Implementation of DAB+ project in Macedonia

Skopje, 2026

1. INTRODUCTION

- **Historical development of the DAB/DAB+ system**

- DAB has been developed since 1981 by the Institut für Rundfunk technik (IRT)
- The Eureka147 project was founded in 1985 by 17 countries and the European Union to research and implementation a DAB (Digital Audio Broadcasting) system. The Eureka 147 standard was defined in 1993 with ITU recommendations published in 1994 and an initial ETSI standard published in 1995. Eureka closed the Eureka 147 project on 1 January 2000.
- WorldDAB was formed in 1995 to encourage international cooperation and coordination for the implementation of DAB to the consumer market

- **Introduction of DAB+ radio in Macedonia**

- The commissioning of DAB+ equipment with a power of 500 W at the PE NRD from RBF Vodno, experimentally began on 10.07.2019 with radio stations of the Macedonian Radio. These are the beginnings of DAB+ radio in Macedonia in an experimental phase.
- The propagation was excellent because the DAB+ signal was heard without problems within a radius of about 50 km. In this way, it was possible for citizens who have appropriate DAB+ receivers to become familiar with the advantages of this technology.

2. PLANNING DIGITAL SYSTEMS FOR DAB+

DAB+ System Parameters

The DAB+ core standard describes the parameters of the coding, modulation and transmission system. Basic data mechanisms are provided: transmission mode and packet mode. Signaling is also defined, which allows the receiver to understand the content of the multiplex.

1) **Modulation scheme and guard interval -** DAB+ uses the Orthogonal Frequency Division Multiplexing (OFDM) modulation scheme.

- ***Carrier structure* -** DAB+ uses a convolutionally encoded D-QPSK OFDM signal. The system is based on the use of 1 536 active carriers with a frequency spacing of 1 kHz. All carriers are transmitted at the same power level.
- ***Frequency interleaving***
- ***Time interleaving***
- ***Multipath capability***

2) **Transmission modes -** Number of carriers 1 536, spacing 1 kHz, useful symbol duration 1 000 µs, guard interval 246 µs, total symbol duration 1 246 µs

3) **Protection levels, coding and net bit rates -** DAB+ audio protection ensemble, using EEP option A profiles.

4) **Channel Models**

The C/N value is a fundamental planning parameter for DAB+ networks. In general, the C/N should provide acceptable sound quality with a Bit Error Ratio (BER) of 1 × 10-4 Viterbi.

5) **SFN Performance**

-Theoretical evaluation of SFN performance **-** In Single Frequency Networks (SFNs), transmitters are required to transmit the same OFDM symbol at the same time.

- ***- Practical SFN performance*** **-** 0 (i.e. no protection ratio required) at relative delay $0 \leq t \leq 246$ µs (i.e. inside, protection)

Receiver Parameters

1) **Receiver Noise Figure** – 6 dB noise figure for planning.

2) **Minimum receiver input signal levels**

3) **Minimum requirements for home and in-car DAB+ receivers**

Frequency range and antenna connection, Gaussian sensitivity, Rayleigh sensitivity, Receiver selectivity (adjacent channel interference), DAB+ channel decoding, Re-tuning and text display

Additional considerations for DAB+ planning

Coverage prediction height, Planning height loss values, Building and vehicle entry loss, Site percentages for planning

Planning parameters

1) **Minimum mean field strength** - 95% for "good" and 70% for "acceptable" portable reception, for mobile reception the defined percentages are 99% and 90%, respectively.

2) **Calculation of minimum mean field strength level** - calculated parameters for reception planning are presented, according to the presented mathematical formulas - **Rep. ITU-R BS.2214-3**

3) **Transmitter spectrum mask -** Outside the 1.5 MHz COFDM spectrum, the signal contains natural sidebands, attenuated relative to the main signal by some 40-50 dB. The spectrum of the DAB+ signal is measured in a bandwidth of 4 kHz, within 1.5 MHz and for ±0.77 MHz the relative level is – 26 dB with respect to the total signal power.

4) **DAB+ frequency block raster and bandwidth**

5) **Protection coefficients -** Co-channel protection coefficients (average 12 dB, Adjacent channel protection (N ± 1, protection ratio – 40 dB)

3. DAB+ SYSTEM OVERVIEW

DAB+ Features and Applications

1) DAB+ features an audio space for many services:

Station Selection from List, Program Linked Data PAD (Dynamic Label Segment (DLS) Display – Text, Slide Show (SLS) – Images), **Data Services** (TMC and TPEG, Newspaper), **Support Features** (Service and Program Information (SPI), Announcements, Service Tracking), **Emergency Features-Signaling, Emergency Features-Hybrid Radio**

2) Data Applications: SPI - Service and Program Information, Slide Show, Traffic Information, Newspaper etc.

3) Recommendations: New markets should deliver services using DAB+, All stations should provide dynamic label text, Preferred transmission band is VHF Band III, Logo should be transmitted

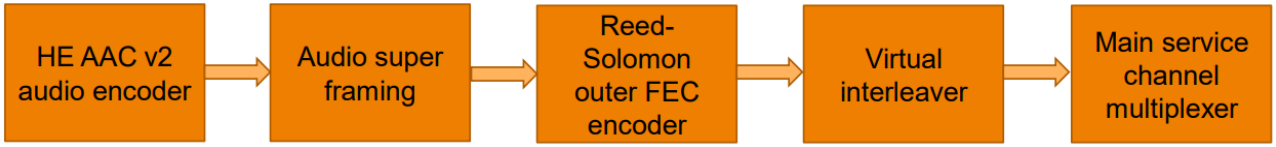
4) DAB+ Attributes Fact Sheet : DAB+ Attributes, DAB+ Functionalities, Short Latency, Surround Sound, DAB+ Performance in Field Tests

5) DAB+ Emergency Broadcasting and Emergency Alerts : DAB+ Emergency Alert Function (AAS) Alarm – Switching, What are Emergency Alerts, Who initiates Emergency Alerts, How DAB+ helps in an emergency, Implementation

6) Scenario examples

Forest Fire, Emergency Features - Example of a Tunnel System, Earthquake, Guidelines

- **Ensemble structure and services**

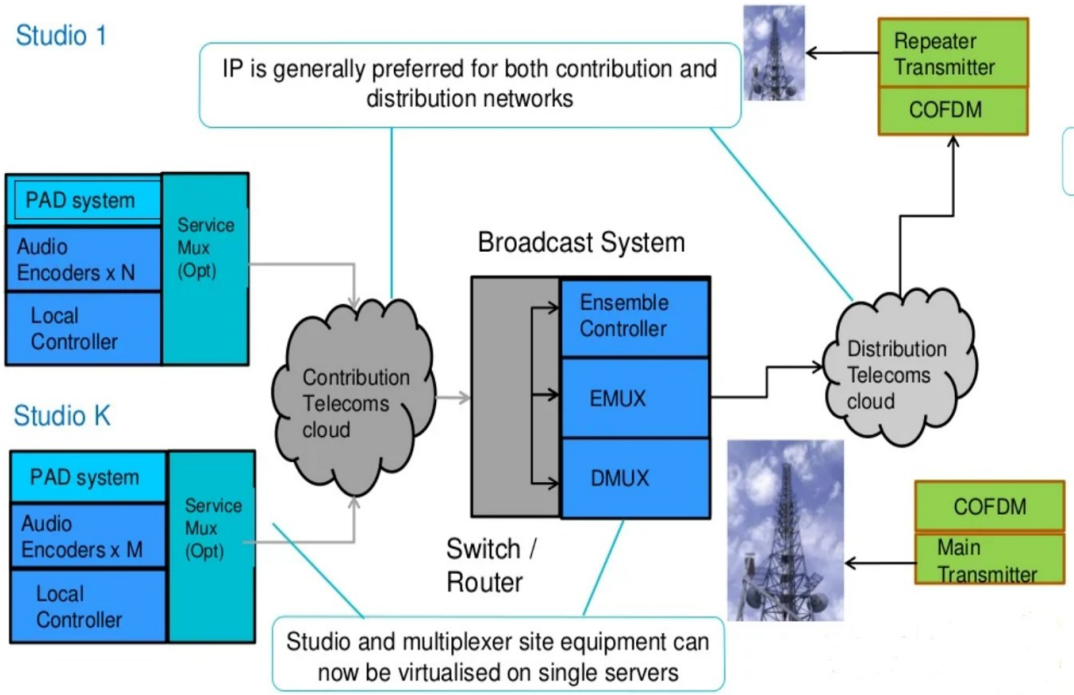


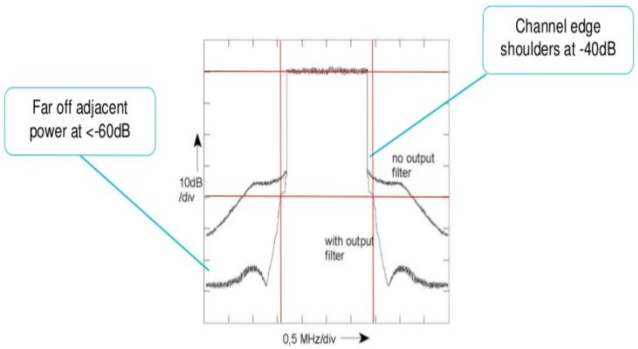
DAB+ audio encoding with signal flow with FEC outer layer

Various DAB+ services are integrated into a single ensemble (also commonly referred to as a multiplex). These services may include:

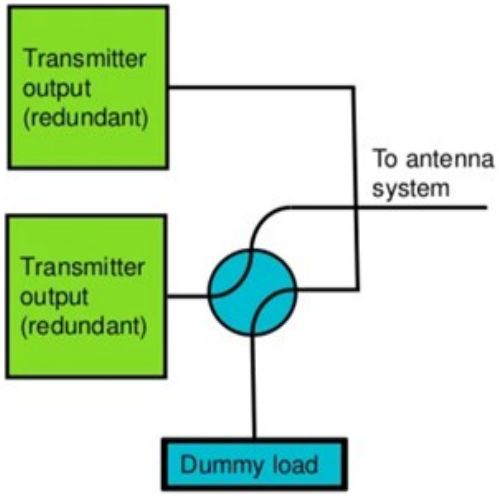
- Primary services, such as the main radio stations
- Secondary services, such as additional sports commentary
- Data services
- Service and Programme Information (SPI) and Electronic Programme Guide (EPG)
- Collections of HTML pages and digital images (known as "broadcast web pages")
- Slideshows, which can be synchronised with audio broadcasts. For example, a police complaint may be broadcast with an e-fit or CCTV footage of a suspect.
- Video
- Java Application Platform
- IP Tunnelling
- Other raw data

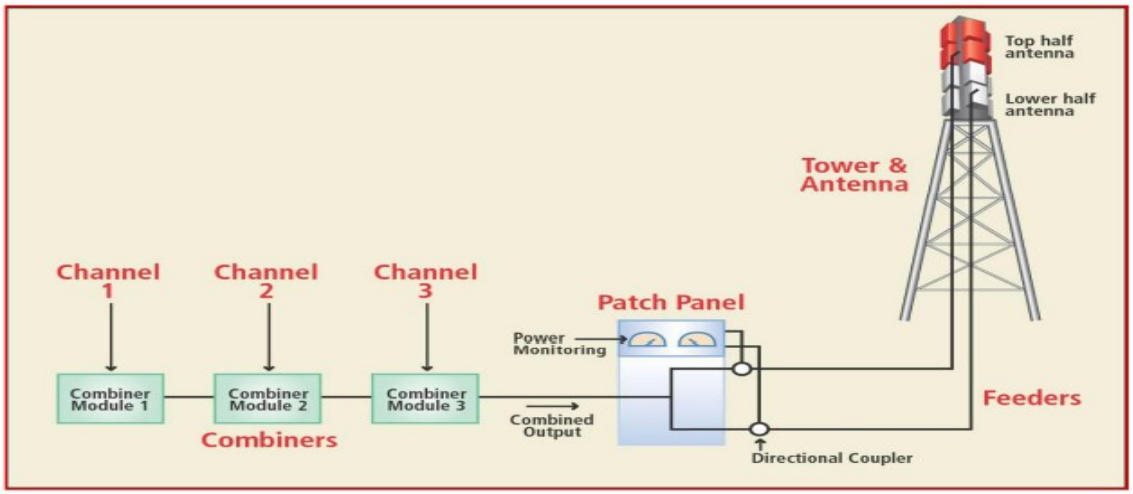
❑ SYSTEMS OF NETWORKS AND TRANSMISSIONS





1 + 1 redundancy configuration

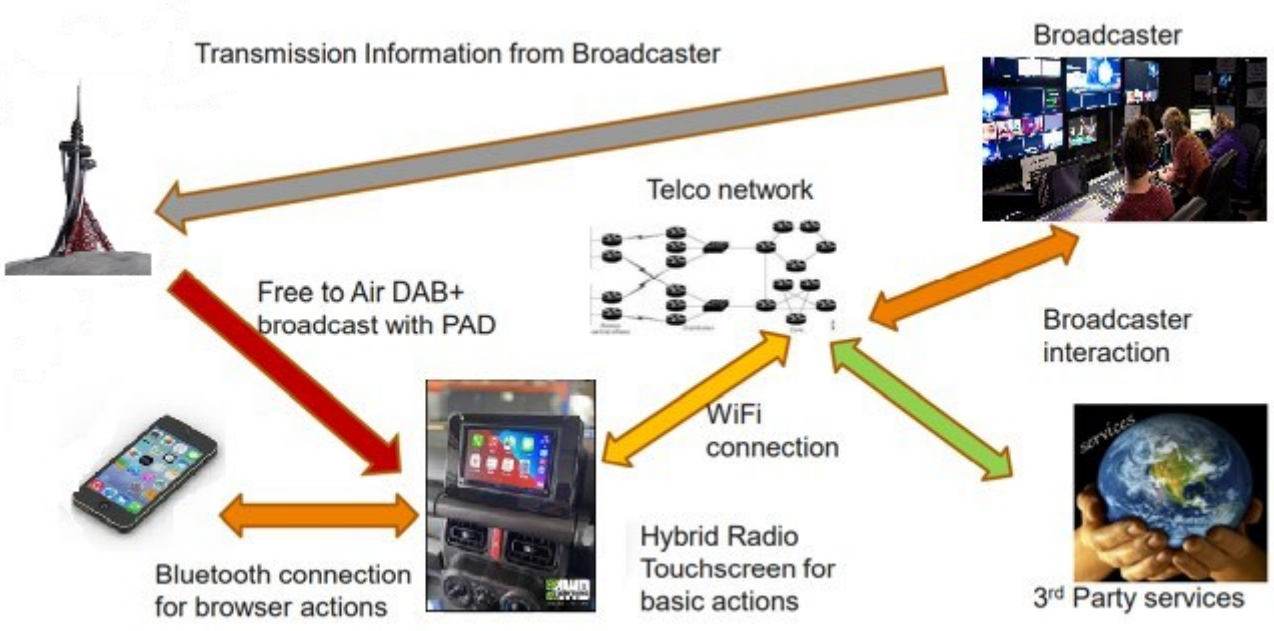




Hybrid Radio - Future

Hybrid technologies are evolving in the following five areas:
Branding and logos, Textual information on air, Seamless listening, Interactivity, Personalization

Why hybrid radio is the future - Hybrid radio seamlessly combines radio broadcasting and the internet. The broadcast signal (FM, HD, DAB, DAB+) continues to transmit audio (and some data), but a radio with an internet connection (WiFi, 4G, LTE, 5G) can seamlessly connect to the station for multimedia and interactivity.



4. ANALYSIS OF DAB+ WITH OTHER RADIO TECHNOLOGIES

- **DAB+ and Mobile for Radio**

1) **5G a viable solution for radio:** Terminology, Functionality, Articles and studies *(5G - not reliable enough to support the entire radio ecosystem, 5G as a complement to DAB+, 5G is not adapted for radio broadcasting, 5G broadcasting does not meet the specific requirements needed for radio broadcasting)*

2) **Comparison of DAB+ and mobile transmission:** Access; Battery, consumption; Capacity (peak, time, listening, etc.); Costs for broadcasters; Costs for the listener; Coverage; Future proofing; Barriers; Infrastructure, cost; Interactivity; Mobility; Multimedia; Network neutrality; Reliability; Scalability; Services

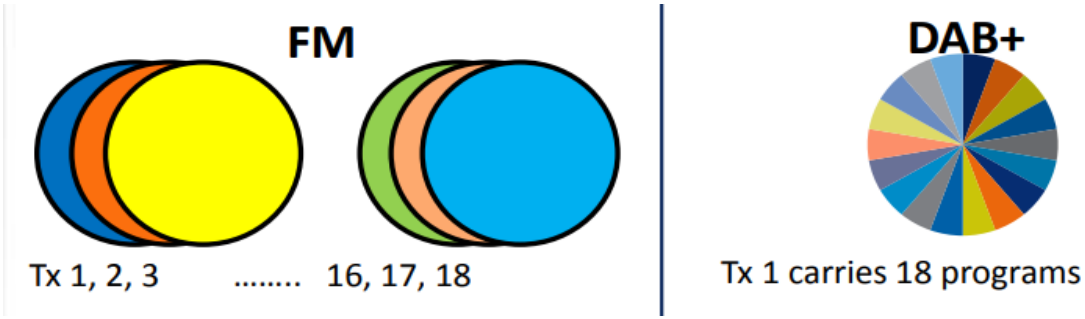
3) **Conclusions from the comparison of the presented facts**

- **Cost-benefit analysis of FM, DAB+ and IP for Radio**

A "model country" of around 72 million is determined, where the economic viability of the selected distribution platform should be for all parties involved with operating expenses (OpEx) and capital expenditures (CapEx).

1) **Distribution cost analysis -** Requirements analysis, Network analysis of FM and DAB+, DAB+ predictive model,FM and DAB OpEx and CapEx, Internet radio OpEx

Example of Cost Efficiency of FM, DAB+ for 18 radio programs



2) **Comparison of distribution technologies -** An assessment and conclusion is made on the distribution costs for each of the technologies studied

3) **Analysis of listening costs** - Radio can be used anywhere, anytime and all distribution technologies can cover different use cases.

- **The impact of DAB+ on the environment**

  Sustainable development and carbon neutrality are key objectives of the European Union as a vision, and broadcasting is no exception. The research studies on DAB+ focused on three topics:

  Energy consumption, Transmission costs, Recycling initiatives for DAB+

1) **Climate change and energy**

2) **DAB+ as green radio**

5. IMPLEMENTATION OF DAB+ RADIO IN MACEDONIA

- **Overview analysis for the introduction of DAB+ radio**

- In the first phase – projects have been made for 32 RBFs, which plan to have coverage with DAB+ signals, more than 80% of the territory or more than 90% of the population of the country.

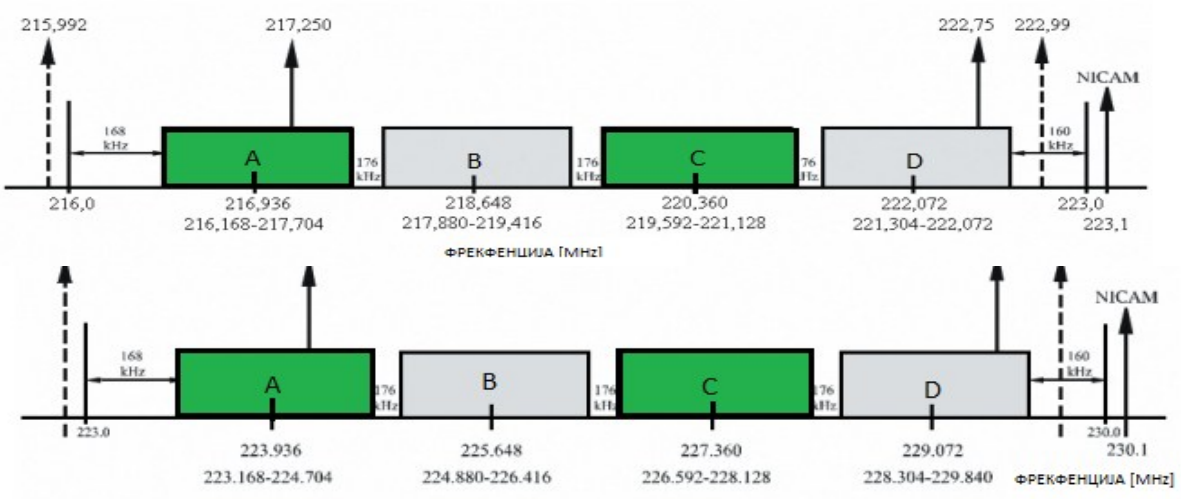
- The planning in the first phase provides more than 90% coverage with DAB+ signals for all highways, expressways and regional roads.

1) **Characteristics of the transmission signal**

Channel width 1.536 MHz, DAB+ transmits 2.432 kbit/s

- Part is for synchronization
- Main channel is 2.304 kbit/s
- Channel for fast inf. 96 kbit/s

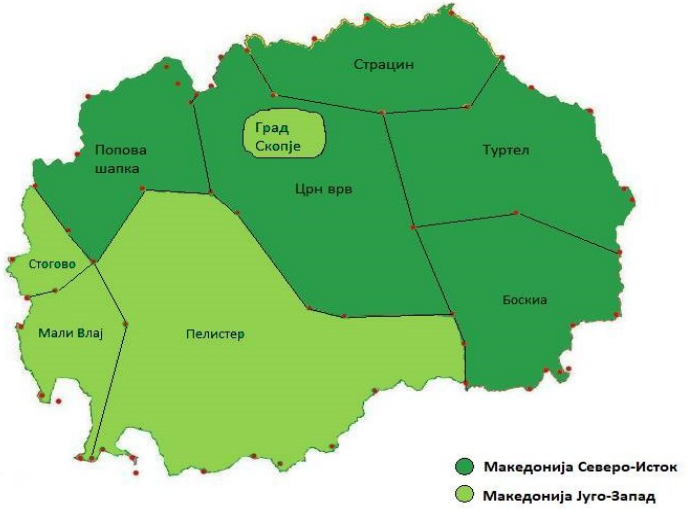
2) **Frequency planning for DAB+ radio**



11 VHF channel

12 VHF channel

Блокови	Опсег на блоковите	Носител	Алотмент-зони
11A	216.160 MHz – 217.696 MHz	216.936 MHz	југо-запад (SW) Скопје град
11C	219.584 MHz – 221.120 MHz	220.360 MHz	северо-исток (NE)
12A	223.168 MHz – 224.704 MHz	223.936 MHz	југо-запад (SW) Скопје град
12C	226.592 MHz – 228.128 MHz	227.360 MHz	северо-исток (NE)



- **Preliminary design of an antenna system for DAB+ (Vodno tower)**

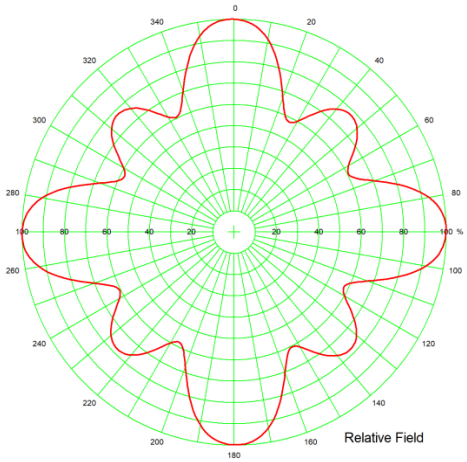
General Data

Operating Frequencies	216 – 230MHz
Polarisation	Vertical
Horizontal Pattern	Omni-directional
Nominal Beam Tilt	5°
Null Fill	>12%
Antenna Aperture	8m
Number of Main Feeders	2
Antenna Input	1 5/8" EIA
Antenna Input Impedance	50 ohm
Maximum IP Power	3 x 2kW

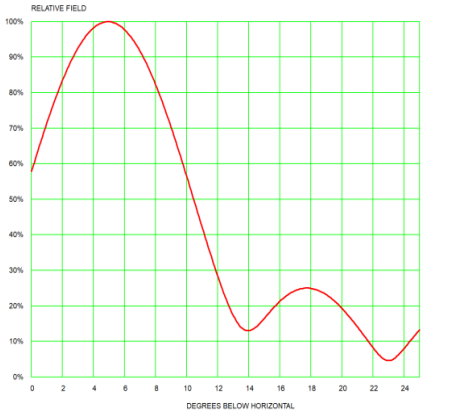
Horizontal and vertical radiation characteristics

HORIZONTAL RADIATION PATTERN

Station	***Vodno, Skopje, Macedonia***
Frequency	***216.928 MHz***
Type	***DAB Shared Aperture 6.4 (24)***



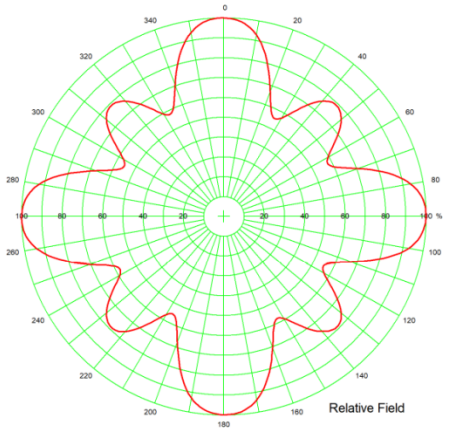
Station	***Vodno, Skopje, Macedonia***
Frequency	***216.928 MHz***
Type	***DAB Shared Aperture 6.4 (24)***
Face	***All***



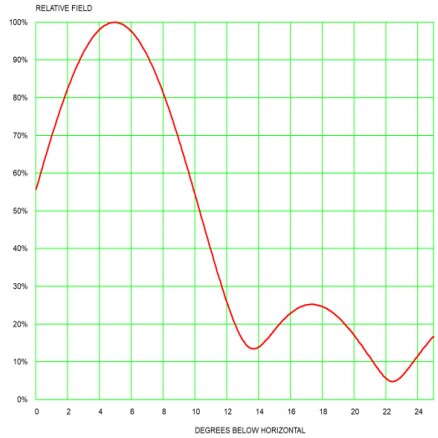
VERTICAL RADIATION PATTERN

HORIZONTAL RADIATION PATTERN

Station	***Vodno, Skopje, Macedonia***
Frequency	***223.636 MHz***
Type	***DAB Shared Aperture 6.4 (24)***

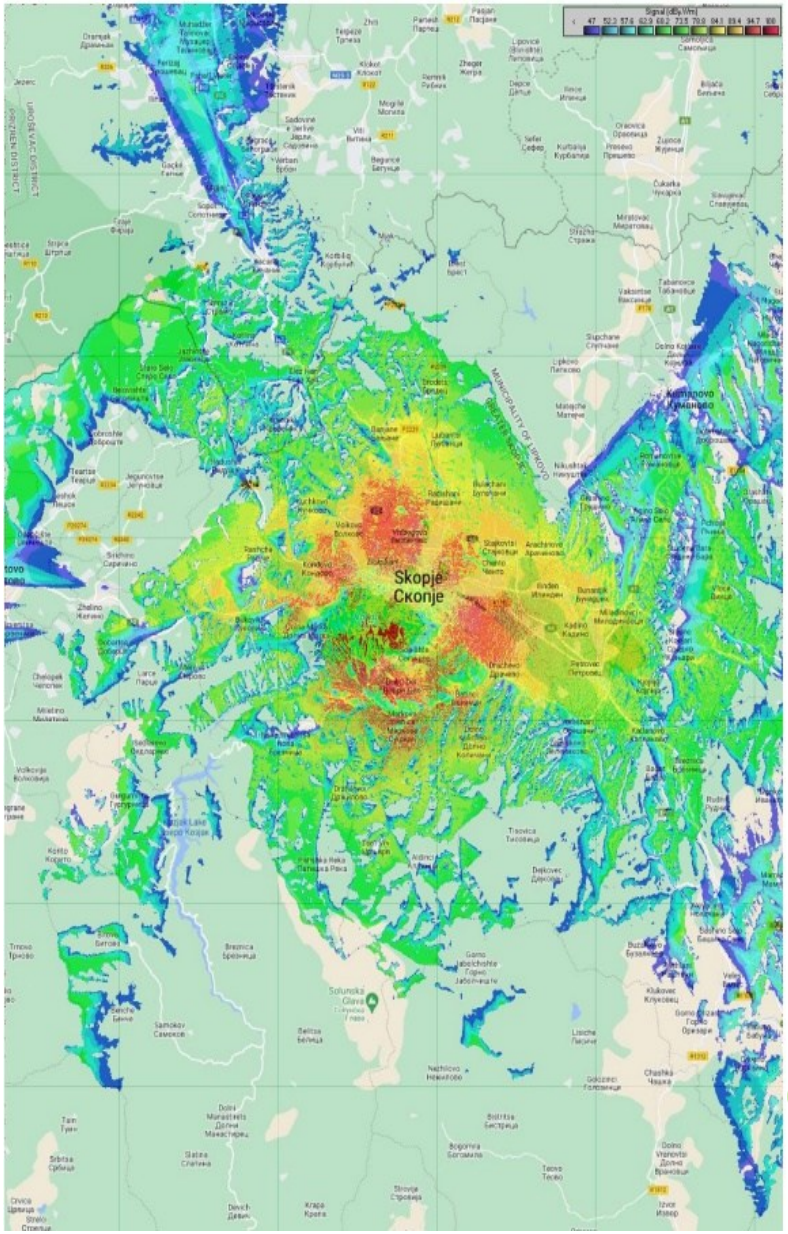


Station	***Vodno, Skopje, Macedonia***
Frequency	***223.636 MHz***
Type	***DAB Shared Aperture 6.4 (24)***
Face	***All***



Coverage parameters

Terrain Data:	SRTM 1 arcsecond 30m Resolution
Land Cover:	Corine and Globcover Clutter Databases
Model parameters:	
Surface refractivity (N-Units):	301
Ground Conductivity (S/m):	0.005
Ground Permittivity (Farads/m)	15
Climate:	Continental Temperate
Propagation Model	ITM (Irregular Terrain Model)
Probability	70% of situations
	50% of time
	50% of locations
Transmitting Site:	
Type:	Vertical Dipole
Mean Height	133.5m Shared FM Aperture
Transmitter Power	1kW
System Gain	9.3dB
Outdoor Receiver Parameters:	
Height:	10m / 1.5m
Gain	0dB
Recommended Minimum field strengths	
	54dBuV/m better than 95%
	47dBuV/m better than 70%



6. CONCLUSION

The presentation describes a platform or standard for broadcasting a designed digital audio broadcasting system DAB+, for the delivery of high-quality digital audio, video and data services. The DAB+ standard allows us to:

- Better spectral efficiency
- Possibility of broadcasting 12 – 18 radio programs in one frequency block
- Enables the introduction of additional services and choice for citizens
- Provides information on traffic and roads, thus ensuring a safer road network for citizens
- Building the broadcaster's brand (broadcaster logo, banners)
- Visualization (basic information, transmission of images accompanying radio news, CD cover)
- Greater coverage and savings of its own broadcasting network
- A new source of income
- Part of the frequency spectrum is provided for radio stations
- Radio of the future in the digital world
- Lower costs per station
- The possibility of diverse content
- Much more for your listeners

The introduction of digital broadcasting of audio signals via DAB+ technology, which is recommended by European Studies and Research as the most optimal solution for the transmission of audio signals in countries planning to start digitalization in this area, and so for the Macedonia.

It's time for DAB+
In Macedonia!

THANK YOU FOR YOUR ATTENTION!