New Technology DVB-T2 Products from GatesAir

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Featuring GatesAir’s Martyn Horspool
Product Manager, TV Transmission
New Technology
DVB-T2 Products from GatesAir

Martyn Horspool
Product Manager, TV Transmission
GatesAir
Mason, Ohio, USA
Introduction & History of GatesAir

- **1922** – Gates Radio starts business. Parker Gates was only 15 years old
- **1950** - Gates Radio had become a major Radio equipment supplier in USA
- **1957** – Harris Corporation acquires Gates Radio
- **2013** – Gores Group acquires Harris Broadcast Division
- **2014** – Harris Broadcast splits into two companies – Imagine Communications and GatesAir
1922
First Commercial Radio Station

1929
First TV Broadcast

1957
Harris Acquires Gates Radio

1996
First Digital TV Broadcast

2008
Mobile TV

What’s Next
UltraHD, LTE Broadcast

Connecting What's Next
End-to-End Terrestrial Transmission Solutions

- **Flexiva™**
  - Radio Studios

- **Intraplex™**
  - STL Audio Networking

- **Flexiva™**
  - Radio Transmitter
    - AM – FM
    - Analog & Digital

- **Maxiva™**
  - TV Transmitter
    - ATSC – DVB-T/T2
    - ISDB-T – CTTB
    - CMMB – DAB
    - Analog

Multi-Platform
- Terrestrial TV
- Mobile TV
- Terrestrial Radio
GatesAir Products Support All Standards

Flexiva™ – Studio
- Analog Audio
- AES/EBU
- TCP/IP
- Ethernet / CAT5
- USB

Intraplex™ – STL
- T1/E1
- AES67 / IP
- TDM / RJ-48C
- BNC
- RF

Flexiva™ – Radio
- AM / FM
- HD Radio
- DRM
- DAB

Maxiva™ – TV
- UHF / VHF
- ATSC – DVB-T/T2
- ISDB-T – CTTB
- CMMB – DAB

Connecting What’s Next
Product Portfolio

Create
- Networked Digital Radio Studios

Transport
- Contribution & Distribution: IP - TDM - RF

Radio Transmitters
- AM - FM - DAB Analog & Digital

TV Transmitters
- VHF - UHF Analog & Digital
Television: Maxiva Product Family

**UHF Band IV/V**
- Low Power Air Cooled: 5W
  - Maxiva™ UAXT
  - UAXT Ultra Compact
- High Power Liquid Cooled: 2kW
  - Maxiva™ ULX & ULXT

**VHF Band III**
- Low Power Air Cooled: 5W
  - Maxiva™ VAX-3D
- High Power Liquid Cooled: 10kW
  - Maxiva™ VLX

**Very High Power Liquid Cooled**
- Very High Power Liquid Cooled: 40kW +
  - Maxiva™ ULXT (Multi-rack)

Supports All Standards, Including:
- DVB-T2
Advanced Technology

- Broadband High Efficiency technology for lowest cost of ownership
- Software defined modulation capability addresses today’s needs and tomorrow’s opportunities

Introducing Maxiva™ with PowerSmart® 3D
Best-in-class broadband performance with no tradeoff in efficiency

Maxiva ULXT

Less weight
Smaller
More efficient
GatesAir is an active member, partnered with, or sponsors:

- ATSC
- DVB Project Office
- World DMB
- DRM Consortium
- Ibiquity (HD Radio)
- Mackenzie University, São Paulo, Brazil
- ABU, Asia-Pacific Broadcast Union
DVB-T2 Review
DVB-T2

- DVB-T2 is currently the most advanced digital terrestrial television (DTT) system
- More robustness
- More flexible
- 50% more efficient than any other DTT system available today
- Supports SD, HD, UHD, mobile TV, or any combination of these
Additional DVB-T2 Notes

- DVB-T2 works with both fixed and portable receivers
- Large capacity increase over DVB-T, with similar planning constraints and conditions as DVB-T
- Improved Single Frequency Network (SFN) performance compared to DVB-T
- Includes a mechanism for service-specific robustness (i.e. provide different levels of robustness to some services compared to others. Also possible to target some services for roof-top reception and other services for portable reception
- Provides bandwidth and frequency flexibility
- Provides the ability to reduce the peak-to-average ratio (PAPR), in order to reduce transmission costs
How Does DVB-T2 Work?

- Like its predecessor, DVB-T2 uses **OFDM** (orthogonal frequency division multiplex) modulation with a large number of sub-carriers delivering a robust signal, and offers a range of different modes, making it a very flexible standard.

- DVB-T2 uses the same error correction coding as used in DVB-S2 and DVB-C2:
  - **LDPC** (Low Density Parity Check) coding
  - **BCH** (Bose-Chaudhuri-Hocquengham) coding, offering a very robust signal. The number of carriers, guard interval sizes and pilot signals can be adjusted, so that the overheads can be optimized for any target transmission channel.
Main Advantages of DVB-T2

- New generation Forward Error Correction and 256 QAM
  - Capacity gain of > 30%
- OFDM carrier increase up to 32k and additional guard Interval selections
  - In SFN can provide up to 18% overhead gain
- Rotated Constellations
  - Robust transmission in difficult conditions
- Bandwidth extension
  - 2% payload gain
- Extended Interleaving
  - Including bit, cell, time and frequency interleaving
- Multiple PLP’s (Physical Layer Pipes)
  - See next slide
- DVB-T2 Lite
  - Optimized for Mobile applications
Multiple Physical Layer Pipes

Simplified Explanation of Concept:

- All PLPs are broadcast over the same frequency (TV channel)
- Every PLP carries an MPEG-TS
- Every PLP has its own modulation, FEC code rate and interleaving
- PLP-based robustness configurations allow adjustment bandwidth and coverage area per PLP
## DVB-T and DVB-T2 Comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>DVB-T</th>
<th>DVB-T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward error correction (FEC) &amp; Code Rates</td>
<td>Convolutional Coding + Reed Solomon 1/2, 2/3, 3/4, 5/6, &amp; 7/8</td>
<td>LDPC + BCH 1/2, 3/5, 23, 3/4, 4/5, &amp; 5/6</td>
</tr>
<tr>
<td>Modulation</td>
<td>QPSK, 16QAM, &amp; 64QAM</td>
<td>QPSK, 16QAM, 64QAM &amp; 256QAM</td>
</tr>
<tr>
<td>Rotated constellation Mode</td>
<td>N/A</td>
<td>Rotated or None rotated modes</td>
</tr>
<tr>
<td>Guard intervals</td>
<td>1/4, 1/8, 1/16, &amp; 1/32</td>
<td>1/4, 19/256, 1/8, 19/128, 1/16, 1/32, &amp; 1/128</td>
</tr>
<tr>
<td>Discrete Fourier Transform (DFT size)</td>
<td>2k &amp; 8k</td>
<td>1k, 2k, 4k, 8k, 16k, &amp; 32k</td>
</tr>
<tr>
<td>Scattered Pilots</td>
<td>8% of total</td>
<td>1%, 2%, 4%, or 8%</td>
</tr>
<tr>
<td>Pilot Patterns</td>
<td>N/A</td>
<td>8 Patterns Available</td>
</tr>
<tr>
<td>Continual Pilots</td>
<td>2.6% of total</td>
<td>0.35% of total</td>
</tr>
<tr>
<td>PLP’s</td>
<td>One</td>
<td>Single or Multiple PLP</td>
</tr>
</tbody>
</table>
DVB-T2 Lite

- The DVB T2-lite profile was added in June 2011 to the DVB-T2 standard v1.3.1 as Annex I
- The T2-Lite profile is mostly a subset of the DVB-T2 standard which is now called the "DVB T2-base" profile
- Two additional code rates were added for improvement of mobile performance

<table>
<thead>
<tr>
<th>DVB-T2 Lite</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FEC block size</td>
<td>LDPC 16k only</td>
</tr>
<tr>
<td>Code Rate</td>
<td>1/2, 3/5, 2/3, 3/4, 2/5*, 1/3* (* New code rates)</td>
</tr>
<tr>
<td>Constellation Size</td>
<td>QPSK, 16QAM, 64QAM, 256QAM (up to code rate 3/5)</td>
</tr>
<tr>
<td>Rotated Constellation</td>
<td>Only for QPSK, 16QAM and 64QAM</td>
</tr>
<tr>
<td>Guard Interval</td>
<td>Reduced set of combinations of FFT size, guard interval and pilot pattern.</td>
</tr>
<tr>
<td>FFT size</td>
<td>2K, 4K, 8K, 16K, 16K ext.</td>
</tr>
<tr>
<td>Scattered pilots</td>
<td>PP8 not allowed</td>
</tr>
<tr>
<td>Max. Bandwidth</td>
<td>4 Mb/s</td>
</tr>
<tr>
<td>P1 Signalling</td>
<td>New signaling for T2-mobile SISO/MISO</td>
</tr>
<tr>
<td>L1 Scrambling</td>
<td>Optional scrambling of L1-post only or entire L1</td>
</tr>
</tbody>
</table>
DVB-T2 Lite

- The T2-Lite signal may either be transmitted as a stand-alone signal ie. in a regular PLP, or as a T2-Lite signal with FEF parts.
- The Future Extension Frame (FEF) carries a T2 Frame dedicated for mobile services and may have different modulation parameters (FFT size, Guard Interval, SFN/MISO, Pilot pattern) than the other T2 Frame to improve mobile reception. The FEF interval and size of the T2-Lite super frame can be defined in the T2 Gateway. The maximum duration of a FEF part is 1 second.
DVB-T2 Lite Summary

- The T2 Lite profile allows a 50% smaller chip size – extends battery life
- T2 Lite and normal T2 Base signals can be transmitted together in a single multiplex, to allow separate optimization for each receiver type

DVB-T2 1.3.1 Provides both optimum waveform (Fixed vs. Mobile) & Multiple PLP Robustness (Outdoor vs. Indoor)
Programs Per RF Channel – Analog / T / T2

- **DVB-T** 24 Mbps
- **DVB-T2** 40 Mbps

<table>
<thead>
<tr>
<th>Channel Type</th>
<th>Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogue 1 Program</td>
<td>100%</td>
</tr>
<tr>
<td>DVB-T SD 5 SD</td>
<td>5 SD</td>
</tr>
<tr>
<td>DVB-T HD 2 HD</td>
<td>2 HD</td>
</tr>
<tr>
<td>DVB-T2 SD 20 SD</td>
<td>20 SD</td>
</tr>
<tr>
<td>DVB-T2 HD 4 or 5 HD</td>
<td>4 or 5 HD</td>
</tr>
</tbody>
</table>

**DVB-T** 24 Mbps:
- Analogue 1 Program: 100%
- DVB-T SD 5 SD: 5%
- DVB-T HD 2 HD: 20%

**DVB-T2** 40 Mbps:
- Analogue 1 Program: 100%
- DVB-T SD 20 SD: 40%
- DVB-T2 HD 4 or 5 HD: 40%
Summary of Main DVB-T2 Benefits

- Flexibility for network design
  - Frame rates, bit rates, modulation rates, Guard Intervals, etc. to fit what any particular operator desires to achieve.
- Pilots (fixed and scattered) to enable receiver lock in tough conditions (channel estimation)
- PAPR reduction techniques
  - TR and ACE
- Performance limits very near theoretical Shannon limit
- Multiple PLP’s
- T2-MI for multiplex management
- FEF’s for other data formats (LTE-A+), T2-Lite
DVB-T2 Resources for Further Reading

- Useful documents are available to assist in better understanding DVB-T2 and network planning aspects:
  1. DVB-T2 Fact sheet (Copy on Thumb Drive)
     DVB.org web site: [http://www.dvb.org/technology/dvbt2/](http://www.dvb.org/technology/dvbt2/)
  2. Frequency and Network Planning Aspects of DVB-T2 (Copy on Thumb Drive)
     EBU Technical Document 3348: [http://tech.ebu.ch/publications](http://tech.ebu.ch/publications)
  3. DVB-T2 Standards (ETSI EN 302 755 V1.3.1 and others) (Copy on Thumb drive)
     DVB.org web site: [https://www.dvb.org/standards?__noframe=8031](https://www.dvb.org/standards?__noframe=8031)
GatesAir High Efficiency Transmitters
High Efficiency TV Transmitters

**UHF Band IV/V**
- **Low Power Air Cooled**: 5W
- **High Power Liquid Cooled**: 2kW
- **Very High Power Liquid Cooled**: 10kW

**Maxiva™ UAXT**

**VHF Band III**
- **High Power Liquid Cooled**: 40kW +

**Maxiva™ ULXT (Multi-rack)**

**Maxiva™ VLX**

**High Efficiency Broadband**

**Maxiva™ VAX-3D**

Connecting What's Next
Review of Selected Products

- Note: Refer to individual product presentations
TCO – Total Cost of Ownership
Definition of TCO

- **Total Cost of Ownership - General Definition**

  Total Cost of Ownership is the total cost of acquisition and operating costs over the asset life cycle. A TCO analysis can be used to gauge the viability of any capital investment.

**Typical Asset Life Cycle Costs**

- Planning Costs
- Acquisition Costs
- Operation & Maintenance Costs
- Disposal Costs

Cost

Time

Upgrades
TCO versus Efficiency

- TCO is what is really important to a transmission operator:
  - It’s the total cost to own and operate the transmitter system over time
  - Includes initial equipment cost and delivery
  - Includes the installation/commissioning cost
  - Routine and unscheduled maintenance costs
  - Repair/replacement and other operational costs

- AC power consumed by the transmitter is important
  - However, other factors also affect the system efficiency:
    - AC transformers and voltage regulators
    - Heat load to the room (HVAC costs)
    - RF system losses (often significant)
    - RF feeder losses
    - Non-optimal antenna pattern
Transmitter Efficiency Basics

- **Efficiency of a transmitter:**
  - Definition: \( \frac{\text{RF Power Out}}{\text{AC Power In}} \times 100\% \)

Increased efficiency: reduces power consumed and reduces energy wasted.
Typical Class AB Tx Efficiency

- Example: 5kW Standard Class AB DVB-T2 transmitter
- Efficiency \(\frac{5}{25} \times 100\% = 20\%

Input power 25kW
Waste heat 20kW
Typical High Efficiency Tx

- Example: 5kW Doherty DVB-T2 transmitter
- Efficiency $\frac{5}{13.2} \times 100\% = 38\%$

Input power reduced: $(25-13.2)/25 = 47.2\%$
Waste heat reduced: $(20-8.2)/20 = 59\%$
Transmitter Efficiency Includes:

- Power Amplifiers
- Power Supplies
- Exciter(s)
- Drive Stages
- Cooling System
- Control System
Space Efficiency Improvements

<table>
<thead>
<tr>
<th>Year</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Atlas DVB-T</td>
<td>Maxiva ULX DVB-T/T2</td>
<td>Maxiva ULXT DVB-T/T2</td>
</tr>
<tr>
<td>Square Area</td>
<td>0.728 m²</td>
<td>0.774 m²</td>
<td>0.674 m²</td>
</tr>
<tr>
<td>Max Power</td>
<td>3.4kW</td>
<td>8.3kW</td>
<td>10.8kW</td>
</tr>
<tr>
<td>Power Density</td>
<td>4.67kW/m²</td>
<td>10.72kW/m²</td>
<td>16.02kW/m²</td>
</tr>
</tbody>
</table>
Power Density Trend

For consistency all transmitters shown are Harris/GatesAir

Power Density kW/m²


Atlas

ULX

ULXT

Next Gen Tx?

Connecting What’s Next

Proprietary and confidential.
Cooling and TCO

- Three common cooling methods for broadcast transmitters
  1. Air-cooled using outside air
  2. Air-cooled using inside air and Air-Conditioning
  3. Liquid cooling of Tx

- Each of these has some advantages and disadvantages
Connecting What's Next

Air Cooling – Outside Air

- Intake Fan
- Exhaust Fan
- Air Duct
- Louvers
- Air Filter
- Tx

Cool Air

Warm Air

For dust & pollen

And insect shield
Air Cooling – Sealed Room HVAC

- HVAC Unit
- Cool air
- Warm exhaust air
- Outdoor A/C Unit

Connecting What's Next
Liquid Cooling

- Small HVAC Unit
- Tx
- Minimal heat load to room
- >90% of heat goes outside via liquid
- Outdoor Fan Unit
- Pump Rack

>90% of heat goes outside via liquid.
# Cooling Comparison

<table>
<thead>
<tr>
<th>Item</th>
<th>Air-Cooled (outside air)</th>
<th>Air-Cooled (HVAC)</th>
<th>Liquid Cooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy cost</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Very High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Installation cost</td>
<td>High</td>
<td>Medium</td>
<td>Medium/Low</td>
</tr>
<tr>
<td>Site visits</td>
<td>Frequent</td>
<td>Infrequent</td>
<td>Infrequent</td>
</tr>
<tr>
<td>Humidity control</td>
<td>None</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Dust &amp; dirt</td>
<td>Filter dependent</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Reliability</td>
<td>Medium</td>
<td>Medium</td>
<td>Good/Excellent *</td>
</tr>
<tr>
<td>TCO Rank</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

* Redundant pumps and fans provide excellent reliability, on-air service capability.
The GatesAir TCO Calculator

- TCO Calculator:
  - Calculates the total cost of ownership of a transmitter system
  - Compares TCO of a new GatesAir transmitter with your existing transmitter (GatesAir or another brand)
  - Adjust cost of AC power and other factors to match your scenario
  - Calculate total savings over time
  - Estimate break-even period
TCO – New vs. Previous Gen Tx

- Input New Tx Data (Maxiva ULXT)
  - Tx Model
  - Tx Max power level
  - Required power level
  - New Tx cost
  - Installation cost
  - Commissioning cost
  - Training cost
  - Electrical cost (look up table, or manual entry)
  - Currency/ex rate (manual entry)

- Based on some preset criteria, TCO is calculated
TCO – New vs. Previous Gen Tx

- Input Existing Tx Data (Maxiva ULX)
  - Tx Model
  - Tx Max power level
  - Required power level
  - Costs can be left as zero for existing tx
  - Electrical cost copied from new tx data
  - Currency/ex rate (manual entry)

- Based on some preset criteria, TCO is calculated
TCO – New vs. Previous Gen Tx

- Graphical representation
- GatesAir ULXT and ULX transmitters
- New TX Blue
- Old Tx Red
- Loss/savings Green
- Breakeven period ~ 8.4 years
TCO – New vs. Older Gen Brand x Tx

- Input older generation Tx data
  - Tx Model
  - Tx Max power level
  - Required power level
  - Costs can be left as zero for existing tx
  - Electrical cost copied from new tx data
  - Currency/ex rate (manual entry)

- Based on some preset criteria, TCO is calculated
TCO – New vs. Older Gen Tx

- Graphical representation
- GatesAir ULXT and other brand early gen transmitters
- New TX Blue
- Old Tx Red
- Loss/savings Green
- Breakeven period only **4.6 years**
In addition to the savings and payback analysis, there are additional potential savings with a new tx:

- Room Space savings due to higher power density
- Higher MTBF (less down time, less unexpected site visits)
- Lower maintenance - longer time between routine site visits
- Intuitive design – easier set up – less training required
- Availability of spare parts in the future versus discontinued model(s)
- Commonality of spares across platforms
Maxiva Advantages versus Competition
### Comparison between GatesAir and Main Competitor

<table>
<thead>
<tr>
<th>Item</th>
<th>Main Competitor</th>
<th>Maxiva ULXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of rack (mm)</td>
<td>2000 x 600 x 1100</td>
<td>1809 x 598 x 1150</td>
</tr>
<tr>
<td>Volume of Rack (m³)</td>
<td>1.32</td>
<td>1.24</td>
</tr>
<tr>
<td>Power density - Max power per rack</td>
<td>13.5kW</td>
<td>10.8kW</td>
</tr>
<tr>
<td>Broadband</td>
<td>No (Several bands, not easy to retune)</td>
<td>Yes (single band 470-750MHz)</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Up to 38% (claimed COFDM)</td>
<td>Up to ~ 36% (COFDM)</td>
</tr>
<tr>
<td>Weight of PA module</td>
<td>28kg</td>
<td>11kg</td>
</tr>
<tr>
<td>One man PA change ?</td>
<td>No – 2 people for safety</td>
<td>Yes</td>
</tr>
<tr>
<td>Weight of PA power supply</td>
<td>28kg (it’s built into PA module…)</td>
<td>&lt; 2kg (separate unit)</td>
</tr>
<tr>
<td>Time to replace PA module</td>
<td>&lt; 1 Minute (Hot Swap), but 2 people!</td>
<td>&lt; 30 seconds (hot swap), 1 person</td>
</tr>
</tbody>
</table>
## Comparison between GatesAir and Main Competitor

<table>
<thead>
<tr>
<th>Item</th>
<th>Main Competitor</th>
<th>Maxiva ULXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to replace PA power supply</td>
<td>Hours (it’s built into PA module)</td>
<td>&lt; 20 seconds (hot swap), 1 person</td>
</tr>
<tr>
<td>Power with 1 PA removed (5kW tx)</td>
<td>64% of max. (5 PA's)</td>
<td>81% of max (10 PA's)</td>
</tr>
<tr>
<td>Max number of tx per rack</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Stand alone exciter</td>
<td>No, blade architecture</td>
<td>Yes, easy to access</td>
</tr>
<tr>
<td>Exciter UPS option</td>
<td>No</td>
<td>Yes, 1 minute full back up, 20 mins frequency processing unit</td>
</tr>
<tr>
<td>Redundant layered control system</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Optional GUI Display Panel</td>
<td>Yes</td>
<td>Yes, detachable Wifi connected</td>
</tr>
<tr>
<td>Cost to replace a power supply</td>
<td>More</td>
<td>Much Less</td>
</tr>
</tbody>
</table>
Thank you for attending

Martyn Horspool  
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www.gatesair.com