New Technology DVB-T2 Products from GatesAir

March 19, 2015

Featuring GatesAir's

Martyn Horspool
Product Manager,
TV Transmission

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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

GATESAIR™

1922
GATES
First Commercial Radio Station

1929

First TV Broadcast

1957
HARRIS INTERTYPE CORPORATION GATES A DIVISION OF HARRIS-INTERTYPE
Harris Acquires Gates Radio

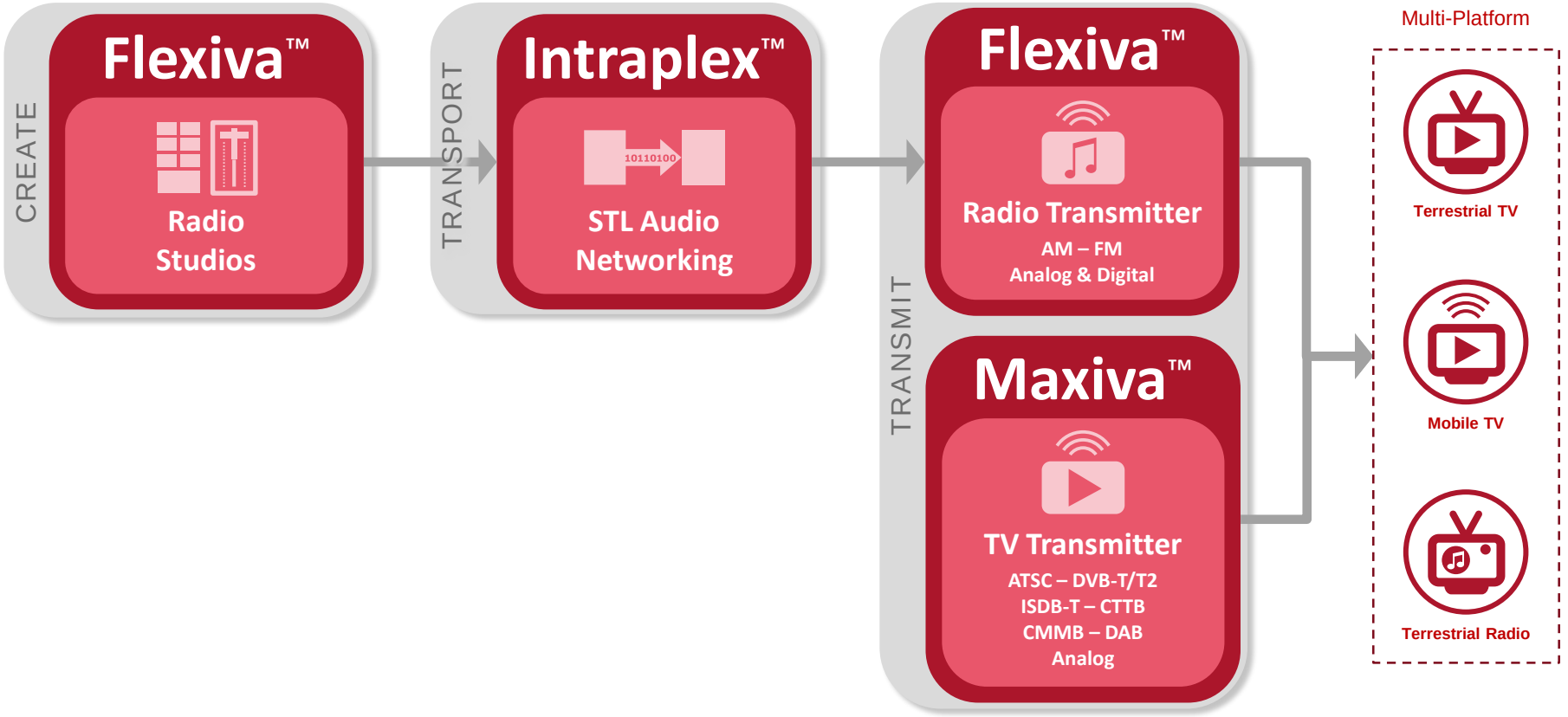
1996
HD
First Digital TV Broadcast

2008

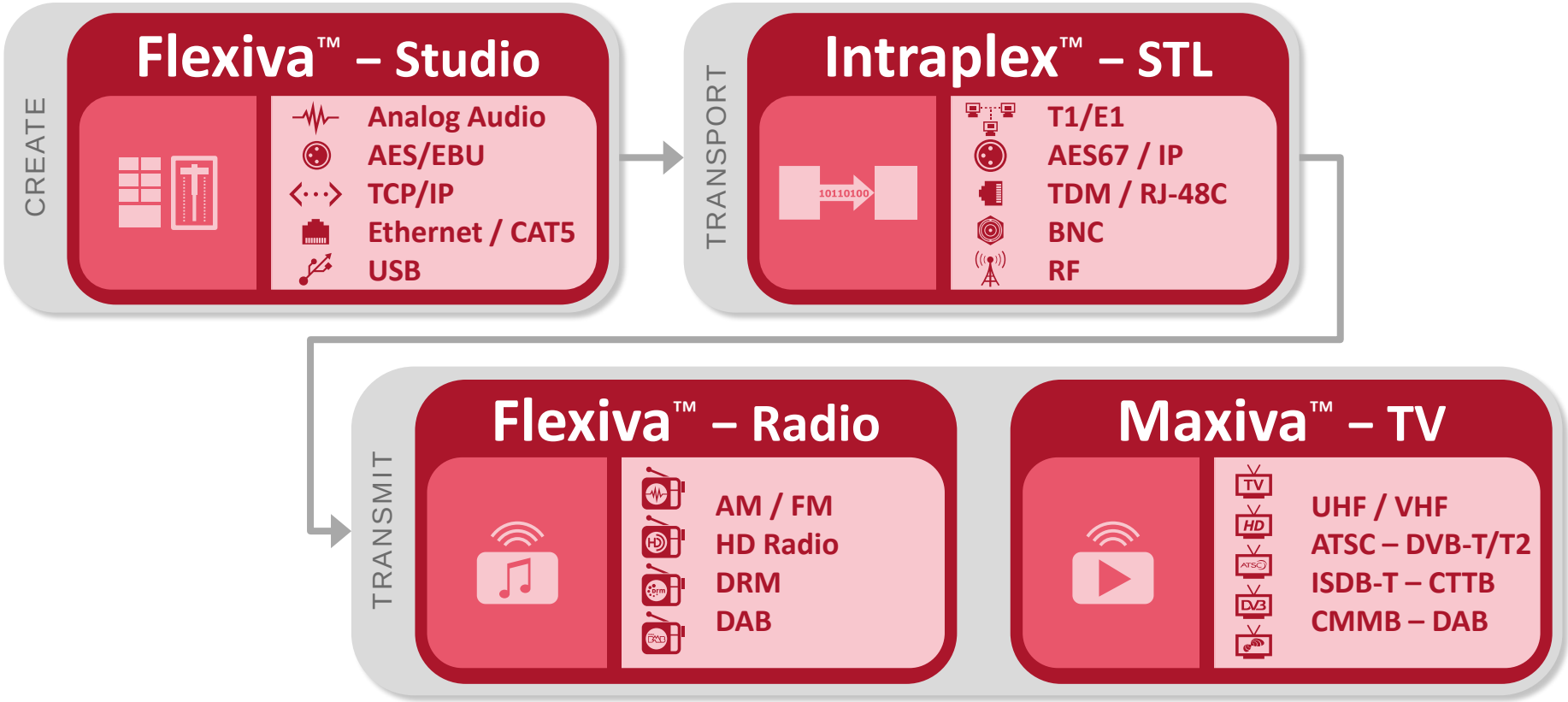
Mobile TV

What's Next
UltraHD, LTE Broadcast

End-to-End Terrestrial Transmission Solutions



GatesAir Products Support All Standards



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

	Low Power Air Cooled (5W → 2kW)	High Power Liquid Cooled (→ 10kW)	Very High Power Liquid Cooled (→ 40kW+)
UHF Band IV/V	 Maxiva™ UAXT UAXT Ultra Compact	 Maxiva™ ULX & ULXT	 Maxiva™ ULXT (Multi-rack)
VHF Band III	 Maxiva™ VAX-3D	 Maxiva™ VLX	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

Maxiva ULXT

- Less weight
- Smaller
- More efficient

Actively Defining the Future of Broadcasting

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

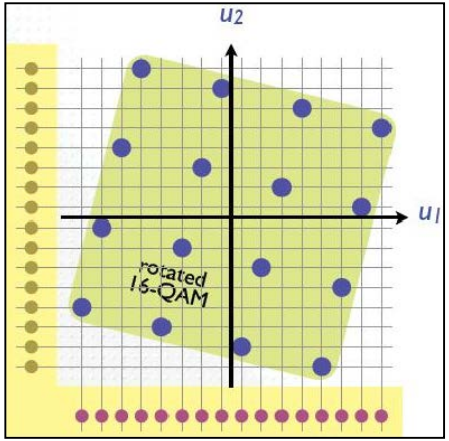
- DVB-T2 works with both fixed and portable receivers
- Large capacity increase over DVB-T, with similar planning constraints and conditions as DVB-T
- Improved Single Frequency Network (SFN) performance compared to DVB-T
- Includes a mechanism for service-specific robustness (i.e. provide different 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

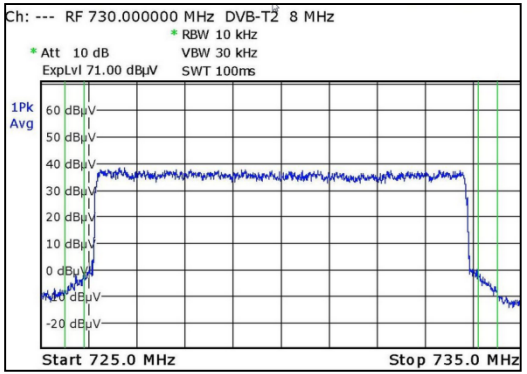
How Does DVB-T2 Work?

- 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

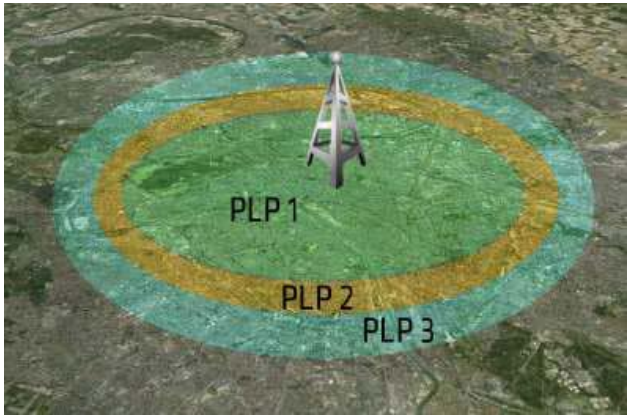




Multiple Physical Layer Pipes

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

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

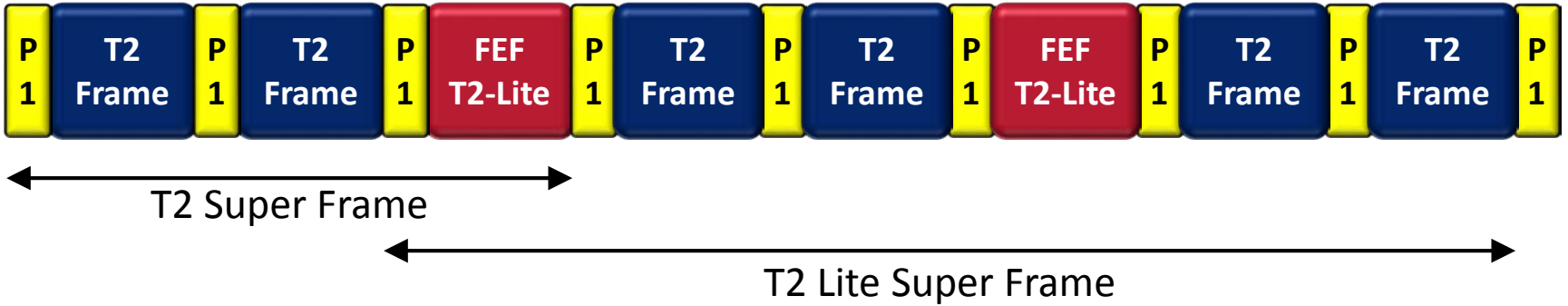
DVB-T2 Lite

- 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

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

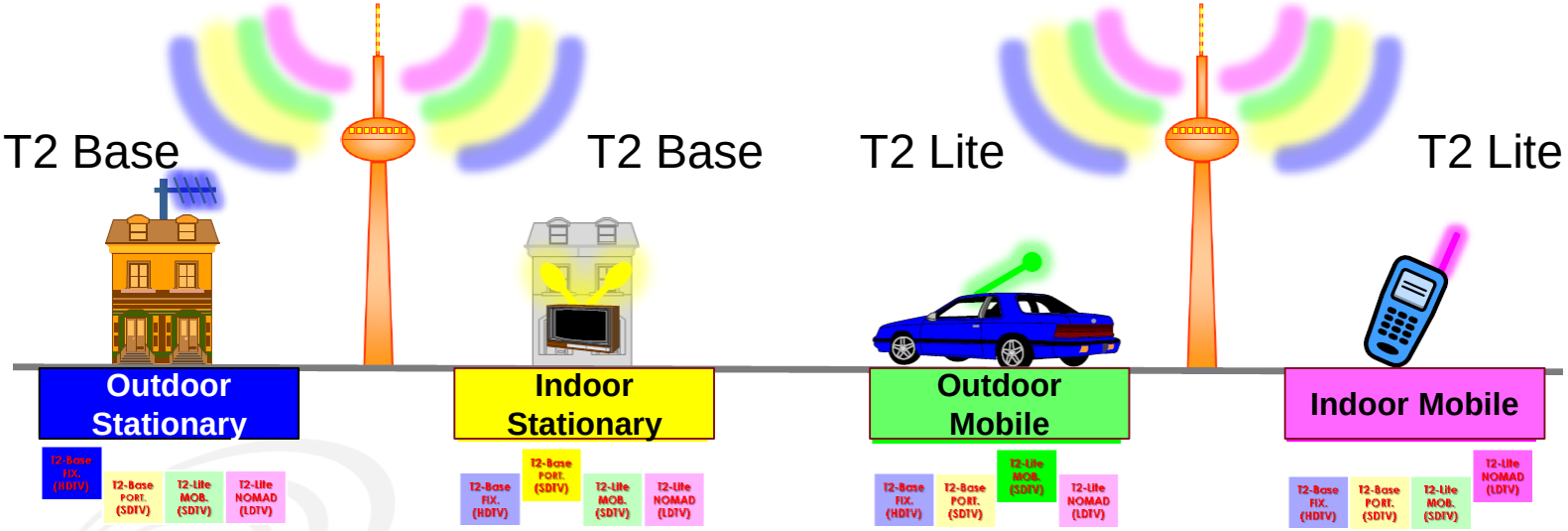
DVB-T2 Lite

- 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.



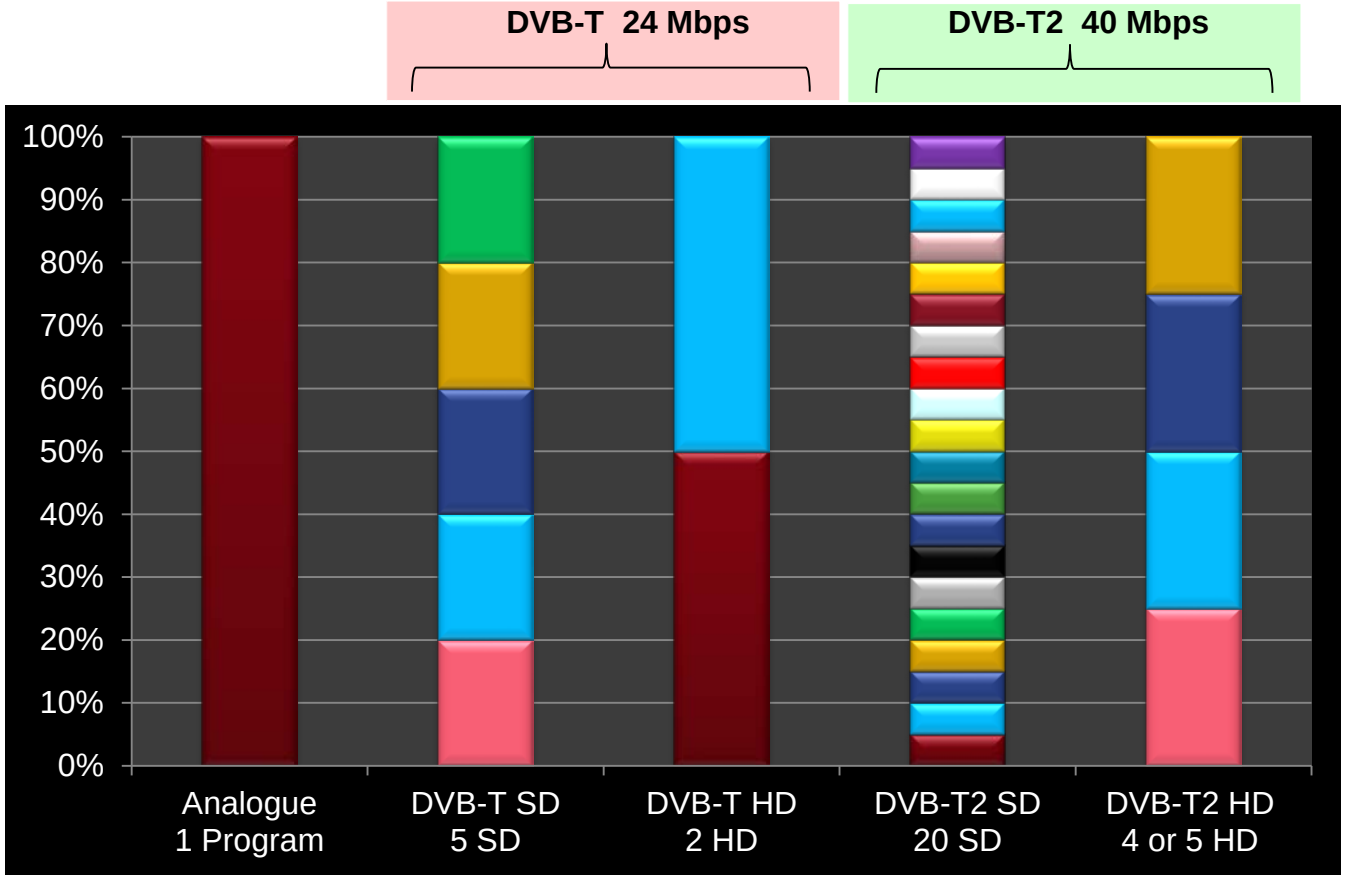
DVB-T2 Lite Summary

- 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



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/

  2. Frequency and Network Planning Aspects of DVB-T2 (Copy on Thumb Drive)

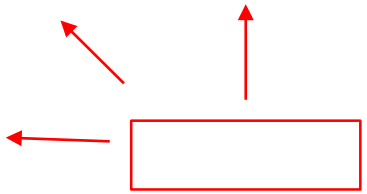
     EBU Technical Document 3348: http://tech.ebu.ch/publications

  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

GatesAir High Efficiency Transmitters

High Efficiency TV Transmitters

	Low Power Air Cooled	High Power Liquid Cooled	Very High Power Liquid Cooled
	5W → 2kW	10kW	40kW+
UHF Band IV/V	 Maxiva™ UAXT	 Maxiva™ ULXT	 Maxiva™ ULXT (Multi-rack)
VHF Band III	 Maxiva™ VAX-3D	 Maxiva™ VLX	 High Efficiency Broadband

Review of Selected Products

- Note: Refer to individual product presentations

Maxiva™ ULXT
Liquid Cooled

Maxiva™ UAXT
Air Cooled

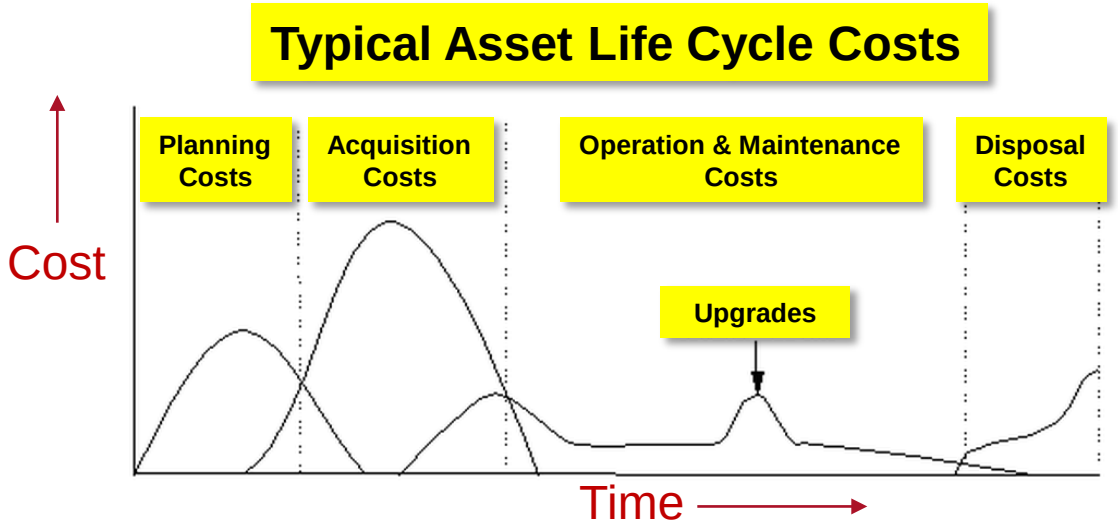
Maxiva™ UAXT Ultra
Compact
Air Cooled

TCO – Total Cost of Ownership

Definition of TCO

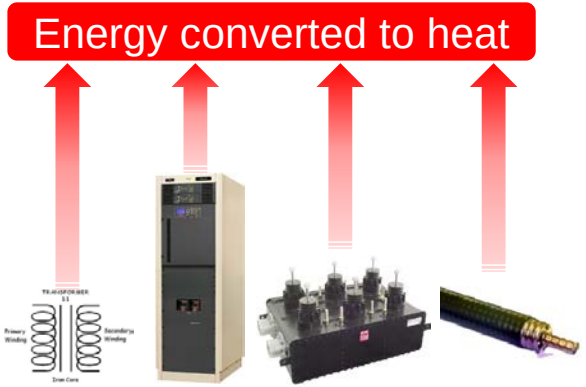
- **Total Cost of Ownership - General Definition**

  Total **C**ost of **O**wnership 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



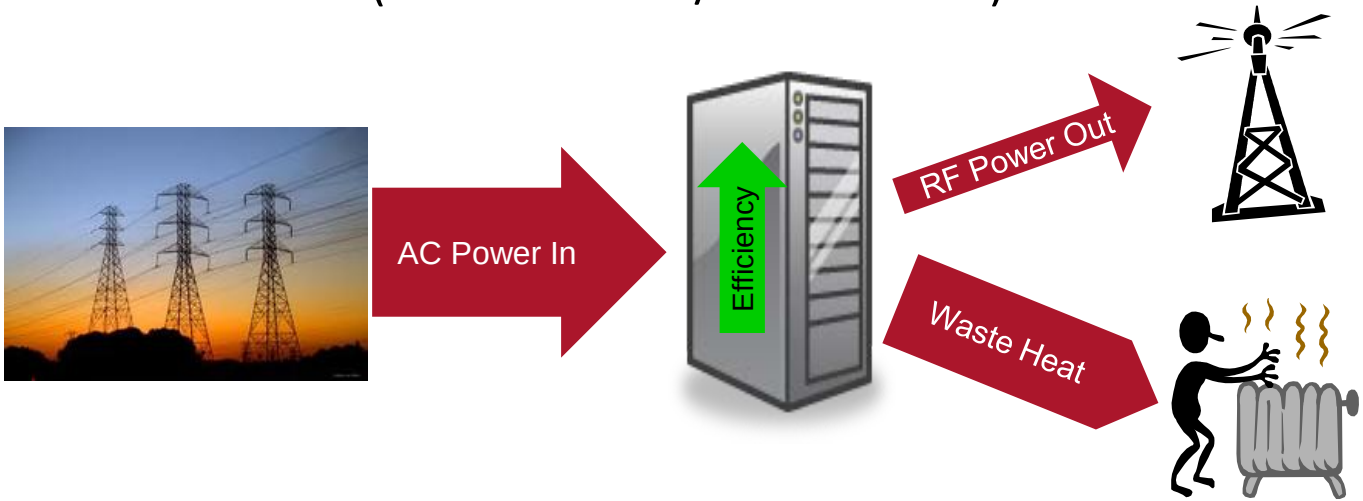
TCO versus Efficiency

- **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

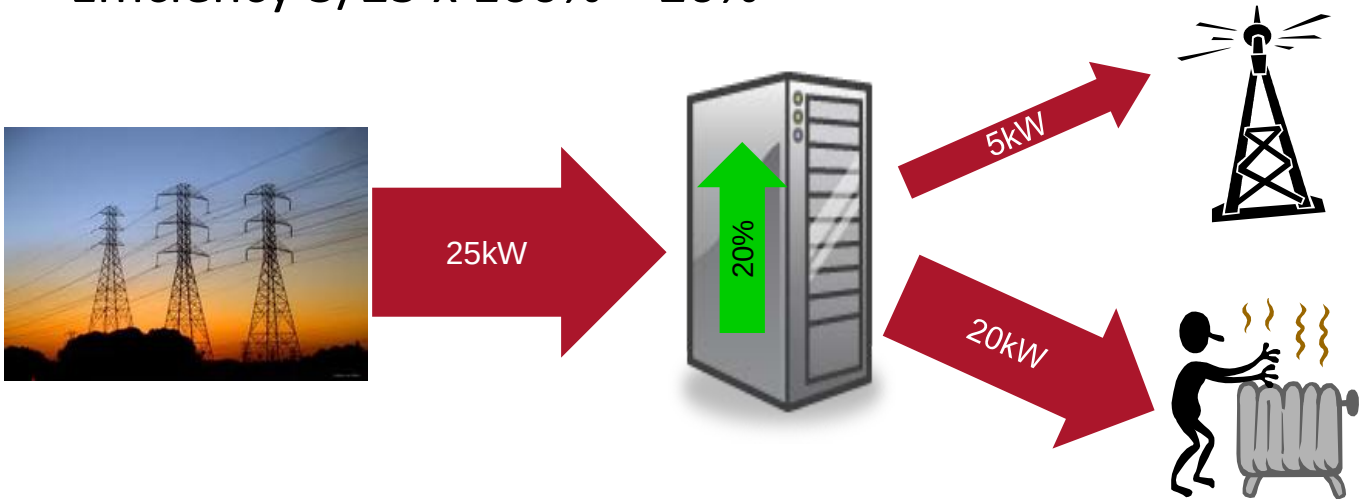
- **Efficiency of a transmitter:**
  - Definition: (RF Power Out / AC Power In) x 100%



Increased efficiency: reduces power consumed and reduces energy wasted

Typical Class AB Tx Efficiency

- Example: 5kW Standard Class AB DVB-T2 transmitter
- Efficiency 5/25 x 100% = 20%

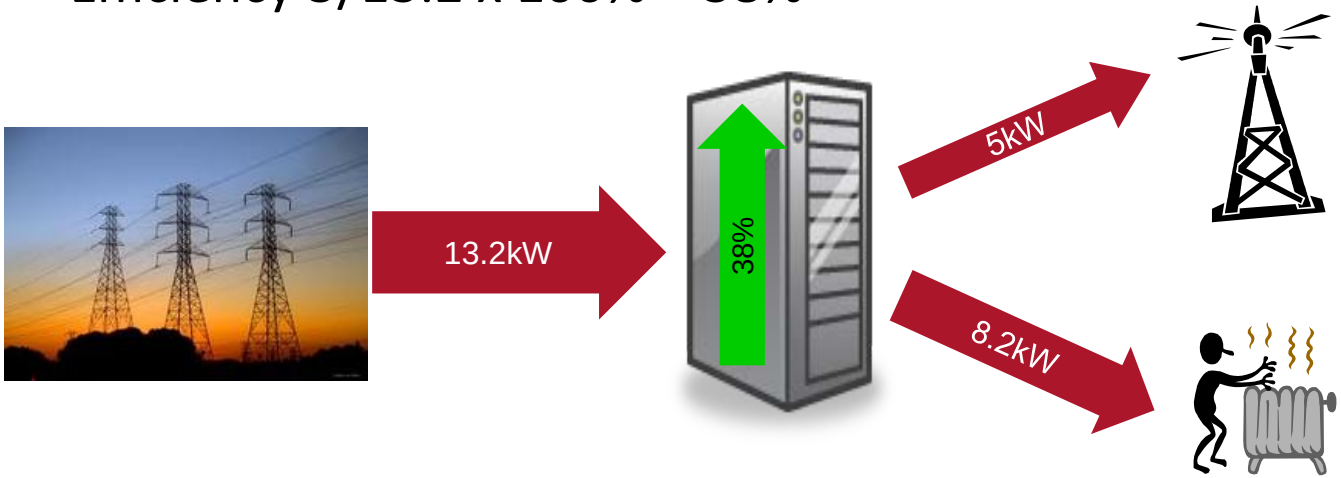


Input power 25kW

Waste heat 20kW

Typical High Efficiency Tx

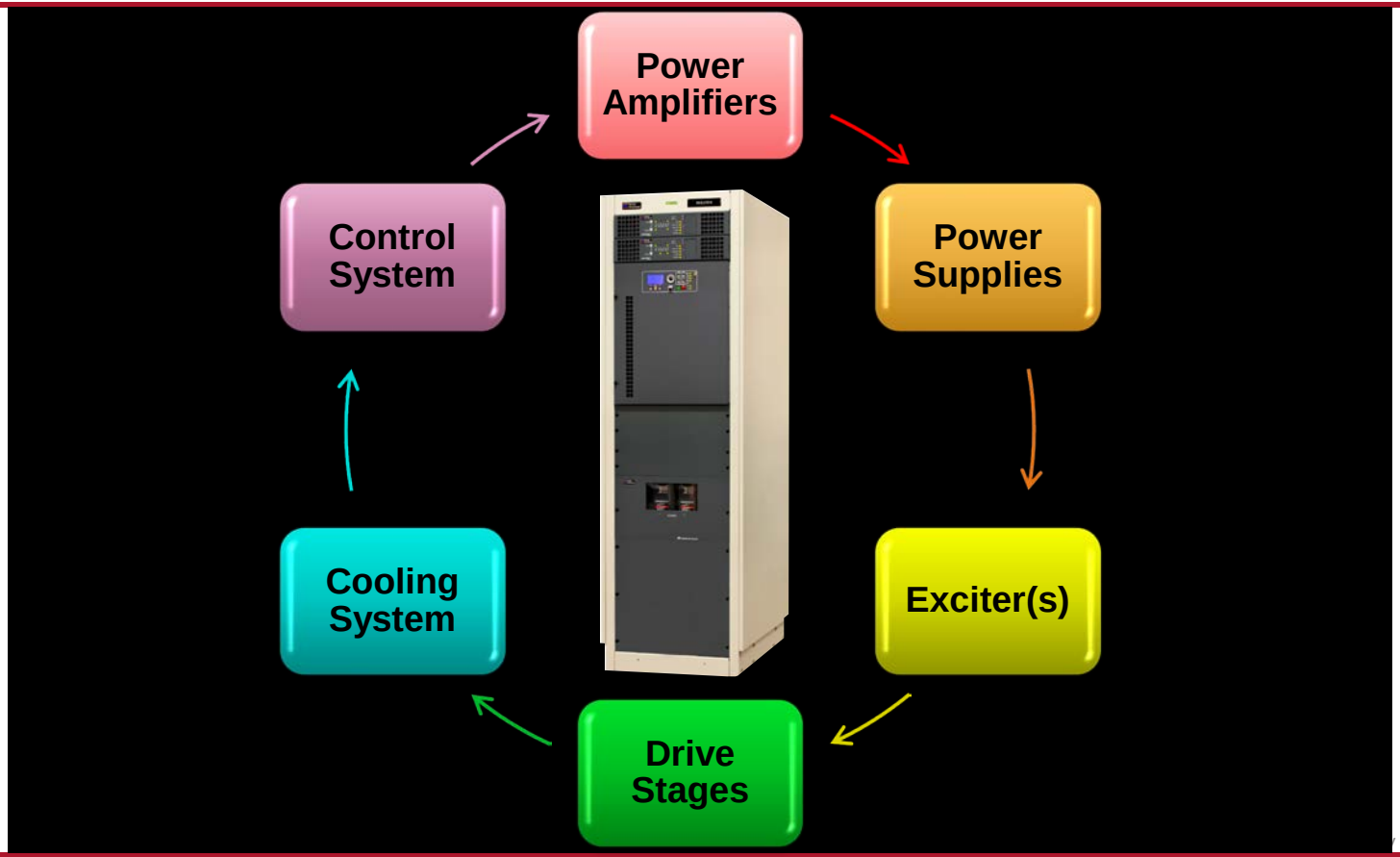
- Example: 5kW Doherty DVB-T2 transmitter
- Efficiency 5/13.2 x 100% = 38%



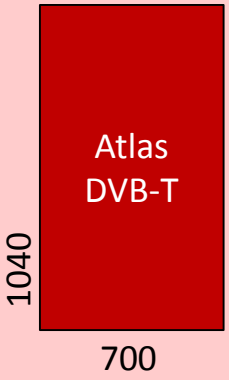
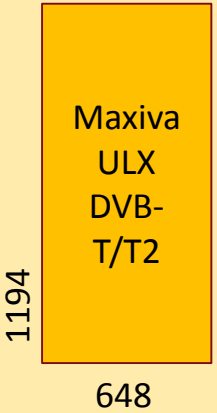
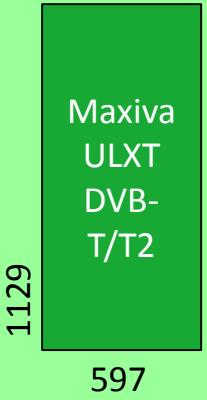
Input power reduced: (25-13.2)/25 = **47.2%**

Waste heat reduced: (20-8.2)/20 = **59%**

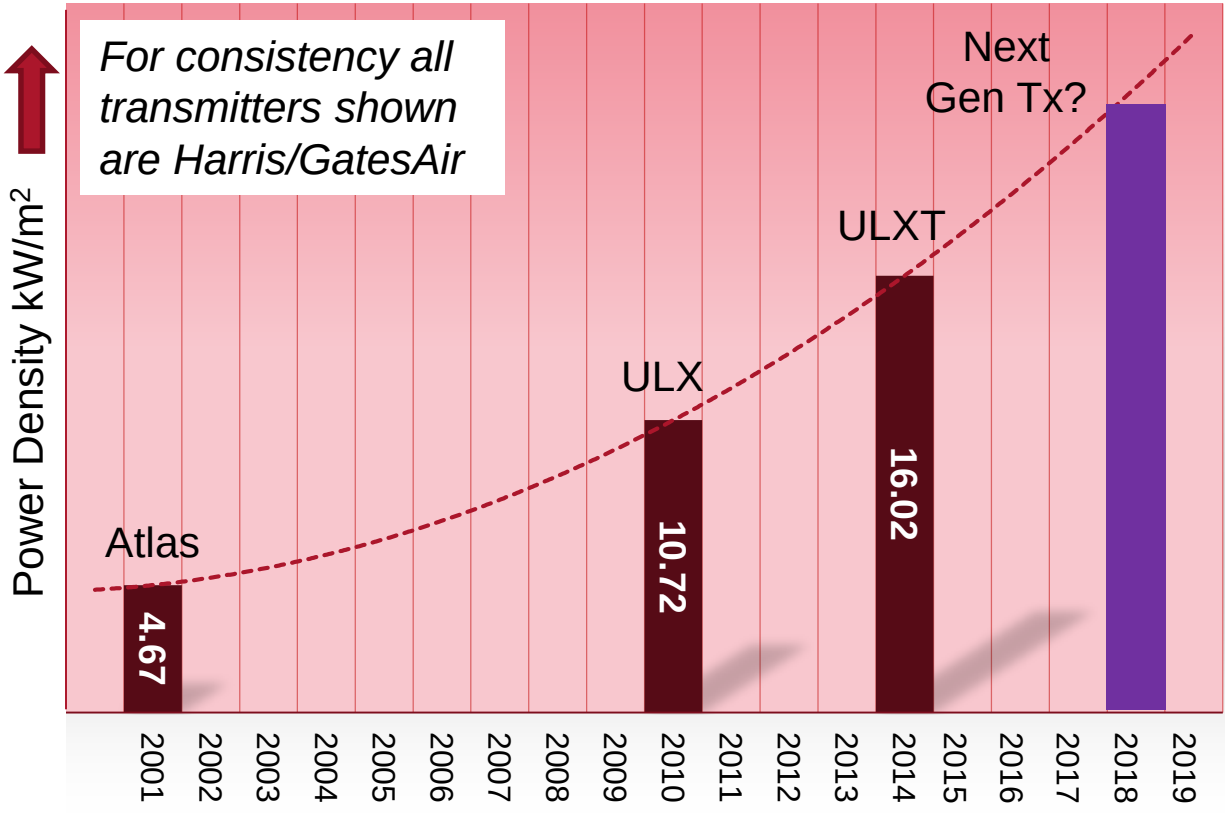
Transmitter Efficiency Includes…



Space Efficiency Improvements

	2001	2010	2014
			
Square Area	0.728 m^2	0.774 m^2	0.674 m^2
Max Power	3.4kW	8.3kW	10.8kW
Power Density	4.67kW/m^2	10.72kW/m^2	16.02kW/m^2

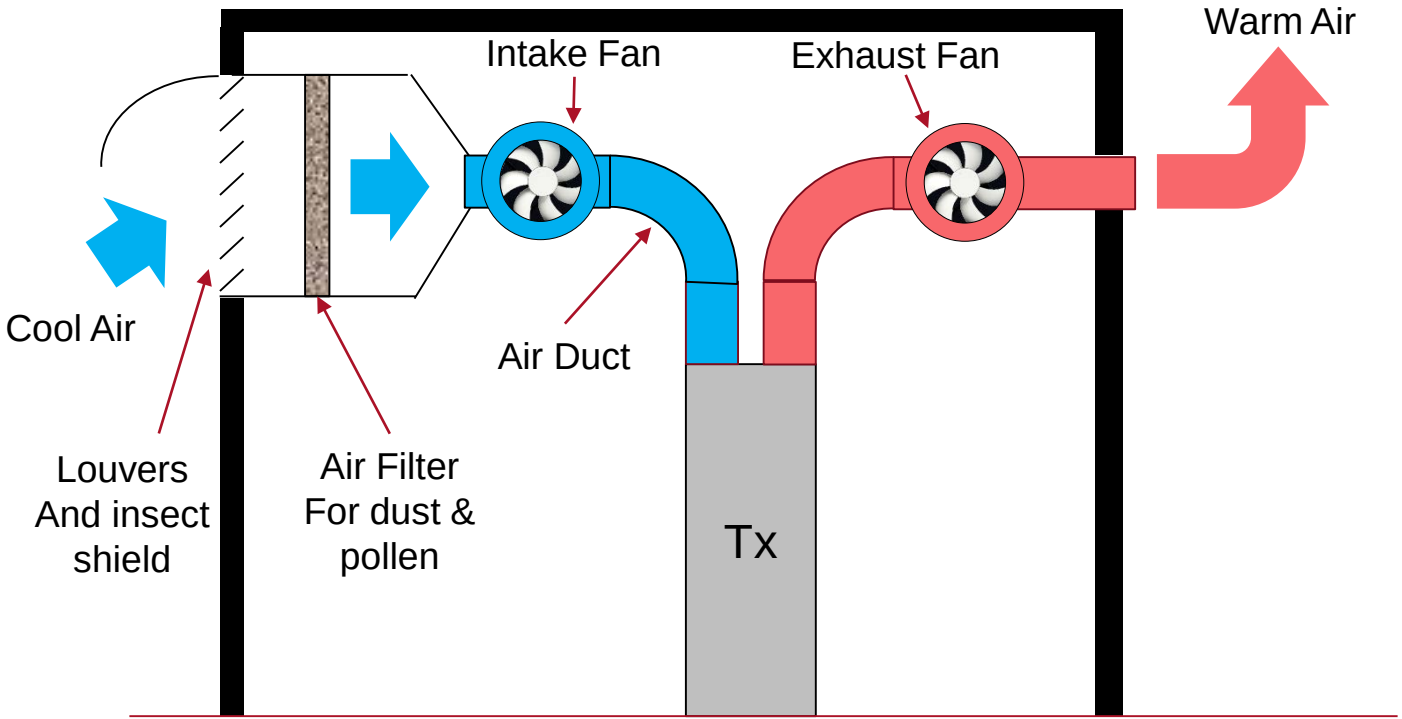
Power Density Trend



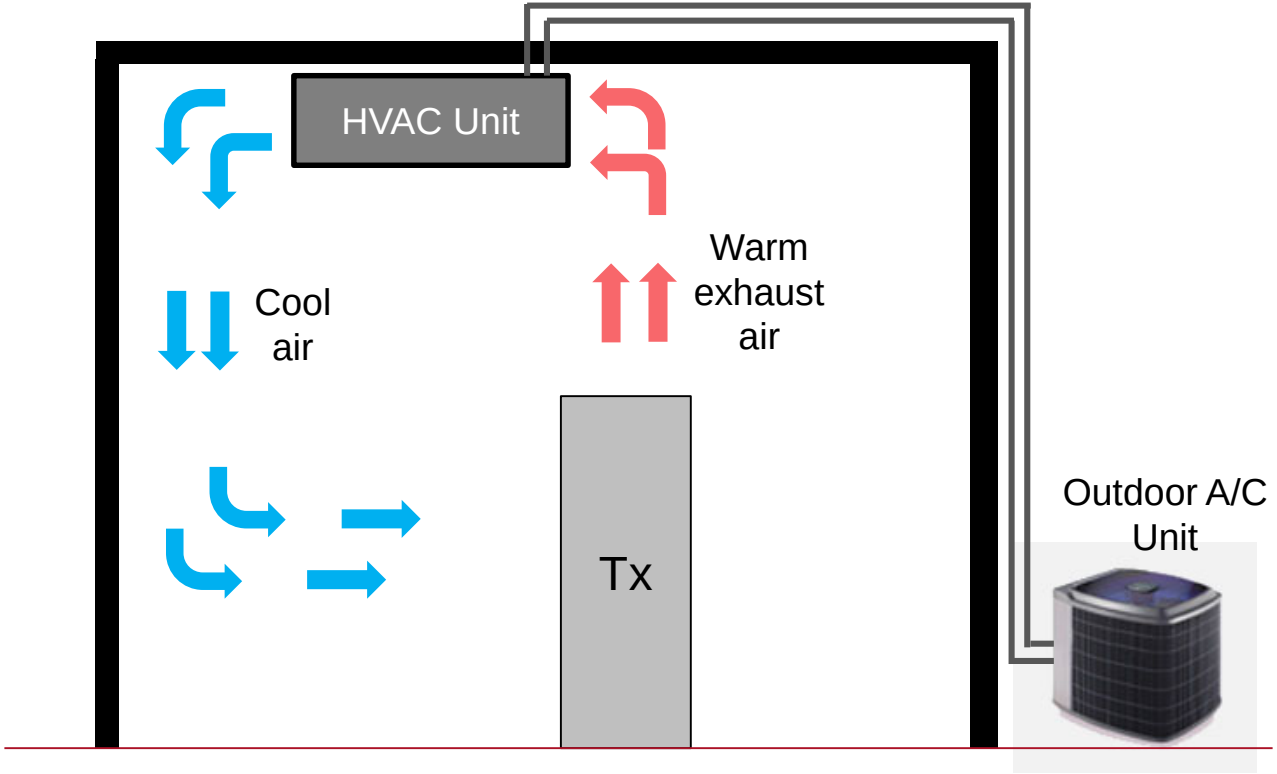
Cooling and TCO

- 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

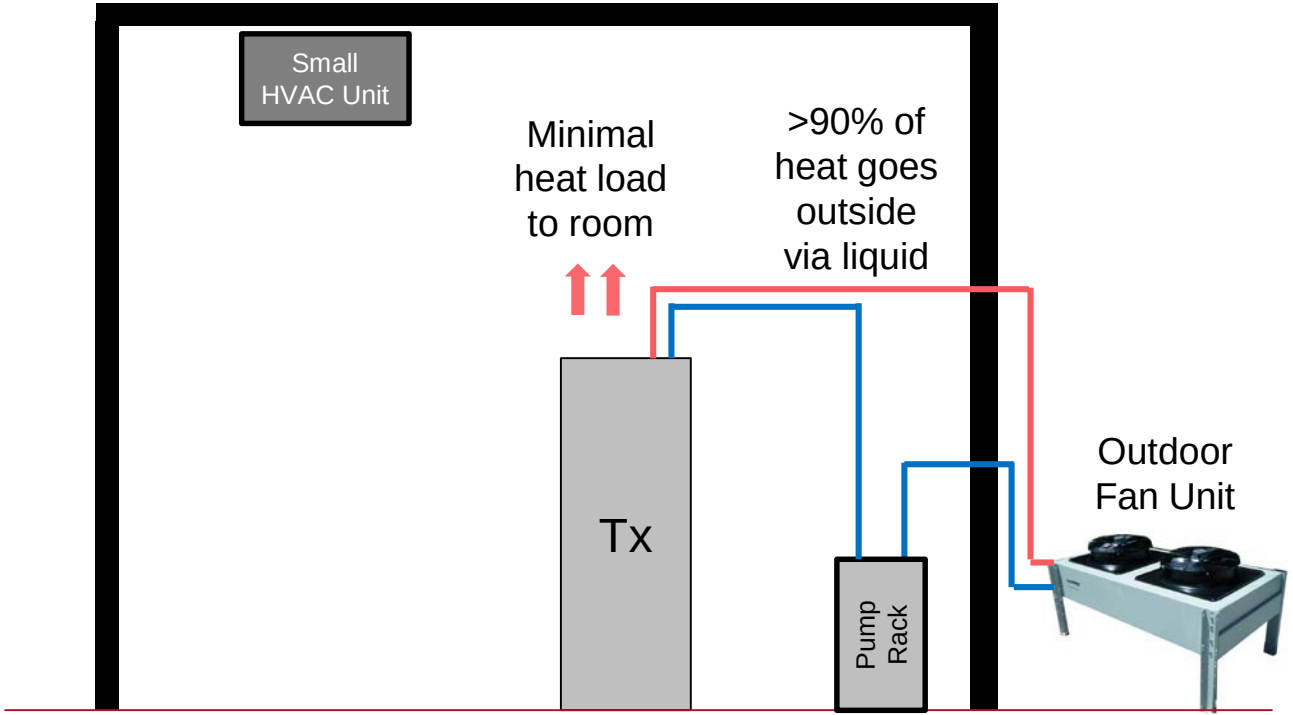
Air Cooling – Outside Air



Air Cooling – Sealed Room HVAC



Liquid Cooling



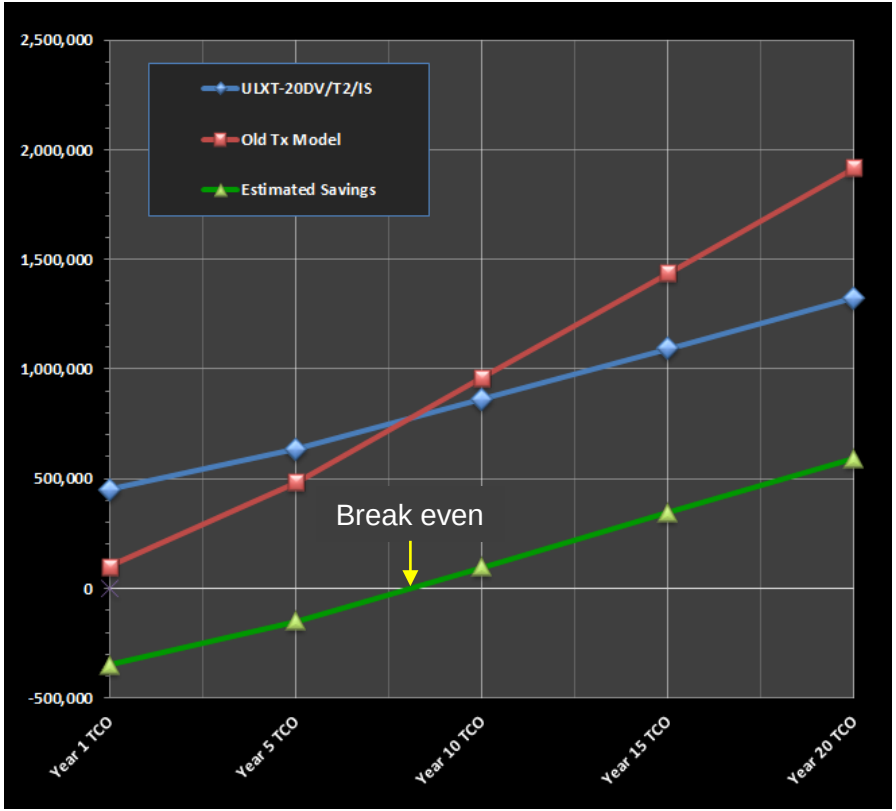
Cooling Comparison

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

* Redundant pumps and fans provide excellent reliability, on-air service capability

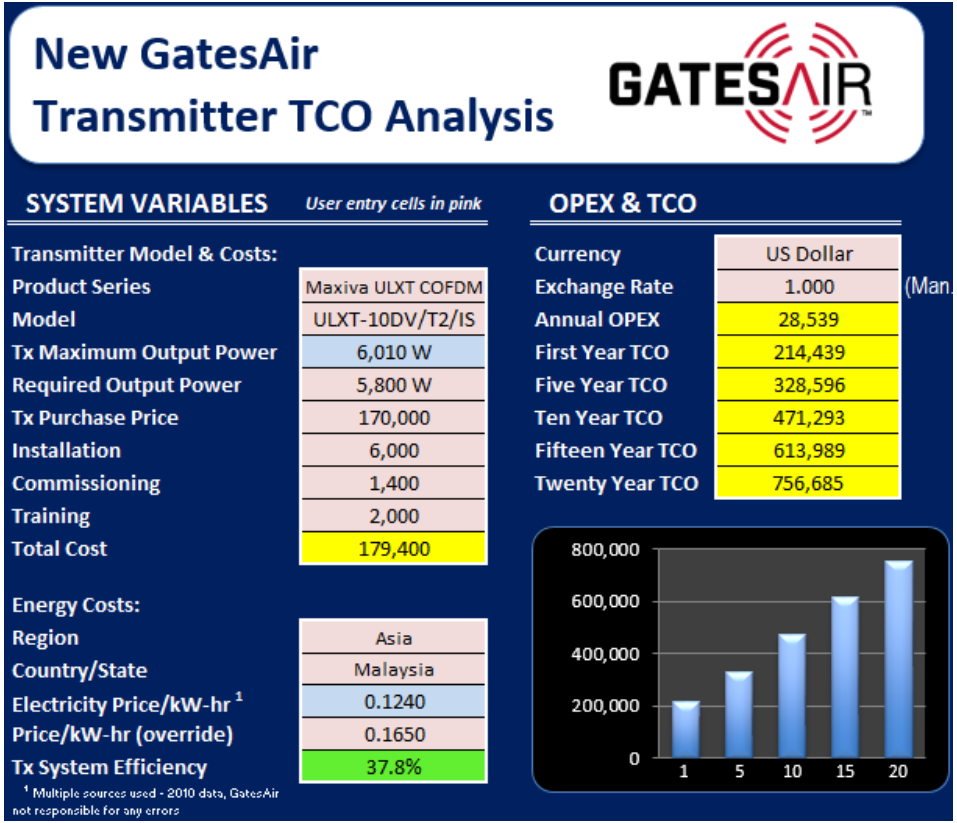
The GatesAir TCO Calculator

- 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



New GatesAir Transmitter TCO Analysis

SYSTEM VARIABLES

User entry cells in pink

Transmitter Model & Costs:	
Product Series	Maxiva ULXT COFDM
Model	ULXT-10DV/T2/IS
Tx Maximum Output Power	6,010 W
Required Output Power	5,800 W
Tx Purchase Price	170,000
Installation	6,000
Commissioning	1,400
Training	2,000
Total Cost	179,400
Energy Costs:	
Region	Asia
Country/State	Malaysia
Electricity Price/kW-hr [1]	0.1240
Price/kW-hr (override)	0.1650
Tx System Efficiency	37.8%

[1] Multiple sources used - 2010 data, GatesAir not responsible for any errors

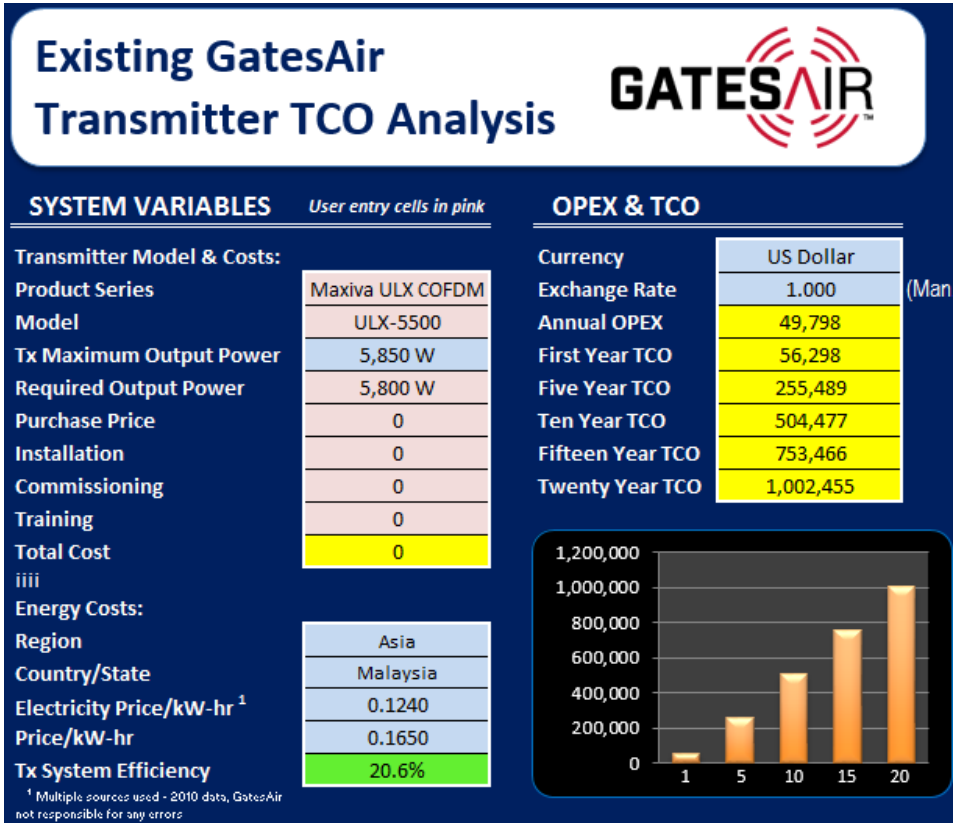
OPEX & TCO

Currency	US Dollar
Exchange Rate	1.000
Annual OPEX	28,539
First Year TCO	214,439
Five Year TCO	328,596
Ten Year TCO	471,293
Fifteen Year TCO	613,989
Twenty Year TCO	756,685

(Man

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



Existing GatesAir Transmitter TCO Analysis

SYSTEM VARIABLES

User entry cells in pink

Transmitter Model & Costs:	
Product Series	Maxiva ULX COFDM
Model	ULX-5500
Tx Maximum Output Power	5,850 W
Required Output Power	5,800 W
Purchase Price	0
Installation	0
Commissioning	0
Training	0
Total Cost	0
iiii	
Energy Costs:	
Region	Asia
Country/State	Malaysia
Electricity Price/kW-hr [1]	0.1240
Price/kW-hr	0.1650
Tx System Efficiency	20.6%

[1] Multiple sources used - 2010 data, GatesAir not responsible for any errors

OPEX & TCO

Currency	US Dollar
Exchange Rate	1.000
Annual OPEX	49,798
First Year TCO	56,298
Five Year TCO	255,489
Ten Year TCO	504,477
Fifteen Year TCO	753,466
Twenty Year TCO	1,002,455

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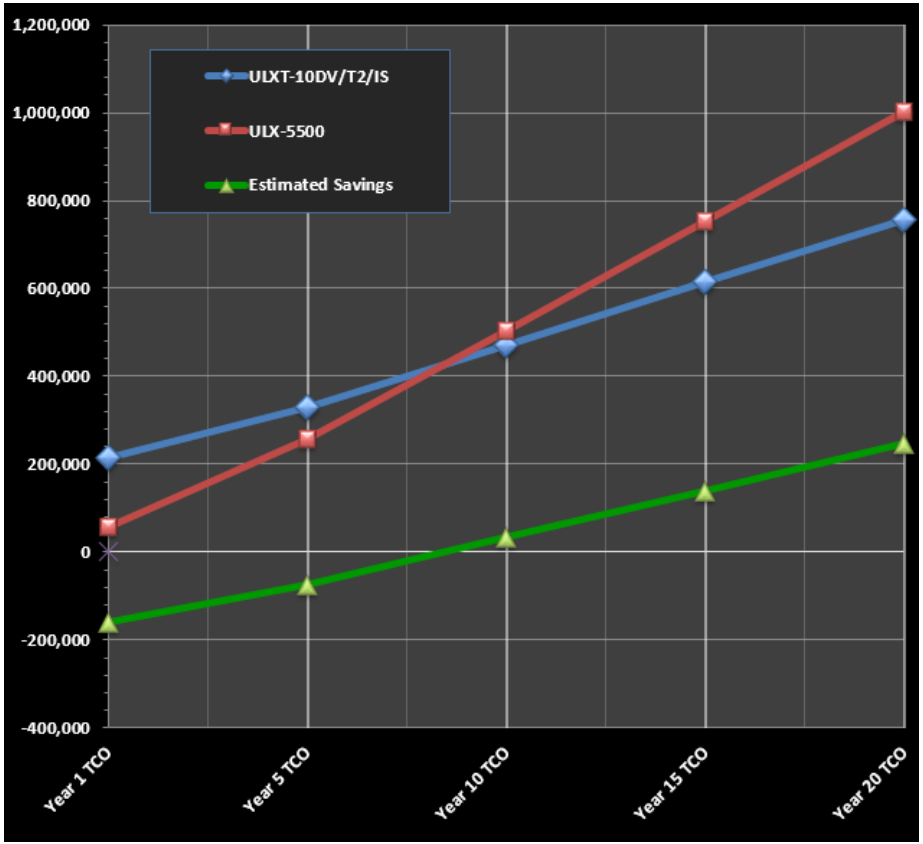
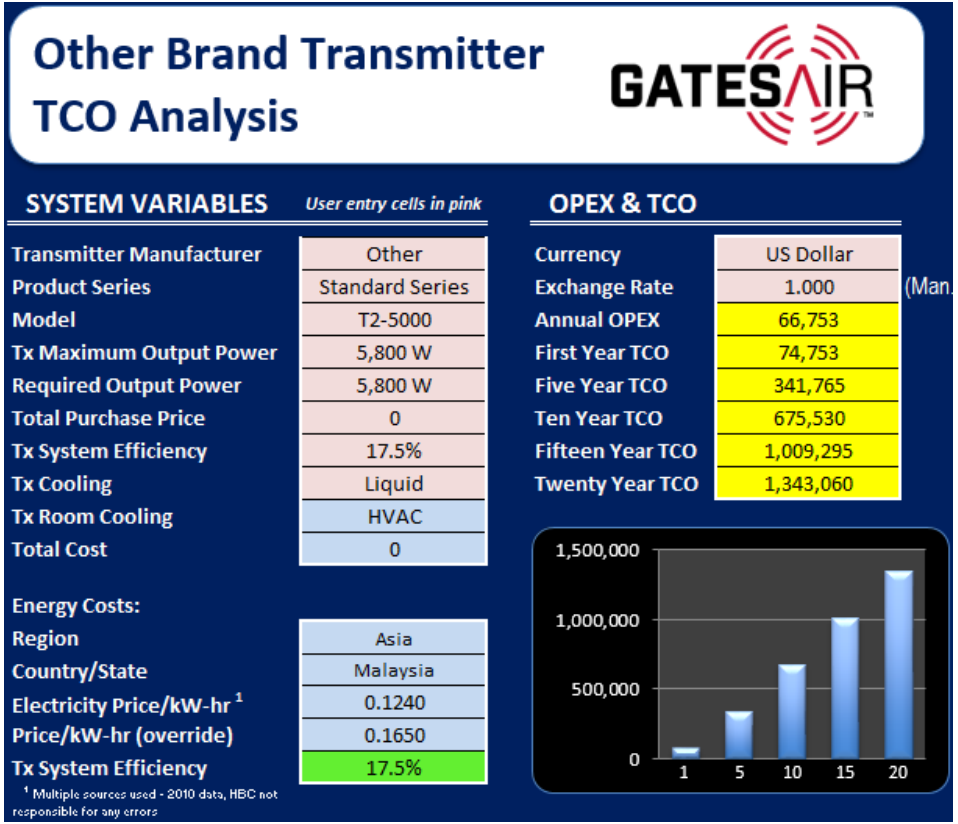
TCO – New vs. Previous Gen Tx

- Graphical representation
- GatesAir ULXT and ULX transmitters
- New TX Blue
- Old Tx Red
- Loss/savings Green
- Breakeven period ~ 8.4 years



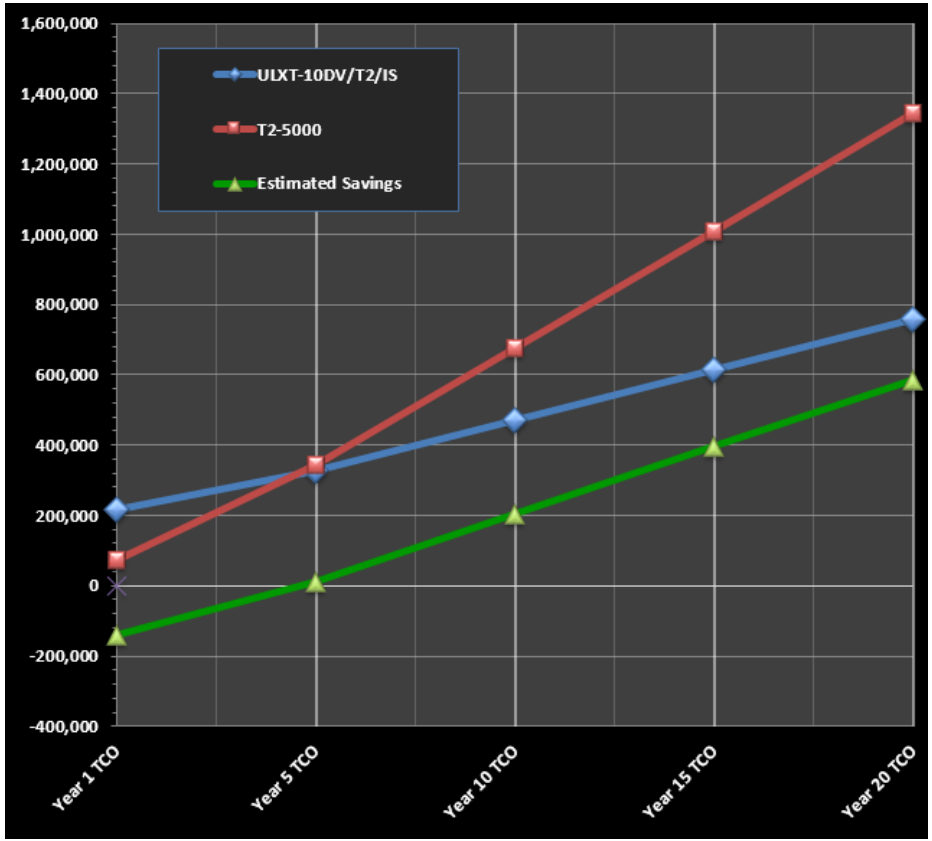
TCO – New vs. Older Gen Brand x Tx

- 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**



Other Benefits Beyond the TCO Calculation

- 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

Item	Main Competitor	Maxiva ULXT
Size of rack (mm)	2000 x 600 x 1100	1809 x 598 x 1150
Volume of Rack (m^3)	1.32	1.24
Power density - Max power per rack	13.5kW	10.8kW
Broadband	No (Several bands, not easy to retune)	Yes (single band 470-750MHz)
Efficiency	Up to 38% (claimed COFDM)	Up to ~ 36% (COFDM)
Weight of PA module	28kg	11kg
One man PA change ?	No – 2 people for safety	Yes
Weight of PA power supply	28kg (it's built into PA module…)	< 2kg (separate unit)
Time to replace PA module	< 1 Minute (Hot Swap), but 2 people!	< 30 seconds (hot swap), 1 person

Comparison between GatesAir and Main Competitor

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

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Thank you for attending

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