DIGITAL RADIO BROADCASTING FORMAT FOR NIGERIA

By

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ABSTRACT

This paper seeks to reveal the relevance of Digital Radio Broadcasting {DRB} in Nigeria as well as describe the developments in Digital Radio. It also describes the various types of Digital Radio Technologies and highlights the factors to consider in the choice of Digital Radio format for Nigeria.

It briefly outlines the strategies Engineering Directorate of Federal Radio Corporation of Nigeria {FRCN} adopted in the selection of HD Radio out of the various technologies of the Digital Radio Broadcasting format for FRCN nationwide.

Considerable work has been done by the FRCN to exploit these opportunities for digital radio its relevance to Nigeria taking cognizance of the listeners, the broadcast regulator/ Nigerian government, the operators {broadcasters} and the industry/broadcast manufacturers as the stakeholders.

The FRCN Engineers established that HD Radio is meaningful, feasible, flexible, cost effective and a seamless transition to digital format in Nigeria.

1.0 Introduction

A digital standard is superior to analogue because of its greater accuracy, flexibility, efficiency, and interoperability with other electronic media. Digital signals also have the benefit of generating no noise and being more resilient to signal interference. Within the range of the signal, this results in a faultless signal {Asaad S & Roland K, 2005}.

The arrival of digital radio has brought remarkable, exciting changes to broadcasting. Digital technologies are changing the basic principles of broadcasting. Interactivity is adding important new dimensions to broadcast services.

According to Moses {2004}, digital technology is rapidly being adopted for the reproduction, storage and transmission of information in all media. This means that any form of content, still or moving pictures, sound, text, data, can be made available via any transmission medium, eroding the traditional distinctions between telecommunications and broadcasting. Already it is possible to receive television or radio over the Internet, while digital televisions have some of the capabilities, which in the

past we find only in computers. The greatly increased capacity and

adaptability of networks provide opportunities to improve the delivery of existing services and to create new ones. Consumers will have easier access to a wider range of content through various transmission media. They will be able to select the services they want at a time convenient to them and to benefit from enhanced two way communication including on-line purchases through interactivity.

As Kang {2001} point out, broadcasters will have new opportunities to develop innovative programming and services, along with new revenue streams and market franchises.
As part of its drive towards new services, the FRCN has been at the forefront of this work and this is reflected in the position paper presented at 2008 Commonwealth Broadcasting Association conference, Bahamas {Moses, 2008}. The choice between the different digital radio technologies can be confusing and complex.

1.1 Relevance of Digital Radio Broadcasting Nigeria

Digital Radio is the pure digital transmission medium that greatly improves the sound quality of radio broadcasts, virtually eliminating static, hiss, pops and fades and offers data display capabilities on receivers and opens up the opportunity for multicasting: broadcasting multiple high quality channels on each frequency.

FRCN believes that the quality of reception from the Digital Radio will do a lot to restore listener ship to the broadcast band. The Digital Radio may even return music programmes to the

AM band. With the deregulation of broadcasting in Nigeria, the monopoly of radio broadcasting is no longer controlled by FRCN. The technical qualities, content and costing are the determinant factors to our survival in the broadcast business. It has become necessary to explore new ways to communicate with our listeners, whether it's running out text of an advertiser's telephone number or on-radio emergency traffic and weather alerts. In doing so, we can realize ways to make more money.

FRCN also believes that Digital Radio gives more business opportunities for radio stations.

Nigeria as we all know is made up of different tribes, cultures, beliefs and religions, with the adoption of DRB, the various needs of all the groups in Nigeria could be accommodated utilizing the same bandwidth for analogue radio broadcasting network which could only provide one channel.

Supplementary to the above, Nigerian Communication Commission {NCC} and National Broadcasting Commission {NBC} are saddled with the challenge of limited frequency spectrum. Utilization of DRB format would enhance efficient use of the frequency spectrum.

Hardware power consumption equipment in analogue would be eliminated as the DRB format is based on IT technologies which are efficient in energy consumption, less failure rate and easy maintenance.

Stations will also be able to provide text advertisements and station branding-

programme names, jingles and other promotional messages – to help build listener's loyalty.

2.0.0 Types of Digital Radio Technologies

2.1.0 Digital Audio Broadcasting {DAB}

According to World DAB Forum, DAB was developed by a consortium of 12 partners, known as EUREKA-147; DAB has been under development since 1981. In 1994, Eureka-147 was adopted as a world standard and, today, most of the world has either implemented the standard or is currently testing it. The exceptions are the United States, which has embraced both satellite digital radio and H D Radio, and Japan where cable is the chosen method of delivery for new radio formats.

From the field trial by Shelswell et al {1991}it can be deduced that analogue and DAB are two completely different broadcast techniques, an FM aerial will not work for digital radio.

The services that have been introduced in Europe, Canada and Australia, together with pilots in India, are using other frequencies. Many countries (including the UK) are using Band III (around 221 MHz), formerly used for black and white television signals. Others like Germany and Canada are using L-Band (1452-1492 MHz) {Gandy, 2003}. DAB receivers currently on the market can receive both Band III and L-Band transmissions {ETSI Specifications}.

2.1.1 Field Test of DAB

From the field test carried out by FRCN Engineers and the author the following drawback were noticed with DAB:

- Music radio stations broadcasting in mono.
- The reception quality on DAB can be poor even for people that live well within the coverage area. The reason for this is that the old version of DAB uses weak error correction coding that is not capable of correcting multiple errors {Shelswell, 1998}.
- Transmission on DAB is far more expensive when compared with the conventional FM.
- Compatibility problem with DAB +.

However recent studies by Gandy {2003} have produced an improved version of DAB called DAB+.

The benefits of DAB+ include:

- Latest MPEG-4 audio codec delivers exceptional performance efficiency
- More stations can be broadcast on a multiplex
- Greater station choice for consumers
- More efficient use of radio spectrum
- Reception quality more robust on DAB+ than on DAB due to the addition of Reed-Solomon error correction coding.

2.2.0 HD Radio

Development of HD Radio began in 1991, when three major broadcasting companies in United States came together with the aim of creating a digital radio standard. In 2000, broadcasters and technology development companies consolidated their efforts, forming iBiquity Digital Corporation.

The U.S. Federal Communications Commission (F.C.C.) adopted the In-

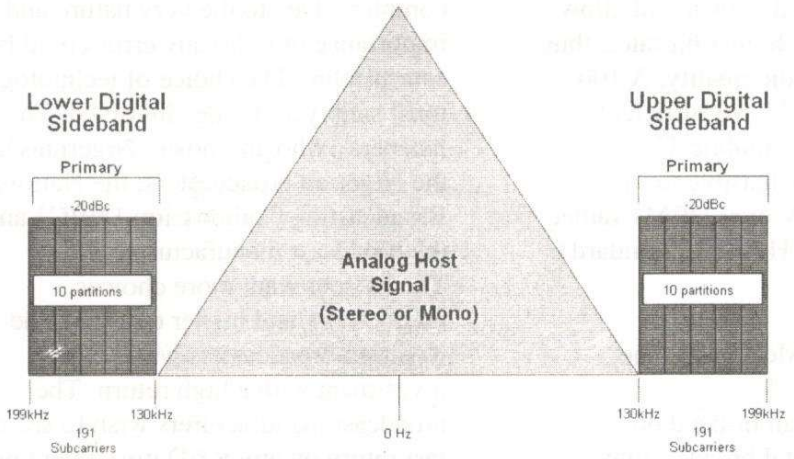
Band On-Channel (IBOC) HD Radio technology from iBiquity Digital as the sole digital standard for U.S. radio in 2002{FCC}.
Many people believe that the HD stands for "high definition." In reality, though, HD Radio is simply a brand name of iBiquity Digital Corp., which invented and manufactured the broadcast equipment {Kelly 2003}.
The International Telecommunications Union's recommendation of iBiquity's AM and FM HD Radio systems for worldwide implementation of digital broadcasting is documented in ITU-R Recommendation BS.1514 (April 2001) and ITU-R Recommendation BS.1114.

2.2.1Field Test of HD Radio

Based on the field test carried out by FRCN Engineers on HD Radio, the under listed were observed:-

- Capable of multicasting additional digital audio channels on the same frequency
- HD Radio works the same as traditional analog radio transmission except that the audio is digitally formatted and transmitted as a continuous digital data stream together with the analog waveform signal.
- The changeover to digital is a smooth one for both radio stations and their listeners because HD Radio rides on top of the existing analog spectrum without compromising the transmission quality of analog broadcasts. This allows broadcasters to make a seamless transition to digital Radio.

Figure1 shows the HD Radio hybrid mode {transmission of analogue and digital signals simultaneously.



Source: Broadcast Electronics

Figure 1: HD Radio in Hybrid Mode

- Listeners could use their current antenna to receive both analogue signal and digital HD Radio signal.
- HD Radio does not increase a station's coverage area but it does greatly improve its reception characteristics within its coverage area.
- HD Radio uses the latest data technologies to provide audio

quality that is superior to MP3 players or satellite radio.

2.3 Digital Radio Mondiale {DRM}

The field test on DRM reveals that, DRM technology is capable of operating in the bands of SW, MW, & LW{Gordon, 2003}. This has a lot of implication for FRCN, as about 85.41 % of FRCN Radio stations are FM.
The modulation used for DRM is COFDM {Coded Orthogonal Frequency Division Multiplexing}, where every carrier is modulated with QAM {Quadrature Amplitude Modulation} with a selectable error coding {ETSI Standard}.

2.4 DRM PLUS {DRM +}

DRM presently covers the broadcasting bands below 30MHz. For the DRM consortium to begin the process of extending the system to the VHF bands up to 120MHz. Bigger bandwidth channels will be used, which will allow radio stations to use higher bit rates, thus providing higher audio quality. A 100 KHz DRM+ channel have sufficient capacity to carry one mobile TV channel; it would be feasible to distribute mobile TV over DRM+ rather than DMB or DVB-H {ETSI Standard}.

2.5 FMeXtra

From our studies FMeXtra has the following features:-

- FMeXtra is an in-band on-channel digital broadcasting technology created by Digital Radio Express.
- Unlike iBiquity's HD Radio system, it uses any FM radio station's existing equipment and transmitter plant to transmit digital audio data on subcarriers instead of sidebands. It also requires no royalties for its use, which run into millions of Naira per year for HD radio.
- FMeXtra is fully compatible with HD Radio hybrid mode, which uses additional radio spectrum beyond the +/- 100 KHz signal. It is not compatible with HD Radio in all-digital mode; however this is not expected to be used for a very long time, given that there are already billions of analogue FM radios already in use.
- The system works very well for high power transmitters, but does not work for low power FM transmitters.

3.0 The Choice of Digital Radio format for Nigeria

Now that we have reviewed the various techniques, which technology will carry Nigeria successfully into the future? The choice between the different digital radio technologies can be confusing and complex. Due to the very nature and importance of radio any error could be catastrophic. The choice of technology must satisfy all parties involved: The listeners {who are mostly Nigerians}, the Nigerian broadcasters, the National Broadcasting Commission {NBC} and the broadcast manufacturers.
The listener want more choices, interactivity and higher quality. The Nigerian broadcasters want a low investment with a high return. The broadcast manufacturers wish to see a fast return on any R&D investment with the lowest risk and it could be assumed that Nigerian government and NBC wish to have a seamless and effective process of implementation and use the least amount of their valuable bandwidth while providing the maximum benefit to

Nigeria, particularly now that frequency spectrum is in high demand due to deregulation of telecommunication and broadcasting.
So how can Nigeria make the right selection? The technologies of DRM, DAB and HD Radio were specifically developed to allow broadcasters to switch from analogue to digital and each system has been implemented with varying amounts of success{Asaads & Roland , 2005}.

Any comparison between technologies must appraise each as it relates to the people using the technology. These include the listener, broadcaster, regulator and broadcasting equipment manufacturers. It is important to understand how technology markets work and what is required to succeed. The evaluation from all points of view particularly those directly involved in the technology are critical for success. Each player must see a distinct advantage in this as it relates to him.

DAB normally uses two frequency bands: Band III (174 – 239 MHz) as used in the United Kingdom and L-band (1452 – 1490 MHz) as used in Canada and parts of Europe. Although VHF Band III is a very good selection for its transmission characteristics, it is in most parts of the world extensively used for television, and because of its almost incomparable coverage capabilities it is in most countries unlikely to be given up. Some countries like USA utilize the L-Band specifically for military and marine, while others have not yet employed L-band for transmission. A feasible challenge with the L-band is that the coverage per kilowatt of power is miserable and a very expensive means of transmission particularly in Nigeria, where the aim of transmission is a nation wide coverage. It then implies that for an appreciable signal reception, a huge number of transmitters would be required and configured in cellular infrastructure. L-band transmitters and components are very expensive compared to the analogue radio equipment. This is as a result of the fact that the frequency of operation prescribes higher silicon costs for the augmentation part of the equipment and the amount of existing analogue.

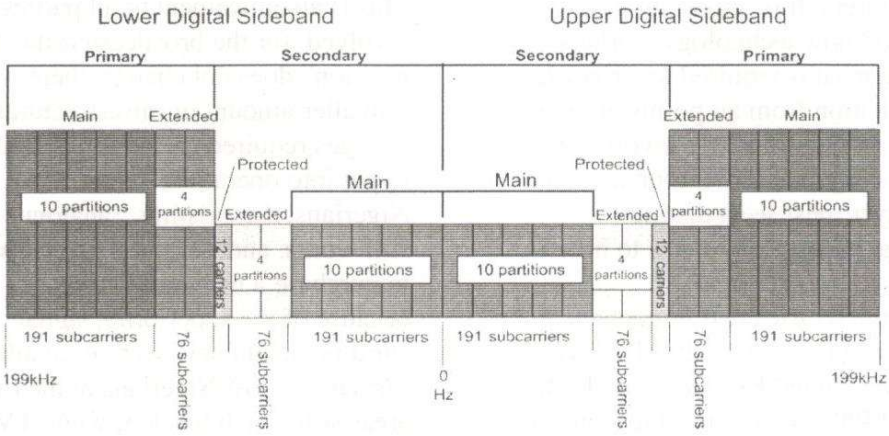
For the HD Radio, it functions in the same band as the active analogue AM-medium wave and FM-VHF Band II. This is an enticement to all parties involved, for the broadcaster; the "dial position" does not change, there will be a smaller amount of infrastructural changes required and lower capital costs to put into operation. As for most Nigerians, the existing analogue radio still works, and when the listener wishes to purchase a new radio it will be because of the superiority, signal sturdiness, and new services available. Presently, most Nigerians in the rural areas still watch black & white TV. The writer has no doubt that Nigerian government would be in favour of no request for new licenses just to provide related content and service. They would rather want to employ additional spectrum for other applications allowing for additional services. Also, the transmitter and receiver manufacturers' would ensure that there is less risk and lower R&D necessary because the equipment is an upgrade of the existing products. iBiquity as we are made to understand have already designed both

the exciter and receiver modules, so it is not a complex issue to integrate into existing equipment.

Transmitter powers are extremely dependent on both the frequency and bandwidth of the transmitted signal – the lower the frequency and the narrower the bandwidth the lower the required transmitter power will be. This explains why, it is associated with lower cost.

A critical look at these two intervening factors reveals that the transmitter powers required for a HD Radio and DRM to provide similar coverage as a DAB multiplex would be drastically lower. This would then illustrate that, cost to operate either a DRM or HD Radio transmitter as compared to a DAB system would be less costly.
The operating costs for both DRM and HD Radio in most cases increased by only a small amount. A key issue to note is that if an HD Radio or DRM broadcaster was to operate in an all digital mode, the required transmission power would be within the range of 10 and 20 dB less and this then implies that, operational costs would be drastically reduced as illustrated in figure 2. In every organization, the two key objectives are:-

- Minimization of cost of operations.
- Maximization of profit.



Source: Broadcast Electronics

Figure 2: HD Radio in all Digital Mode

It is on these bases that FRCN selected the HD Radio format for implementation. HD Radio is meaningful, feasible, flexible, cost effective and a seamless transition to digital format for Nigeria.

4. Conclusion

In closing I would like to make six points with explicitly:

1. Each technology has gained foothold in certain areas: DRM in Asia, DAB in Europe, and HD Radio in the Americas, and hence each could be considered a success in its own right. Each technology has its distinctive advantages designed to meet the requirements of certain

countries. The HD Radio is more relevant to Nigeria.
2. The difference between the technologies lies in the conditions of implementation.
3. A prominent feature of the HD Radio is that it allows hybrid multicast in FM, replicating or tripling the amount of radio programmes in a market without interruption to the existing analogue service.
4. HD Radio requires no large government intervention as it does not require additional spectrum allocations, this is because each digital signal is concurrently transmitted within the same spectral mask of an existing AM or FM allocation.
5. HD Radio is configured, through power level and spectral occupancy, to be transparent to the analogue radio listener.
6. HD Radio allows an economy of spectrum while enabling broadcasters to supply digital quality audio to their present base of listeners, without a significant investment in time or money.

In the totality, HD Radio offers a lower cost, more visible execution and definite returns for additional income or opportunities to serve the public for the broadcaster. New frequencies are not required, easing regulatory issues, and existing large radio markets reduce the risk for both receiver and transmitter manufacturers. The listener would be motivated to purchase a new receiver due to the additional content, greater quality and advanced services. It is on this light that the author recommends HD Radio to radio broadcasting operators in Nigeria. By and large no technology is ideal or meets everyone needs, and the ultimate answer will be that of finding the middle ground that can hopefully present itself to a victorious and realistic digital implementation.

Finally, there is need the digital radio receiver manufacturers come together with a view of providing a digital radio receiver that would have the capability of receiving DRM, DRM+, DAB, DAB+, HD Radio and FMeXtra signals, such receiver should be cost effective and affordable to the developing countries like Nigeria and other African Countries.

5. REFERENCES

ASAAD S. & ROLAND K. {2005}, "Digital Radio Revolution - The Future is Here!" Radio Asia Conference 2005 on "Asian Radio at the Cross Roads: A New Paradigm in the Digital Age", (15 Jun 2005), Singapore.

ASAAD S. &. KANG N. {2001}, "DAB and SmartRadio for a Mobile World", Broadcast Asia 2001 International Conference *on* "The Business of DAB - Opportunities for All", {18-22 Jun 2001}, Singapore.

ASAAD S. & ROLAND K. {2004} "Wireless Technology Battlefield in the 21st Century – Can Radio Survive?", ABU Information Paper for the Annual Meeting of the ABU Technical Committee, {20th -27th Sept 2004} .

BELL, C.P. & WILLLAMS, W.F. {1993}. Coverage aspects of a Single Frequency Network designed for Digital

Audio Broadcasting. BBC Research Department Report No. RD 1993/3.

BROADCAST ELECTRONICS Inc., HD Radio References:http://www.bdcast.com/HDRadio/

DATACASTING Whitepaper link at http://www.impulseradio.com)

Digital Radio Mondiale (DRM) website at http://www.drm.org/

ETSI STANDARD: Digital Radio Mondiale (DRM); System Specification, ETSI ES 201 980 V2.1.1 (2005-10)

ETSI SPECIFICATION, for DAB EN ES 201 980 V2.2.1 (2005-10)

EUROPEAN TELECOMMUNICATION STANDARD ETS 300401. Radio Broadcast Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers. (R031)

FCC REPORT AND ORDER: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-286A1.pdf

FCC: IBOC FM Transmission Specification: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-286A2.pdf

GANDY, C. {2003} DAB: An Introduction to the EUREKA DAB system & a guide to how it Works, BBC R&D white paper.

GIEFER, A. {2002} Digital Radio Mondiale Field Trial & Their Impact on System Design & Operation, BBC R&D White paper.

GORDON, P. {2003}"DRM Overview", ABU-AIR Regional Symposium on Digital Radio Broadcasting, (17-20 Nov 2003), New Delhi, India.

HOEG, W & LAUTERBACH, T {2001} Digital Audio Broadcasting – Principles and Applications, John Wiley & Sons, Ltd, West Sussex, England.

IBIQUITY DIGITAL: http://www.ibiquity.com/technology/papers.htm

IBOC AM Transmission Specification: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-286A3.pdf

IBOC information from Radio World Magazine: http://www.radioworld.com/reference-room/iboc/index.shtml

KANG, N.{2001} "RadioDigital-Mobile", Envision Magazine - A Publication of SBA,{Apr - Jun 2001}, pp 22-23.

KELLY, C.{2003} "iBiquity Overview", ABU-AIR Regional Symposium on Digital Radio Broadcasting, (17-20 Nov 2003), New Delhi, India.

LE FLOCH, B. , HALBERT-LASALLE, R. & CASTELAIN, R. {1989}. Digital Sound Broadcasting to Mobile Receivers, IEEE Trans., August, **CE-35**(3), pp.493-503.

NAKAHARA, S{2003} "ISDB-T SB Overview", ABU-AIR Regional

Symposium on Digital Radio Broadcasting, (17-20 Nov 2003), New Delhi, India.

OHMORI, S. & *ET AL*{2000},"The Future Generation of Mobile Communications based on Broadband Access Technologies", IEEE Comms magazine (Dec 2000), pp 134-142.

RADIO WORLD HDRADIO Reference Room: http://www.radioworld.com/reference-room/iboc/index.shtml

ROLAND, K. {1998}, "Eureka-147 Digital Audio Broadcasting", Sound.Works magazine, (Jan/Feb 1998), pp 22-26.

MOSES, S.O.{2004}Transition from Analogue to Digital Television Broadcasting : The Nigerian Experience. Annual International Broadcasting Convention in collaboration with Commonwealth Broadcasting Association, Amsterdam, September, 9-14.

MOSES, S.O.{2008} Radio Development: The Case of Radio Nigeria A Paper Presented at the 2008 Commonwealth Broadcasting Association Conference, Nassau, the Bahamas, January 23-26, 2008

SHELSWELL, P., *et al.* {1991}. Digital Audio Broadcasting, the first UK field trial. BBC Research Department Report No. RD 1991/2.

SHELSWELL. P. {1998}: The COFDM Modulating System: The Heart of Digital Audio Broadcasting, BBC RD, Publication.

WORLDDAB FORUM website at http://www.worlddab.org/