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Spectrum Management in Developing Countries (Case study on Sudan)

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ABSTRACT

The increasing growth of society and the heavy demand for wireless technologies and telecommunications services called the traditional spectrum framework into question, therefore to achieve the highest benefit of this limited resource a spectrum management process must be implemented in an effective way. The variety of radio spectrum applications such as national security, society safety, mobile communications, broadcasting, business and navigation can be optimally achieved in its highest performance and be protected from interference and also give the way for the future expansion of spectrum use by applying aphoristic spectrum management plan taking into consideration the economic issues. This paper aims to provide a structured way of looking at spectrum management in developing countries. A methodic case study of spectrum management in developing countries (Sudan case) is examined the national policies and procedures to give a sharpened understanding of spectrum regulation process.

Keywords—Spectrum; Radio; licensing; Sudan.

I. INTRODUCTION

This Frequency spectrum contains all the electromagnetic frequencies used for wireless services such as broadcast services, fixed and mobile radio communication services, microwaves, space commutation and cellular mobile and safety services. The increasing demand for frequency spectrum services makes more complications in frequency assignment process that many administrations have found difficult to resolve using the traditional spectrum management tools [1].

In Sudan according to the law, National telecommunication Corporation NTC is responsible for the electromagnetic spectrum management and its most advantageous and effective use to maximize its benefits and make the needed frequencies available for public and social services. This is normally achieved with a careful balance between national policies and international interests. This task necessitates periodical revision of spectrum use and the future plans of its exploitation to support social and economic development.

Sudan Facts and IndicatorsThe regulatory body of Sudan is National Telecommunication Corporation. operators: 2 fixed service, 4 mobile services and 2 ISPs. Sudan population is 39.58 million, number of mobile subscribers is 27.81 million, number of fixed service subscribers is 440 thousand. Fiber length is more than 22,000KMs. Sudan shares its borders with eight countries, in some borders, there are highly populated areas [2].

II. LEGAL FRAMEWORK FOR SPECTRUM MANAGEMENT IN SUDAN

Ministry of Communications and Information Technology (MCIT) The importance of MCIT role is appears in the sponsorship of telecommunications industry and informatics mechanisms such as National Information Network, and e-government projects in coordination with all the relevant units and institutions in addition to developing plans and policies for promoting and developing the telecommunication systems and the information existing in Sudan. The ministry also in charge of setting the standards and principles of telecommunication instruments and devices to contribute in maintain the citizens and the environmental health [3].

National Telecommunication Corporation (NTC) The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

Legislations: As recommended in the Handbook of National Spectrum Management 2005, published by the Radio-Communication Group 1 of the International Telecommunication Union (ITU) [1], the radio communication law must be a basic document that gives recognition to the radio spectrum as a national resource and the need to govern it in the interest of all citizens.

Therefore the NTC revise and work on supervising and applying the telecom law, which is by adjusting the offences, providing license and devices certification according to specifications and standards approved. The telecom acts applied to achieve a successful telecommunications and spectrum

management system in SUDAN are The telecommunication Act, 2001. The Informatic Offences (Combating) Act, 2007. The Electronic Transactions Act, 2007. The competition (organization) and monopoly prevention Act, 2009.

III. National Allocation Table

Frequency allocation must be guided by the ITU regional Allocation Table to satisfy national requirements, but the country can deviate from the international allocations, for a limited degree [1]. National spectrum policies and plans must be under revision and updating regularly and when necessary to keep conveying with technology and changing demands. However, as discussed in the ITU workshop on National Spectrum Management and Spectrum Management System for Developing Countries (SMS4DC) in Suva, Fiji, February, 2016, the regulator would institutionalize working groups and the expertise to affirm technical and regulatory work and using the National Table for Frequency Allocation (NTFA) as one of the most important tools for effective spectrum management, they must work on frequency bands separately to determine service allocations are required nationally [5].

In Sudan, the national allocation table has been prepared as an effective mechanism which represents the NTC strategy in spectrum management and takes this consideration carefully [6]: National requirements and antecedents. The ITU recommendations. National radio regulations and the footnotes related to Sudan in these regulations. National agreements signed by Sudan and related to the frequency spectrum. The national allocation table determines the utilization of the radio frequencies in the Republic Of Sudan and it aims to determine the spectrum ranges for communications services.

National Allocation Table structuring: The national allocation table involves the frequencies from 9 kHz to 300 GHz distributed in 48 table according to this regulation [6]: The first column in each table gives the frequency bands in KHz, MHz and GHz.

The second column involves the services that determined to the frequency band in the first region according to the ITU distribution, in addition to the footnotes numbers mentioned in the ITU regulations.

The third column involves the services that determined by the NTC to the frequency band in Sudan, in addition to the national Sudanese footnotes numbers. The fourth column involves the customer categories which can be licensed to benefit from the services determined in the frequency band.

Table (1): Frequencies from 68 - 137 MHz allocation [6].

Frequency Bands (MHZ)	**First Region**	**Sudan**	
		Services	***Users Categories***
68 - 74.8	Fixed - Mobile (except mobile aviation)	Fixed - Mobile (except mobile aviation)	Mixed
74.8 - 75.2	Radio navigation for aviation 5.181	Radio navigation for aviation	Mixed
75.2 - 87.5	Fixed - Mobile (except mobile aviation)	Fixed - Mobile (except mobile aviation)	Mixed
87.5 - 100	Radio broadcast 5.190	Radio broadcast	Civil
100 - 108	Radio broadcast 5.192, 5.194	Radio broadcast	Civil
108 - 117.975	Radio navigation for aviation 5.197A	Radio navigation for aviation	Civil
117.975 - 137	Mobile aviation (C) 5.201, 5.202	Mobile aviation (C)	Mixed

IV. Electronic Facilities

Sudan depends on several electronic facilities to enable efficient use of frequency spectrum, and mitigation of interference such as spectrum management for developing countries (SMS4DC), Geographical information system GIS, and Cellular expert software, and ITU software, and some local designed software. This paper focused on SMS4DC as a software mainly designated to help regulators in developing countries to convey the growth in telecommunications services and radio technologies which have led to an ever-increasing demand for the use of spectrum among competing for business, public sector and other users.

Spectrum Management for Developing Countries SMS4DCSMS4DC is a software designed by ITU based on ITU recommendations and is consist of both administrative and technical tools. Sudan owned this software since 2007 starting with the first version and kept upgrading of versions, it has been used to perform some technical and administrative tasks in Spectrum Management department (NTC), as well as resolving interference problems [2].

Examples of tasks: Frequency arrangement, assignment, licensing, coordination data, import data from BRIFIC & SRS. Perform electronic notices. Technical analysis of Coverage, field strength, field strength contour, Microwave link calculations, interfere calculations. Replanning of digital broadcasting bands. Replanning of FM broadcasting band.

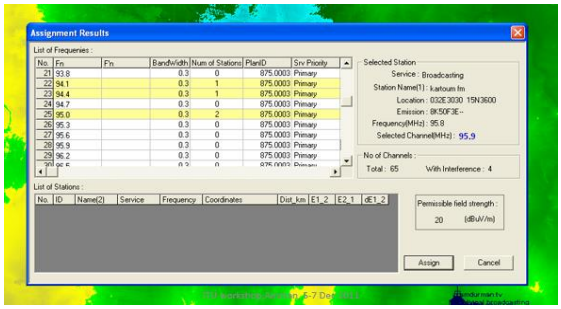


Figure.1 Frequency Assignment.

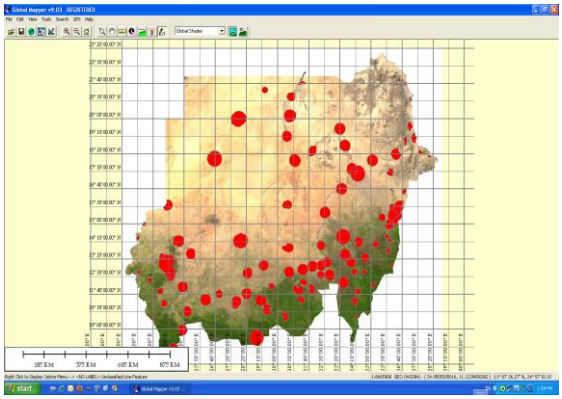


Figure.2 DVB-T Plan [2].

Interference Calculations For clarification and understanding five simulated stations (A, B, C, D, E) has been created and configured with specific gains, heights, powers and frequencies using SMS4DC as shown in Table (2), then the interference effect of them on each other is exhibited.

Stations	Frequency (MHZ)	Power (W_eirp)	Gain	Height
station A	14630	100	40	50
station B	14637	80	8.3	60
station C	14633	10	11.2	75
Station D	14630	10	0.9	65
station E	14630	100	100	50

Table (2): Stations configuration.

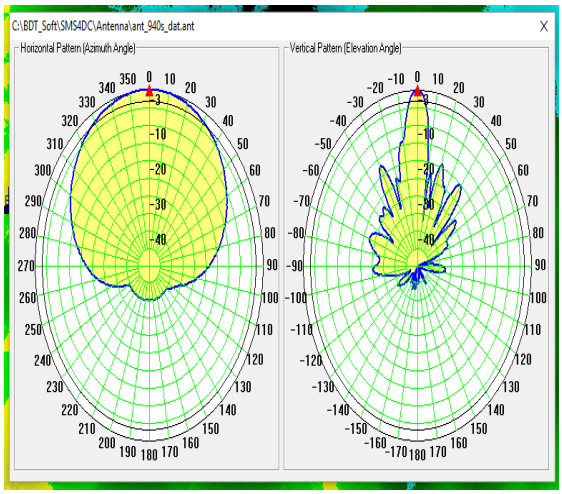


Figure.3 Propagation of station (A).

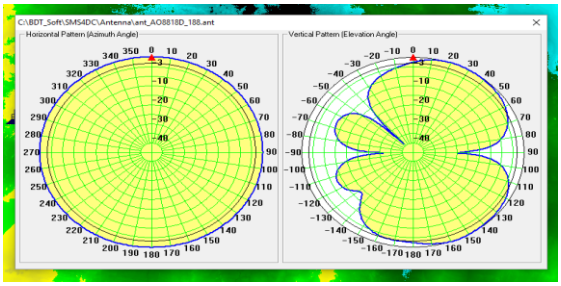
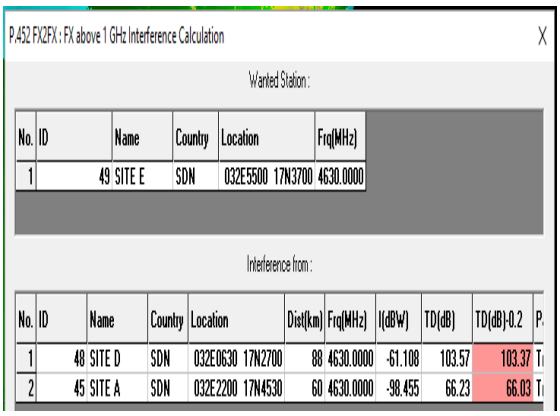


Fig.4 Propagation of station (D).

After simulation process, SMS4DC explained that station A and station D affected station E and caused co-channel interference as shown in fig.5.



P.452 FX2FX : FX above 1 GHz Interference Calculation

Wanted Station :

No.	ID	Name	Country	Location	Frq(MHz)
1	49	SITE E	SDN	032E5500 17N3700	4630.0000

Interference from :

No.	ID	Name	Country	Location	Dist(km)	Frq(MHz)	I(dBW)	TD(dB)	TD(dB)-0.2	P.
1	48	SITE D	SDN	032E0630 17N2700	88	4630.0000	-61.108	103.57	103.37	T
2	45	SITE A	SDN	032E2200 17N4530	60	4630.0000	-98.455	66.23	66.03	T

Figure.5 Station (A-D) interfere with Station (E).

V. SPECTRUM LICENSING

There are two approaches to manage spectrum licensing [7]. The first approach is granting a license for exclusive use. In this approach, a licensee has exclusive and transferable rights for certain spectrum bands. This is used for example in mobile telecommunication. The regulator enforces and protects usage of the spectrum. The second approach is granting a license for shared use. In this approach, access is confined to a particular technology. Examples include the use of digital enhanced cordless telecommunication (DECT) in Europe and public safety services.

NTC aims to provide an efficient and speedy way for the granting of licenses to operators of Radio Frequencies services and to allocate radio frequencies for the various uses of government, and other uses.In preparing the spectrum management and licensing regulation, NTC took into consideration international best practices, general principles of law and other applicable laws and regulations [4].

The licensee thereto with frequencies for operation of general and private communication network shall be alighted with the conditions of the license especially to what relates to Frequencies and frequency spectrum designated thereto. Type and specifications of the transmission equipment. Geographical area limits where he is allowed to work therein. The efficiency of the persons employed for operating such system. None interference with others.

Spectrum licensing procedures: Government makes the process of frequency assignment via public tenders and license agreement, the additional

procedure is according to Bylaws provisions. However, some procedures take place such as submitting an indorsed formal application to NTC General Director describing the network, equipment details, technical specifications, locations, spectrum bands and purpose of use, then filling relevant forms, Submitting the application and Forms by a delegated person and approved license is issued once NTC procedures are completed within predetermined time.

Table (3): Sudan Telecom Information [8].

	Sudan
Country overview	GDP per capita $1 850. Inflation 19%. Exchange rate US$ = 8.73 SDG.
Regulatory Body	National Telecommunication Corporation (NTC).
Telecom Market	Competition is investing aggressively in new technologies (e.g. LTE) and coverage areas. Competitors offering extremely discounted tariffs on data bundles [8].
Broadband Subscri-ptions	Active mobile-broadband subscriptions per 100 inhabitants is 25.19 [9].

VII. CONCLUSION

The growth in telecommunications services and radio technologies have led to an increased demand spectrum use among competing for business, public sector and other users. The limitation of radio spectrum necessitates an effective spectrum management process to avoid spectrum scarcity and such problems and to get benefit from this natural resource in a perfect way. The good regulation process must follow the ITU recommendations and the regulators would institutionalize working groups and the expertise to affirm technical and regulatory work. Adopting flexible spectrum access policies and open the doors for optimal radio technologies such as Cognitive Radio (CR). Harmonizing the National Radio Frequency Plan with effective radio spectrum techniques of radio frequency migration and radio spectrum re-farming. Getting rid of the inefficient use and the artificial spectrum scarcity reasons such as non-utilized licensed spectrum.

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