



Advanced Digital Radio: HD Radio, DRM, DAB & CDR

September 2015

Featuring
GatesAir's



Tim Anderson
Radio Product & Business
Development Manager

Advanced Digital Radio: HD Radio, DRM, DAB & CDR

Tim Anderson

The greatest energy efficiency.
The most standards supported.
The simplest operation.

The lowest total cost of ownership.



DAB+ DMB DRM HD Radio

The Leading Choice for Digital
Radio Solutions Worldwide

Harris Broadcast
is now

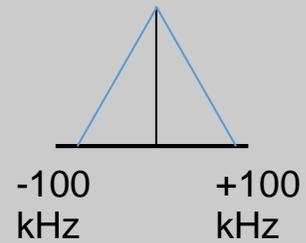
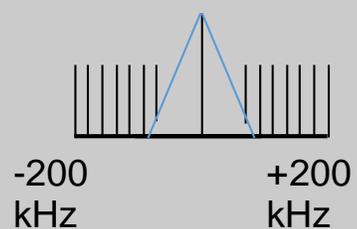
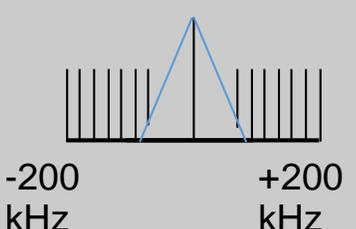
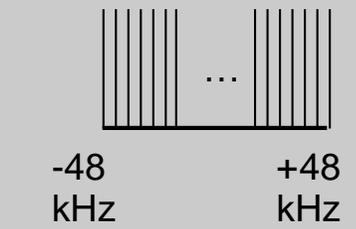
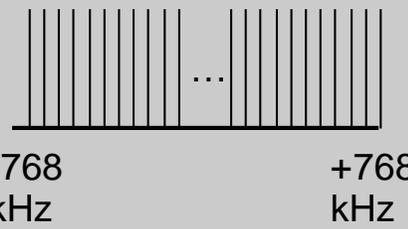


The logo for DAB+, consisting of the letters "DAB" in a bold, black, sans-serif font, followed by a plus sign "+".

- All use OFDM modulation
- Differences in spectrum use and data capacity
- For optimized coverage Single Frequency Network (SFN) in DAB+ DRM+ and HD Radio possible
- DAB+ effective solution for large number of programs, Network operators and centralized distribution where Band III is available.
- DRM & HD Radio (IBOC) effective solution for smaller, independent operators with fewer programs where Band II frequencies are available

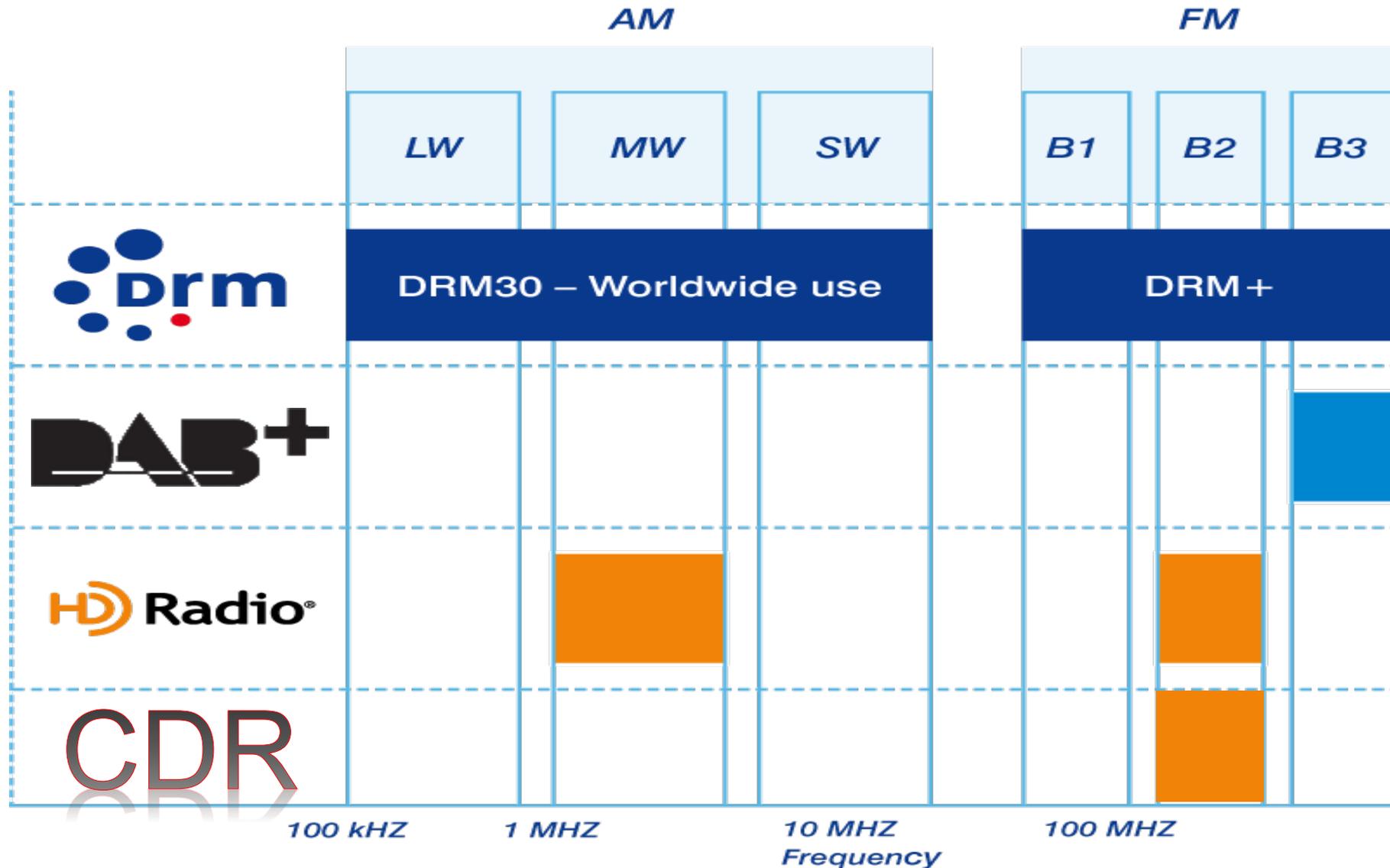


Comparison FM, HD Radio™, China Digital, DRM+ and DAB+

Parameter	FM	HD Radio	China Digital	DRM+	DAB+
Frequency	87.5 MHz – 108 MHz Band II	55kHz - 1705kHz 87.5 MHz – 108 MHz	87.5 MHz – 108 MHz Band II	47 MHz – 68 MHz 87.5 MHz – 108 MHz 174MHz – 230 MHz	174 MHz – 240 MHz Band III
Programs / Channel	1	1 to 4 (max)	1 to 4 (or More)	1 to 4 (max)	Typically 9 to 24 (64 max)
Data / Channel	RDS 1,2 kBit/s	Flexible Program Associated and Non Program Associated Data rates	Flexible Program Associated and Non Program Associated Data rates	Flexible Program Associated and Non Program Associated Data rates	Flexible Program Associated and Non Program Associated Data rates
Analog Simulcast	N/A	Yes	Yes	Yes*	No
Channel	200 kHz	400kHz	400kHz	96 kHz	1.5 MHz
BW Capacity	N/A	96/124 kBit/s	96 kBit/s-1.5 MBits/s	96/kBit/s	1.5 Mbits/s
Modulation	Single Carrier FM  -100 kHz +100 kHz	Multi-carrier (up to 524) OFDM, 4 QAM  -200 kHz +200 kHz	Multi-carrier (up to 524) 4,8,16,32,64 QAM  -200 kHz +200 kHz	Multi carrier (106) OFDM, 4 or 16 QAM  -48 kHz +48 kHz	Multi Carrier (1536) OFDM, type DQPSK  -768 kHz +768 kHz



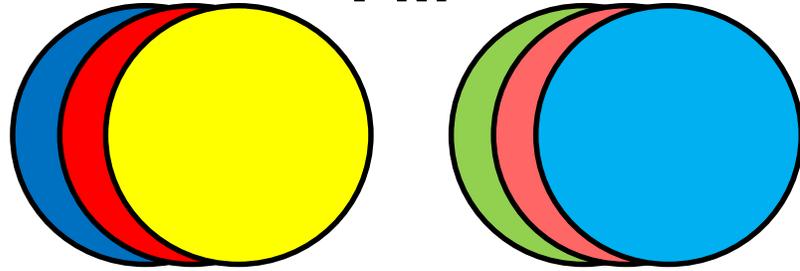
Digital Radio Standards IBOC & DAB+



Cost efficiency of FM vs. IBOC and DAB+

Example: 18 Radio Programs same coverage

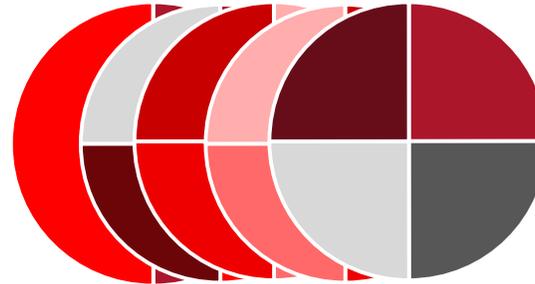
FM



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 High-Power antenna

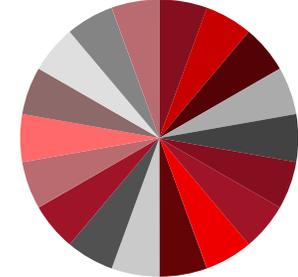
IBOC



20 Programs possible - 2 program channels left over

- 5x FM Transmitter
- 5x Frequencies
- 5x Frequency License fee
- 4x Studio-Transmitter Link (STL)
- 4x RDS encoder/ Data
- 4x DAB+ Play-out/Multiplexer
- 5x Medium power 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/Multiplexer
- 1x Medium power antenna

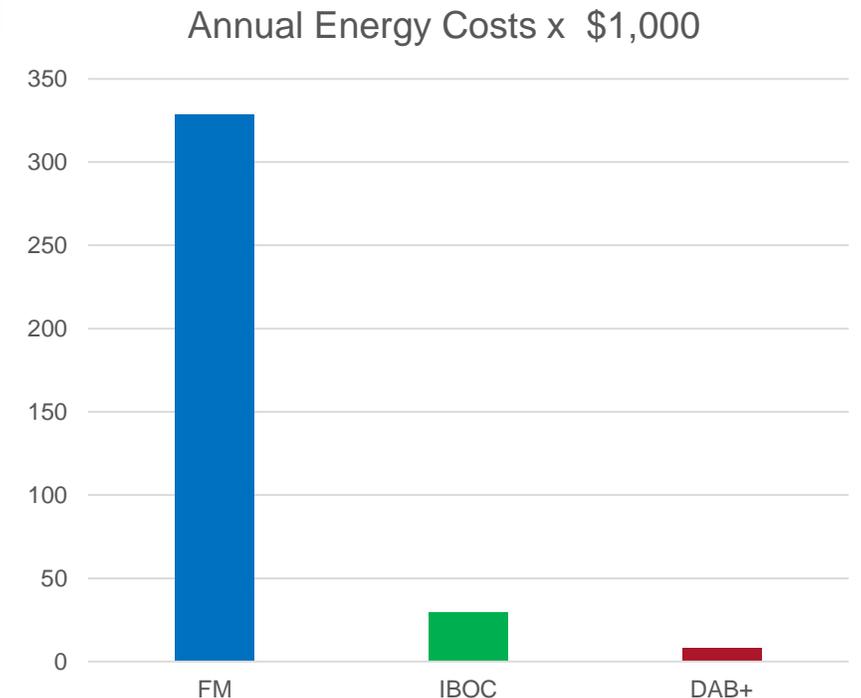


Cost efficiency of FM vs. IBOC and DAB+



Example: 18 Radio Programs same coverage

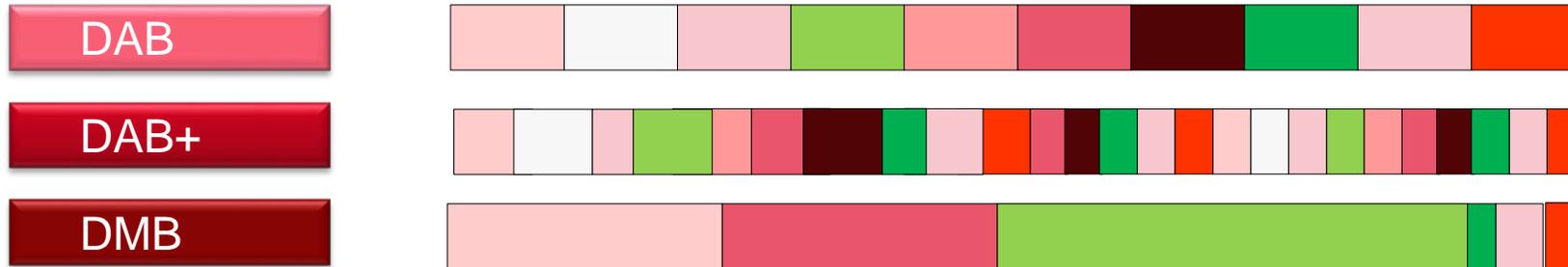
Transmitter	FM	IBOC – HDR/DRM/CDR	DAB+
Power	10 kW	2.5 kW	2.5 kW
Efficiency	72%	50%	40%
Energy consumption Per TX	13.9 kW	5 kW	6.25 kW
Transmitters	18	4.5	1
Energy all Transmitters	250 kW	22.5 kW	6,25 kW
Annual cost of energy	\$328,500	\$29,565	8.000 USD



Assumes 0,15 USD per kWh



DAB family of standards - no difference for the transmitter



up to 10 Radio/ Data

up to 24 Radio/ Data

up to 7 Video/ Radio /Data

- Net data rate of 1.152MBit/s for commonly used rate $\frac{1}{2}$ FEC coding
 - Flexibility for data rate / transmission power trade off from 576kbps to 1.728Mbps
- Each DAB transmitter can operate DAB, DAB+, DMB without changes
- There is **no** difference in Hardware or Software for the transmitter !

- The differences are managed by the Play-Out equipment
 - audio encoding
 - video encoding (DMB)
 - data server
 - error protection



DRM30 MW complementary to DAB+ or separate usage possible for:

- coverage of large territories and international coverage
 - Digital Medium Wave (DRM30 and HD Radio)
 - Digital Short Wave and Long wave (DRM30)

- FM Band II HDR, DRM+ or CDR complementary **if frequencies available** for simulcast of analog + digital
 - Up to 4 programs plus data services per frequency. More programs but with individual coverage
 - Local programs
 - In case broadcasters want to stay in control of Tx equipment and
 - Want to keep using parts of existing FM infrastructure (antennas, excitors)

- DRM+ standardized also in Band I and Band III



- Broadcasting in AM and FM bands
- Migration from and co-existence with analogue broadcasting: Complies with existing spectrum masks and analogue frequency grids.
- Up to four services per frequency, each of which can be any mixture of audio and data.
- Single-frequency and multi-frequency networks, plus associated signaling and automated receiver tuning.
- HDC Audio Coding supporting bit-rates from 32kB/s to 124kb
- Data Services, Album Art,, traffic services and news headlines and a wide range of similar value added services.

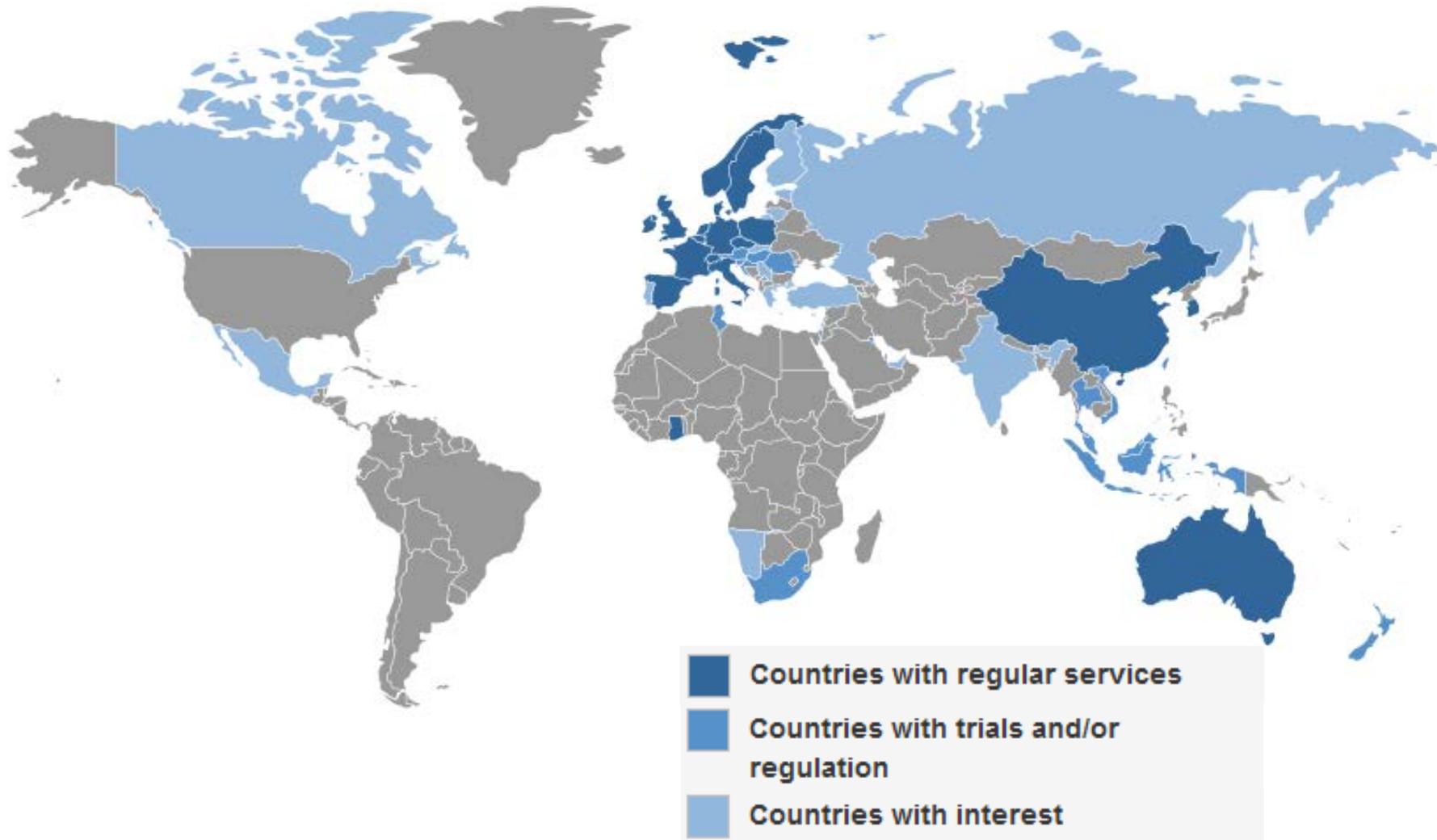


- Broadcasting in all the AM and FM bands extending from 150kHz through to VHF Band III.
- Migration from and co-existence with analogue broadcasting: Complies with existing spectrum masks and analogue frequency grids.
- Up to four services per frequency, each of which can be any mixture of audio and data.
- Single-frequency and multi-frequency networks, plus associated signaling and automated receiver tuning.
- A choice of three audio coders supporting bit-rates from 2kB/s upwards.
- Text-messaging, slide-shows, multi-media object transmission, traffic and news headlines and a wide range of similar value added services.



Global Situation for Digital Radio





- Over 500 million people worldwide are within range of a DAB/DAB+ signal
- Over 1,000 services on air
- Several thousand receiver models available for home & car.
- Successes: Australia, Belgium, Germany, Hong Kong, Netherlands, **Norway***, South Korea, Switzerland
- Failures: Canada, United Kingdom



Global HD Radio Coverage



1. Adoption and Nationwide Operation
2. Adoption and Regional Operation
3. Limited Operation
4. Testing/Advanced Interest
5. Active Interest

- Adopted as THE Digital Radio Standard in the US
 - 90% of the US population can receive an HD Radio signal
- Mexico and Brazil have adopted and actively broadcasting
- Argentina, China and others are actively testing
- Canada has renewed interest and is actively pursuing



Proprietary and confidential. | 13



Global DRM Coverage







- The Chinese government's Academy of Broadcast Science (ABS) has developed their own FM digital radio standard called China Digital Radio (CDR).
- GatesAir has agreed to assist the State Administration of Radio, Film and Television (SARFT) with the development of actual hardware platforms for signal generation (CDR Exciters) and RF transmission systems
- The CDR Channel Coding Modulator uses the G4 Engine option card developed for HD Radio in the Flexiva FAX transmitters/exciter.
- CDR has similarities with HD Radio, in that it is a hybrid analog/digital, in-band-on-channel (IBOC) system using upper and lower OFDM subcarriers,
- It also closely resembles CMMB "lite" using Low Density Parity Check (LDPC) error correction with the DRA (Chinese) audio codec. So, this is technology with which we have substantial experience.
- The first two GatesAir FAX10kW CDR transmitters are being shipped to Guangdong Province now and expected to be on-air in April
- 300 Cities expected to be deployed over next 5 years



We believe that export of CDR to Africa is in their plans much as CMMB

CDR

Proprietary and confidential. | 16



Competition



	DTV	AM	FM	DAB+	HD Radio	drfm	CDR
AMPEGN	NO	YES	NO	NO	NO	AM	NO
BBEF, Beijing	YES	YES	YES	NO	NO	NO	YES
IBE	NO	YES	YES	NO	AM/FM	AM/FM	NO
	NO	YES	YES	NO	AM/FM	AM/FM	NO
ELTRONIA GROUP	YES	NO	NO	YES	NO	YES	NO
CTE Digital Broadcast	YES	NO	YES	YES	NO	NO	NO
electrosys	YES	NO	YES	YES	NO	NO	NO
GATESAIR	YES	YES	YES	YES	AM/FM	AM/FM	YES
清华同方 GIGA-MEGA TSINGHUA TONGFANG	YES	YES	YES	NO	NO	NO	YES
Katieng, Beijing	YES	NO	YES	NO	NO	NO	YES
nautel	YES	YES	YES	NO	AM/FM	AM/FM	NO
NEC	YES	YES	YES	YES	NO	NO	NO
PLISCH	YES	NO	NO	YES	NO	NO	NO
RÖHDE & SCHWARZ	YES	NO	YES	YES	FM???	NO	TBD
RIZ	NO	YES	NO	NO	NO	AM	NO
R.V.R. ELECTRONICA	NO	NO	YES	NO	FM???	NO	TBD
THOMSON	NO	YES	NO	NO	NO	AM	NO
TRANSRADIO Sendersysteme Berlin	NO	YES	NO	NO	NO	AM	NO

Many significant competitors across the radio space.

GatesAir is the only supplier of ALL digital radio and TV modulations



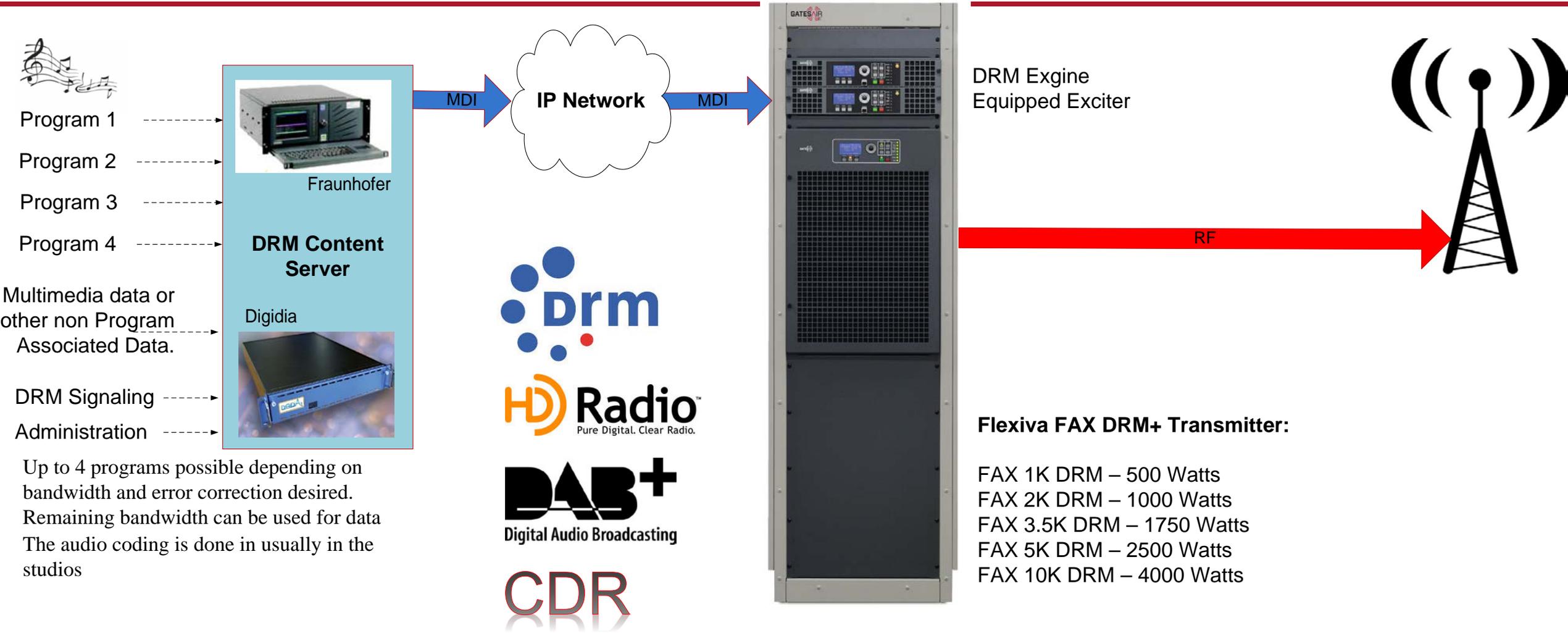


Connecting What's Next

GatesAir Digital Radio Solutions



IBOC & DAB+ Transmission System



Up to 4 programs possible depending on bandwidth and error correction desired. Remaining bandwidth can be used for data. The audio coding is done in usually in the studios





- KAJM and KNRL dual-redundant FAX20 HD Radio transmitters
- Four 20kW transmitters and equipment racks in six racks
- Sierra H Broadcasting - 8,000 feet in central Arizona's Sonoran desert



AM HD Radio Installation



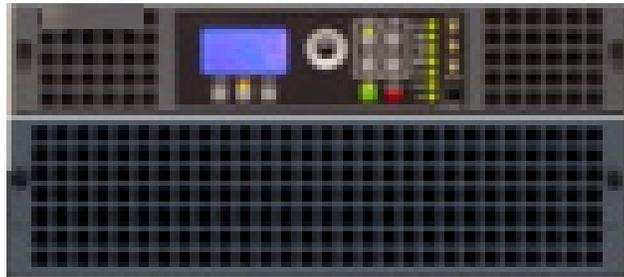
- WOR AM
- Rutherford, NJ
- Dual 3DX50 50kW AM HD Radio Transmitters



Norkring – Oslo Norway

2 x 5kW VAX3D DAB+
Transmitters





**1 and 2 PA Transmitter
(Dual drive optional)
(Rack optional)**

Maxiva™ VAX Compact: DAB Transmitter

Low Power VHF Band III TV/DAB Transmitter/
Transposer/Gap Filler

- Broadband frequency; agile design 168 MHz to 242 MHz
- 10W to 150W DAB/DAB+/DMB
- Automatic digital pre-correction (non-linear and linear) using GatesAir's RTACTM technology for outstanding performance
- Compact , space-saving 2RU design





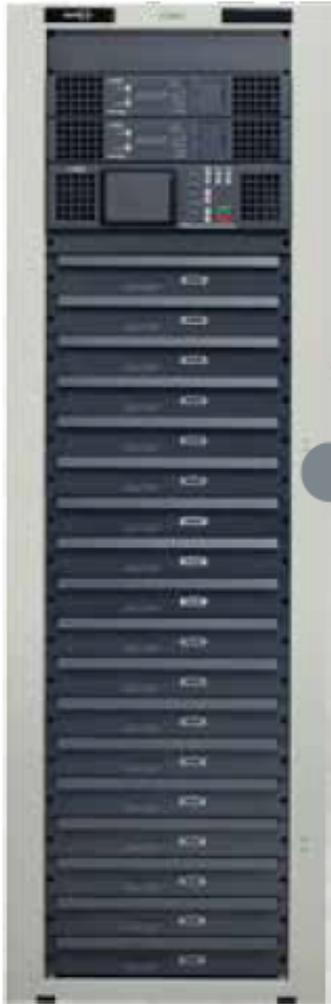
PowerSmart^{3D} Ⓞ

Maxiva™ VAX 3D: DAB Transmitter

Medium & High Power, Air-Cooled with PowerSmart[®]3D

- High-efficiency design
- Broadband operation 170MHz to 240MHz, no tuning or power amplifier modification
- 1,25kW to 10kW DAB/DAB+/DMB
- High active and passive redundancy
- Automatic digital pre-correction (non-linear and linear) using GatesAir's RTAC™ technology for outstanding performance
- Hot-swappable low-weight power amplifier and power supplies
- Rugged design for operation in critical environments





Maxiva™ VLX: DAB Transmitter

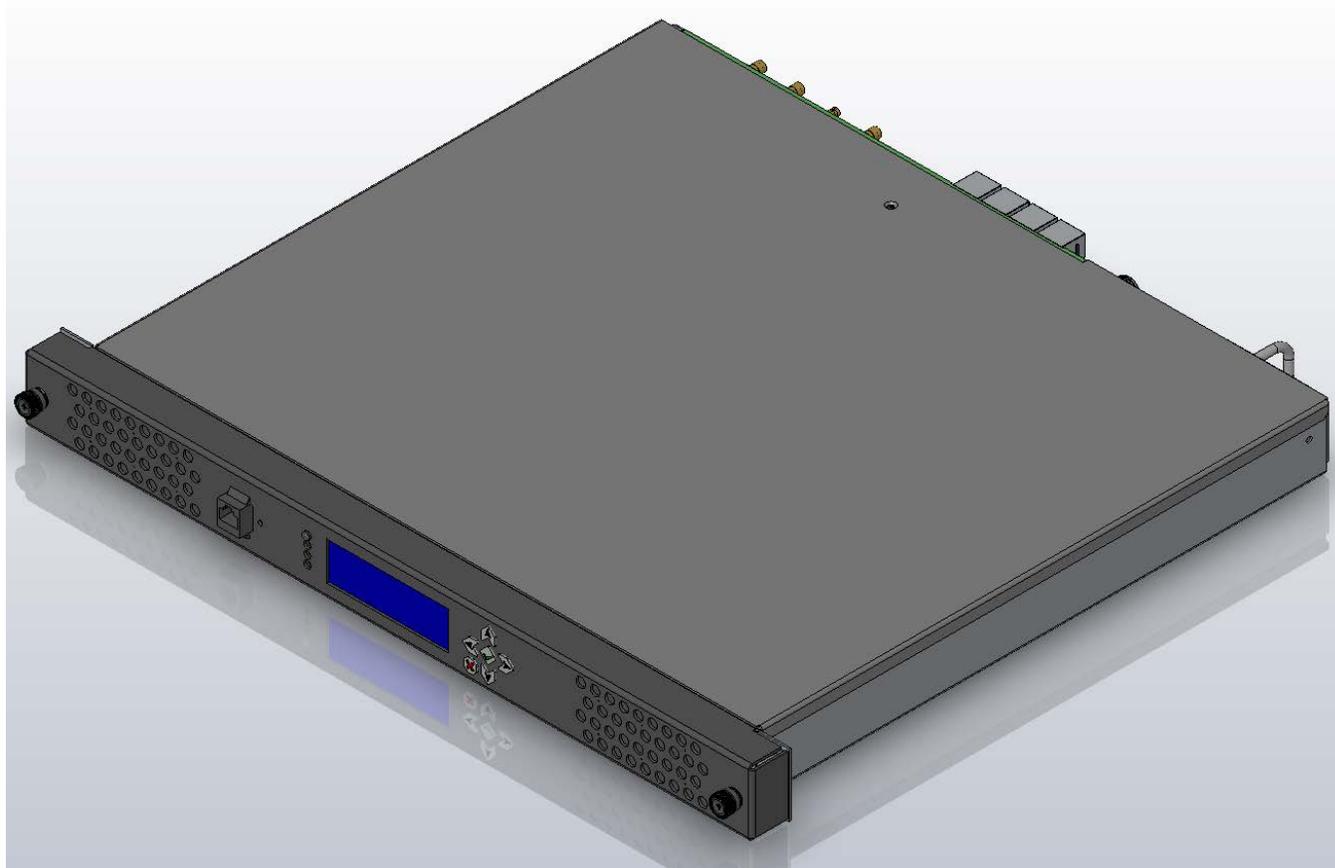
High Power, Liquid-Cooled with PowerSmart® 3D

- Broadband operation 170MHz to 240MHz; no tuning or power amplifier modification
- Hot-swappable power amplifier
- 1,1kW to 9,6kW DAB/DAB+/DMB
- Automatic digital pre-correction (non-linear and linear) using GatesAir's RTAC™ technology for outstanding performance
- Pump system rack integrated or external

PowerSmart® 3D 

www.gatesair.com





The next generation DAB+ Exciter will be the XTM Universal Exciter Platform in development now.

Will be integrated into VAX3D

- More processor power
- Improved pre-correction
- Improved Crest Factor Reduction
- Improved performance
- Lower production cost than UEP





Flexiva™ FAX Compact: HD Radio, DRM+ and China Digital Radio Transmitters

Low Power VHF Band II Analog FM or Digital
Radio options for HDR/DRM+/CDR

- Broadband frequency agile design. 88 to 108MHz
- 10 Watts to 1500W HDR/DRM+/CDR
- Automatic digital linear and non-linear pre-correction using GatesAir's RTAC™ technology
- Compact, space-saving design – 2, 3 & 4RU
- Easy conversion from analog to digital with G4 Engine



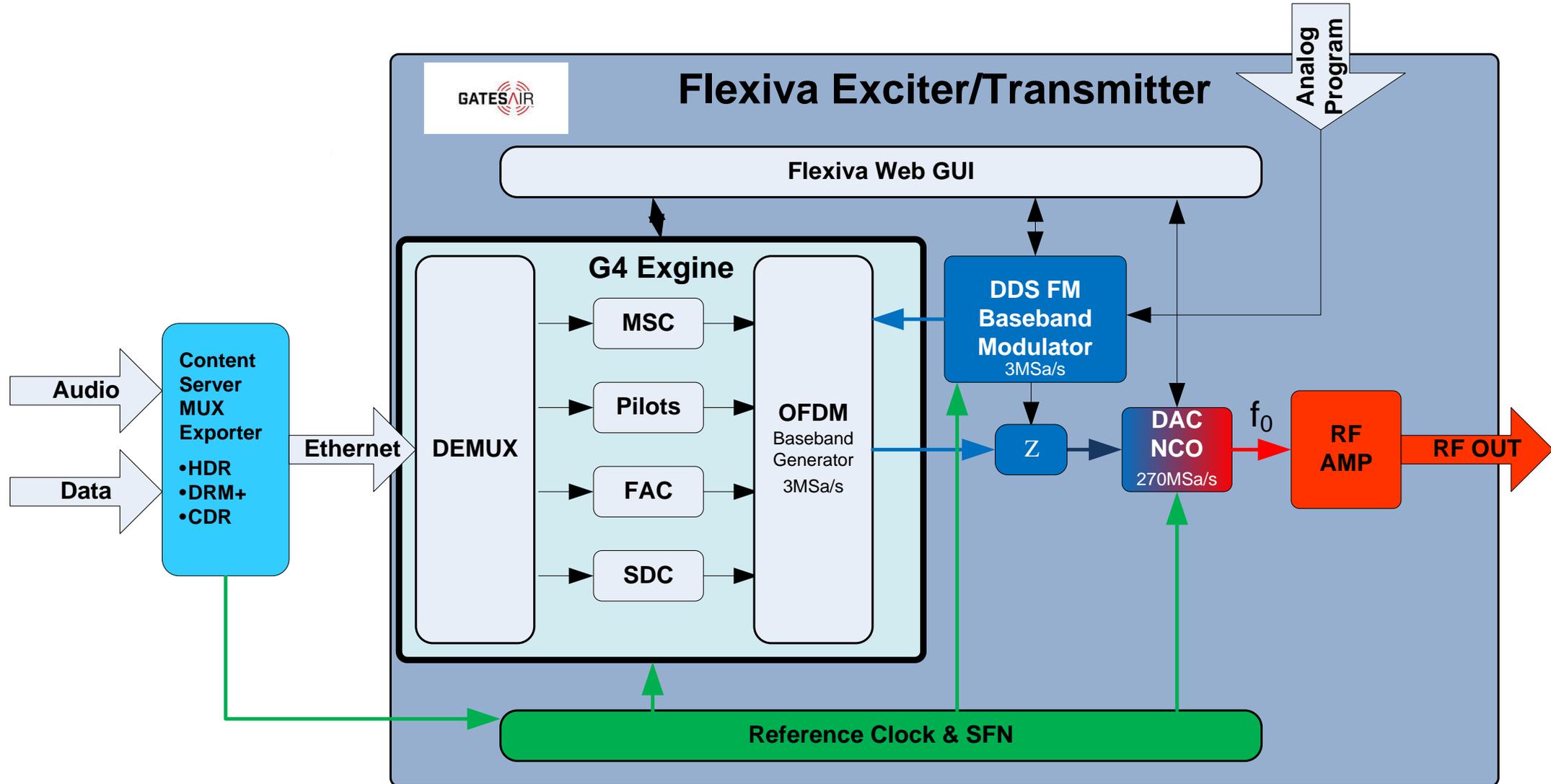


Flexiva™ FAX High-Power: HD Radio, DRM+ and China Digital Radio Transmitters

High-Power Power VHF Band II Analog FM or
Digital Radio options for HDR/DRM+/CDR

- Broadband frequency agile design. 88 to 108MHz
- 2.5kW to 40kW HDR/DRM+/CDR
- Automatic digital linear and non-linear pre-correction using GatesAir's RTAC™ technology
- Compact, space-saving design
- Highest Efficiency, highest power density
- Uses FAX Compact exciter for easy conversion from analog to digital with G4 Engine







G4 Engine Modulator Card



G4 Engine Installed in Flexiva

Flexiva™ FAX G4 Modulator for HD Radio, DRM+ and China Digital Radio Transmitters

- Provides easy upgrade from analog to digital for all Flexiva FM transmitters
- Hybrid Crest Factor Reduction reduce the high peak-to-average power ratio (PAPR) improving RF power amplifier utilization
- Real-Time Adaptive Correction (RTAC™) for digital pre-correction of non-linear distortions providing continuously superior RF mask performance
- High quality Spectrum Analyzer for verifying FCC, NRSC & ITU spectral mask compliance
- Modulation Error Ratio (MER) measures the digital signal-to-noise ratio for data-bearing and reference carriers within the OFDM sidebands giving diagnostic signal-to-noise reference
- Graphical User Interface (GUI) provides full control of all of the digital radio generation processes integrated with the Flexiva GUI



HD Radio Control & Analysis from FAX GUI



The screenshot displays the GATESAIR Flexiva FAX GUI interface. At the top, it shows the user 'e4 (Engineer)' with a 'Logout' button, the station call sign 'WXYZ', and the mode 'FAX 150 FM-HD'. The status is 'On' with a power indicator. Forward power is 0.15 W and Reflected power is 0.00 W. The time is 09:37 on 02/18/2015.

The main section is titled 'Analysis' and features a spectrum plot showing a signal centered at 0 kHz. Below the plot is a 'Total Modulation(75kHz)' bar graph with segments for A AES, M AES, SCA 1, SCA 2, RDS, and Pilot. The modulation level is approximately 60%.

On the right side of the GUI, there are several control buttons: 'Analysis Expand', 'Drive Chain', 'Non-Linear Pre-Corr', and a 'BACK' button.

To the right of the main GUI is a vertical control panel with the following indicators and buttons:

- Exciter: Green indicator light
- Drive Chain: Green indicator light
- Power Amp: Green indicator light
- Power Supply: Green indicator light
- Output: Grey indicator light
- System: Green indicator light
- Mute: Yellow indicator light
- Exc A On Air: Blue indicator light
- Exc B On Air: Grey indicator light

Control buttons include 'REMOTE ENABLE' (green), 'POWER RAISE', 'DISABLE', 'LOWER', 'ON' (green), and 'OFF'.



HD Radio Control & Analysis from FAX GUI



The screenshot displays the FAX GUI interface for a radio system. The top bar includes the GATESAIR logo, the Flexiva logo, and the system name "MASON HD 10K FAX 10K FM-HD". A "Login" button is visible on the left. The main display area is titled "HCFR & MER" and contains several control panels:

- Power Status:** A power button labeled "Off" is shown. Forward and Reflected power levels are both 0 W.
- Time and Date:** The current time is 10:22 and the date is 02/24/2015.
- Hybrid Crest Factor Reduction:** The "Effort" is set to 8. The "PAPR/MER Balance" slider is positioned at 70, with "Lower PAPR / MER" and "Higher PAPR / MER" labels and adjustment buttons (- and +).
- PAPR (0.01% CCDF):** The "Average (dB)" slider is set to 2.728.
- MER:** Two sliders are shown for "Lower Side Band" and "Upper Side Band". The "Avg, Ref (dB)" for both is 53.6, and the "Avg, Data (dB)" for both is 13.8.

On the right side of the interface, there are several control buttons and status indicators:

- REMOTE ENABLE:** A button with a green indicator light.
- POWER RAISE:** A button with a slider.
- DISABLE:** A button.
- LOWER:** A button.
- Exciter:** A green indicator light.
- Drive Chain:** A green indicator light.
- Power Amp:** A green indicator light.
- Power Supply:** A green indicator light.
- Output:** A grey indicator light.
- System:** A green indicator light.
- Mute:** A yellow indicator light.
- Exc A On Air:** A blue indicator light.
- Exc B On Air:** A grey indicator light.

A "BACK" button is located at the bottom right of the main control area.



GATESAIR
Flexiva

Login
MASON HD 10K
FAX 10K FM-HD

Off
Forward: 0 W
10:23

Reflected: 0 W
02/24/2015

A B
 Non-Linear Pre-Correction
 Analysis

RF Sample: XMTR
 Analysis Expand

Input Level: -3.0
LOW

Non-Linear Pre-Correction (RTAC)

Mode: Hold
IDLE

Profile: Use case 1

Success: 0

Attempts: 0

Performance Message:
RTAC hold-off due to Exgine RF Sample Input unsettled.

BACK

REMOTE ENABLE

DISABLE

POWER RAISE

LOWER

ON

OFF

Exciter

Drive Chain

Power Amp

Power Supply

Output

System

Mute

Exc A On Air

Exc B On Air



HD Radio Control & Analysis from FAX GUI



The screenshot displays the FAX GUI interface for HD Radio control and analysis. The interface is divided into several sections:

- Top Bar:** Shows the user as 'e4 (Engineer)' with a 'Logout' button. The station name is 'MASON HD 10K' and the mode is 'FAX 10K FM-HD'. The power status is 'Off', and the time is '10:19' on '02/24/2015'. Forward and Reflected power are both shown as '0 W'.
- HD Injection Section:** Features a 'Home' icon and the title 'HD Injection'. It includes controls for 'Exgine Operation' (set to 'Enable'), 'HD Protection Carriers' (set to 'Enable'), 'Primary Service Mode' (set to 'MP3'), 'Digital Sideband Power (dBc)' (set to '-10.0'), and 'Sideband Injection' (set to 'Symm').
- Equivalent Symmetric Power Section:** Displays two vertical bar graphs for 'L' and 'U' sidebands. The current power level is '-13.8 dBc' for both. Control buttons range from '+1' to '-1' dBc. The scale ranges from -23 to -13 dBc.
- Control Panel:** Includes a 'REMOTE ENABLE' button (illuminated green), a 'POWER RAISE' button, a 'DISABLE' button, a 'LOWER' button, an 'ON' button (illuminated green), and an 'OFF' button. A 'BACK' button is located at the bottom right of this panel.
- Status Indicators:** A vertical list of indicators on the right side shows the status of various components: 'Exciter' (green), 'Drive Chain' (green), 'Power Amp' (green), 'Power Supply' (green), 'Output' (grey), 'System' (green), 'Mute' (yellow), 'Exc A On Air' (blue), and 'Exc B On Air' (grey).



Thank You!

