



DIGITAL RADIO DEPLOYMENT CHOICES

RICH REDMOND

PRESIDENT/MANAGING DIRECTOR - INTERNATIONAL



- Radio in a sea of media options
- Analog and digital standards: FM, HD Radio DRM+, DAB+
- Cost comparison of various radio network topologies
- Main cost factors of radio operation
- New advanced technology impacts network deployment costs
- Snapshot of deployment around the world
- Receiver status
- Conclusion





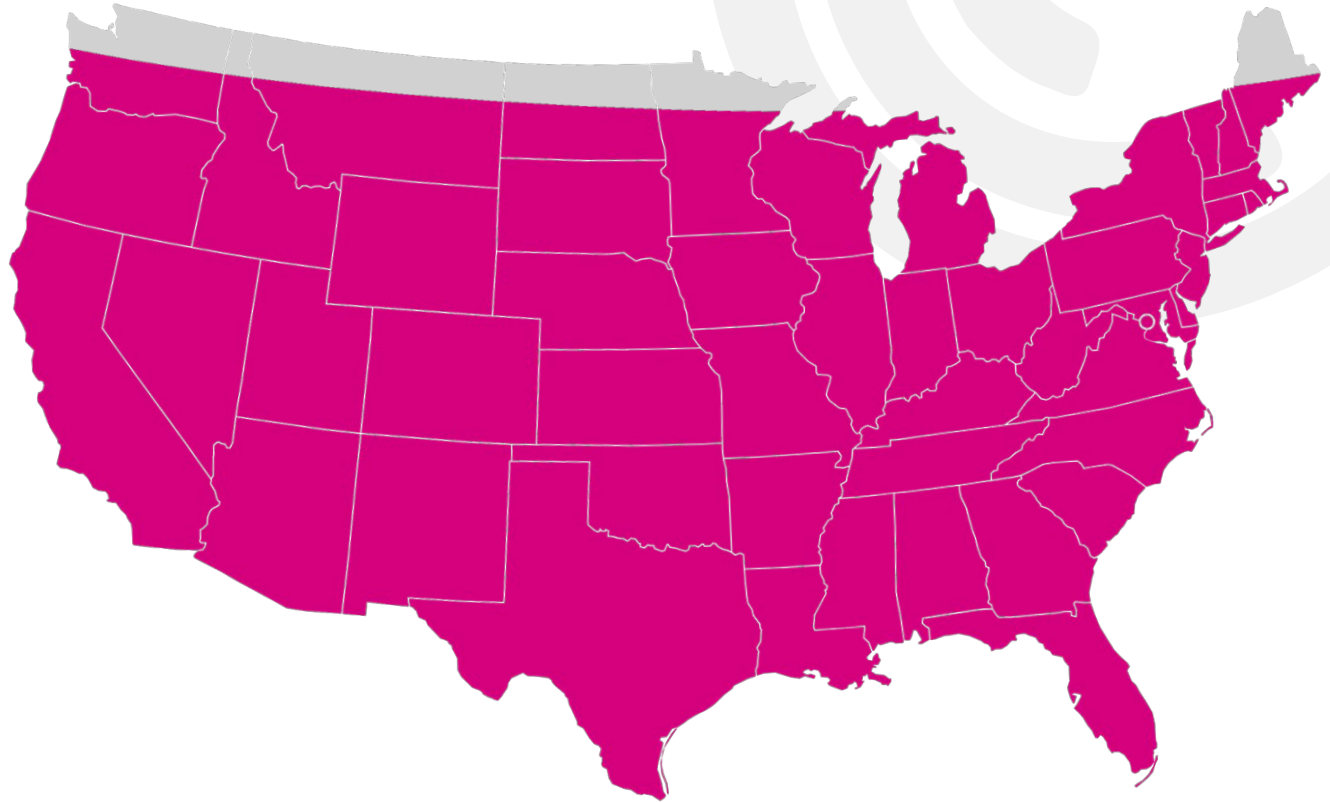
AM / FM RADIO – THE REACH MEDIUM



92%*

of Americans 12+
listen to the radio

every week

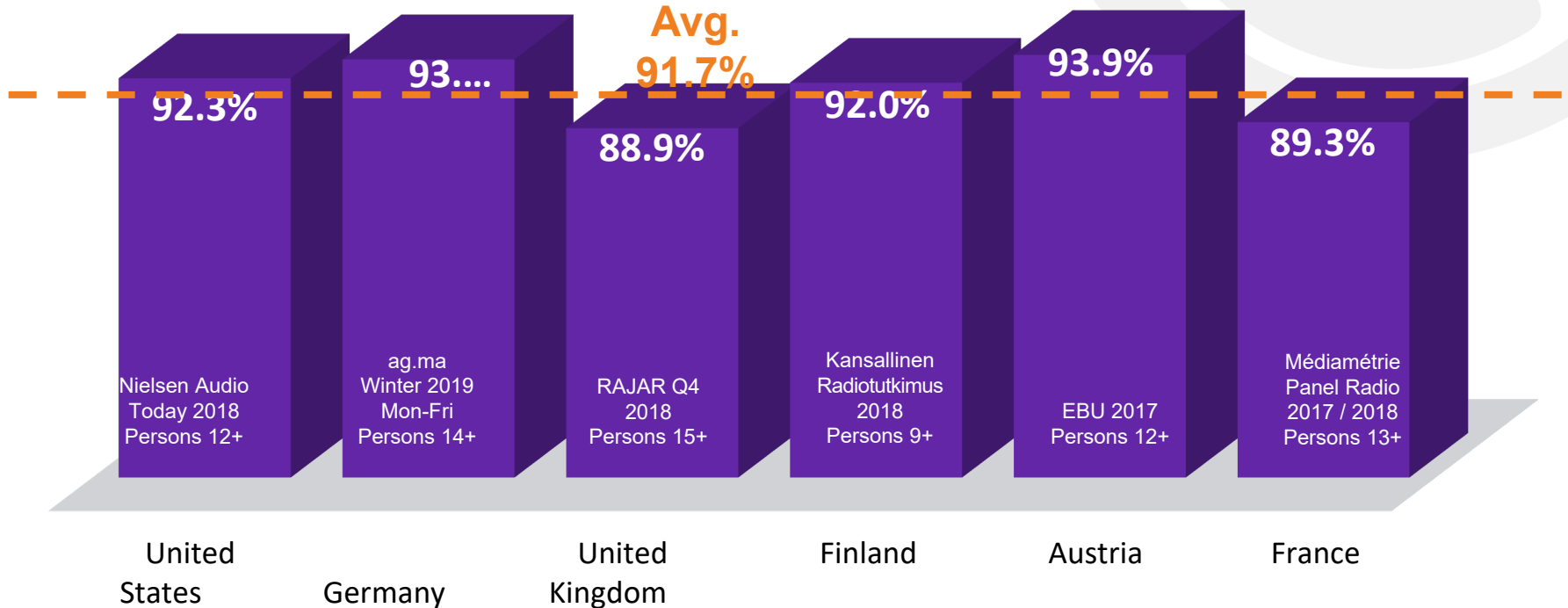


* Nielsen NRD Database Spring 2019.

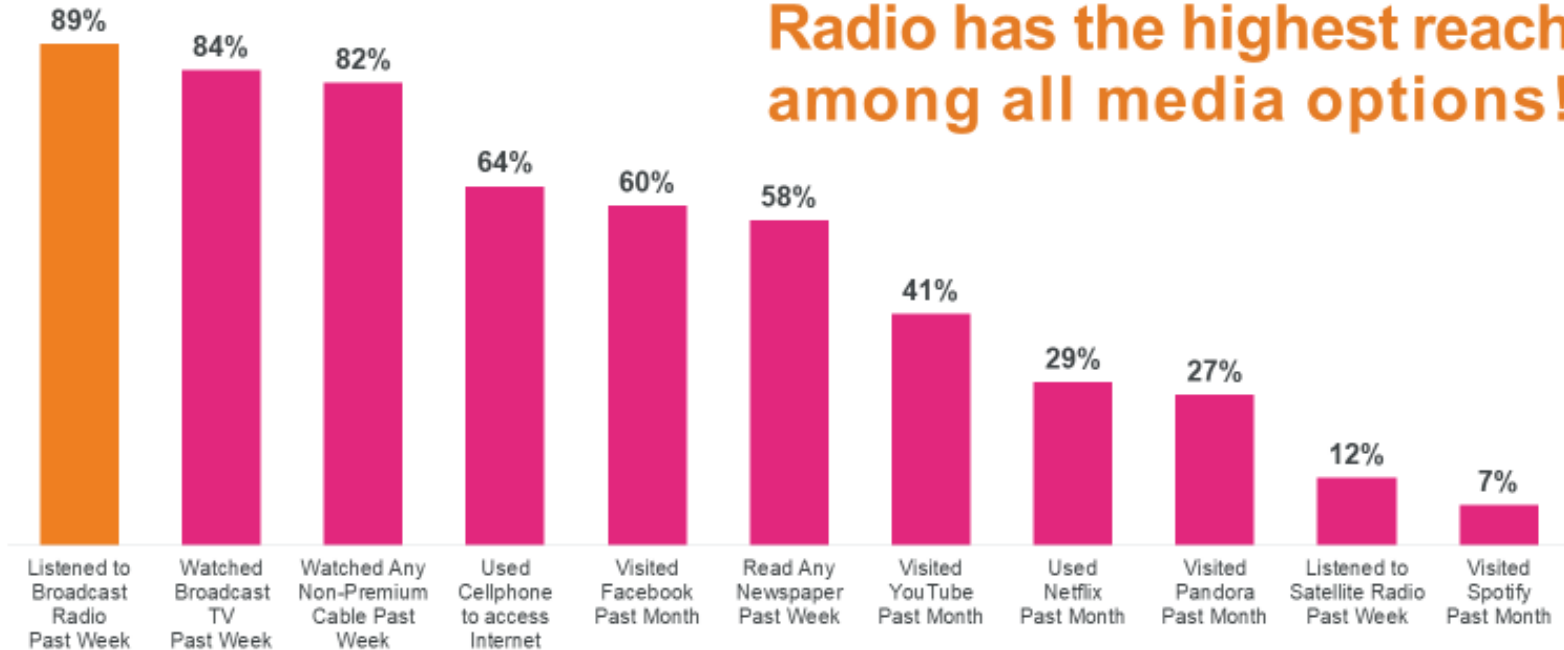


SELECTED FIRST-WORLD COUNTRY RADIO REACH (%)

LISTENING TO RADIO EACH WEEK



AM / FM RADIO – THE REACH MEDIUM





KEY DIGITAL RADIO STANDARDS



WWW.WorldDAB.ORG



WWW.HDRadio.com



WWW.DRM.org

- **DAB DAB+ Uses Band III VHF and L-Band to provide a suite of audio and multi media services**
 - Common transmission infrastructure
 - Occupies 1.5 MHz RF bandwidth
 - Supports Multiple Audio channels
 - Multiple Video Channels
- **HD Radio – Uses existing AM and FM frequencies to provide audio and multi media services**
 - Broadcast in analog and digital simultaneously
 - Uses current AM or FM channel – no new spectrum
 - Supports Multiple Audio channels
 - Offers wide array of data services
- **DRM – Uses existing SW, AM with DRM+ FM to provide audio and multi media**
 - Broadcast in analog and digital
 - Uses current AM – or additional FM channel
 - Supports Multiple Audio channels
 - Offers wide array of data services

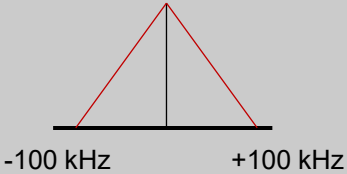
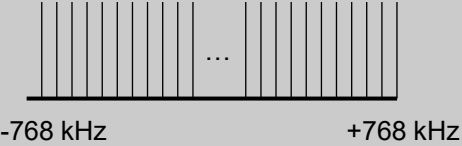
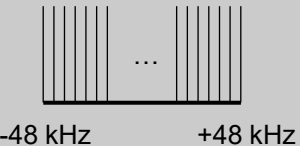
All using OFDM type of modulation

New digital Radio receiver necessary in all cases

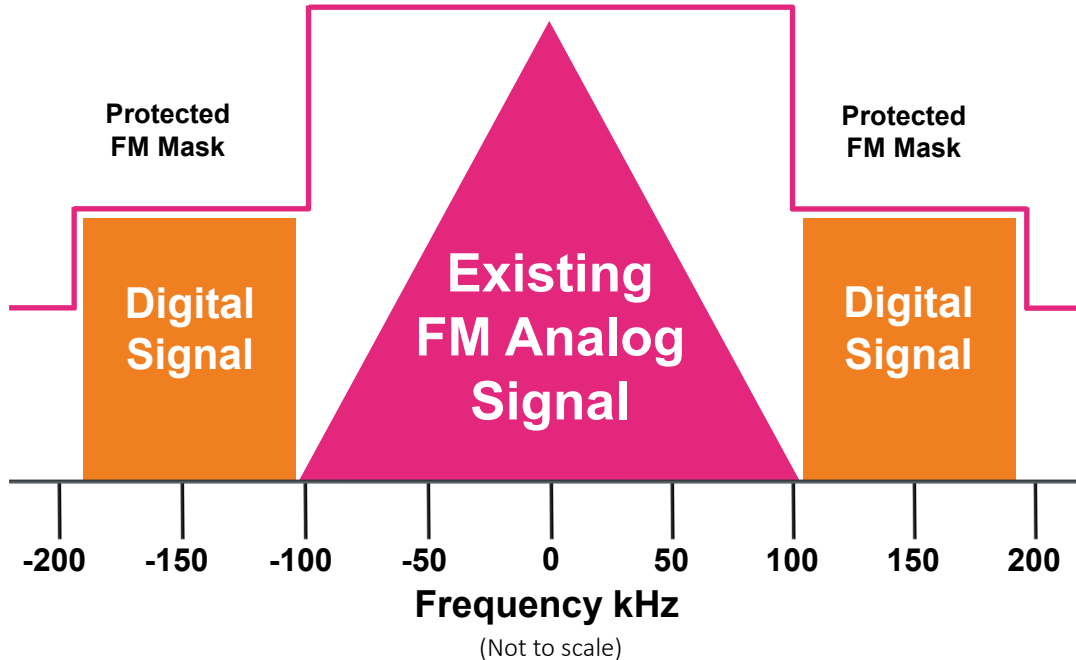




DIFFERENCES BETWEEN DAB+, DRM+ & FM TRANSMISSION

Parameter	FM	DAB+	DRM+
Frequency	87,5 MHz – 108 MHz	174 MHz – 240 MHz	47 MHz – 68 MHz 87,5 MHz – 108 MHz 174MHz – 230 MHz
Tx Power	Peak	RMS	RMS
Channel	200 kHz	1,5 MHz	96 kHz
Programs / Ch	1	typically 9 to 24 (64 max)	1 to 4 (max)
Data	RDS 1,2 kBit/s	Flexible data rates for Program Associated and Non Program Associated Data rates	Flexible data rates for Program Associated and Non Program Associated Data rates
Input	Analog L/R, Stereo Composite, AES-IP (Audio over IP)	Digital ETI 2.048 Mbit/s or EDI (ETI over IP)	Multiplex Data Interface (MDI) 37-186 kBit/s
Modulation	Single Carrier FM 	Multi Carrier (1536) OFDM, type DQPSK 	Multi carrier (106) OFDM, 4 QAM or 16 QAM 

HD RADIO TECHNOLOGY USES IN-BAND, ON CHANNEL (IBOC) METHOD



Enables simultaneous transmission of analog and digital signals

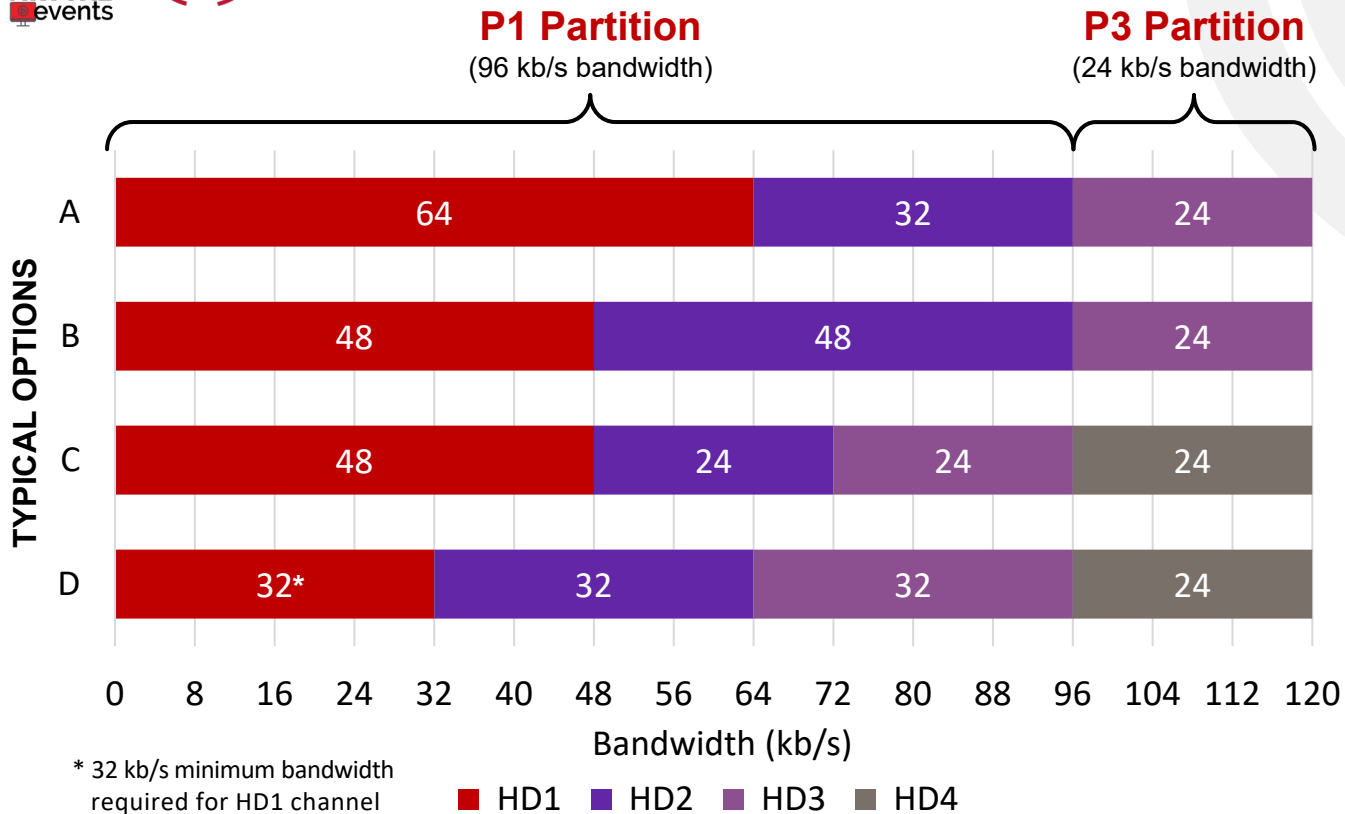
Analog receivers continue to function normally – digital channels “invisible” to analog receivers

Digital transmissions immune to multipath distortion, adjacent channel interference and static

IBOC technology makes the PPM watermark more robust



MULTI CHANNELS PER FREQUENCY



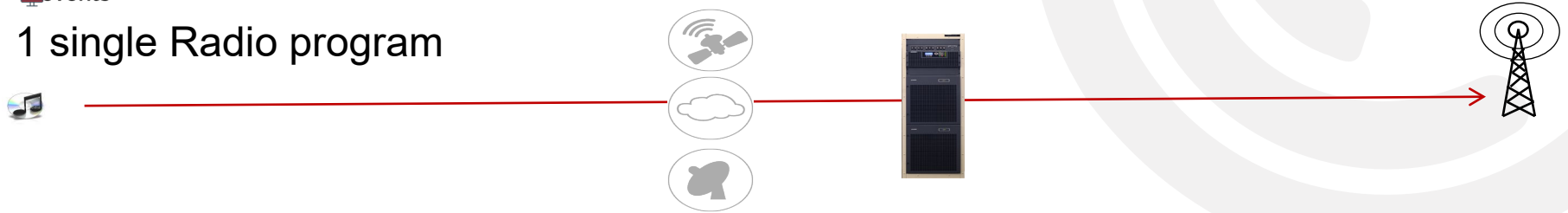
Allocate 120 kb/s channel bandwidth according to program content and user preference

All bandwidth above 96 kb/s (P3 partition) must be treated as a single stand-alone unit – it cannot be combined with lower 96 kb/s (P1 partition)



TRANSMISSION SYSTEM DAB+ VS. FM

1 single Radio program



Studio

Distribution (STL)

Transmitter

Feeder

Antenna

Studio

Contri-
bution

Head-End

Distribution

Transmitter

Filter

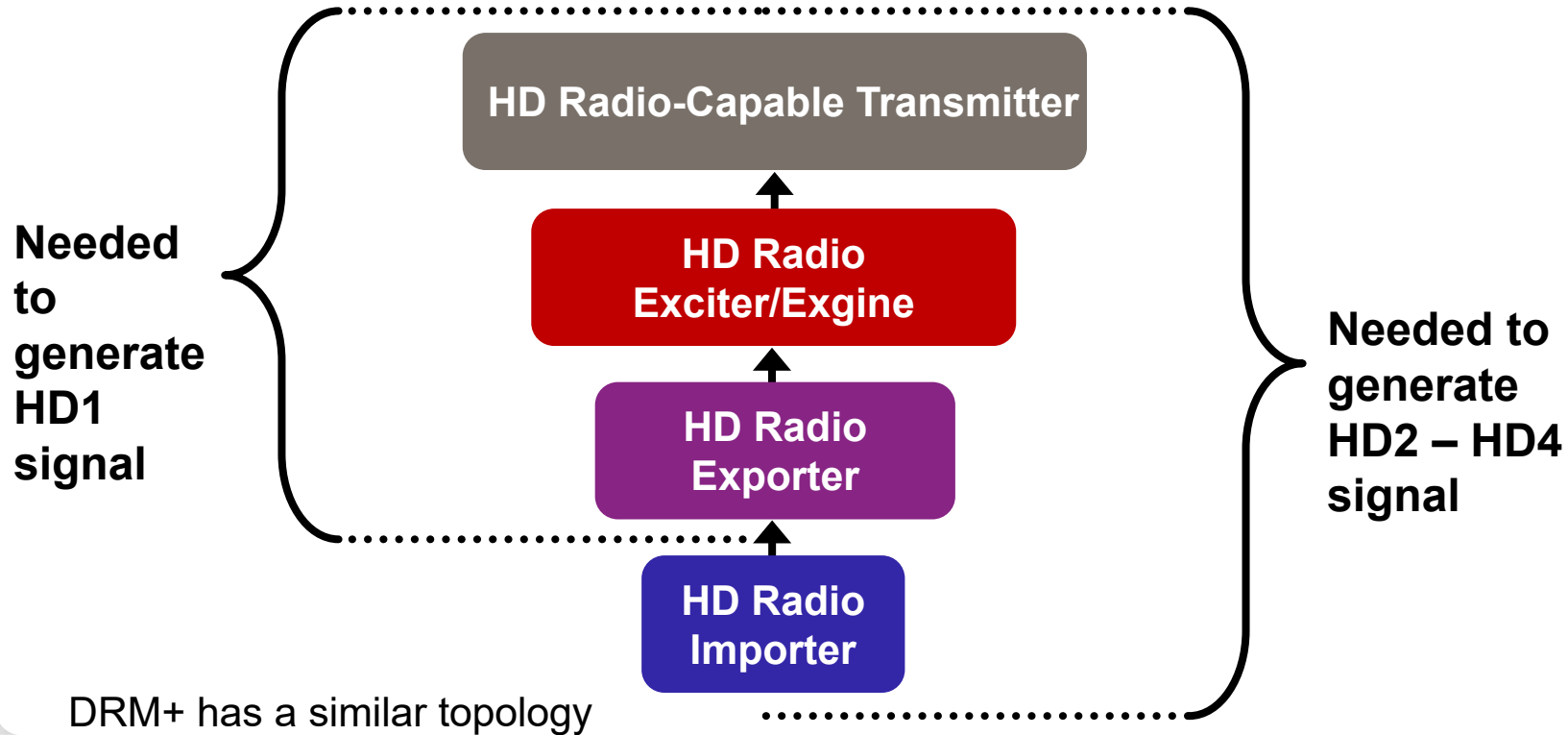
Feeder

Antenna



Up to 18 Radio programs (64kbps) of good audio quality

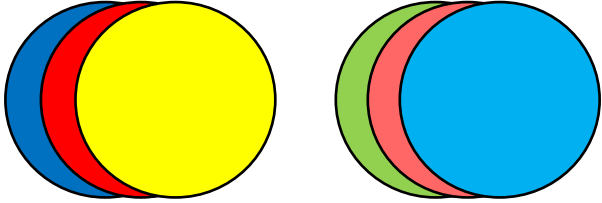




Cost efficiency of FM, DAB+ and DRM+

Example: 18 Radio Programs same coverage

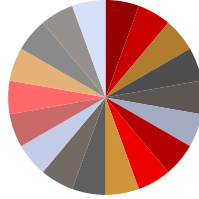
FM



Tx 1, 2, 3 16, 17, 18

- 18x FM Transmitter
- 18x Frequencies
- 18x Frequency License fee
- 18x Studio-Transmitter Link (STL)
- 18x RDS encoder/ Data
- 18x Large antenna

DAB+

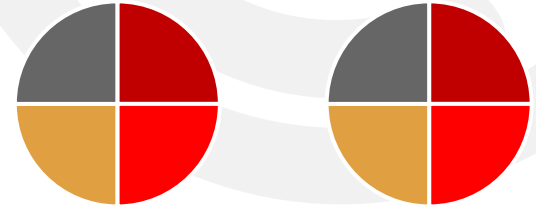


Tx 1 carries 18 programs

- 1x DAB+ Transmitter
- 1x Frequency
- 1x Frequency License fee
- 1x Studio-Transmitter Link (STL)
- 1x DAB+ Play-out
- 1x Medium antenna system

NOTE: Antenna system aperture for DAB+ around 200MHz is approximately 1/2 that of FM and DRM+ around 100MHz for the same gain.

HD Radio



Tx 1, 5
carries 18 programs

- 5x HD Radio Transmitter
- 5x Frequency
- 5x Frequency License fee
- 5x Studio-Transmitter Link (STL)
- 5x HD Radio Head-End
- 5x Large antenna system

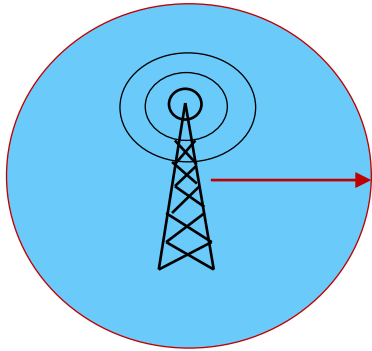
NOTE: DRM+ typically uses 3 channels per transmitters



TRANSMISSION RF POWER DAB+ VS FM

- 10 times less RF power in DAB+ for same coverage as FM
- Due to higher losses in Band III (Filter, RF line) the effective transmitter power of DAB+ is $\frac{1}{4}$ to FM (conservative)

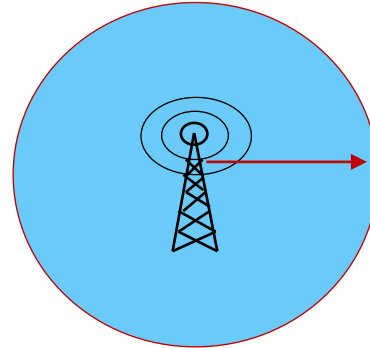
FM



100 kW
10 kW

Power on Antenna (ERP)
Transmitter Power

DAB+



10 kW
2.5 kW



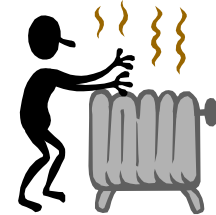
POWER EFFICIENCY OF A TRANSMITTER

- **Efficiency, what does it mean?**

- Definition: $(\text{RF Power Out} / \text{AC Power In}) \times 100\%$



PowerSmart™ 



Increased efficiency: reduces power consumed and reduces energy wasted

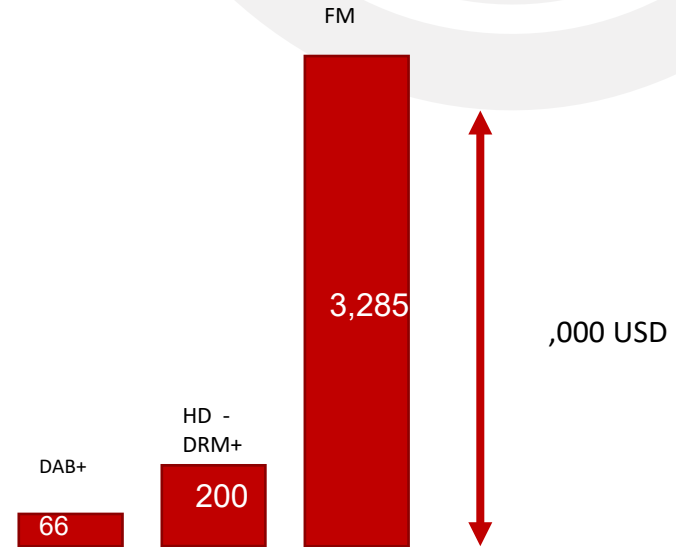


ENERGY CONSUMPTION – ANALOG & DIGITAL

Transmitter	FM	DAB+
Power	10 kW	2.5 kW rms
Efficiency	72%	50%
Consumption per Transmitter	13.9 kW	5 kW
Transmitters	18	1
Energy all Transmitters	250 kW	5 kW
Annual cost of energy	328,500	6,570

- **DAB+ energy savings 50x lower compared to FM**
- Power consumption in kW
- Assumes 0.15 USD per kWh

- Energy costs over 10 years of operation
- **DAB+ energy savings over 10 years 3,219,300 USD compared to FM**



SUMMARY OF COSTS PER SYSTEM TYPE

Drastic cost reductions using DAB+ compared to FM and DRM+ for areas which have 18 or more services.

	Transmitter	FM	HD Radio - DRM+	DAB+
	Number of transmitters	18	6	1
,000 USD	CAPEX: Cost of transmitters	900	270	80
,000 USD	OPEX			
	Power	328	20	6.57
	Cooling	92	12	3.333
,000 USD	Total OPEX	420	32	~10

Note: Opex per year



- The approximate OPEX cost **SAVINGS** of operating 18 services over a 10 year period using Digital radio:

	DAB+ vs. FM	HDRadio - DRM+ vs. FM
OPEX Savings	4.1M USD	3.9M USD

- Note that we have not considered further savings from:
 - Rental of floor and antenna space if site is not owned by broadcaster
 - Higher cost of keeping spares and the amount of maintenance effort



HD Radio®

NORTH AMERICA HD RADIO ADOPTION

- Adopted - Approved
- Experimental Approval

U.S. Totals

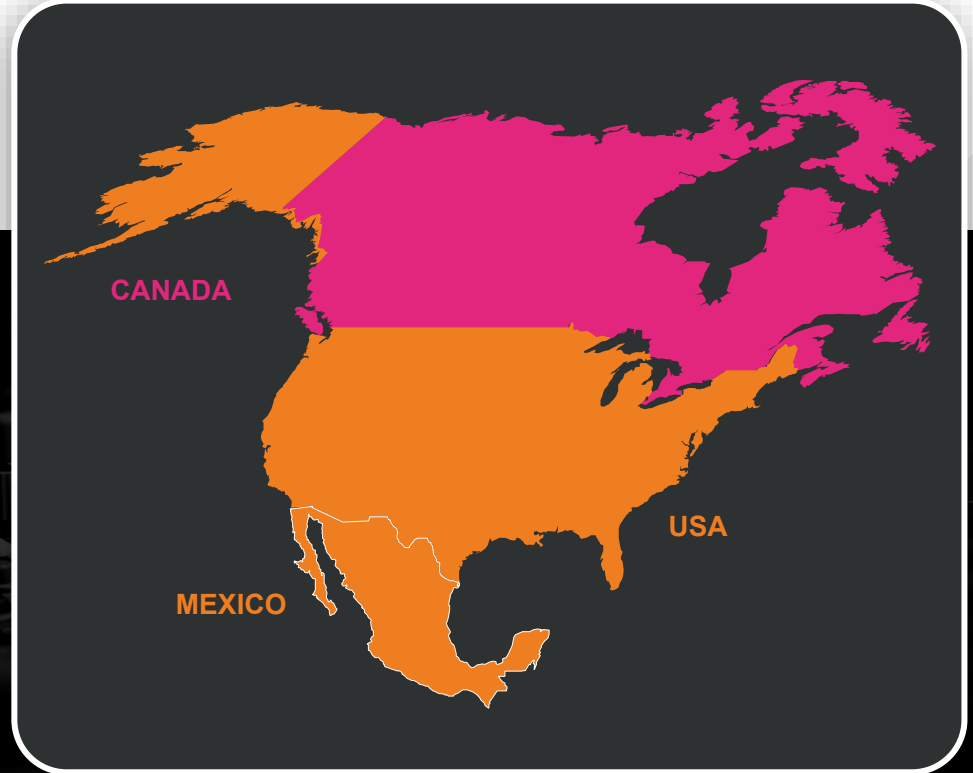
- Stations On-Air: 2,298
- Total Digital Channels On-Air: 4,495

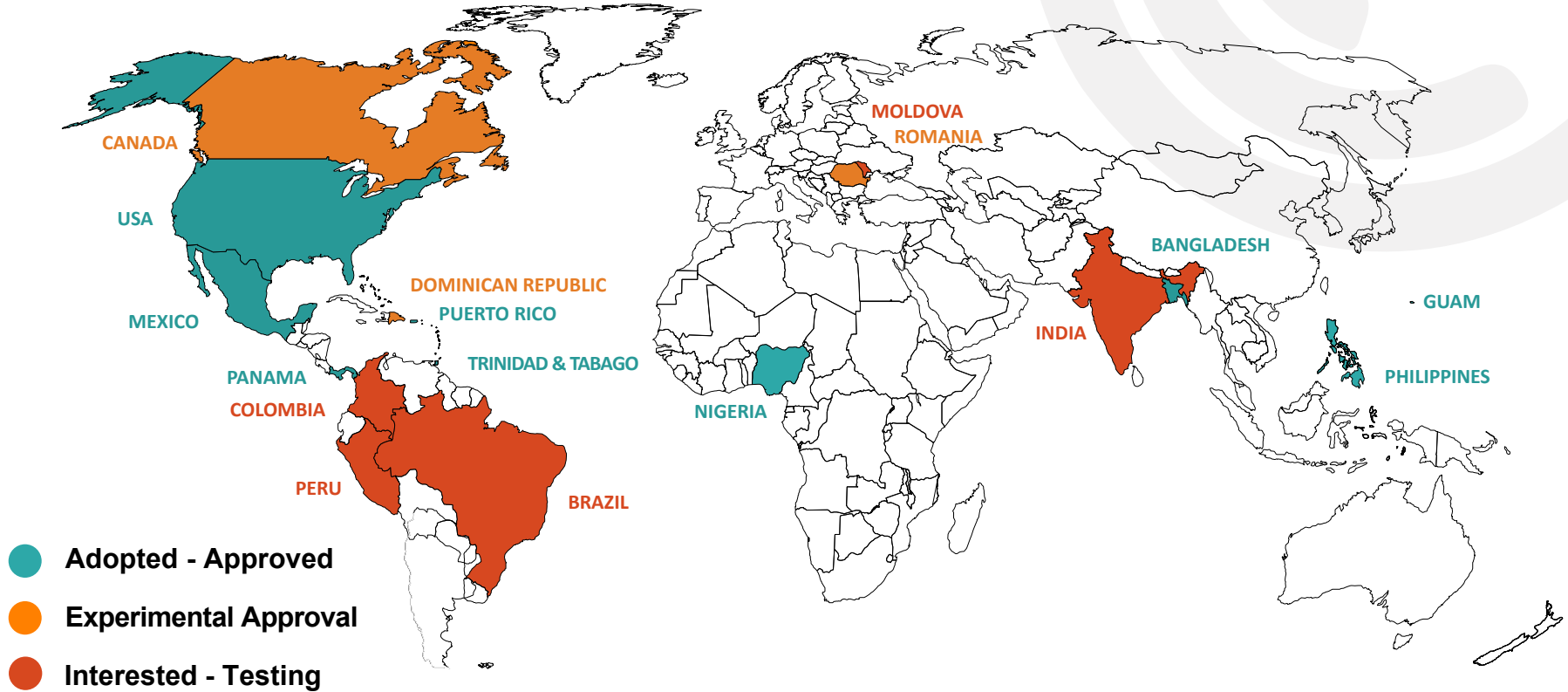
Mexico Totals

- Stations On-Air: 117
- Total Digital Channels On-Air: 190

Canada Totals

- Stations On-Air: 33
- Total Digital Channels On-Air: 80





ALL MAJOR BRANDS OFFER FACTORY-INSTALLED HD RADIO TECHNOLOGY

NEW CARS DELIVERED IN
THE U.S. IN 2019 WITH
FACTORY-INSTALLED HD
RADIO RECEIVERS

49.2
Percent

CARS ADDED ANNUALLY IN
U.S. WITH
HD RADIO RECEIVERS
(INCLUDING AFTERMARKET)

8.9
Million

RUNNING TOTAL U.S. HD
RADIO-EQUIPPED CARS ON
THE ROAD (INCLUDING
AFTERMARKET)

60.9
Million

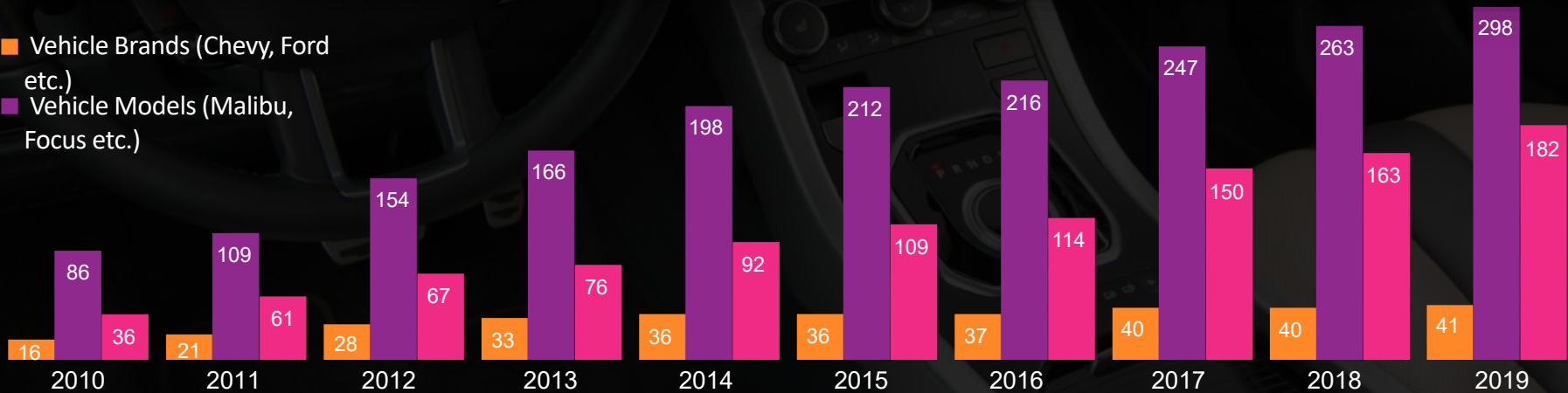


HD RADIO AND THE BATTLE FOR THE DASHBOARD

All major brands offer factory-installed HD Radio



■ Vehicle Brands (Chevy, Ford etc.)
■ Vehicle Models (Malibu, Focus etc.)



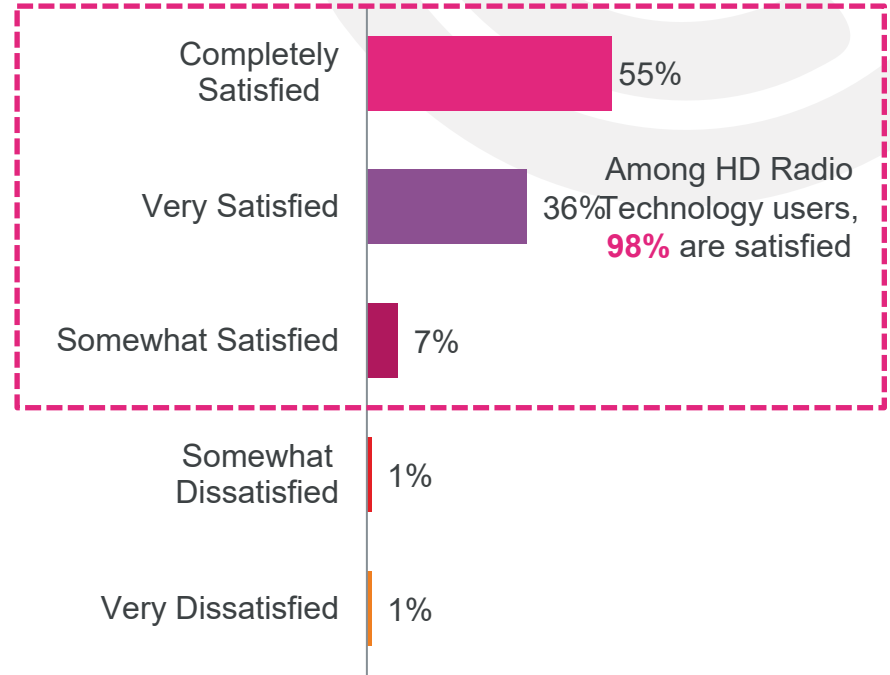
OVERALL CONSUMER SATISFACTION WITH THE TECHNOLOGY

Virtually all (**98%**) HD Radio Technology users surveyed are satisfied with their HD Radio Technology experience

91% of listeners said they are “completely” or “very” satisfied

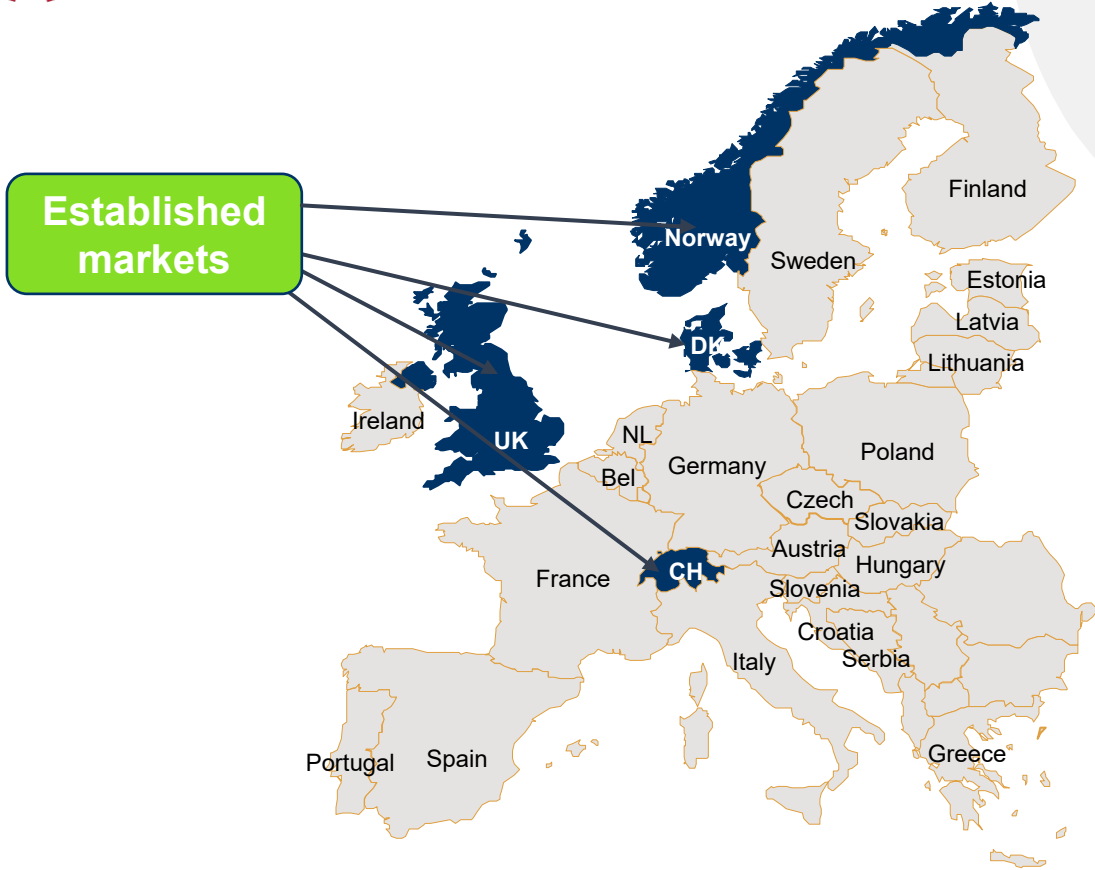
55% indicated they are “completely satisfied” with the HD Radio Experience

Those under 40 years old and heavy users (listen to radio >15 hours a week) have the highest satisfaction with HD Radio Technology



world dab

TEN YEARS AGO, FOUR DAB MARKETS IN EUROPE



FIRST COUNTRIES ARE SWITCHING OFF FM



Norway: 2017



Switzerland: 2024



STRONG PROGRESS IN MAJOR MARKETS



UK:
58% of listening is digital



Germany:
Launching 2nd national multiplex this year



Italy:
All receivers must have DAB+ from 2020



Switzerland:
Switch-off FM by end 2024



SIGNIFICANT NEW LAUNCHES ACROSS THE CONTINENT



Belgium:

**Flemish & French
launches (2018/19)**



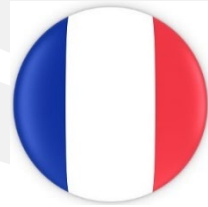
Austria:

**National DAB+
(May 2019)**



Sweden:

**40% population
coverage (2019)**



France:

**Regional services on
air - national DAB+
next to launch**

Tunisia launched 2019; Algeria trial in
2020



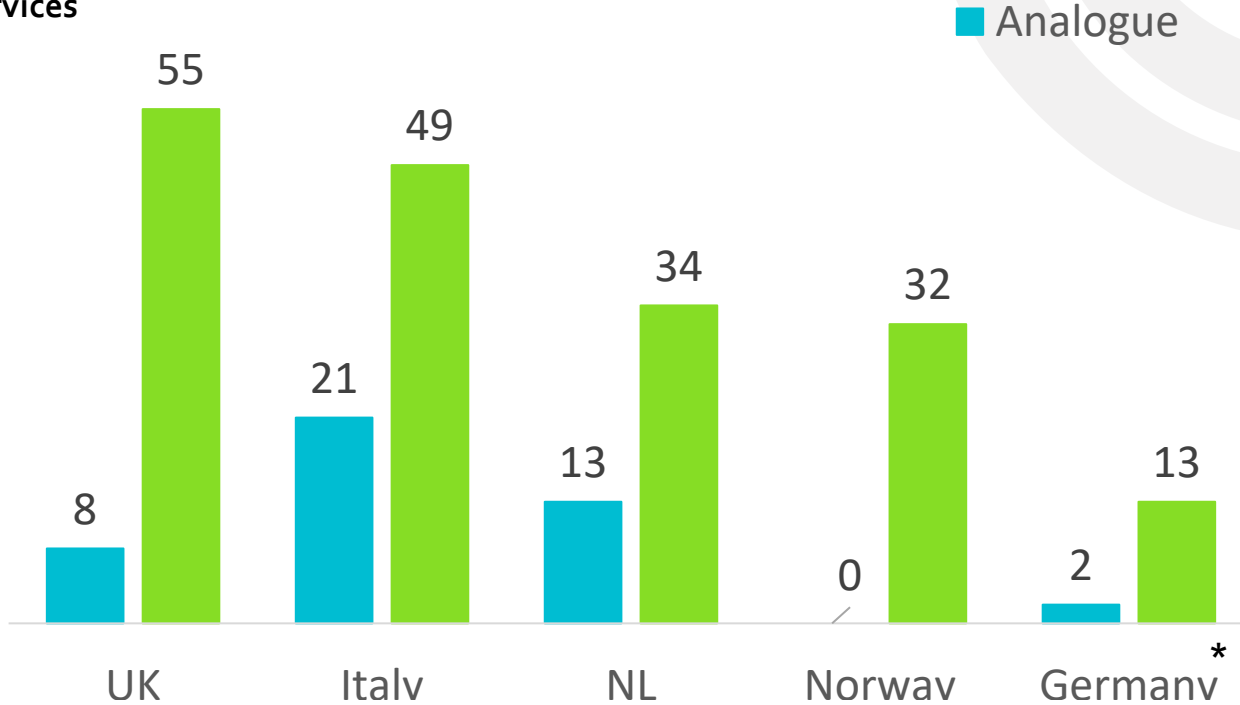
- Over 529 million people are within reach of a DAB/DAB+ signal
- DAB/DAB+ is now available in 45 countries/territories worldwide*
- Countries that have put DAB+ services on air in the last 12 months:
Azerbaijan, Serbia, Thailand, Tunisia, Vietnam

**Includes Gibraltar, Holy See and Monaco in that total as territories*



DAB+ OFFERS GREATER CHOICE – UP TO SIX TIMES AS MANY SERVICES

National radio services



* Will double with launch of second national multiplex – expected September 2020

Source: dabplus.de



RECEIVERS ARE NOW MASS MARKET



- Over 80 million receivers sold*
- Prices from €20



GROWING NUMBER OF NEW CARS WITH DAB



Norway
100%



UK
95%



Switzerland
91%



Australia
73%



Italy
46%



Germany
40%



Netherlands
43%



THE IMPORTANCE OF DAB+ IS RECOGNISED BY THE EU

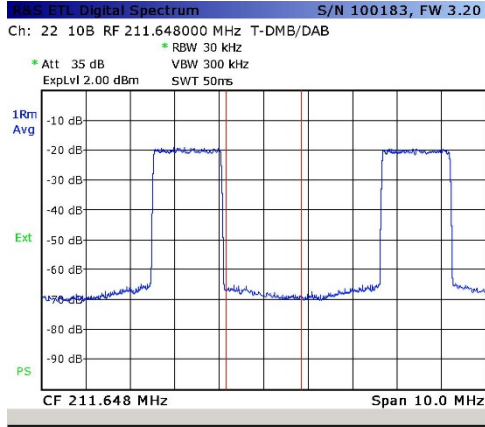
European Electronic Communications Code (Dec 18)

- From end 2020, all new car radios in EU must be able to receive digital terrestrial radio
- Member States free to introduce own legislation for consumer radios

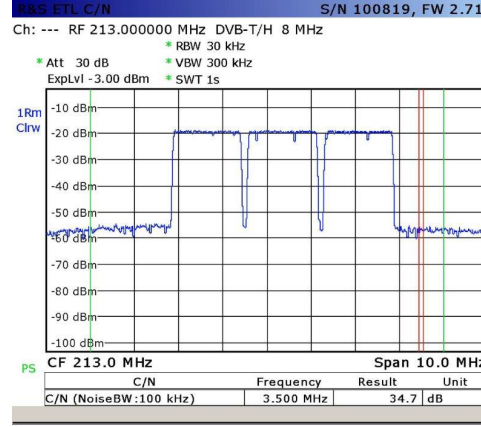




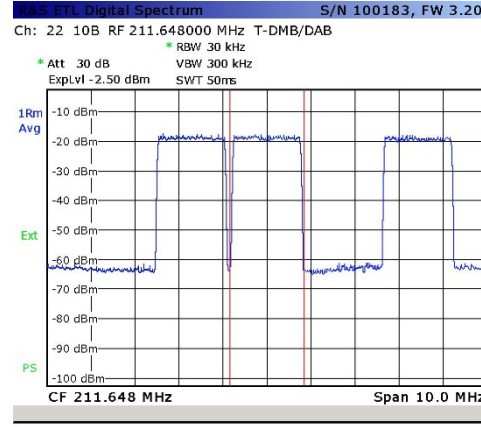
MULTI CARRIER DAB SOLUTIONS REDUCE COSTS, AND INCREASE ROI



2 non adjacent channels



3 adjacent channels



3 non adjacent channels

N&S ETL Digital Overview S/N 100183, FW 3.20
Ch: 24 10D RF 215.072000 MHz T-DMB/DAB

* Att 30 dB
ExplLvl -2.50 dBm

MER (total,rms) **38.3 dB**

Ensemble	EnsembleTest	Date & Time(UTC:---				
Pass	Limit	<	Results	<	Limit	Unit
Level	-60.0		-2.3		10.0	dBm
Sideband			Normal			
Transmission Mode			Mode 1, 1536 carriers			
Carrier Freq Offset	-30000.0		0.0		30000.0	Hz
BR Rate Offset	-20.0		0.0		20.0	ppm
MER/EVM (rms)	24.0		38.3		----	dB
MER/EVM (peak)	10.0		26.8		----	dB
BER before Viterbi			0.0e-7(39/100)		1.0e-2	
FIB Errors			0		1	/s

Tx Antenna



VHF BIII Band Pass Filter





OUTDOOR TRANSMITTER SYSTEM MAKE COVERAGE EXPANSION MORE COST EFFECTIVE

MAIN FEATURES:

- 70W RMS power or one analog signal (130 W p.s.) with amazing efficiency
- No need for servicing blowers and filters
- Enable complete remote control via SNMP/Web interface through a standard Ethernet connection or integrated 4G modem
- Compact chassis: just 18.9x14x6.7 in (480x360x170) mm.
- Several Input interfaces :
 - ASI input (TS, BTS, T2MI, SMPTE-310M, ETI)
 - GbE port (TS over IP or EDI)
 - Optional: DVB-S/S2 Satellite Receivers (up to 4, including CAM interface and multi-stream capabilities)
 - Optional: RF receiver input for repeater/gap-filler configuration
- DVB-T/H/T2, ISDB-T/Tb, **DAB/DAB+**/T-DMB, ATSC modulations
- Adaptive pre-correction circuits
- High stability GPS / GLONASS receivers with battery



- Consumers demand more and different types of content – Radio still most used
- Digital Radio lowers deployment cost per channel
- Key technologies deliver superior green footprint
- Additional savings are realized from facility space, cooling, construction and maintenance costs
- Advancements in multi channel and outdoor system reduce the cost to expand network coverage
- Digital radio receivers are widely available for HD Radio and DAB – especially in cars
- Digital Radio is a cost-effective mobile content delivery platform



THANK YOU

WWW.GATESAIR.COM

