Key Technologies and Development of DAB and DRM Digital Broadcasting

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1. Introduction

Traditional analog broadcasting has served the public as a means of information dissemination due to its convenience and speed. With the continuous advancement of technology, people have raised higher demands for broadcasting services, such as the monotonous form of service content and the need for improved sound quality. Consequently, the digital revolution in broadcasting was initiated.

Digital broadcasting is the inevitable trend in the development of broadcasting technology. It expands the single audio service of traditional analog broadcasting to simultaneously transmit various digital services such as images, text, data, pictures, and moving video, opening up new application spaces for the development of traditional broadcasting services. Digital Audio Broadcasting (DAB) and Digital Radio Mondiale (DRM) are pioneers in the progress of digital broadcasting, representing the broadband and narrowband systems within the digital broadcasting framework, respectively. DAB, an early successful example of digital broadcasting trials, has been operating successfully in Europe for many years. DRM represents a further exploration into digital broadcasting. Their development plays a significant role in advancing and improving broadcasting technology.

2. DAB System Overview

2.1 Domestic and International Development Trends

The emergence of the DAB system marks the transition of broadcasting systems from analog to digital. Based on digital technology, it employs advanced audio digital coding, data compression, error correction coding, and digital modulation techniques. At the receiving end, it delivers program content with quality equivalent to the originally transmitted information.

This technology was developed in Europe, originating from research on terrestrial audio broadcasting technology by the Institut für Rundfunktechnik (IRT) in Germany in the 1980s. This led to the establishment of the Eureka-147 DAB standard, which has seen significant development in Europe. In China, the Guangzhou-Foshan-Zhongshan DAB pilot network was launched in 1996. The Beijing-Langfang-Tianjin synchronous network was completed in 1999 and officially opened in 2000. Currently, several radio stations within China have also begun adopting diversified DAB broadcasting technology.

2.2 Advantages of DAB Systems Compared to Traditional FM Broadcasting

(1) Can operate within the 30MHz~3GHz frequency range, exhibiting strong resistance to fading caused by multipath propagation;

(2) Can achieve coverage via terrestrial, cable, and satellite means. Sound quality can reach CD levels, making it highly suitable for fixed, portable, and mobile reception;

(3) DAB operates in different frequency bands (VHF, UHF, L-band). Synchronous operation in Single Frequency Networks (SFNs) conserves spectrum resources, and high-power transmitters are not required within the synchronous network;

(4) It can function as a multimedia broadcast, capable of simultaneously transmitting multiple sound programs and data services, and can also be used to transmit moving video programs.

2.3 Key Technologies of DAB

The first key technology is Source Coding. DAB employs the MUSICAM method, which corresponds to Layer II of the MPEG-1 Audio standard, applicable to sampling frequencies of 32 kHz, 44.1 kHz, and 48 kHz.

The second key technology is Channel Coding and Modulation, utilizing COFDM (Coded Orthogonal Frequency Division Multiplexing). In DAB, channel coding employs punctured convolutional coding with variable coding rates. Different levels of error protection are applied based on the importance of the data and application conditions, while the same information receives the same level of protection. The OFDM modulation method utilizes a broadband system composed of numerous closely spaced subcarriers with orthogonal spectral relationships for data transmission.

The third key technology is Synchronous Network Technology (SFN). This allows many transmitters at different locations to use the same frequency block, transmitting the same program synchronously in frequency and time. This significantly improves spectrum utilization efficiency and requires only low-power transmitters.

3. DRM System Overview

3.1 Domestic and International Development Trends

In the broader and more effective coverage domain of analog AM broadcasting, inherent shortcomings have hindered its wider promotion and use. Therefore, technological improvements and updates are necessary in these areas to better utilize existing resources using digital technologies, leading to the emergence of the DRM system.

DRM is the name of a non-governmental international consortium. The digital sound broadcasting system it developed for long, medium, and short waves below 30 MHz is called the DRM system. Worldwide, five different digital AM system proposals were put forward: France's Skywave 2000 system. France's CCETT/TDF system. USA's Medium Wave IBOC DSB system. Germany's Digital Radio Mondiale (DRM) DMW system. USA's VOA/JPL Digital Shortwave system. Among these, the first three systems belong to the OFDM multi-carrier parallel transmission method, while the latter two belong to the single-carrier serial transmission method.

Among these five different digital AM systems, the most extensively tested and mature are Germany's Digital Radio Mondiale (DRM) DMW system and France's Skywave 2000 system. The former is a single-carrier serial transmission system with slightly more complex receivers but high transmitter efficiency. The latter is a COFDM-based multi-carrier parallel transmission system, offering strong implementation flexibility but lower transmitter efficiency compared to single-carrier systems. Although each has its own advantages and disadvantages, both have reached a practical level, offering comparable transmission quality and capability.

3.2 Advantages of DRM Systems Compared to Analog AM Broadcasting

(1) The DRM system operates in frequency bands below 30 MHz, allowing full utilization of existing medium and shortwave spectrum resources. It possesses strong penetration and diffraction capabilities, offers large coverage areas, and is suitable for mobile and portable reception;

(2) While maintaining the same coverage, digital AM transmitters require lower power than analog AM transmitters, improving transmitter efficiency and economic benefits;

(3) While retaining the existing bandwidth of 9 kHz or 10 kHz, it utilizes audio data compression and digital signal processing technologies to enhance the reliability of AM band signal transmission, improve interference immunity, eliminate shortwave fading, and significantly improve the sound quality of AM band signals;

(4) Within the specified bandwidth, it can simultaneously transmit one analog signal and one digital signal, facilitating a gradual transition to all-digital broadcasting;

(5) It can also provide additional services and data transmission.

3.3 Key Technologies of DRM

DRM uses MPEG-4 AAC (Advanced Audio Coding) as its audio compression method, combined with SBR (Spectral Band Replication) technology, forming a highly capable compression scheme. The multiplexing is relatively complex, encompassing channel multiplexing, frame multiplexing, service multiplexing, and digital multiplexing.

Regarding Channel Coding, the method used in DRM is identical to that in DAB: punctured convolutional coding with a constraint length of 7. It applies either equal error protection (EEP) or unequal error protection (UEP) to the transmitted data stream. The Digital Modulation method employs a combination of OFDM and QAM modulation.