



TERRESTRIAL DIGITAL RADIO SERVICES IN EUROPE

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Abstract:

The paper presents an overview of terrestrial digital radio services in Europe. The first is presented the overview of the digital radio characteristics in Europe, which includes year of start experimental and regular broadcasting digital radio, the standards used for digital radio, the number of active multiplexes (national, regional and local) as well as the area coverage. After that is presented number of radio stations which emitting simulcast in the analog FM and digital DAB (DAB+) standard and number of radio stations which emitting exclusively in the DAB (DAB+) standard. In the end is presented comparison of data from 2014 and 2019 relating to the percentage of population covered by DAB/DAB+ signal, the total number of DAB and DAB+ services, services number in the DAB standard and the number of stations in the DAB+ standard.

Keywords:

Digital Audio Broadcasting, DAB, DAB+, digital radio.

1. INTRODUCTION

DAB (Digital Audio Broadcasting) is a family of digital standards for broadcasting digital audio and multimedia signals. DAB consists of DAB and DAB+ standards, which serve for digital broadcasting audio signals via radio and DMB (Digital Multimedia Broadcasting) standard, which represents the upgrade of DAB in the form of multimedia capabilities [1].

DAB began to develop in 1981, and since 2000 it has been under the authority of the independent international organization "World DAB Forum". This organization is concerned with the implementation and promotion of DAB, cooperates and coordinates with radio broadcasters, network service providers, equipment manufacturers, governments and competent state authorities.

Based on the RRC-06 (Regional Radio-communication Conference) held in Geneva in 2006 organized by the ITU (International Telecommunication Union), a new international agreement of frequency planning for digital broadcasting radio and television programs has been established and adopted. On the basis of this agreement, a frequency plan for the realization of the digital radio was adopted, so that all European countries received the predicted frequencies for the broadcasting digital radio.

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The transition from analog to digital broadcasting radio using DAB standards brings advantages, such as [1,2]:

- ◆ better use of the frequency spectrum (broadcasting multiple programs on one radio frequency, ie multiplex),
- ◆ broadcasting radio stations using same frequency on a large area using the Single Frequency Network (SFN);
- ◆ providing additional services,
- ◆ broader selection of radio stations, better sound quality (approximate to studio sound),
- ◆ interactivity,
- ◆ significant savings in transmission costs.

2. FEATURES AND DAB SERVICES

For the radio transmission of the DAB signal, two frequency bands are provided:

- ◆ VHF-III band, in the range of 174 - 230/240 MHz and
- ◆ L-band, in the range from 1452 to 1492 MHz, used in countries where the VHF-III band (Band III) is not yet available or as an additional distribution band, with the width of a single multiplex channel of 1.5 MHz [3].

The DAB standard is based on MPEG Audio Layer 2 coding, which is still used in broadcasting. An improved version of this encoding is MPEG Layer 3. The DAB+ standard is more efficient than the DAB standard. It uses the MPEG-4 High Efficiency AAC v2 profile (co-dec, known as HE-AAC v2) and it is the most efficient available audio compression scheme in the world and allows up to three times more multiplex services than the original DAB [1,4,5].

Geographical coverage area of radio services that use HE-AAC v2 is larger than the radio services that use MPEG Audio Layer 2. The multimedia information transmitted through the HE-AAC v2 radio service is much better protected against transmission errors than the radio service that use MPEG Audio Layer 3 codec. Audio bit rate range is from 32 kb/s to 384 kb/s [6,7].

Besides the basic function, the transmission of audio signals, DAB supports the following additional services:

- ◆ EPG (Electronic Program Guide) - is designed to offer similar services like TV EPG but for radio and related data transmission services.

- ◆ Slideshow - uses standard formats of Web images and standard Web publishing tools to enhance the radio program and visualize it. All standard formats such as JPEG, PNG or APNG (Animed PNG) can be broadcast by DAB without losing audio and video synchronization.
- ◆ TCM / TPEG (Traffic and Travel Information / Transport Protocol Experts Group) - was formed due to increased demand for more accurate and timely traffic and travel information) and serves to send information on traffic and roads. Regardless of the fact that the RDS / TMC (Radio Data System / Traffic Message Channel) technology has been quite successful in various European countries, it has certainly shown its limitations due to the limited RDS bandwidth. Implementation of the DAB, and later of the DMB standard offers enormous opportunities as a carrier for improved traffic and travel services, such as: traffic occasions/news, weather in traffic, driver assistance, parking information, local hazard alerts, traffic density, etc.
- ◆ Journaline, is a relatively new data transmission service, which is internationally standardized by the World DMB Forum. Basic functionality similar to electronic journal or teletext in TVs.
- ◆ Broadcast Website, serves for broadcasting Web site applications. Allows the transmission of complete Web sites for offline use to a digital radio receiver, which should have Web browsing software. Besides to the related HTML pages, in the offer can be multimedia elements in the form of images, animated graphics, mp3 or video files.

A large percentage of radio listeners are still in cars and digital radio broadcasting industries around the world investing heavily in involving the automotive sector in their plans. Every year, WorldDAB holds annual European automotive manifestations. These events bring together distributors, manufacturers and automotive industries from different markets to share knowledge and look for the best practical solution for digital radio in cars, as well as drivers' expectations [8].

3. OVERVIEW OF THE MAIN DIGITAL RADIO CHARACTERISTICS

Table 1 shows an overview of the main digital radio characteristics in Europe that includes the year of start experimental and regular broadcasting digital radio, the



standards used for digital radio, the number of active multiplexes (national, regional and local) as well as the area coverage. Data refer to March 1, 2019. and were

collected from the official websites of the national bodies responsible for the radio digitization and telecommunications regulations in [8-39].

Table 1. Overview of the main digital radio characteristics

Country	Experimental	Regular	Standard	MUX number			Coverage [%]
				N	R	L	
United Kingdom	1993	1999	DAB/DAB+	3	10	61	97.3
Norway	1995	1999	DAB/DAB+	1	7	7	99.7
Sweden	1995	2012	DAB/DAB+	1	1	-	41.8
Denmark	1995	2002	DAB/DAB+	2	-	1	98
Germany	1995	1999	DAB+	1	26	4	97
Poland	1996	2013	DAB+	-	17	6	56
Ireland	1998	2006	DAB	1	1	-	52
Belgium	1998	2012	DAB/DAB+	-	3	-	95
Spain	1998	2011	DAB/DAB+	3	-	-	20
Italy	1998	2012	DAB+	3	-	8	80
Austria	1999	2018	DAB+	-	1	-	29
Switzerland	1999	2009	DAB/DAB+	4	3	2	99.5
Netherlands	2004	2008	DAB+	2	5	-	95
Malta	2004	2006	DAB+	3	-	-	100
Slovenia	2006	2016	DAB+	1	-	-	73
Czech Republic	2007	2011	DAB+	-	1	3	62
France	2010	2015	DAB+	-	15	3	21.3
Hungary	2008	-	DAB+	1	-	-	30
Romania	2015	-	DAB	-	1	-	10.4
Slovakia	2015	-	DAB+	-	-	6	38
Croatia	2017	-	DAB+	1	-	-	70
Turkey	2017	-	DAB+	-	-	1	21.5
Ukraine	2018	-	DAB+	-	-	1	7.1
Greece	2018	-	DAB+	-	1	-	NA
Luxembourg	2018	-	DAB+	-	-	1	100
Serbia	2018	-	DAB+	-	1	-	28

^aN - National, R- Regional, L - Local

The first tests of digital radio began in the 1990s. In some countries (Poland, Ireland, Belgium, Spain, Italy and Austria), the process from experimental to regular broadcasting included a longer time period (more than 15 years). In the last few years, some of countries that did not have digital radio services, they started broadcasting. Besides to the countries listed in Table 1, Bulgaria and Estonia occasionally experimentally broadcast digital radio services. Portugal, Bosnia and Herzegovina, North Macedonia, Montenegro, Albania, Finland,

Moldova, Lithuania and Latvia are countries that do not currently broadcast digital terrestrial radio in Europe.

It is mainly applied DAB+ standard or in combination with the DAB standard. All countries that have started broadcasting in the DAB standard tend to switch to advanced DAB+. The DAB standard is currently exclusively represented in Romania and Ireland. The number and types of the multiplex are different. The most common are regional multiplexes, with the largest number of multiplexes being activated in United Kingdom, Germany, Poland and France.



The largest coverage of the population by DAB signal was achieved in Malta, Norway, Switzerland, Denmark, Germany and United Kingdom, which have almost 100% coverage of the population.

4. OVERVIEW OF DAB AND DAB+ SERVICES

Table 2 shows the number of DAB and DAB+ in European countries. The number of radio stations emitting simulcast in the analog FM and digital DAB (DAB+) standard and the number of radio stations emitting exclusively in the DAB (DAB+) standard is given [8-39].

From Table 2 it can be seen that most digital terrestrial radio stations are broadcast in United Kingdom, as many as 495. Next are France, Norway, Denmark, Italy, Switzerland, which broadcast more than 100 digital radio channels. Also, it can be seen that broadcasting in the DAB standard is the most represented in United Kingdom, while other countries generally broadcast radio services in the DAB+ standard (the DAB standard is slightly or not at all included). Romania and Ireland broadcast services exclusively in the DAB system. The number of radio stations is directly related to the number of multiplexes shown in Table 1.

Table 2. Number of DAB and DAB+ services

Country	DAB			DAB+			Total DAB and DAB+
	simulcast FM and DAB	exclusively DAB	Total	simulcast FM and DAB+	exclusively DAB+	Total	
United Kingdom	329	158	487	1	7	8	495
Norway	1	1	2	20	193	213	215
Sweden	1	9	10	14	2	16	26
Denmark	7	7	14	11	3	14	28
Germany	-	-	-	110	40	150	150
Poland	-	-	-	21	7	28	28
Ireland	5	5	10	-	-	-	10
Belgium	12	4	16	11	1	12	28
Spain	18	0	18	1	0	1	19
Italy	-	-	-	116	20	136	136
Austria	-	-	-	4	11	15	15
Switzerland	6	9	15	80	41	121	136
Netherlands	-	-	-	94	18	112	112
Malta	-	-	-	53	0	53	53
Slovenia	-	-	-	14	2	16	16
Czech Republic	-	-	-	16	13	29	29
France	-	-	-	76	90	166	166
Hungary	-	-	-	7	0	7	7
Romania	5	1	6	-	-	-	6
Slovakia	-	-	-	36	21	57	57
Ukraine	-	-	-	9	5	14	14
Croatia	-	-	-	15	1	16	16
Turkey	-	-	-	8	0	8	8
Greece	-	-	-	7	0	7	7
Luxembourg	-	-	-	2	0	2	2
Serbia	-	-	-	3	0	3	3

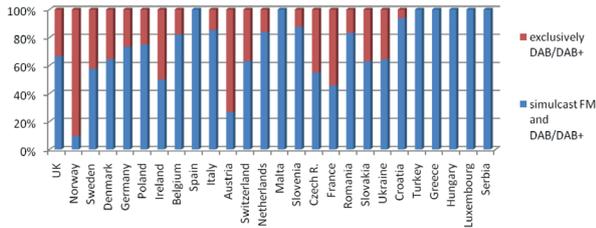


Fig. 1. Share of exclusively DAB/DAB+ and simulcast DAB/DAB+ services

Fig. 1 shows the share of exclusively DAB/DAB+ and simulcast DAB/DAB+ service in the countries of Europe. It can be seen that in almost all countries, a large number of stations emit simulcast in an analog FM standard and a digital DAB/DAB+ standard. The only exception is Norway, France and Austria, where a large number of radio stations are broadcast exclusively in digital format. Countries that have begun experimental DAB broadcast during 2018 do not yet have exclusive radio services that exclusively broadcast digital.

5. COMPARISON OF DAB AND DAB+ SERVICES

Fig. 2 shows a comparison of the % coverage of the population with the DAB/DAB+ signal at the beginning of 2014 and March 1, 2019 [8-40]. Increased coverage with digital terrestrial radio signal in all European countries is evident. The largest percentage increase in coverage is represented in countries where DAB broadcasting started in the given period.

In Fig. 3, Fig. 4 and Fig. 5, a comparison of the number of services is shown: total DAB and DAB+, only DAB and only DAB +, respectively, for 2014 and 2019. From the given figures can be seen increase of the number of digital radio services. The largest increase is in Norway, Netherlands, France and Slovakia.

From Fig. 4 it can be seen that the number of services using DAB standard has decreased in the last five years (the exception is United Kingdom), while from Fig. 5 it can be seen that in all countries there was an evident increase in the number of services in the DAB+ standard. The highest increase in the number of radio stations in the DAB + standard is in Norway, France and Slovakia. In the coming period, further increase of the more advanced DAB+ standard is expected, which will completely suppress its previous DAB version.

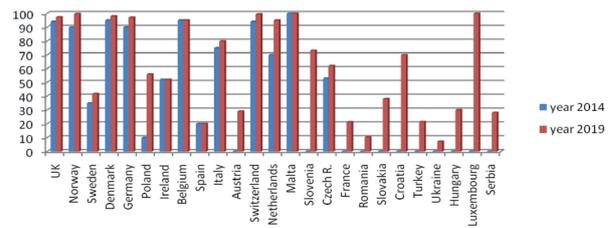


Fig. 2. DAB signals coverage in 2014 and 2019.

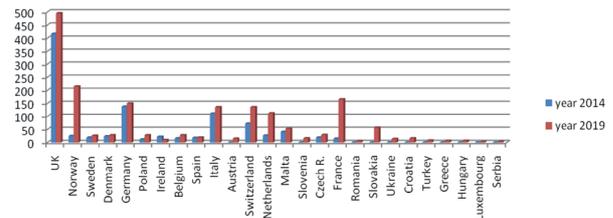


Fig. 3. Number of services (DAB and DAB+) in 2014 and 2019

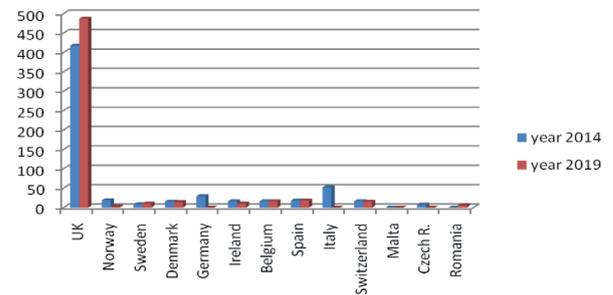


Fig. 4. Number of DAB service in 2014 and 2019

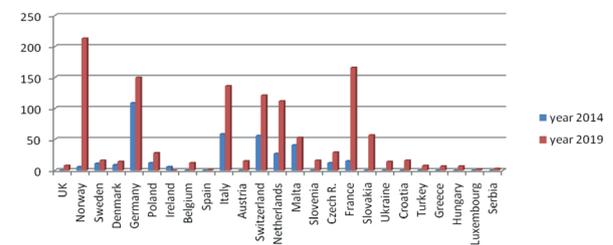


Fig. 5. Number of DAB+ service in 2014 and 2019



6. CONCLUSIONS

A large number of European countries are currently broadcasting a digital radio signal, either on a regular or experimental basis. According to the number of radio stations in digital form in front of all countries United Kingdom is leading, while in terms of coverage of the population with the digital signal at the very top are Malta, Norway, Switzerland, Denmark, Germany and United Kingdom where coverage is greater than 95%. Many countries are in transition from DAB to an upgraded DAB+ standard, which allows the broadcast up to 28 radio stations in one multiplex, as opposed to DAB which allows up to 15 radio stations. All countries have plans to expand the digital network to equalize the coverage of analog and digital radio signals. In recent years, there is increasing of radio programs that are broadcast exclusively in digital form.

The transition to digital radio broadcasting is closely linked with the transition from analogue to digital TV broadcasting, because part of the VHF-III range is designed for digital radio that is used for analog TV broadcasting

Although the advantages of digital radio lead to its popularization, for now there is not yet a specific date for completely switching off the analogue radio network, except for United Kingdom and Norway that are planning to completely switch to digital broadcasting in 2020.

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