guinea-Bissau: Guinetel (not operational) and Spacetel operating in the 900 MHz frequency range.

14 There are four cellular operators in Liberia: Atlantic Wireless (Libercell) on the 900 MHz frequency, Cellcom on 900/1800 MHz, Comium (planned) on 900 Mhz, and Lonestar on 900 MHz. Coverage is good in and around Monrovia and in a few other towns. The issuing of licences to GSM has been controversial.

15 There are two cellular GSM operators in Mali: Ikatel and Malitel operating in the 900 MHz frequency range. Coverage is good in the capital Bamako, and in a few other towns.

16 There are three cellular GSM operators in Niger: Celtel, Sahel and Telecel operating in the 900 MHz frequency range. Coverage is limited to only a few areas.

System (SMMS). As part of the SMMS implementation, detailed information is required about current and continuing utilization of frequencies assigned to telecommunications operators, equipment operating on those frequencies and sites/locations where they are deployed, etc. The information is required for creating a database on the utilization of frequencies and associated information that will be constantly updated. The records will provide an invaluable resource for (i) facilitating resolution of interference; (ii) spectrum planning, policy; and (iii) the overall spectrum management strategy of the NCC.

Fees: Spectrum fees are levied at the assignment stage for major licences and on a recurring basis for other licences. There is also a geographical zoning method for certain classes.[17]

Priorities: It is not known whether spectrum scarcity is an issue, though rapid growth in services may soon lead to congestion in certain bands.

SENEGAL

Governance: The regulator ART (Agence de Régulation des Télécommunications) is funded wholly by spectrum fees and is responsible for spectrum management. Broadcasting spectrum is assigned by ART. Spectrum is assigned on demand.

Fees: Spectrum fees are levied.[18]

Priorities: It is not known whether spectrum scarcity is an issue.

SIERRA LEONE

Governance: Appears to be overseen by the Ministry for Transport and Communications. A number of GSM licences have been issued and several operators are or plan to provide services.

Fees: Not known whether spectrum fees are levied.

Priorities: It is not known whether spectrum scarcity is an issue.

TOGOLESE REPUBLIC

Governance: The regulator CCRPT (Cellule de Coordination de la Réforme des P&Ts) oversees spectrum.

Fees: Not known whether spectrum fees are levied.[19]

Priorities: It is not known whether spectrum scarcity is an issue.

5.3 Summary

Most of the countries in the region have in place primary legislation for dealing with spectrum management. However, only a few countries have an effective management regime in practice. This is due to a number of reasons, most notably the lack of human resources to support detailed management of radio spectrum.

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17 See http://www.ncc.gov.ng/index1_e.htm for details.

18 There are currently two cellular GSM operators in Senegal: Sentel and Sonatel operating in the 900 MHz frequency range. Coverage is good around Dakar, the coastal area and along the border with Mauritania. The government plans to license a second national operator and a third mobile operator, following a tender expected to be launched in June 2005.

19 There are two cellular GSM operators in Togo: Telecel Togo and Togo Cell operating in the 900 MHz frequency range. Coverage is good in Lome and inland in many towns and villages.

In most countries the agency responsible for telecommunications is also responsible for frequency management. In several cases frequency management is limited to frequencies utilized by telecommunications operators. Frequencies used by government (such as by defence agencies) are often managed separately. It is typically the case that there is not a single agency managing the entire radio spectrum.

National frequency band distribution tables are often partial, and in most cases still available only in hard (paper) format only. Spectrum control tools are in an embryonic state, and sometimes non-existent.

Fee calculating systems for spectrum use often comprise elements of allocated band width and surface area covered. In some cases the number of stations or subscribers is added. Spectral efficiency and economic efficiency are not usually the primary factors determining spectrum fees. A key driver behind the setting of fees appears to be revenue generation. In many of the countries the tax base is very narrow and government can more effectively raise much needed revenues through spectrum fees. However, the risk of using spectrum as a tax raising device is that it burdens operators with high costs which could dampen the development of the ICT sector. The issue of spectrum fees is discussed further in the next chapter.

6 Coordinating spectrum management across civilian uses and governmental uses

In all countries radio spectrum is used by a number of agencies in government, as well as by commercial entities, research bodies, educational institutes and private individuals. The use of spectrum by public defence and security agencies is often overseen by a separate management regime to that applied in telecommunications. In many cases the use of spectrum in broadcasting is also subject to a separate management framework, although convergence is increasingly bringing about in many countries a single spectrum manager overseeing telecommunications and broadcasting (e.g. Malaysia, New Zealand).

The multi-jurisdictional framework for spectrum management has historically conferred benefits, as specialist agencies can determine how best to manage spectrum in their areas of expertise (e.g. military, aeronautical, maritime, space, telecommunications, broadcasting, etc.). Furthermore, the allocation of spectrum blocks to specific uses has encouraged the proliferation of specialist agencies.

Where spectrum scarcity is not an issue, as was the case in the past in many countries, there is little need for the different agencies overseeing spectrum management to coordinate activities in detail. Indeed, international coordination through the ITU has ensured that standards and allocations are such that interference across the main use areas is minimal.

Rising civilian and governmental demands for radio based communication and broadcasting services, the onset of convergence and the digitalization of electronic communications, however, increasingly require that the use of radio spectrum across the main use areas is coordinated. In some countries in the recent past the agencies responsible for spectrum management have been restructured significantly to accommodate better and more effective coordination of radio spectrum.

6.1 Civilian use of spectrum

Civilian use of spectrum is expected to continue to grow markedly in the region, and this will require increased coordination across the major use areas. As wireless systems will constitute the main access to communications services in all of the countries, it is essential that an organizational structure is put in place that ensures coordination in both use and planning. Where feasible, the countries in the region should aim to pool the limited and scarce human resources to oversee spectrum use in areas featuring some common characteristics.

The countries in the region should consider establishing a single authority to oversee broadcasting and telecommunications, if such an authority currently does not exist. This would enable synergies to be exploited between currently separate jurisdictions, and permit more effective planning for future spectrum assignments and allocations.

The move to a converged regulatory framework occurred in the United Kingdom in 2003 when Ofcom (The Office of Communications) was established. Ofcom is regulates both broadcasting and telecommunications and embraces the work of five previous regulatory agencies:

- The Independent Television Commission (ITC)
- The Broadcasting Standards Commission (BSC)
- The Office of Telecommunications (Oftel)
- The Radio Authority (RAu)
- The Radiocommunications Agency (RA)

As well as improving coordination in spectrum policy, Ofcom has also been able to realise improvements in efficiency and effectiveness. By bringing together the activities of five separate regulators, it has been able to reduce operating expenditures, for example, in the areas of human resources, finance, communications, information systems, and buildings rationalisation, and it has reduced the number of staff in comparison to the five legacy regulators from 1,100 to 880.[20]

In France the telecommunications regulator ART was renamed ARCEP (Autorité de régulation des communications électroniques et de postes) very recently, bringing together previously separate agencies.

6.2 Government use of spectrum

A particular concern for coordination is the use of radio spectrum by the military. It is important that frequencies used by the military, particularly in critical mission situations, do not suffer from interference from civilian radio users. To ensure this the ECOWAS/UEMOA countries allocate certain frequency bands exclusively to the military.

However, in some cases the military may hold more spectrum than it requires. Where this occurs it would likely be more efficient to transfer excess spectrum to other users or use areas if there is demand. In some cases it may be feasible to permit the military to lease spectrum to other users, or to allow other users to share spectrum under certain conditions.

6.3 Organization and information

The organizational models deployed in many countries for the management of civilian and military spectrum use vary in detail but in general fall into two broad categories:

1) *The multi-jurisdictional model* Separate agencies are vested powers to manage spectrum in civilian and military uses. Coordination between the agencies usually occurs via an inter-departmental committee. This model is used widely, for example in United Kingdom and the United States.

2) *The single authority model* A single agency is responsible for managing all the radio spectrum. This model is less common, but can be found in Malaysia and New Zealand among others.

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[20] See Ofcom's Annual Plan April 2004-March 2005, section 5 available at: http://www.ofcom.org.uk/consult/condocs/plan/annual_plan/section5/?a=87101.

In most of the countries in the ECOWAS/UEMOA region, the model for spectrum management is multi-jurisdictional. It is unclear whether any country in the region has applied the single authority model. However, in some of the countries it is not clear what model is in place for coordinating spectrum use across civilian and military uses.

6.4 Case examples of radio spectrum coordination

The United States

The US 1934 Communications Act established the FCC as an independent agency to manage all non-federal government spectrum (including commercial, state and local government use). The Department of Commerce's National Telecommunications and Information Administration (NTIA) manages spectrum used by the federal government. The Deputy Under Secretary for Command Control Communications and Intelligence (C3I) is responsible for Department of Defense (DOD) spectrum management policy within the US and its Possessions (US&P). The three military services, Army, Air Force and Navy, coordinate spectrum management through the Interdepartment Radio Advisory Committee (IRAC). The IRAC is composed of 25 federal agencies, which are the policy making agency on radio spectrum of the NTIA.

The United States Military Communications-Electronics Board (USMCEB) is the main coordinating agency for signal matters among DOD components. The USMCEB functions under the policies and directives of the Secretary of Defense and the Joint Chiefs of Staff (JCS). The USMCEB guides the DOD in preparing and coordinating technical directives and agreements and in allocating spectrum allotments from the NTIA.

The Joint Frequency Panel (JFP) is the principle DOD coordinating agency for spectrum management. This panel works closely with the IRAC agencies. The JFP reviews, develops, coordinates, and implements DOD directives, studies, reports, and recommendation for the USMCEB.

Regulatory Issues

In a NTIA report of 1991[21] it was stated that the NTIA would move to open its process of managing federal government spectrum use to permit a greater degree of public participation, by increasing the availability of information concerning federal spectrum use and by opening a portion of the meetings of the IRAC to the public. The report made some suggestions for increasing the efficiency and speed of the FCC process, and recommended increased emphasis on NTIA-FCC coordination and on U.S. coordination on international spectrum issues.

The report also proposed that NTIA study the possibility of "leasing" spectrum from the federal government to private sector uses, as well as possibly explore establishing a fee system for federal government spectrum users, to encourage greater spectrum efficiency among such users, and to provide funds to improve management of federal spectrum.

The report also emphasized the importance of long-range planning by the FCC and NTIA, not to micro-manage spectrum use, but to anticipate user needs and to avoid unnecessary conflicts among proposed uses. NTIA proposed to increase the level and quality of coordinated long-range planning with the FCC, and presented specific recommendations to meet that goal.

Many of the proposed reforms have occurred.

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21 This section is based on http://www.ntia.doc.gov/osmhome/91specagen/1991.html

Malaysia[22]

Malaysia has adopted the single authority model, the Malaysian Communications and Multimedia Commission (MCMC) which carries out the following key activities:

1) Planning, coordinating, regulating and administering the use of the spectrum within the country;
2) Establishing regulations, technical parameters and standards governing the use of each frequency band or specific frequency by stations of different services, having regards to current international regulations and agreement;
3) Optimizing the use of spectrum, space and geo-stationary satellite orbit, ensuring the harmonious operation of different services, which use them;
4) Allocating frequency bands in accordance with international regulations and the national priorities and assigning specific frequencies as appropriate;
5) Authorising the installation and operation of radio stations, assigning call signs, MMSI numbers for ships and life boats, and granting appropriate frequency assignment;
6) Updating all information on authorised wireless systems such as frequencies, the locations, transmitting powers, call signs, etc, and their notification to the Radiocommunication Bureau (ITU) if necessary;
7) Representing, establishing relations, coordinating and issuing technical opinions concerning the use of frequencies in international forum such as the World Radiocommunication Conference (WRC), which is held every two years;
8) Measuring the technical parameters or emissions of wireless stations as appropriate;
9) Conducting systematic inspections of Radiocommunication stations to check that they must meet the technical standards and parameters for which their equipment and operations were authorised;
10) Participating, insofar as the use of frequencies is concerned, in the development plans and projects of all wireless services, ensuring that those plans are in acceptance with current international and national regulations;
11) Preparing for participating in international conference convened by the ITU, participating in such conferences and implementing any decisions adopted;
12) Conducting negotiations in connection with frequency spectrum management, space and satellite orbit location, and other related problems with other countries and international organisations;
13) Facilitating national industry technical forums to carry out works relating to the Study Groups and Working Groups of ITU-R (Radiocommunications), preparing for the participation of specialist at meetings of the ITU-R and participating therein;
14) Constituting the national body for relations with international and regional organisations other than the ITU on technical, regulatory and administrative matters, technical cooperation and other subjects related to utilisation of frequency spectrum, space and the geo-stationary satellite orbit.

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22 See http://www.cmc.gov.my/what_we_do/spectrum/pdf/planv2_3.pdf

New Zealand[23]

New Zealand, like Malaysia, has adopted the single agency model. Within the Business Services Branch of the Ministry of Economic Development is the Radio Spectrum Management Group, which administers the radio spectrum under the auspices of the Radiocommunications Act 1989 and its subordinate regulations, the Radiocommunications Regulations 2001 as amended. The following functions are carried out by the group:

- radio spectrum policy
- radio spectrum planning
- licensing
- licence registration
- interference complaints (particularly those affecting public safety services and commercial interests)
- compliance

The group is organised into four divisions:

Business Services

- Registration and access
- Radio Licensing
- Spectrum Licensing
- Engineering Services
- Compliance
- Enforcement
- Interference resolution

Business Planning

- Operational Guidelines
- Public enquiries
- Quality Assurance
- Internet Services
- Standards

Spectrum Planning

- Engineering projects
- Spectrum Band Plans
- Technology forecasts
- Spectrum use forecasts
- International relationships

Spectrum Policy

- Advice on spectrum planning, allocation and related matters
- Policy and engineering planning documents

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[23] See http://www.med.govt.nz/rsm/about/index.html

- Spectrum allocation
- Spectrum auction rules
- International liaison
- Auction management

Nigeria

Nigeria has both a Federal government and state governments, and shares some similarities structurally with the United States. Nigeria has in place a multi-jurisdictional framework and has recently established an interdepartmental committee to bring about more effective coordination of radio spectrum. This has been achieved through the sub-committee on Frequency Spectrum Management Policy for Nigeria, set up by the Minister of Communications in January 2002. This committee also involves the participation of non-governmental stakeholders. The Terms of reference for the committee were:

- To study the report of the Telecom Sector Review Implementation Committee (TSRIC) sub-committee on frequency management and to adapt and expand it in order to develop a Frequency Management Policy for Nigeria
- To go through the telecom bill and ensure that Regulations required for effective frequency management are developed. The committee is to draft the necessary Regulations for publication as a separate byelaw. In recognition of the fact that various organizations and institutions utilize frequency spectrum in Nigeria, membership of the sub-committee comprised representatives of:
  - Ministry of Communications
  - Nigerian Communications Commission
  - National Broadcasting Commission
  - Bureau of Public Enterprises
  - Private Telecom Operators
  - Chairman of the frequency spectrum management sub-committee to the TSRIC

The Committee met regularly from inception and the focus was on establishing a policy framework. The Committee was divided into two sub committees namely:

- Sub-committee on Policy
- Sub-committee on Regulations

At the end of 2004, the Sub-Committee produced two documents:

- National Frequency Spectrum Management Policy ('The Policy')
- Frequency Spectrum Management Regulations ('The Regulations')

The Policy document set out objectives, functions relating to spectrum management and policy guidelines. The Regulations covered licensing, frequency assignment, spectrum sharing, interference, spectrum fees, *inter alia*.

Section: Proposed organizational structure

The model adopted in Nigeria seems to be a very useful framework for other countries in the ECOWAS/UEMOA region to consider.

7 Applying market mechanisms for managing spectrum

7.1 Economic principles of spectrum management

Where demand for spectrum exceeds supply, users should face an appropriate charge, explicit or implicit, which reflects the opportunity cost of their spectrum use. Because spectrum is a scarce and finite resource, its use involves an opportunity cost. This opportunity cost is the value of output foregone when a block of spectrum is employed for one particular use rather than the next best alternative. If the value of spectrum to a particular user is less than the opportunity cost, then the spectrum is, by definition, valued more by someone else. If it were to be reassigned to that alternative potential user then there would be a gain in economic efficiency. Although spectrum scarcity is unlikely to be a pressing issue in many of the countries, the misallocation of spectrum and sub-optimal assignment of frequency bands provides good reason to apply economic management to radio spectrum.

It follows therefore that a spectrum user will have incentives to alter spectrum usage if it faces a charge for the spectrum equivalent to the opportunity cost and if the value it attaches to the spectrum differs from the opportunity cost. This should apply to all users of spectrum, whether in the private or public sector.

The incentives for operators to use spectrum more efficiently include those:

- to examine their spectrum needs, and release unused spectrum;
- to use spectrum to provide alternative services;
- to use less congested parts of the spectrum; and
- to implement more spectrally efficient technologies, e.g. introducing new systems which use less spectrum, but require higher investment.

If the right incentives to use spectrum efficiently are not in place, then, this will lead to a misallocation of resources, with consequent damage to economic efficiency, productivity and economic development.

If the correct incentives are in place, then economies will benefit as individual users economize on their use of spectrum. The gains will partly come from the fact that spectrum is not wasted. But the most significant gains will come from added dynamic efficiency, i.e. more innovation and greater competition in the markets in which spectrum is used, as new entrants and new technologies win access to spectrum. In the ECOWAS/UEMOA region this is especially important so as to facilitate a broadening of access to communication services via innovative wireless media.

This principle of opportunity cost charging can be applied in a number of different ways: trading, auctions and pricing. These are discussed below. Before addressing these, however, we turn to another important issue: restrictions on spectrum licences.

In many of the ECOWAS/UEMOA states spectrum licences are highly prescriptive and restrict usage, principally in terms of coverage and service restrictions.

7.2 Coverage conditions

Some licences which give rights to use spectrum include rollout requirements, and/or requirements for holders of spectrum to use spectrum or else return it to the spectrum manager (‘use it or lose it’ clauses).

‘Use it or lose it’ clauses seem designed to ensure that spectrum which is assigned to an operator is used in practice. Rollout clauses meanwhile seem designed to ensure that operators using spectrum provide their services to a proportion of the country.

But where users of spectrum have faced the opportunity cost of spectrum, they are likely to have the incentive to deploy services in order to make a commercial return. Obliging holders of spectrum to take account of the opportunity cost of the spectrum, through auctions, incentive pricing or trading, would therefore make rollout and 'use it or lose it' clauses redundant.

If, on the other hand, such clauses force an operator to deploy services faster than commercial imperatives alone would have done, then this could cause problems for the company concerned. New entrants into a market are often short of positive cash flows at a time when they are investing heavily in infrastructure to provide services to consumers. Obliging an operator to invest in infrastructure to meet a 'use it or lose it' or rollout clause at such a time could cause it financial difficulties.

Countries have used rollout clauses to meet their universal access objectives. Regulators therefore need to balance the interests of operators who must invest in infrastructure with the needs of consumers. In many cases, governments may prefer to accept lower licence fees in exchange for wider commitments in terms of coverage and roll–out obligations.

Obliging holders of spectrum to use it may also prevent useful economic functions. In some cases, for instance, a purchaser of spectrum may hold spectrum for which it does not currently have a use in expectation of a future technological or market development. Forcing the purchaser to use spectrum may prevent such developments from gaining access to spectrum. 'Use it or lose it' clauses have also been proposed as a means of preventing 'speculation' once trading has been introduced. But speculators may contribute to the functioning of the market by, for instance, purchasing spectrum which they expect to rise in value. This can provide useful liquidity by allowing spectrum to be made available to other potential users.

7.3 Service restrictions

Another form of restriction which is sometimes imposed limits the type of service or technology which can be deployed in a particular band – even where this is not necessary to meet international and/or interference management obligations. The limits seem designed to ensure that the services which are provided using the spectrum assigned are the ones which a government has decided should be provided. But such restrictions are becoming increasingly ill-suited as a result of digitalization of systems and convergence of services. Growing integration between broadcasting, telecommunications and information technology industries is making it possible to provide new innovative services using spectrum.

Given the unpredictability of new service developments (e.g. WiMAX in the 3.5 and 5 GHz ranges), it seems preferable to devolve decisions on which services are deployed in which bands to the market players who have the best available information, and who can respond fastest to shifting patterns in consumer demands. Information about which services consumers find most appealing at any one particular point in time is more likely to be available to operators than to governments. Second-guessing by governments' on which parts of the radio spectrum are devoted to which services seem unlikely to serve consumers' best interests.

Removing restrictions on the apparatus deployed in particular blocks of spectrum would also have advantages since it would allow operators the flexibility to decide which technology to use. Users of spectrum are best placed to balance the extra costs associated with using more spectrum against the extra costs associated with engineering their systems to offer the same capacity with less spectrum.

7.4 New approaches to spectrum licensing

In many of the ECOWAS/UEMOA states legislation regulates use of radio frequencies via licensing of apparatus for the transmission or reception of wireless telegraphy signals. Some types

of radio equipment (depending upon use) are exempted from the requirement for a licence by regulations.

The approach to licensing based upon equipment worked satisfactorily when technical progress was relatively predictable, and before digitalisation. A number of national regulatory authorities, including those in Australia, Canada, New Zealand, and the US, have begun to introduce a more generic approach to licensing access to radio spectrum, motivated by the desire to enable flexibility and innovation in spectrum use. Of these, the Australian approach is the most fundamental reform of traditional spectrum management methods.

Australian approach to spectrum licensing

Spectrum licensing is a form of licensing introduced in Australia by the Radiocommunications Act 1992 and implemented by the Australian Communications and Media Authority (ACMA). Spectrum licences were awarded for the first time in 1997, following the auction of the 500 MHz band. Spectrum licences are a tradeable, technology neutral spectrum access right for a fixed non-renewable term. Instead of authorizing the use of a specific device, spectrum licences authorize the use of spectrum space, and give licensees the freedom to deploy any device from any site within their spectrum space, provided that the device is compatible with the core conditions of the licence and the technical framework for the bands.

Spectrum licences offer a new way of managing the radiofrequency spectrum. Licensees have the flexibility to plan and deploy devices within their spectrum space. Licences are for a fixed term of up to fifteen years. Within the bounds of spectrum space and the technical co-ordination framework, licensees are free to operate whatever type of communications service they choose, and are able to change that service in response to technical improvements or changes in consumer demand. The only requirement is that some types of device must be registered with the ACMA before they can be operated. Spectrum licences are tradeable. Licensees can negotiate with others to buy and sell spectrum space in the open market as the need arises, or authorize others to use their spectrum space. Spectrum licences can be aggregated or sub-divided to form new licences, based upon finite indivisible units of spectrum space called standard trading units, or STUs. The frequency bandwidth of STUs may vary in size depending on the spectrum band in which licences are being issued, but the area grid will be constant for all bands.

The ACMA has applied the spectrum licensing approach selectively in the following bands to date: 500 MHz, 800 MHz, 1.8 GHz, 2 GHz, 2.3 GHz, 3.4 GHz, 27 GHz, 28 GHz and 31 GHz. These bands were selected on the basis that there is a choice of technologies and services which operators could practically deploy in these frequencies, and so take advantage of the flexibilities offered by spectrum licensing. These bands were also by and large clear of incumbent users when licensed, so the new licensee is relatively unconstrained by existing services in deciding how best to utilize the spectrum. In all other bands, the ACMA continues to issue apparatus licences, which are more specific as to technology and service to be provided by the licensee.

Source: www.acma.org.au

7.5 Spectrum Trading

Some countries (notably Australia and New Zealand) are exposing users of spectrum to the opportunity cost of their spectrum use through spectrum trading. This gives users of spectrum the ability to sell on the rights to use spectrum, without approaching a spectrum manager. If it is possible to trade spectrum then each user will have to consider whether it is worth retaining these rights to use spectrum, or alternatively whether it should sell them. Trades will take place when the spectrum is worth more to another user than it is to the existing user, i.e. when the opportunity cost is greater than the value of the spectrum to the incumbent holder.

While spectrum trading is being implemented in some high income countries and being considered in others, it seems premature to recommend that the states of the ECOWAS region implement spectrum trading. However, in some spectrum ranges (such as cellular GSM frequencies and fixed

wireless access frequencies) it would seem desirable to permit spectrum trading where this would result in clear economic efficiency gains.

There are different varieties of spectrum trading:

- Outright sale of a block of spectrum or an apparatus licence would involve complete transfer of all the rights and obligations covered by a licence to another party.
- Leasing of a block of spectrum for a fixed time (or other condition) would mean that current apparatus licences were modified to allow licensees to lease some or all of the assigned spectrum. The length of the lease would be up to the time included within the original apparatus licence. The lessee would be able to use the spectrum for any purpose it chose within the relevant international allocation provided that it ensured that all the conditions included within the original licence were not breached. Such trades should be notified to the spectrum regulator, this would be a relatively simple process which achieved flexibility without extensive intervention on the part of the regulator.
- Partition of current apparatus licences by geography, frequency or other means, so that individual parts could then be leased. If an operator decided that it no longer wished to use part of its assigned spectrum, it could return it to the NRA for reassignment.

7.6 Auctions

The auctioning of spectrum licences is now a well established practice in many countries and has been applied successfully in Nigeria. Many economists argue that auctions should be the preferred method of assigning spectrum. But others argue that auctions cause bidders to overpay for licences and should consequently be avoided; the example of certain European 3G auctions is often cited to support this view.

It is not necessarily true that spectrum auctions raise prices to consumers. In fact there is some empirical evidence to suggest that they do not. Likewise, spectrum auctions do not necessarily delay deployment of services, or force bidders to overpay for spectrum.

More than 20 countries have employed auctions over the past decade to award licences. Properly designed, an auction can be an objective, timely, transparent and non-discriminatory method of distributing spectrum. Although auctions are sometimes contentious, their success hinges on whether auctions are used mainly as a revenue tool or a licensing mechanism. Using them for the former emphasizes the disadvantages.

The chief advantage of auctions is that they assign spectrum to the user who values it the most. This in turn serves as a proxy for judging which particular user will contribute most to overall economic welfare. As well as allowing spectrum to go the user which brings the most overall benefit to the economy, auctions can also ensure that spectrum is employed in the best possible use – provided there are no unnecessary restrictions on usage.

Within the ECOWAS region well-designed auctions also have the attractive advantage of creating a clear and objective process by which to allocate assets for which demand exceeds supply. Comparative selection or 'beauty contests' inevitably involve a degree of subjective judgement – even if the criteria against which bids are assessed are entirely clear – which can mean that spectrum is not assigned to the user who can most benefit the economy. The GSM frequency auction held in Nigeria was a very good example of a well-designed auction.[24]

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24 Doyle, C., & McShane, P. (2003). On the design and implementation of the GSM auction in Nigeria—the world's first ascending clock spectrum auction. Telecommunications Policy (27)

7.7 Spectrum pricing

The introduction of auctions and spectrum trading will allow the development of a fully fledged market in spectrum, which is likely to be a long-term objective in the ECOWAS/UEMOA region. In many cases, however, this will not be possible. For instance, some spectrum may not be suitable for trading, or spectrum may need to be reserved for public service users. Spectrum pricing is another means by which spectrum users can factor in the opportunity cost of spectrum into their decisions on usage.

There are a number of different ways in which the opportunity cost of spectrum use can be derived. The methodology set out in the Smith-NERA report[25] submitted to the UK Government currently remains the most appropriate for the purpose of establishing administratively set spectrum prices.

The Smith-NERA Methodology

The Smith-NERA approach to spectrum pricing involves calculating the marginal value of the spectrum to the user. The rationale for this is that ideally, administrative pricing would result in fees equal to market clearing rates that balanced supply and demand for spectrum. In practice, it is extremely difficult to estimate these fees. One possible method is to assess the marginal value to the user on the basis of the additional cost of the least cost practicable alternative to the present assignment. This is a measure of the worth of the assignment since it reflects the amount that the user would have to pay if deprived of it.

For example, for a user of a point-to-point fixed links band the most cost-effective alternative is regarded as the installation of narrow bandwidth equipment or moving to higher frequency links. The costs involved give the marginal value of the spectrum. For a private mobile radio user, the marginal value of the spectrum was regarded as being equivalent to the additional cost involved in using a public access mobile radio band. The Smith-NERA report proposed that the marginal values should be based on the least-cost practicable option for enhancing spectrum efficiency. The actual prices charged should vary according to factors such as bandwidth, coverage, degree of sharing, and geographical location.

Administrative spectrum prices have been applied in a number of countries, including Jordan and the UK. Assessing prices is a complex task in practice and can be very demanding.

Pricing radio spectrum using other methodologies can be considered where government policy sets different objectives to economic efficiency.

8 Coordinating spectrum management in wireless communications

As discussed in Section 1, wireless is playing, and will play, a significant role in the development of telecommunications and of electronic communications more generally in the ECOWAS/UEMOA region. As the status of fixed and wireline communications services in the region is generally poor, with most towns and villages having little or no infrastructure in place, wireless affords an opportunity to extend communications services to peoples in many areas quickly and efficiently. It will therefore be crucial for economic development that spectrum is organised efficiently to permit the development of new wireless services.

In Section 2 it was recommended that policy should be designed to provide for responsiveness and flexibility to changes in markets and technologies, accommodating new services as these become technically and commercially feasible. In this section we focus on the need for spectrum managers in the region to assist the deployment of wireless based services, in particular cellular services (frequencies in the ITU Region 2 range as agreed at the WRC-2000 Istanbul, see Figure 1.2),

[25] See presentations at http://www.itu.int/osg/spu/ni/spectrum/UK-RSM.pdf. http://www.cdoyle.com/papers/Warwick_160104.pdf Presentation on Smith-NERA

broadband wireless access (BWA[26]) systems (frequencies in the range 3-29.5GHz and around 40GHz) and newly emerging WiMAX services (frequencies in the range 3.5GHz and 5GHz, and possibly also in 2.5GHz).

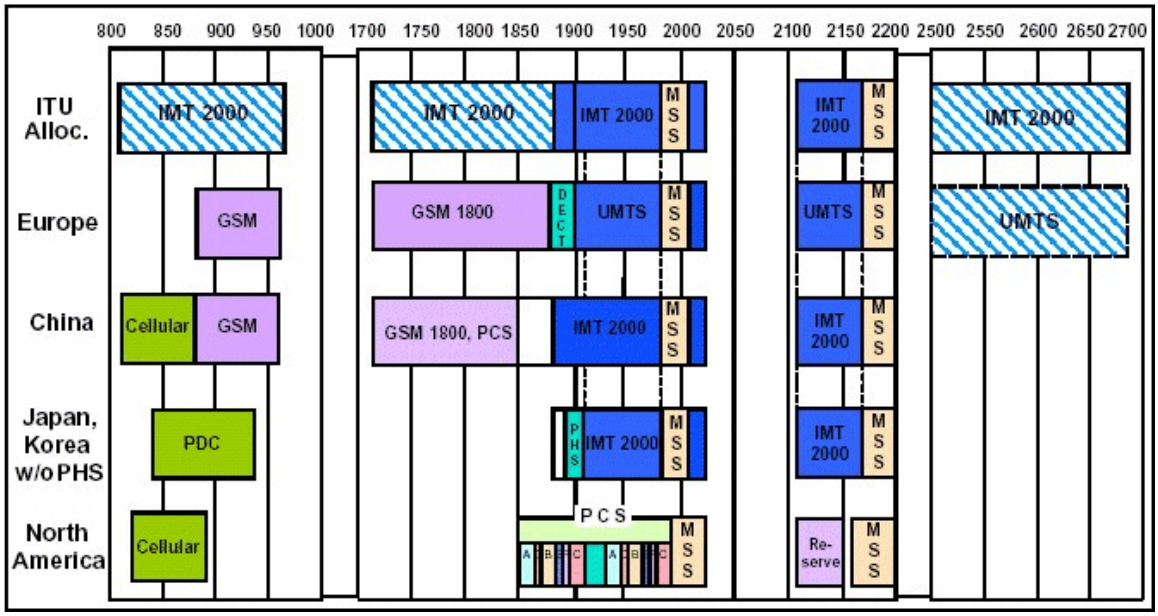

Figure 1.2 – IMT-2000 allocated frequencies as agreed at WRC-2000 Istanbul

8.1 Coordinating spectrum deployment for wireless communications

A challenge facing spectrum managers around the world and in the ECOWAS/UEMOA region is the uncertainty surrounding the evolution of wireless communications. Radio planners are under pressure to reserve certain frequency ranges for particular technologies and services before any proven commercial and technical viability. Some commentators are suggesting that rather than tie up spectrum, a more laissez faire approach towards its use should be adopted so that successful services and technologies enjoy the rights to use frequencies.

In some countries, such as the United States, a flexible approach is often taken to new technologies, such as WiMAX, whereas in other countries, like the SAR Hong Kong, WiMAX has been barred from using frequencies in the 2.5-2.69GHz range as these are reserved for 3G expansion.[27]

In the ECOWAS/UEMOA region radio planners will be primarily concerned with fostering an environment that promotes the deployment of advanced broadband services, such as BWA services. There is likely to be merit in establishing coordination in the region with regard to frequency ranges and policy with regard to BWA services, as this will permit roaming for users and enable service providers to enjoy bulk purchasing discounts.

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[26] These can support fixed, nomadic and mobile services.

[27] See http://www.ofta.gov.hk/en/ad-comm/rsac/paper/rsac1-2004.pdf.

Annex 1

Guidelines for radio spectrum management

Guideline 1 – Spectrum demand in the ECOWAS/UEMOA region

Although the use of economic instruments to manage the demand for and supply of radio spectrum may not be at the forefront of policy today, it would be prudent for the countries to establish a common radio spectrum management framework that permits the development of an effective economic management regime of spectrum. This will also complement the objective of promoting liberalized ICT markets.

Guideline 2 – Managing spectrum

A high policy priority in the region is the development of a common framework for documenting and monitoring the use of spectrum. It would be desirable, perhaps under the auspices of WATRA, to establish a common methodology for documenting and monitoring spectrum, and for the countries to share the costs of developing a software tool for these purposes.

Furthermore, it is suggested that a forum be established within WATRA, to bring together those responsible for spectrum management, to:

- Exchange information and experiences to foster the harmonization of spectrum management rules;
- Prepare common positions to be presented to regional, then global instances;
- Pool existing expertise.

Guideline 3 – Interference issues

The countries in the ECOWAS/UEMOA region should establish a common framework for developing a public register (i.e., database) of technical and locational information about radio systems.

Guideline 4 – Challenges for Interference management in the ECOWAS/UEMOA region

The countries in the ECOWAS/UEMOA region should in the near future populate a common template for a national frequency table in each country.

Guideline 5 – The objectives of radio spectrum management

Radio spectrum management policy in the region should have the following objectives:

Economic efficiency

- Market allocation of spectrum to users, and to uses, that derive higher value from the resource.
- Provide for responsiveness and flexibility to changes in markets and technologies, accommodating new services as these become technically and commercially feasible.
- Transactions costs, entry barriers and other constraints on the operation of efficient economy activity should be minimized.

Technical efficiency

- Intensive use of scarce spectrum consistent with adherence to technical interference limits.

- Promote development and introduction of new spectrum-saving technologies where the cost of such technologies is justified by the value of the spectrum saved.

Public policy

- Consistent with Government policy.
- Safeguard interests of spectrum use for efficient functioning of defence, emergency and other public services.
- Changes to spectrum use in a member state should remain consistent with international and regional obligations.

Guideline 6 – Global and regional regulatory framework

The countries of the ECOWAS/UEMOA should manage spectrum by promoting flexibility while respecting the ITU international allocations.

Guideline 7 – Role of regulators

The countries in the ECOWAS/UEMOA region should vest radio spectrum management powers in the new independent NRAs overseeing telecommunications. Ideally these NRAs should have remits to embrace electronic communications broadly defined. By doing this the countries will enable a management regime that embraces technological neutrality.

Guideline 8 – Coordinating spectrum management across civilian uses and government uses

Countries in the ECOWAS/UEMOA region should aspire to the establishment of a framework which permits the effective coordination of all spectrum use, nationally, bilaterally, regionally and internationally.

Guideline 9 – Civilian use of spectrum

Countries in the ECOWAS/UEMOA region should merge separate regulatory authorities dealing with spectrum use in broadcasting and telecommunications. This will facilitate more effective coordination and realise efficiencies that will help promote and sustain economic development.

Guideline 10 – Government use of spectrum

Where government requirements for a particular frequency band are negligible or even zero, then such spectrum could be permanently reallocated to civil uses, following a definitive renunciation by the government.

Guideline 11 –radio spectrum coordination

Countries in the ECOWAS/UEMOA region that manage radio spectrum according to the *multi-jurisdictional model* should establish an inter-departmental committee to facilitate the coordination of effective spectrum utilization. The committee established should in the first instance focus on establishing a policy agenda and guidelines for regulations (e.g., interference issues EMC). The committee should comprise members of key government agencies involved in spectrum management, as well as key non-governmental stakeholders. The meetings of the committee should be recorded and made public (except where national security interests may be compromised). The government members on the committee should be appointed by a key member of government (a Minister, Prime Minister, President, etc.), and membership should not exceed five years. Reappointment may occur for a further five years. The appointed governmental committee members should elect a Chair. The person holding the position of Chair cannot hold the post for more than two years. The committee should also comprise non-governmental members, chosen from applicants responding to a government advert. Non-governmental committee memberships cannot exceed more than three years. Ideally the committee should not exceed more than 12

persons, including the Chair. The Committee should also publish its reports, all work it commissions, and all other relevant material, subject to confidentiality clauses, on a dedicated website. Each participating governmental committee member's department's website should contain a link to the Committee's website. The Committee should produce an annual report to Government, which should also be published on its website. Finally, two members of each Committee should be nominated to sit on a regional committee comprising members from the ECOWAS/UEMOA region. The regional committee shall meet once a year in one of the ECOWAS/UEMOA states, to discuss matters of international relevance in the context of spectrum management, and to discuss areas of mutual interest.

Guideline 12 – Economic principles of spectrum management

All classes of users should face incentives to economize on the spectrum they occupy. For the majority of frequency bands, where demand exceeds supply, this will entail paying a positive price to obtain access to spectrum, provided there are potential alternative users or uses of a block of spectrum (i.e. the opportunity cost is greater than zero). Where demand does not exceed supply, the price may be set equal to the costs associated with its administration or to a value consistent with government policy.

Guideline 13 – Service restrictions

Spectrum agencies in the ECOWAS region should aim to minimize the licence conditions to those necessary for efficient spectrum use. Existing licences should be amended to remove restrictions which are not needed for reasons of international co-ordination or interference management, and new licences should be issued with the minimum number of restrictions possible.

Guideline 14 – New approaches to spectrum licensing

(Generic) licensing of spectrum should be adopted for some frequency ranges in the ECOWAS/UEMOA states. Moving to a generic spectrum licensing regime would permit more flexibility and benefit users, and therefore aid economic development.

Guideline 15 – Auctions

Auctions should be considered as a means of assigning major spectrum licences between competing users, to achieve an efficient market-driven outcome. Using auctions enables the assignment process to be more transparent and objective and is less susceptible to corruptive influences.

Guideline 16 – Spectrum pricing

Spectrum pricing should be adopted where demand exceeds available supply, and where auctions have not been used and where trading is not practiced. The determination of the cost calculation method, which is generally based on spectrum opportunity cost, could equally take into consideration objectives defined by the State..

Guideline 17 – Coordinating spectrum deployment for wireless communications

The countries in the ECOWAS/UEMOA region should establish a special committee to establish a common approach towards BWA radio systems. The committee should examine spectrum assignments and allocations, and recommend policy for promoting BWA service provision across the region. The committee should report its findings by the end of 2006.