RADIO DEVELOPMENT: THE CASE OF RADIO NIGERIA

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RADIO NIGERIA

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Historical Review of Radio Development Worldwide

Radio is based on relationship between electric current and magnetism suggested by Gian Domenico Romagnosi in 1802, his report then went unnoticed. Later Hans Christian in 1820 performed a widely known experiment on man-made electric current and magnetism. Michael Faraday in 1831 discovered electromagnetic induction, which was mathematically modeled by faraday's law- one of the four Maxwell equations {1861-1865}.

David E. Hughes was the first to transmit and receive radio waves in 1878. Heinrich Rudolf Herz validates Maxwell theory between 1886 – 1888. In April 1909 Charles David Herrold constructed a broadcasting station. Herrold did not claim to be the first to transmit the human voice but he claimed to be the first to conduct "broadcasting". He designed some ominidirectional antennas

Guglielmo Marconi conducted a reported In 1901, Marconi conducted the first successful transatlantic experimental radio communications and established the first commercial transatlantic Radio service in 1907, In 1904, Sir John A. Fleming developed the first vacuum electron tube, which was able to detect radio waves electronically. Two years later, Lee de Forest invented the audion, a type of triode, or three-element tube, which not only detected radio waves but also amplified them.
Radio telephony—the transmission of music and speech—also began in 1906 with the work of Reginald Fessiden and Ernst F. W. Alexanderson, but it was not until Edwin H. Armstrong patented (1913) the circuit for the regenerative receiver that long-range radio reception became practicable. The major development in radio initially was for ship-to-shore communications. The first Radio Station was built and operated by Armstrong.

Historical Review of Radio Development in Nigeria
Radio broadcasting was introduced into Nigeria as a form of distribution system in 1933. The Post & Telegraph received and re- transmitted via the wire system of BBC News, which was later called **Radio Diffusion system**.

In 1939, a station was opened in Ibadan, Kano Station was commissioned in 1949 while between 1945 to 1949 stations had been opened in towns like Kaduna, Enugu, Abeokuta, Ijebu-Ode, Jos, Zaria, Calabar and Port-Harcourt as relay stations.

The Nigerian Broadcasting Services {NBS} which was established on April 1, 1951, later transformed into the Nigerian Broadcasting Corporation {NBC} under the NBC Act No. 39 of 1956.

By 1st January, 1962, Voice of Nigeria {VON} was launched as the International Service of Radio Nigeria covering West Africa, East Central & Southern Africa, North Africa & other parts of the world. VON was later excised from Radio Nigeria on January 5, 1990.

The 1st FM in Nigeria was commissioned on April 22, 1977. It was known then as Radio Nigeria 2 {now Metro FM}. A year later when NBC was reorganised, the state stations were handed over to State Governments NBC was left with only Lagos, Ibadan, Enugu & Kaduna which became Federal Radio Corporation of Nigeria {FRCN}. In 2000, FRCN was directed by the Federal Government of Nigeria to operate FM Stations at various State capitals.

The Partial Commercialisation of FRCN came up in 1992 which means FRCN was to be free from government support with a take-off grant {yet to be provided} that would equip FRCN for commercialisation.

Decree no. 38 of 1992 gave birth to National Broadcasting Commission, which regulates broadcasting in Nigeria.
With the deregulation of broadcasting in Nigeria, FRCN ceased to benefit from the monopoly of radio broadcasting; giving room for quality programming & value for money.

At the last count, there are more than 100 Radio Stations now operating in Nigeria. The only challenge is that the commercial Radio Stations are concentrated in the urban cities with the exception of FRCN 32 FM Project which was established as a grass-root/ community Radio.

Digital Radio

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.

Broadcasters believe 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. Stations competing against other audio entertainment and information delivery systems can direct their programming to special audience, whether it's a local, ethnic group or a particular demography previously unattainable. They can offer new ways to communicate with their listeners, whether it's running out text of an advertiser's telephone number or on-radio emergency traffic and weather alerts. In doing so, they can realize ways to make more money. Digital Radio gives more business opportunities for radio stations.

Data and Text Capability

For AM, enough to display the station name as well as song title and artist on the face of the tuner. Initially, FM broadcasters will be able to send out what is known as Program Associated Data or PAD, song title and artist name. Stations will also be able to provide text advertisements and station branding—programme name, jingles and other promotional messages—to help build listener's loyalty.

In the future, broadcasters may want to add further information such as the name of the album and the year it

was launched and, artists' biographies to their display broadcasts.
Text feeds of breaking news, weather, sports information, traffic updates and more are all possible.

Data services enabled by Digital Radio are not limited to on-screen text displays.
Using a feature called data tunneling that transmits data for special nonbroadcast applications; broadcasters can send their listeners the latest traffic information for their in-car navigation systems to help them avoid delays due to accidents or road construction. Future developments could include images, such as album art and other file-based services, as well as the transmission of information services as data streams or file transfer.

Types of Digital Radio Technologies

A} DAB

DAB digital radio which 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.
Because analogue and DAB are two completely different broadcast techniques, an FM aerial will not work for digital radio.

DAB can be transmitted on frequencies from the FM band (88 MHz to 108 MHz), but 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). DAB receivers currently on the market can receive both Band III and L-Band transmissions.

DAB gives substantially higher spectral efficiency, measured in programmes per MHz and per transmitter site, than analogue communication.

Some drawback of 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 so that when there are a lot of errors with the received data not enough of the errors can be corrected and a bubbling mud sound occurs.
- ❖ Transmission on DAB is far more expensive than on FM.
- ❖ Compatibility problem with DAB +.

Recent studies 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
- ❖ Approximately three times more efficient than DAB due to the adoption of the AAC+ audio codec.
- ❖ It allows broadcasters to provide far higher audio quality.
- ❖ Reception quality more robust on DAB+ than on DAB due to the addition of Reed-Solomon error correction coding.
- ❖ Is not backward compatible with the original standard.
- ❖ The vast majority of existing DAB receivers will not be able to receive DAB+ radio services when they are launched.
- ❖ Lower transmission costs for digital stations
- ❖ New receivers' backwards compatible with existing MPEG Audio Layer II broadcasts

- Compatible with existing scrolling text and multimedia services
- Robust audio delivery
- Optimised for live broadcast radio
- Broadcasters/regulators can select either standard MPEG Audio Layer II, or the additional audio coding, or both, to suit their country
- Fast re-tuning response time (low zapping delay)
- MPEG Surround is possible
- Uses MPEG-4 High Efficiency AAC v2 profile (HE-AAC v2). This audio codec is the most efficient audio compression scheme available worldwide.

B} HD Radio

Development of HD Radio began in 1991, when three major broadcasting companies with 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.

Many people assume that the HD stands for "high definition." In reality, though, HD Radio is simply a trademarked brand name of iBiquity Digital Corp., which invented and manufactures the broadcast equipment.

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.

Features of HD Radio

- Simultaneous broadcast of both conventional analog and digital signals on the same channel

- Capable of multicasting additional digital audio channels on frequency

- Data tunneling for file transfer

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 transition 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. 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.

Another, advantage of this technology is that HD Radio uses the latest data technologies to provide audio quality that is superior to MP3 players or satellite radio. Bit for bit, HD Radio sounds twice as good as MP3 or satellite.

C. DRM

DRM technology is capable of operating in the bands of SW, MW, & LW.

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.

DRM PLUS

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

D. FMeXtra

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 thousands of Pounds per year for HD radio.

The system is run from a single rack unit box called the X1 Encoder, which is actually based upon a personal computer server and digital audio hardware from Lynx Studio Technologies.

FMeXtra is fully compatible with HD Radio hybrid mode, which uses additional radio spectrum beyond the +/- 100KHz 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. It is also not compatible with all existing subcarriers.

The system works very well for high power transmitters, but does not work for low power FM transmitters if the area covered does not have good stereo coverage. The coverage is similar to FM Stereo, and therefore high ERP is required in large urban areas similar like the normal FM transmissions.

E. Satellites

Sirius Satellite Radio is one of two satellite radio services operating in US and Canada. Currently provides 69 channels of music and 65 channels of sports, news and entertainment to listeners. The channels are broadcast from three satellites in a tundra orbit above North America.
Sirius spacecraft Radiosat 1 through Radiosat 4 were manufactured by Space Systems /Loral. The first three of the

series were orbited in 2000 by Proton-K Block-DM3 launch vehicles, with the final three-satellite constellation completed on November 30, 2000. Radiosat 4 is a ground spare, in storage at Space Systems / Loral's facility in Palo Alto, California, ready to be launched if any of the three active satellites encounter transmission problems.

Sirius does not as yet use geostationary satellites. All the three satellites broadcast directly to the consumer's receiver, but due to the highly elliptical orbit only two of them broadcast at any given time. A third, separate signal is uplinked to the AMC-6Ku-band. Satellite and received by 36-inch satellite dishes for the ground repeater network. This third signal is broadcast on a third segment of the signal.

Sirius broadcasts using 12.5MHz of the S band between 2320 and 2332.5MHz. Audio channels are digitally compressed using a proprietary variant of Lucent's Perceptual audio coder compression algorithm and encrypted with a proprietary conditional access system. To economize on bandwidth up to 25 %, Sirius intends to implement hierarchical modulation.

WorldSpace is digital satellite radio network based in Silver Spring, Maryland, USA. It covers most of Asia and parts of Africa by satellite.

Each satellite provides three transmission beams that can support 50 channels each, carrying news, music, entertainment and education and including a computer multimedia service.

Currently, two satellites are in use, AfriStar 1 at 21.0 degrees east longitude and AsiaStar at 105.0 degrees east longitude. AfriStar 1 serves Africa, Europe, and the Middle East, while AsiaStar serves most of South Asia and overlaps in the Mideast.

All WorldSpace satellites are EuroStar – 2000+ spacecraft and the payload is the WorldStar platform by Alcatel Space.

XM Satellite Radio provides digital programming directly from two high-powered satellites in geostationary orbit above the equator; XM Rhythm at 115 degrees west longitude and XM Blues at 85 degrees west longitude in addition to a network of ground based repeaters.

Astra Digital Radio{ADR} is a system used by SES Astra for digital radio transmissions on Astra 1 satellites, using the audio subcarrier frequencies of analogue television channels.

Special receivers are required to listen to ADR stations, although some combined analogue / digital satellite boxes as well as later normal analogue boxes are equipped to decode it.

ADR is incompatible with DVB-S, although DVB-S digital radio stations are also transmitted using Musicam and generally at the same bitrates.

Internet Radio is

- ❖ An audio broadcasting service transmitted via the Internet.
- ❖ Internet radio "stations" are usually accessible from anywhere in the world.
- ❖ Usually referred to as web casting , since it is not transmitted broadly through wireless means.
- ❖ A streaming medium that presents listeners with a continuous *stream* of audio to which they have no control much like traditional broadcast media.
- ❖ It is not synonymous with podcasting which involves downloading.
- ❖ Nor does Internet Radio suggest "on-demand" file serving.
- ❖ Many Internet "radio stations" are associated with a corresponding traditional "terrestrial" radio station or radio network.
- ❖ One of the most common ways to distribute internet radio is via streaming technology using a lossy audio codec.

- ❖ The MP3 format is most popular, followed by Ogg Vorbis, Windows Media Audio, and RealAudio; use of HE-AAC {sometimes called AAC+} is gaining in popularity.
- ❖ The bits are "streamed" {transported} over the network in TCP or UDP packets, then reassembled and played within about 2-10 seconds, depending on server characteristics. This delay is referred to as lag time.

Digital Radio Technology for Radio Nigeria

But 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: listeners, Radio Nigeria, NBC and manufacturers. The listener typically wants more choices, interactivity and higher quality; this would be confirmed by the fast implementation of DVD and MP3 players. Radio Nigeria wants a low investment with a high return; this may be measured by a financial result or in the case of a non-commercial public station by it being able to provide a better service to the community. 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.
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.

Any comparison between technologies must appraise each as it relates to the people using the technology; the listener, broadcaster, regulator and manufacturers. It is important to understand how technology markets work and what is needed 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 and be able to gain benefits from the technology.

The combination of Spectral Band Replication with AAC is called High Efficiency AAC or AAC+ and is one of the most efficient audio codecs in existence. Coding technologies have since further improved the coding algorithms which produced HDC {the codec used in HD Radio}.

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. The L-band is also used in the USA and other countries are already used for military and marine communications. Some countries have not yet employed any transmission in the L-Band, but a very real problem with this particular band of frequencies is that the coverage per kilowatt of power is poor and becomes an expensive method of transmission particularly if the objective is to obtain nation wide coverage. For reasonable signal reception there must be strong signal strength.

Consequently a great number of transmitters would be needed & organized in cellular infrastructure. In addition, relatively high transmission powers will be required. The result is that a colossal investment would be necessary for a country like Nigeria with a large landmass and widespread population.

HD Radio operates in the same band as existing analogue AM-medium wave and FM-VHF Band II. This has advantages to all parties involved, for the broadcaster; the “dial position” does not change, there will be less infrastructural change necessary and lower capital costs to implement. From the listeners point of view; the existing analogue radio still works, and when the listener wishes to purchase a new radio it will be because of the quality, signal robustness and new services available. It could be assumed that most governments would prefer not to require new licenses just to provide similar content and service. It is a good assumption that any government would prefer to utilize additional spectrum for other applications allowing for additional services. From the transmitter and receiver manufacturers' point of view, there is less risk and lower R&D necessary because the equipment is an upgrade to existing products. iBiquity has already designed both the exciter and receiver modules so it is a simple matter of integration into existing equipment.

Operational costs

L-Band transmitters and components are in common more expensive than the equivalent standard analogue and digital radio equipment; this is due to the fact that the frequency of operation dictates higher silicon costs for the amplification part of the equipment and the amount of existing analogue. On the other hand DRM and HD Radio extensively utilize analogue transmitter types with a new exciter system.
Due to its use of existing infrastructure and low technical constraints, HD Radio will work with most existing AM and FM equipment. For AM it is necessary as with DRM, to purchase a new digital exciter. FM HD Radio implementation can be accomplished by using either the existing transmitter or antenna system and a new exciter or installing a completely new but lower power, parallel system.

Transmitter powers are highly 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. Hence, the lower the cost involved. Taking these two factors into account, the transmitter powers required for a HD Radio and DRM to provide similar coverage as a DAB multiplex would be significantly lower. This would indicate immediately that cost to operate either a DRM or HD Radio transmitter as compared to a DAB system would be less expensive.
The operating costs for both DRM and HD Radio in most cases increased by only a small amount. For both systems it is estimated that the annual operating cost would typically increase by no more than 15%. One important note is that if

an HD Radio or DRM broadcaster was to operate in an all digital mode, the required transmission power would be between 10 and 20 dB's less and as such, operational costs would be reduced possibly by as much as 80%.

In conclusion, each technology has gained a foothold in certain areas: DAB in Europe, DRM in Asia and HD Radio in the Americas, and hence each could be considered a success in their own right.

Each technology has its distinctive advantages designed to meet the requirements of certain countries.

It could be concluded that the differences between the technologies lies in the conditions of implementation.
A notable feature of the HD Radio is that it allows hybrid multicast in FM, doubling or tripling the amount of 4 radio programs in a market without interruption to the existing analogue service.
The key to HD Radio is that it requires no large government intervention as it does not require additional spectrum allocations, this is because each digital signal is simultaneously transmitted within the same spectral mask of an existing AM or FM allocation. HD Radio is designed, through power level and spectral occupancy, to be transparent to the analogue radio listener. 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.

Summary
On the whole, HD Radio offers a lower cost, more visible implementation 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. Overall no technology is perfect or meets everyone needs, and the final solution will be that of finding the middle ground that can

hopefully present itself to a victorious and practical 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 and FMeXtra signals, such receiver should be cost effective and affordable to the developing countries.

Thank you for listening.