Paper

# Technical Aspects Outline for the Strategy of Launching Digital Broadcasting in Poland on Wave Bands Below 30 MHz

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**Abstract—The article discusses the state of art knowledge concerning the introduction of DRM in the world and prospects for its further development. It presents the possibility of introducing this system in Poland.**

***Keywords—digital radio broadcasting, Digital Radio Mondiale, DRM features, technical aspects, DRM in Poland.***

## 1. Introduction

To present the strategy for transition to digital broadcasting in Poland we need to determine the possibility of undertaking such a task. There is no doubt that the digital broadcasting system is well defined and documented both in technical and legal terms. The Digital Radio Mondiale (DRM) system is approved by radio broadcast regulators such as ETSI (European Telecommunications Standards Institute) and ITU (International Telecommunication Union). It is supported by international organizations such as the EBU (European Broadcasting Union), ABU (Asia Pacific Broadcasting Union) and IEC (International Electrotechnical Commission) too. There are adequate facilities for the transmission of radio signals such as RF high-power amplifiers and transmitters, modulators, antennas and informatics apparatus like PCs or servers, as well as a wide range of receivers both independent and associated with the receivers of other radio systems, digital and analog ones.
For the smooth introduction of the DRM system into operation, the DRM Consortium was formed in 1998 [1]. The Consortium is an international non-profit making association of broadcasters, network operators, manufacturers of transmitters and receivers, broadcasters, universities, research institutes and other organizations. Its purpose is to promote and distribute a digital system suitable for use in the 148.5 kHz – 174 MHz frequency range. Currently the consortium brings together 93 members and 90 "fans" from 39 countries.

## 2. The Definition of DRM, Documentation, Regulations

DRM digital system is designed to improve reception quality, reliability and ease of use at long, medium and short wavelengths, and enables further use of these ranges following analog broadcasting. DRM digital broadcasting technology is documented in detail through a series of technical specifications approved and published by ETSI. The basic description, ES 201 980 [2] contains all details of the DRM system: system architecture, coding systems and modes of transmission allowing operation in different propagation conditions at the maximum width of the channel. The V3.1.1 version of August 2009, contains a detailed description of both DRM30 and DRM+ systems.
ITU recommends implementation of digital DRM system in the frequency bands below 30 MHz [3]. ITU has established conditions for the use of digital DRM system in the electronic environment through a series of reports and recommendations. The most important are: ITU-R BS.2144 Report [4] and ITU-R BS.1615 Recommendation [5].
Both documents provide guidance for planning digital broadcasting in the bands below 30 MHz. Parameter sets included there provide useful planning field strengths such as the minimum usable field, strengths and RF protection ratios. There are a number of additional support standards related to distribution and communication protocols.

## 3. Features of the DRM System

The concept of DRM digital radio for frequency ranges of below 30 MHz with its implementation and possibilities of further use have been described above. These opportunities are also provided by the system that offers:

- competitive sound quality,
- additional data transmitted to the radio as "now and then"and other broadcast,
- EPG screen with a list of all digital radio available services,
- the ability to stop receiving in real-time and the ability to scroll backwards,
- the ability to successfully launch additional channels to reach new DRM listeners,
- use of other software to enrich information service.

The main characteristics of the DRM system are [6]:

- Access to four services on one frequency and a convenient choice of all currently received broadcasts:
  - audio broadcast in each service,
  - text information and/or use of multimedia applications [Journaline, Diveemo (see below) and others],
  - the ID (worldwide unique) easily scanning the specific services to make automatic frequency switch possible.
- List of stations (in Unicode – the system designed to handle the worldwide exchange, processing and displaying of texts written in different languages).
- Especially important for DRM:
  - possibility to be received in any country,
  - regular frequency changes.
- Alternative frequency may be limited territorially or temporarily.
- Checking the availability of services without interruption.
- Service announcements:
  - types of ads: traffic information, news, weather, warnings, alarms, an additional maximum of 6 types of ads reserved for the system,
  - active ads may be transferred to other services: to another DRM service within the same multiplex, to another site under another DRM multiplex, to other broadcast system (DAB/DMB, FM-RDS, AM, ...) services.
- Transmission of practical information:
  - current date and time (local/UTC),
  - the language used (ISO code),
  - information on a country of origin (IS code).
- Information can be selected, scanned and displayed.

# 4. Radio Equipment

### *4.1. Transmitters*

There are two possibilities to receive/get a transmitter to broadcast DRM digital signals:

- adaptation of an existing analog transmitter system to work in the DRM system,
- purchasing a digital signal transmitter.

Thus, the senders who provide digital radio broadcasting are facing a very serious question concerning the transmitter: to buy or modify the old one. The transmitter can be modified for DRM broadcasting in a simple and cost effective way. At the moment there is no difficulty in meeting each of these solutions. There are several manufacturers of such devices. And the same may be modified in a short period of time, not exceeding a few hours. In general, manufacturers are producing equipment for broadcasting signal in door transmitters including DRM exciters, modulators, servers and even the antennas.

### *4.2. Receivers*

DRM technology is very demanding and places great emphasis on the quality of the receiver, e.g., a very stringent requirement imposed on phase and noise parameters. Therefore, the receivers are expensive. Although there is a choice of receivers to enable reception of DRM digital radio, but because of their price these receivers do not enjoy too much attention [7].
The easiest way to receive a digital signals is to apply the DRM IF signal from any analog received and shifted it to 12 kHz and apply it to PC sound card input. Computer software will demodulate and decode the digital signal [8].

"Di-Wave 100" DRM receiver [9] is the first one with a color screen. It has been in mass production since 2009. The receiver has all the multimedia features offered by DRM technology: provides the name of the station, information about the Journaline program, MOT slides and time shift listening. The radio can receive DRM and analog stations in the SW, MW and LW bands as well as FM stations. User can store 768 stations. The receiver also has a USB port, SD-reader and mp3/mp4 players. 3.5-inch TFT color screen can display text in multiple languages.

The DR111 is a new receiver designed for receiving DRM, FM, AM signals developed with minimal production costs. Both in DRM, and AM systems the receiver works in the MF and SW. It meets all the minimal requirements which was specified by DRM consortium. DR111 receiver is one of the best solutions for the existing analog AM radio, which evolves toward the digital radio. The receiver has a 16-character LCD screen with two lines. Additionally it plays the recordings from an SD card and USB "pendrive" memory [1].

### *4.3. Communication Capacities of DRM System*

Digital radio has a wide range of extra functions gained through new technologies in the field of semiconductors and the software. The receiver can be implemented with a range of functions provided by electronic program guide applications (EPG), such as:

- schedule view, with different levels of detail for the programs in the area of services,
- view of schedules, programs and events, as expected by various groups of listeners,
- navigation and selection of services and programs,

– search for current programs and the ones planned in the near future,

– choosing individual programs or groups of applications to record and to program selected specific or similar topics,

– careful program selection and recording via PNUM (Programe Number) signaling.

In addition, additional software, such as Journaline and Diveemo, has been created.
Journaline is a relatively new service of data transmission, which has been internationally standardized by the World DMB Forum for use in DAB and DRM [10]. Journaline is an application of data for DAB and DRM digital radio, with a hierarchical structure which provides text information. It is "teletext for digital radio" and is immediately available for interactive use. The listener can easily and quickly access the topics that are currently interested in.
Journaline provides:

– flexible menu structure,

– details of the text (headline, content), the list of messages (automatic update: sports scores, stock market, etc.),

– changing (ticker) messages (classifying information),

– bookmarks (favorite features) [10], [11].

Journaline supports two ways of organizing the transfer of objects, and both options can be easily mixed within a Journaline single site: carousel and transmission in real time [10].
Diveemo is an application of a new video on a small scale based on a DRM standard [12], [13]. It is intended for distribution to large areas of educational and informational programs. Diveemo information can be transmitted by one transmitter operating in one of the ranges: long, medium and short wave. It is an ideal platform for customers scattered over a wide geographical area. The transmission of DRM on shortwave provides virtually unlimited coverage of 100 square kilometers to more than 5 million square kilometers, depending on the transmission system. The system also has all the advantages of DRM, such as a choice of services by a Unicode-compatible labels, alternative signaling and switching frequency, features of announcements and warnings, etc.
Diveemo offers convenient mobile Internet services, a small-scale video, allowing users to quickly switch between channels and listen to the full audio and video, even in poor reception conditions. The video stream may be accompanied by one or more audio streams, allowing for synchronous, multiple languages, features of announcements and warnings. Diveemo provides cost-effective distribution of video programs, education and information by DRM.

Diveemo application was developed by Fraunhofer IIS, and its performance was presented by the Digital Radio Mondiale at IBC 2010 [13].

# 5. The Situation in the World

Digital Radio Mondiale Consortium has achieved a great technical success in developing the DRM system and its effective implementation. This system, despite the obvious limitations imposed by the need to adapt the occupied transmission bandwidth (9/10 kHz) to the arrangements for the allocation of spectrum [14], is promoted as a complementation to digital radio, and not as a competitor to DAB. Narrowed to about 6 kHz bandwidth of the original signal, while the digital sound quality is sufficient for musical and verbal broadcast. DRM+ system implemented in the frequency bands greater than 30 MHz is a European alternative to American HD-Radio, and can be used to replace FM broadcasts. It is recognized that digital radio has to be unified as one solution. An example of such unification are radios designed to receive radio signals broadcast in a variety of DRM, DAB digital systems, and AM and FM analogue systems.

A great opportunity for the DRM development are local information systems for cities, municipalities, tourist centers, social, cultural and commercial organizations as well as in public buildings and during big events (stadiums, rallies, etc.). Predictions are that digital radio systems may be used for safety and civil protection against extraordinary threats as a convenient means of information for the population at risk. At the beginning of October 2010 there were 41 multilingual programs broadcast in the world of, including one in Polish by Vatican Radio (7320 kHz from Santa Maria) and the Polish Radio program broadcast in German on 6135 kHz frequency from Skelton in Britain and in English on 7265 kHz frequency from Kvitsoy in Norway [1]. Three other stations fit experimental programs.

Thus, DRM digital radio has already started in most European countries (unfortunately, not in Poland) in special applications, but did not reach a significant level of universality. A different course of large-scale development is visible in countries where the possibility of getting with the program to large areas is essential. This applies especially to countries such as India, Russia and China. DRM signals are in total broadcast regularly in the world 75 stations, including two long-term and 14 medium-term. Most transmitters use more than 20 kW power, shown in Fig. 1. The most often used power is 90 kW. It is used by 21 transmitters.

A particularly strong interest in DRM is recorded in the Asian and Pacific region. According to ABU assessment, medium-wave digital radio has great potential in Asia-Pacific regions to ensure effective coverage of large areas. Significant progress in the implementation of universal DRM system in such countries as China, India, Pakistan, Indonesia and Iran is being watched with great interest. Hence, special attention given by ABU to the use of medium and short wave [14].

According to ABU, in 2009 India had 42 transmitters operating on medium wave in the AM system, which they intend to convert to DRM digital broadcasting. Further-

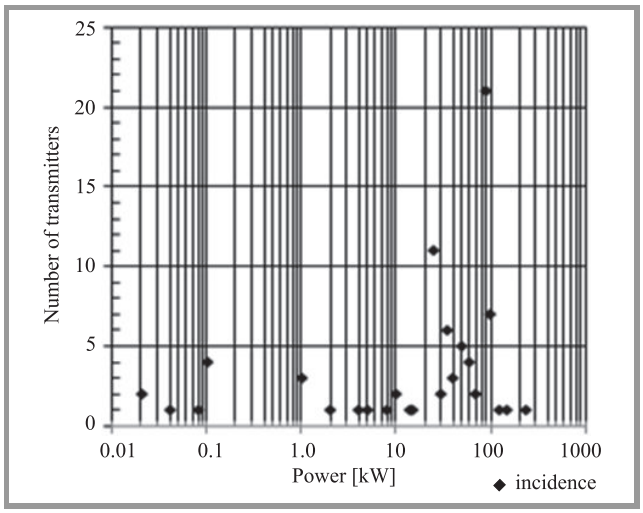


***Fig. 1.*** Relationship between the number of existing transmitters versus their power.

more, 32 high-power transmitters are to be started/run. The main task of broadcasting is to cover the country. The Conversion from analogue to digital signal will take place smoothly with simulcasting.
Currently, the aim of DRM is to achieve better audibility and to enrich the radio reception by:

- optimizing the reception quality in accordance with the requirements of the recipient,
- enhancing technical flexibility to meet all the specific needs of broadcasting,
- introduction of additional features such as dual language programming and related to multimedia access and web content,
- introduction of a wider/additional offer of transmission through better use of available radio spectrum [12].

## 6. The Situation in Poland

Based on the GE75 plan, Poland has the right to use 18 medium-term frequencies and 123 station locations, which means that some low-power stations could operate on the same frequency [14]. Today a significant part of the spectrum is not used, and most of the stations do not longer exist. Some of the frequencies and locations allocated to Poland in the GE75 plan [14], mainly with the permission to broadcast with the power up to 1 kW in AM system, are used by a company called Polskie Fale Średnie S.A. [7], which uses 8 frequencies in 31 locations [16], [17].
On the LW there are two frequencies: 198 and 225 kHz available in Poland. We promote the concept of reconfiguration LW Polish stations assuming that the Polish Radio SA in Solec Kujawski (225 kHz) transmitter will working in a dual channel mode, transmitting AM signals in basic channel and digital signals in a neighboring channel or with time division between two systems. However, Raszyn transmitter (198 kHz) can start transmitting in a single digital channel [18]. Virtually, all awarded to Poland and desirable locations can be used to broadcast in the new DRM technology. We can change the location indicated in the GE75 plan, which would greatly facilitate the creation of a single frequency network SFN stations.

## 7. An Outline of Technical Aspects of the Strategy to Launch Digital Broadcasting in the Waves Below 30 MHz in Poland

### *7.1. The Technical Capacity to Start Broadcasting in DRM System*

Currently, there are several manufacturers of transmission equipment, receivers and measuring equipment who accepted the challenge of digitization of the spectrum already using analog modulation system, such as Transradio AM, Harris, Nutel, Fraunhofer IIS, Thomson Grass Valley, NewStar, Digidia. Additional applications such as Journaline, Diweemo intended for data transmission and presentation greatly increase the usability of DRM. There are known results of propagation for different joint configuration transmissions in the AM and DRM systems.
On the technical side, there are different solutions to the broadcasting of the track. On the receiving side there are a number of receivers, both professional and designed for ordinary listeners. Their only one fault is the price at the moment.

### *7.2. Take the Necessary Action on Medium Wave*

The introduction of digital radio services on medium wave in Poland will require such works as:

- Complementation of the current methods of forecasting the propagation of radio waves:
  - the value of laboratory-set protective factors for digital radio may change,
  - forecasting techniques for network ranges are needed.
- Identification of prospects for the current analogue broadcasting scenes and digital radio:
  - reception of digital signals is exposed to the noise interference of analog, and digital DRM signals,
  - gradual introduction of stations with DRM digital system, changes the interference situation,
  - comparing these forecasts with the forecasts for the expected scene with digital broadcasting onl.
- Proposing new solutions in the plan of the location of radio stations with digital services.

- Developing a plan for a single frequency station network (SFN) considering the following proposals [19]:
  - to cover the country with a network of low power transmitters which allows you to create regional or local networks,
  - to use several high power transmitters carrying the idea to develop a national synchronous network,
  - with plans for full coverage of the country the concept of dual frequency synchronized network may be necessary to use.
- Ceasing to issue NBC permits to broadcast on medium wave in analogue AM technology – in the current situation in the field of radio waves in Poland there is no need for simulcasting as a transition phase.

### *7.3. Opportunities for the Introduction of DRM in Poland*

Purchasing an adequate set of DRM digital transmission path or its components ranging from studio equipment to the antenna should not cause any other problems but cash. There are several manufacturers that offer relevant equipment. Installation and running a digital transmission system in the long waves at a frequency of 198 kHz is practically possible at any time. However, at a frequency of 225 kHz utilized by long wave central transmitter, it requires a transitional period in a form of simulcasting or broadcast time distribution. The easiest way is to run the radio transmissions in the DRM system on medium wave, on the frequencies allocated to Poland under the GE75 plan.
Due to great interest of the neighboring countries in the DRM system there is a risk that they may hold additional spectrum for research purposes. In the future this could hinder obtaining approval for additional channels for the purpose of DRM digital system broadcasting in Poland. Losing any frequency will be an irretrievable loss for Poland. The already owned frequencies may prove useful in the future for various currently unknown reasons. Then, gaining access to the desired frequency may be impossible.

### *7.4. The Benefits of Broadcasting in the DRM System in Poland*

The benefits of digital radio have been explained in the above mentioned characteristics of DRM. The benefits of broadcasting and reception in a digital system can be divided into benefits for broadcasters, both consumers/listeners and governments.
For broadcasters, it means creating new profit-making opportunities, through the use of new forms of transmission of information content- broadcasting of varied, not only audio but also video ads.

For analogue broadcasting listeners it means:

- improving the quality of reception,
- receiving a variety of information parallel with the tuned broadcast,
- enriching experience with radio,
- practical considerations.

For the government and various departments – audio and visual information concerning:

- risks of floods, hurricanes or fires,
- accidents and difficulties on the road,
- important events in the country area.

Polish Radio One now boasts that its anchors are viewed on TV HD for half an hour in the morning. "TVP HD" may be watched on following channels: "n" platform on item 5, "Cyfra+" platform on item 12 and "Cyfrowy Polsat" on position 101 as well as in UPC cable networks, "TP", "Stream Communications", "Sun Film", "Promax", "Petrus", "Telefonia Dialog" [20]. This means that it can only be watched by stationary recipients, and only those who watch the TVP HD channel. DRM system offers to its customers transmission of low resolution pictures 24 hours a day. Of much poorer quality, true, but the video in real time. The question is: which is more important, quality or information? Permanent watching presenters talking can be boring, therefore they can give other information in the intervals between sessions of the video from the radio studio.

## 8. Summary

Replacement of analogue with digital transmission is just a matter of time. DRM has been launched in most European countries (unfortunately, not in Poland) to be used in special applications, but has not yet reached a significant level of universality. A different direction of development is observed in big countries, where the possibility of getting with the program to large areas is essential. This applies particularly to countries such as India, Russia and China.
In Poland, there is potential for rapid mobilization of digital signal transmission with DRM. Frequencies, locations, forecasting programs, access to educated specialists and sets for transmission testing are available.
A vast opportunity for the development of DRM system are applications related to the local scope of use, i.e., local information for cities, municipalities, tourism centers, social, cultural and commercial organizations, as well as inside public buildings and during big events gathering high numbers of participants (stadiums, rallies, etc.).
The digital radio systems can also be used as a convenient means of information for safety and civil protection against extraordinary threats.

KRRiT can play a positive role in implementing the digital system in Poland by giving licenses to broadcast on medium wave, but only to DRM broadcast since now.

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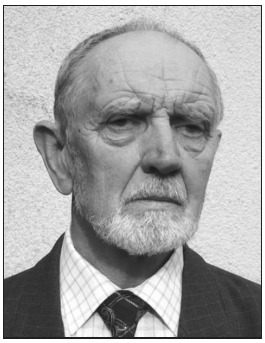


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