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DRM: An Emerging Radio Technology and its Impact on India

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Abstract - *Digital Radio Mondiale (DRM) is the universal, openly standardized digital broadcasting system for all broadcasting frequencies, including the AM bands (LW, MW, SW), as well as VHF Bands I, II – (FM band) and III.*

It is compatible to various modes operating on 5 kHz and 10 kHz bandwidth being used in the current AM broadcasting, and modes requiring larger bandwidth. It provides digital alternative to replace analogue AM broadcasting being used for radio transmission. DRM uses existing frequency bands and infrastructure with little modifications in the transmitters being used for Medium and short-wave transmission. DRM has a wider choice of station, language and content. Information on Electronic program guide (EPG) and greater stereo sound, 5.1 surround sound on FM bands. It uses spectrum more efficiently and uses less power. Moreover, there is emergency warning feature Also saves spectrum as it allows four services per transmission. This paper reviews the key features of DRM, broadcast efficiency and scope of Digital Radio in India.

***Key Words*: Amplitude Modulation (AM), Frequency Modulation (FM), Radio Standard, Digital, Short wave (SW), Transmissions, Medium Wave (MW), VHF Bands, Emergency warning function (EWF), In band on channel (IBOC).**

1. Introduction

DRM is the world's only open standard, digital system for long-wave, medium-wave and short-wave and the VHF bands, including the FM bands, with the ability to use existing frequencies and bandwidth across the globe. DRM is recognized by both The DRM System Specification has been approved and published by the European Telecommunications Standards Institute (ETSI) The standard has evolved from the original, which covered only the AM bands, to the current version which includes operating modes for all the frequency bands below 300 MHz DRM Consortium has worked with ITU-R and fulfils all the condition laid out by the organization [1].

1.1 Operating Bands

The DRM Operates in two bands DRM30 operates below 30 MHz and DRM+ operates above 30 MHz up to 300 MHz DRM30 is deployed for terrestrial broadcast solution and is primarily MW/SW coverage The DRM standard for broadcast frequencies above 30MHz (called 'DRM+') is used for individual services or coverage needs with broadcast-controlled transmission. It uses the same audio coding, data services, multiplexing and signalling schemes as DRM30, but uses a transmission mode optimised for those bands.

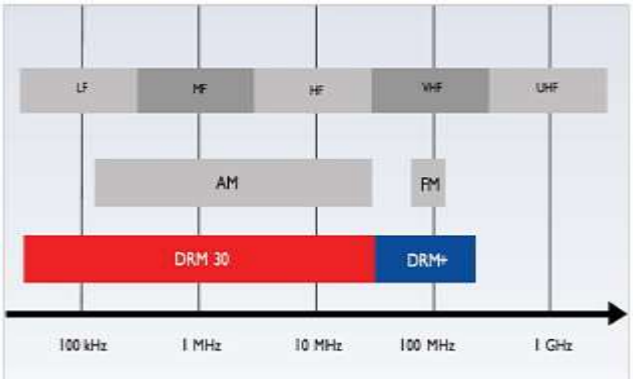

Figure 1: The frequency bands in which DRM operates among other services (Image courtesy of Digital Radio Mondiale)

The DRM Broadcasting system has been designed specifically as a high-quality audio replacement for current analogue radio in all the AM and FM/VHF bands; as such it can be operated using the same existing channel and spectrum allocations as currently used by broadcasters in analogue environment.

1.2 Transmission

DRM provides Free-to-air broadcast for every broadcaster. The present system of transmission faces signal fading by ionospheric layers and by industrialization. Larger area is still on MW which is a spectrum and power-hungry technology [2]. MW transmission still works on century old model with no value-added services. There are solutions provided with the DRM Transmission such as -

- 4 services per frequency which could be either audio or data.
- Most of value-added services and modern media consumption.
- Wider choice of station, language and content.
- No fiddling with buttons or trying to remember frequencies.
- Uses spectrum more efficiently, offers extra opportunity for revenue generation and uses less power.
- Emergency warning and Alerts.
- Interactive features such as Journaline and Electronic program guide [3].

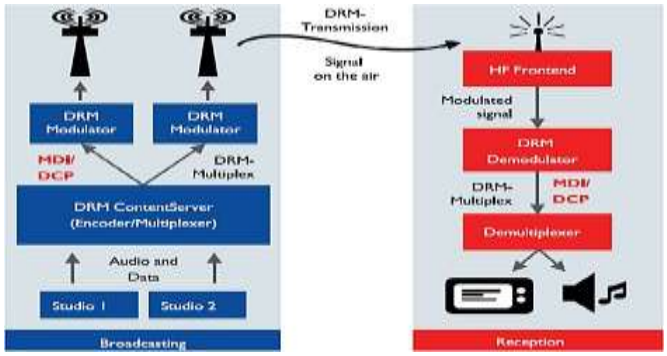

Figure 2: Transmission cycle of DRM. (Image courtesy of Digital Radio Mondiale)

1.3 Availability of DRM

Terrestrial broadcasting is freely accessible with unlimited listeners from single transmitter. In contrast to the cellphones, Mobile Network and data capacity are paid services. Thus, Network operator are in position of being gatekeepers between radio service providers and their listeners. Therefore, Terrestrial broadcast is here to stay.

Equipment implementing the coding and modulation part of DRM requires the use of certain essential patents for which manufacturers need to make agreements with the patent holders. The audio part of DRM falls entirely within the licensing of AAC undertaken by Via Licensing, The DRM Association and the DRM Consortium do not make any charges for the use of the DRM technology. Thus, DRM technology is largely free and open [2].

2. Key Features of DRM

Following are some of the key features of DRM technology

- DRM can be implemented to the existing transmitter systems with little modifications, additionally because of its in band, additionally; it can operate in hybrid mode simulating both analog signal and digital signal. The additional investment to migrate to the digital broadcasting technology only 10 to 20 % that will reduce transmitter power consumption will go down by 20 –40 %.
- DRM can transmit data besides audio. A total of 4 services combination leaving one for emergency, still gives 3 services per frequency which can be a combination of both audio or data [4].
- Encoding and decoding is performed using digital signal processing. Cheap embedded computer with conventional transmitter and receiver can be deployed [5].
- Automatically switch for disaster & emergency warnings in case of impending disasters in large areas, automatically presenting the audio message, while providing detailed information on the screen in all relevant languages simultaneously. Great potential to become the surest and widest means of alerting the population to emergencies [5].
- In AM medium wave band, DRM supports 18 KHz channel assignments in India and Asia pacific conforming with ITU regulation. Enabling simulcast and extended full digital transmission with even more services and content.
- Operates in the existing AM/FM preventing the need to change existing spectrum planning. The white spaces in the spectrum can be utilized for the same.
- DRM has been designed specially to use portions of older AM transmitter facilities such as antennas, avoiding major new investment.
- DRM is robust against the fading and interference [6].
- DRM uses in-band on-channel (IBOC) technology and can operate in a hybrid mode called Single Channel Simulcast.
- A close placement of a Digital System signal to an analogue FM signal is possible and can be flexibly configured depending on the existing use of spectrum. In this way, Digital System may be introduced into the FM frequency band without displacing the existing channels [7].

3. Society Benefits

- EWF retune to Emergency broadcast or even automatically switch-on from stand-by; the emergency broadcast consists of both audio plus journaline text information, which provides information to non-native speakers including the impaired listeners.
- Stereo quality sound in DRM30 and 5.1 surround quality in DRM+. Easy tuning with text, pictures and journaline for all the listeners.
- Broadcasters can use multilingual program with extra information on screens along with reduced power up to 40-50% [2].
- Chipset manufacturers, module and receiver developers, automotive brands, even retailers are involved and benefit from whole new market,
- Indian Manufacturers can start producing DRM capable solutions without asking anyone for a license to acquire secretive and undisclosed proprietary technology components, the sincere form of knowledge transfer and digital empowerment for India.

3.1 Emergency warning system

- The DRM technology provides an ideal platform for delivering emergency warning services using standard radio sets –no extra hardware or infrastructure required.
- EWF support is mandatory as described in the DRM minimum receiver requirements and second-level receiver profile with no need for special chipsets or extra adaptation for EWF. Everything needed for EWF is already in the receivers built according to the above specifications issued by the DRM Consortium.

- The DRM technology should be the major building block of a national emergency warning policy, providing full and continuous services as a last resort potentially even from a remotely located transmitter site.
- In case of emergency all local infrastructure fails. Digital Radio can be a life saver in such a case. Digital equipment does not send continuous signal. It is made up of mathematical code sent in block segment. When digital signal encounters interference the entire block is lost. It is easier to tune into than analog because of mathematical exactness.

3.2. Superior Audio Source Coding

The source coding options available for the DRM system are depicted in Figure 3. All of these options, with the exception of the one at the top of the Figure (AAC stereo), are designed to be used within the current 9/10 kHz channels for sound broadcasting below 30 MHz The CELP option provides relatively low bit-rate speech encoding and the AAC option employs a subset of standardized MPEG-4 for low bit rates (that is, up to 48 Kbit/s). These options can be enhanced by a bandwidth-enhancement tool, such as the SBR depicted in the Figure. Representative output bit rates are noted in the Figure. All of this is selectable by the broadcaster.

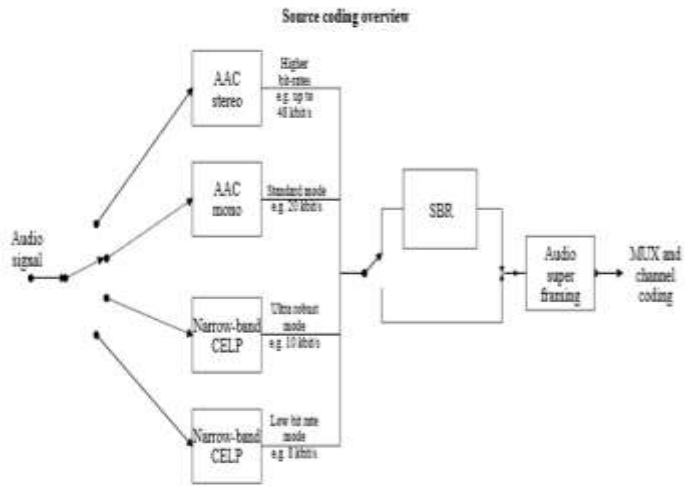

Figure 3: Source Coding Overview. (Image courtesy ITU-R BS.1514-2)

Special care is taken so that the encoded audio can be compressed into audio superframes of constant time length (400 ms). Multiplexing and unequal error protection (UEP) of audio/speech services is affected by means of the multiplex and channel coding components.
As an example of the structure, consider the path in Figure. 3 of AAC mono plus SBR. For this, there are the following properties:

Frame length: 40 ms
AAC sampling rate: 24 kHz
SBR sampling rate: 48 kHz
AAC frequency range: 0-6.0 kHz
SBR frequency range: 6.0-15.2 kHz
SBR average bit rate: 2 Kbit/s per channel
In this case, there is a basic audio signal 6 kHz wide, which provides audio quality better than standard AM, plus the enhancement using the SBR technique that extends this to 15.2 kHz. All of this consumes approximately 22 kbit/s. The bitstream per frame contains a fraction of highly protected AAC and SBR data of fixed size, plus the majority of AAC and SBR data, less protected, of variable size. The fixed-time-length audio superframe of 400 ms is composed of several of these frames [10].

3.3. DRM and FM signal

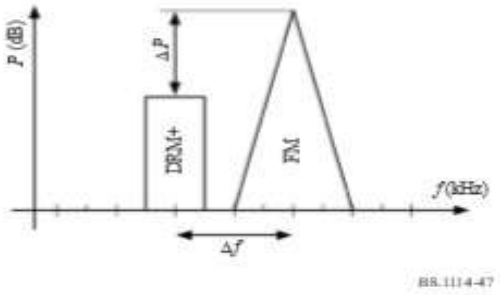

Figure 4: Example Configuration for a digital system G (Image courtesy ITU-R R-REC-BS.1114-9-201506-S)

Figure 4 shows that the Digital System G signal can be placed closely to the left or right of the existing FM signal. To guarantee the respective protection levels and audio quality of the FM signal, the carrier frequency distance (Δf) and the power level difference (ΔP) of the FM and the Digital System G signals can be planned accordingly. Δf can be chosen according to a 50 kHz channel raster. Δf ≥ 150 kHz is recommended. ΔP can be varied flexibly; however, a ΔP > 20 dB is recommended for the minimum Δf = 150 kHz. Two transmission configurations are possible: the analogue and digital signals can be combined and transmitted via the same antenna; or the two signals can be transmitted from different antennas.

Different configurations for the Digital System G signal are possible. The Digital System G signal can have the same programme as the FM service, a different programme or the same programme as well as additional programmes. If the same programme is available via Digital System G and FM, the alternative frequency switching (AFS) flag should be sent in the service description channel (SDC) of the transmission multiplex allowing for a support of heterogeneous networks [7].

4. Field Trial Results

For Effective implementation, many field tests have been conducted. Result from one such field test with DRM 26MHz transmission (equivalent of FM) is summarized below:

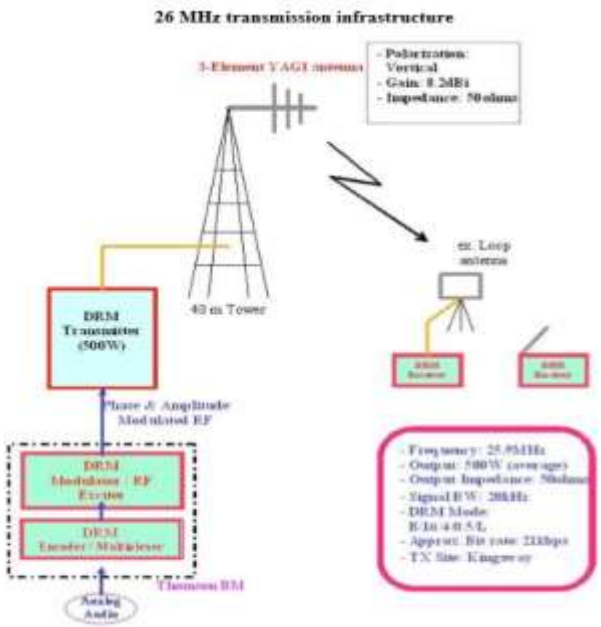

Figure 5: 26 MHz Transmission Infrastructure (Image courtesy ITU-R_WP6A_010_India)

The radiating system consisted of a 3 element Yagi antenna with enough directivity to achieve local coverage and at the same time avoid ionospheric interference. The antenna was placed on a 40-meter height tower. Elevated locations are required to provide coverage by means of line of sight propagation.

The sites at which the experiment was conducted were identified STIT, Delhi and NBH, Delhi. The 26 MHz broadcasting band has been traditionally used for long distance transmission through ionospheric propagation. However, using "line of sight" propagation techniques, like the ones used by the FM broadcasting, the 26 MHz broadcasting band can be used for providing digital radio services to local areas. In this section the results of the tests carried out in New Delhi with the DRM system in the 26 MHz broadcasting band for local coverage are summarized. The relevance of these trials is that local radio coverage is possible with good audio quality using only low power transmitters. Figure 6 displays the location of sites. Some of the observations are stated below: -

Figure 6: Static Locations for 26 MHz measurements (Image courtesy ITU-R_WP6A_010_India)

Location	Distance Tx (km)	Median field strength level (dBμV/m)	Median received SNR (dB)	AudioQ
Location 1 (NBH)	9.86	53.9	26.3	100%
Location 2 (STI-T)	0.56	97.4	31.5	100%

Figure 7: Results for 26 MHz static tests (Image courtesy ITU-R_WP6A_010_India)

- Static reception measurements were done at two locations. The received signal to noise ratio was well above the threshold at these locations. The reception was excellent along the route up to a radial distance of 7 km towards downtown. When entering the center of the city, within an area with high buildings, high power noise sources were encountered along with signal strength dropouts. Several drives were measured in the very center of the city and the reception was very good except for the above-mentioned high building areas.
- The use of a directional antenna showed to provide good results. The DRM audio quality was very good. Precaution must be considered when applying audio processing to the programme source
- The 26 MHz was considered by the participants and attendees as being one of the most promising applications for the Asian continent. The reception quality was very good at the locations and routes tested reaching more than the 98 % of the locations measured in static and mobile modes. It can achieve a near FM audio quality for local coverage using an antenna placed in a 40 m height tower. [6].

5. Current developments

- At Present in AIR there are 35 transmitters, out of the 35 MW transmitters, 2 are working in pure DRM carrying 2 audio services in digital and the other 33 transmitters are working in simulcast mode [8].
- More than 100 thousand cars are on the road in India today and are equipped with DRM receivers (Hyundai, Maruti Suzuki, Mahinda); Hyundai for instance has six models with DRM receivers on the Indian roads with new models to come [9].

6. Conclusions

Some of the important conclusions that can be stated are:

- IP streaming is well established today and will continue to play an important role in the future particularly for niche or locally un-available services, it cannot replace terrestrial radio broadcast services particularly for freely available services targeting a mass audience.
- National rollout and market development will create export opportunity for Indian manufacturers, module and chipset makers. Retail and automotive industries will also benefit.

- The DRM technology has tremendous potential in disaster management. The DRM audio broadcasting system has all required tools built-in and supported by available chipsets for a quick and complete mass notification (including impaired Listeners) when disasters/catastrophes occur. By providing DRM receivers with switch signals and alternative frequencies to get emergency programmes. Also, by providing Listeners (including impaired users) with complete and detailed information by audio and multilingual on-demand text [2].
- The DRM Consortium proposed alternative use of the 26 MHz band for local broadcasting [6]. Field tests was to demonstrate the working of DRM signals at par with the same signal of FM transmission. DRM Signals shows Excellent reception. It Demonstrates the great potential the technology carries and should be implemented further.
- The performance of the digital signal surpasses that of the existing analogue signal. And when the digital signal finally begins to exhibit degradation, the IBOC receiver will automatically change to its analogue signal. Therefore, the performance of the Digital System is better than the performance of existing analogue FM service [7].
- As switching to DRM is the aim of All India Radio Simulcasting is the best suited option. Simulcasting is one strong option with a single transmitter broadcasting is been done side-by-side to bridge the transition, until the digital receiver population is strong enough. Also, Digital signals can fit side by side with FM frequency bands without displacing the existing setup. During phase-II, most transmitters will carry a new DRM signal while still maintaining the analogue AM transmission to support existing analogue receivers (called the 'simulcast' mode of DRM) – with all-digital transmissions inserted at certain points in the day. Phase-III, as presented by AIR, will eventually culminate in the complete transition of radio services to the digital DRM platform, further improving the number and quality of radio services and extra features for the listeners, while also saving tremendous amounts of transmission power every year [8].

7. Future Scope of Work

The present cost of Receivers is above ₹ 10000, efforts are being implemented to reduce it to ₹ 2000-3000. 26Mhz bandwidth can be deployed in addition to 18 MHz for transmission in future. Community radio stations can be constructed at par with DRM for adoption and promotion purposes both. Alarm trigger routing, EWF and Automatic receiver wake-up can be implemented in DRM receiver for the disaster-Prone zones. In case of Emergency Receiver solution, the screen can be developed specially for impaired listeners with catching and flashy fonts and design. For both medium wave and some aspects of short-wave broadcasting, the single frequency network concept is attractive for certain markets. This is another potential spectral efficiency gain and, as the one mentioned above, it will only be realizable when the digital receiver population in the target broadcast area has reached a high level.

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