AMPEGON

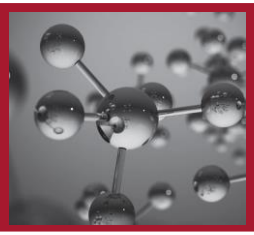
HFCC 2018 Bratislava

Product Launch:
Low Power
Solid-State Shortwave

AMPEGON

Our Mission

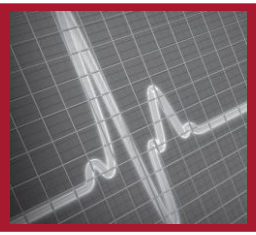
Science



Ampegon designs and delivers high power systems for world-class research facilities.

« We offer RF amplifier systems, high voltage and high current power supplies as well as short and long pulse modulators. »

MedTech



Ampegon designs and delivers high power RF systems for medical institutions.

« We offer pulsed power technologies, RF amplifiers and power supplies as well as our extensive system experience. »

Industry

Ampegon cooperates with industrial partners to implement novel and more efficient processes.

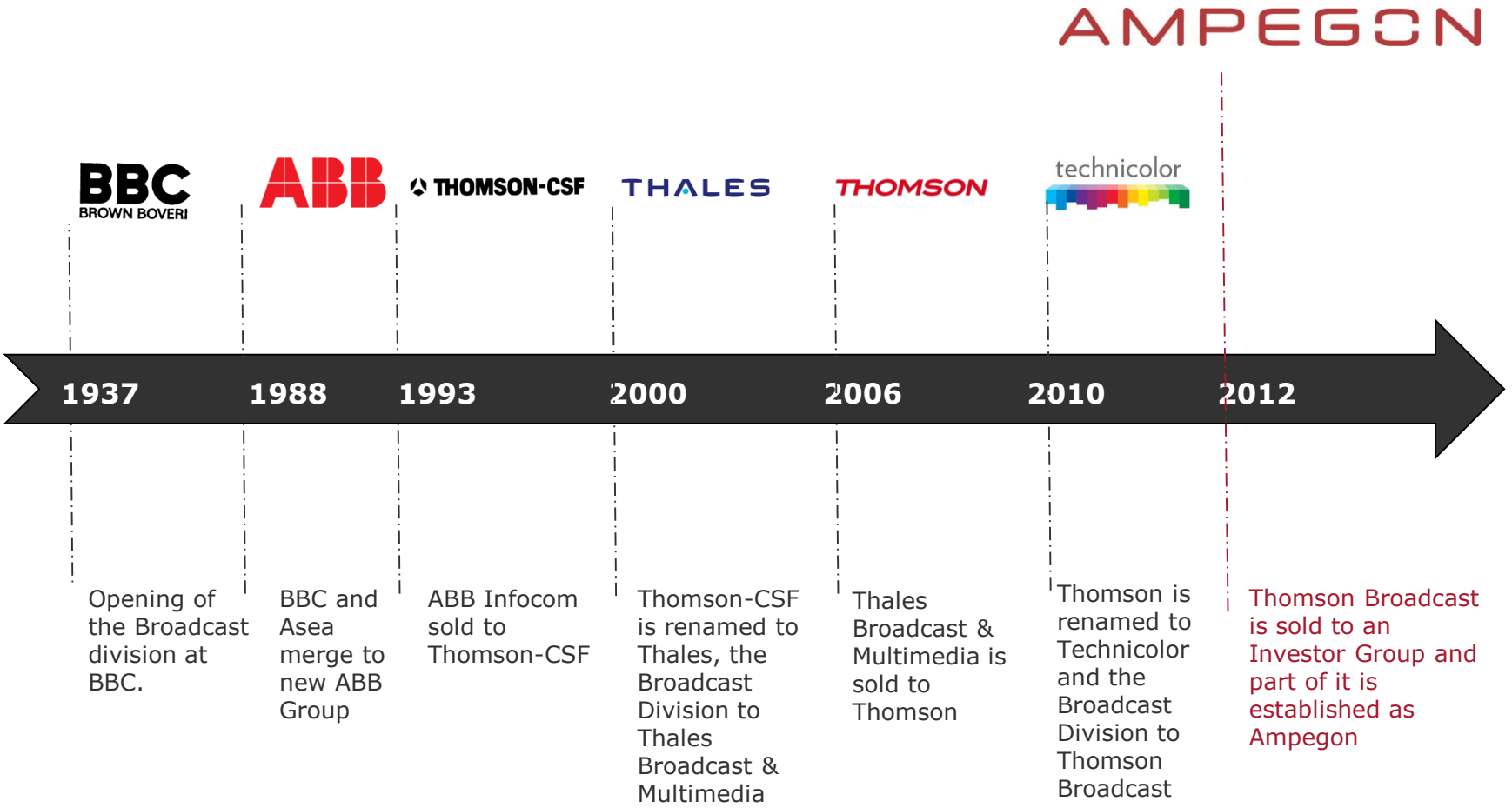
« We offer pulsed vacuum arc power supplies and a wide range of RF amplifiers and power supplies for specialized industries. »

Broadcast

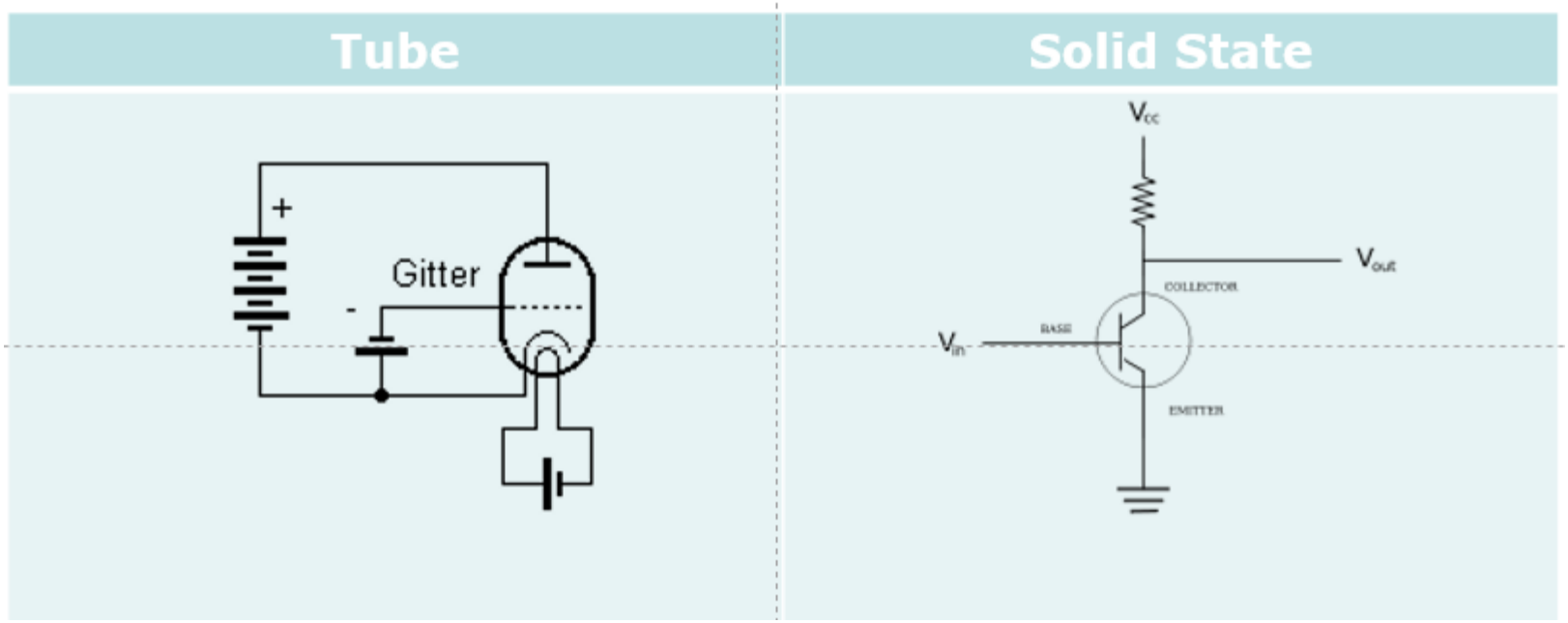
Ampegon is the leading designer, manufacturer and integrator of AM/DRM radio broadcast systems worldwide.

« We offer the complete system including transmitters, antennas, towers and masts and a wide range of auxiliary equipment including adjacent power plants. »

Heritage of Excellence



Term: Solid State



- Electrons are not flowing throug the vaccum gap. Electron gun Electron current flows only through solid semiconductor (transistor).

Shortwave Transmitter Range

1,5 kW – 25 kW solid state:

- Full Solid State class E amplifier, now heading to class A/B thanks to envelope tracking
- Up to 4 broadcast frequency bands with Class E and Wideband with class A/B
- Integrated DRM solution
- User-friendly control with touch screen UCS
- Full remote control facilities and interface
- Compact high quality and modular design
- Overall efficiency > 80%

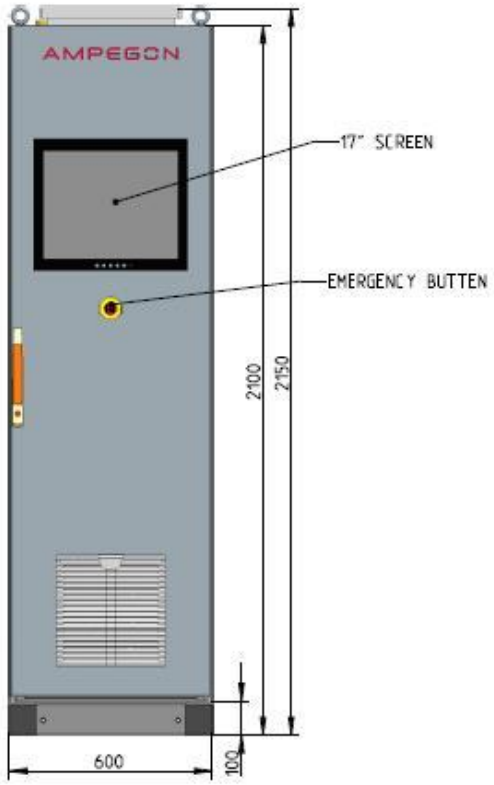
100 kW – 500 kW tube based:

- Universal Control System UCS with touch
- New Tuning System and full remote control
- Simplified Measurement Acquisition System
- Data display, logging; analysis
- DRM integration
- Exceptional overall efficiency >70%

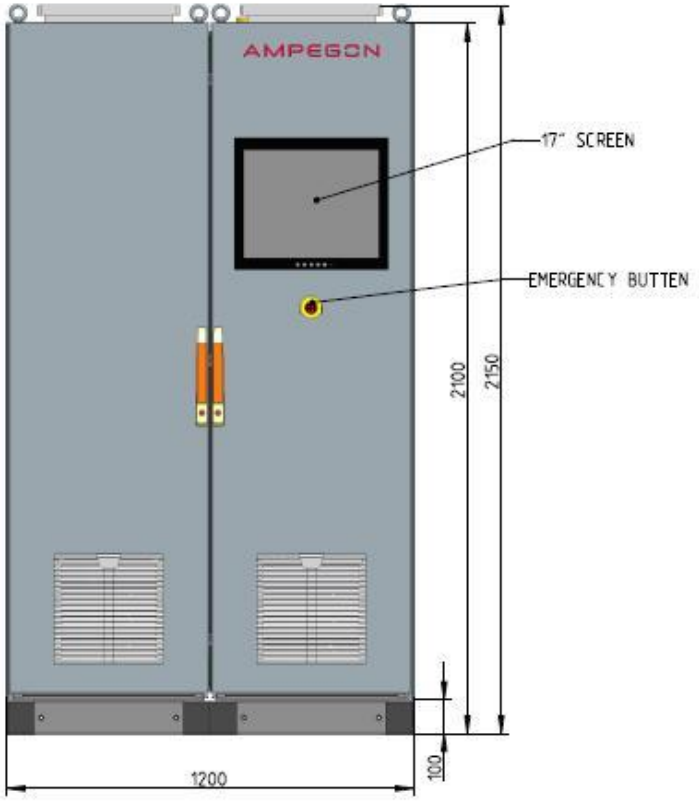
Modular power scaling

- Transmitter system is in four different power classes available
  Optional redundant setup and configuration available

- 1.5 kW - 6 kW



- 12 kW to 25 kW



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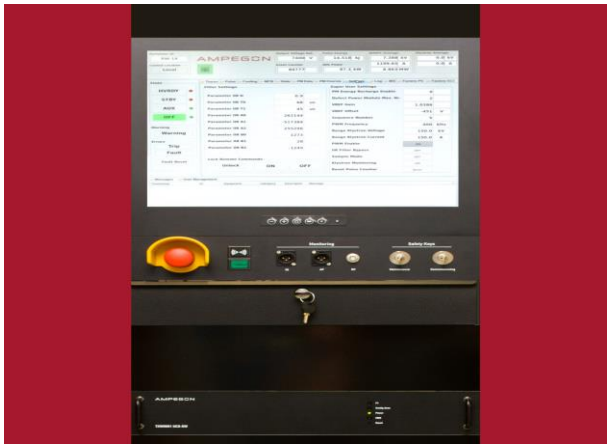
Universal/Unified Control System UCS



- Touch screen monitor
- Dedicated FPGA based control systems
  - SW, ASM, PSM
- Real time signal processing and information
- State machine controller
  - Coordination and supervision
- Provides safety for operating staff
- Equipment protection
- Ensures simplicity of transmitter operation
  - Dedicated login levels
  - Remote control interfaces

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drm

Comparison: Solid state vs. tube based

Item	Tube	SSA	Comments
Carrier Power	100 kW-500 kW	1.5 kW to 25 kW	SSA limited by RF power. Needs combiners but still limited.
Voltage	10 kV to 20kV	400 V	SSA plug & play
Coverage	> 1000 km	< 1000 km	SSA good enough for most regional and national territories
Efficiency	> 70%	> 80%	Saves consumption: less power for the same coverage
Maintenance / after sales	Tube: consumable Not redundant	Semiconductor Redundant	SSA requires very low maintenance. Tubes are expensive. Transistors within days. Tubes : 4-6 months!!!
Installation & infrastructure	4 to 5 weeks	1 week	Services are much less costly with SSA.

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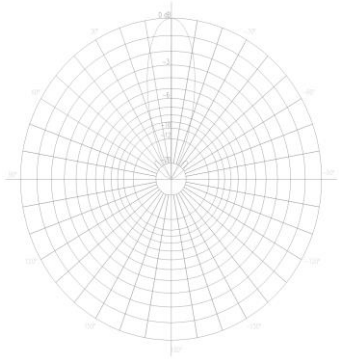
Engineering/System Optimisation

Transmitter

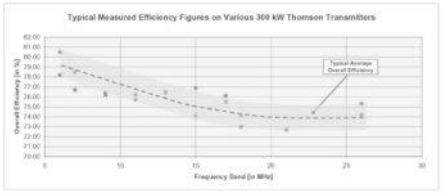
Feeder Lines

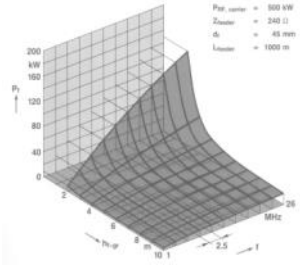
Antenna

Radiation



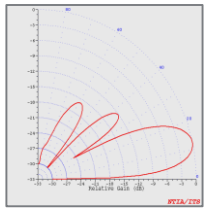
Perfect Coverage

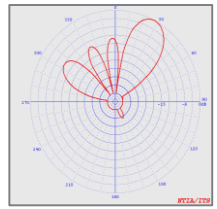




- ground losses
- ohmic losses
- Radiation losses

Reality with slewing "rotating beams"





η TX		η Feeder		η Antenna		η Radiation		η Total	
Modern TX:	75 to 80 %	Best:	95 %	Best:	98 %	Perfect Design:	99 %	Best:	~ 70 %
Older TX:	50 to 55 %	Very Often:	70 %	Very Often:	95 %	With Shielding:	70 %	Very Often:	~ 25 %

System Efficiency = $\eta_{Transmitter}$ x η_{Feeder} x $\eta_{Antenna}$ x $\eta_{Radiation}$

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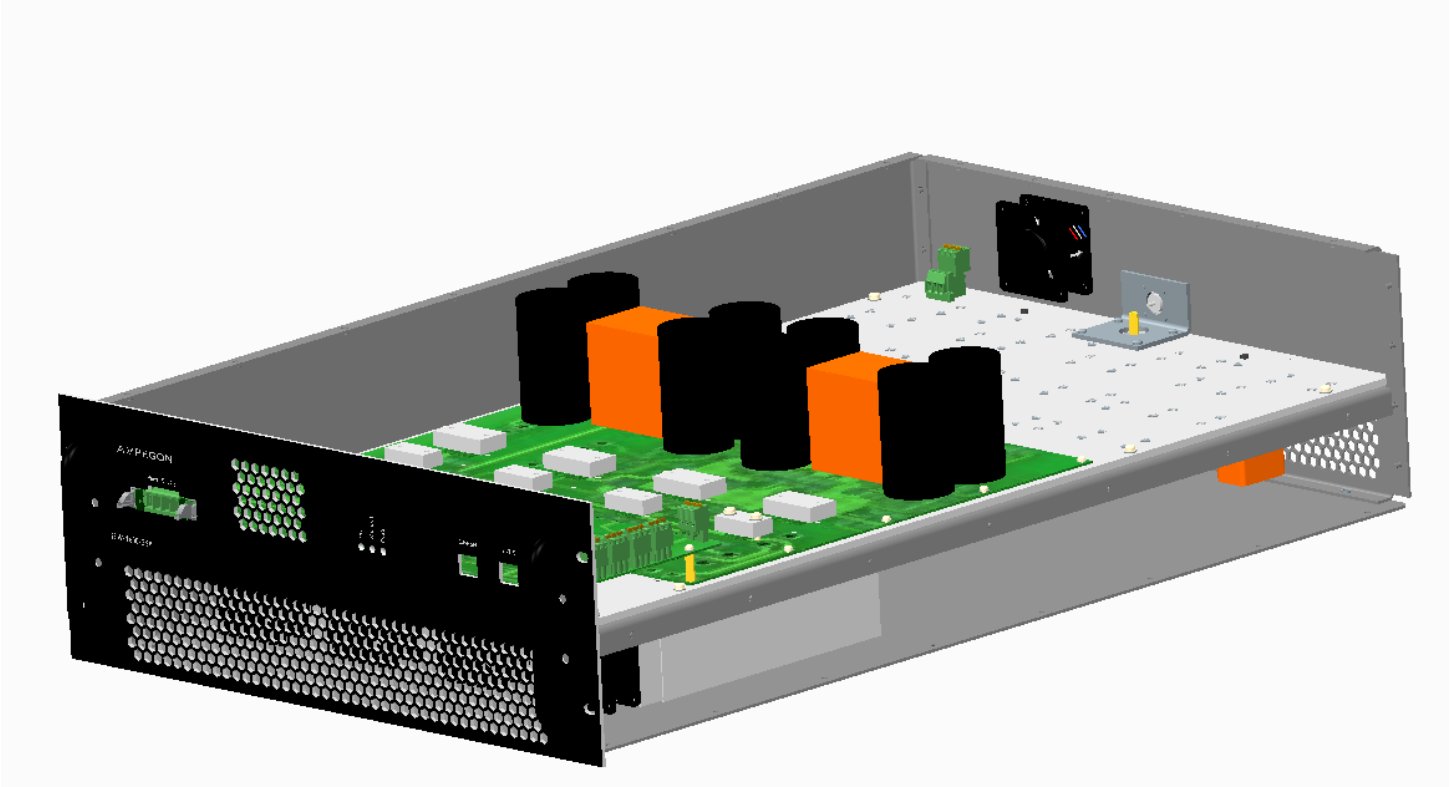
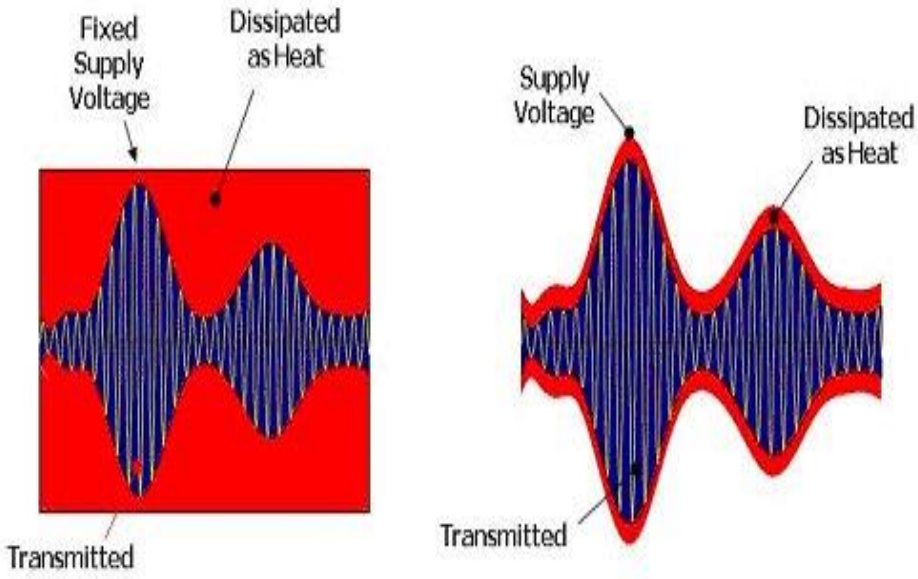
Solid state amplifiers

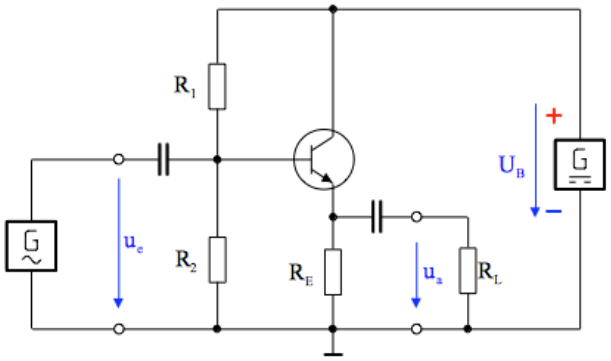


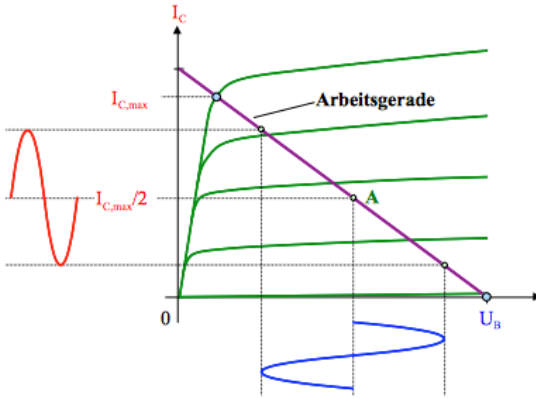
Full Solid-State Class-E, A/B Amplifier Module

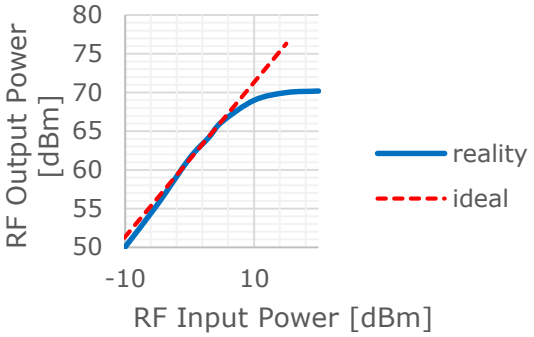


- Class-E : η >80%
  but limited to 10 MHz: 1st generation. Only 4 freq. bands
  Modern Class A/B η >70%, covers all SW range: 3 to 26 MHz. 2nd generation: Wideband
- Modern class A/B amplis efficient thanks to Enveloppe tracking
- Reliable and robust design
- Direct modulated RF and AF digitally controlled
- Fast measurement and supervision on board
- Embedded interface for control and monitoring
- Future aim is 50 kW

Linear RF Amplifier : e.g. Class A



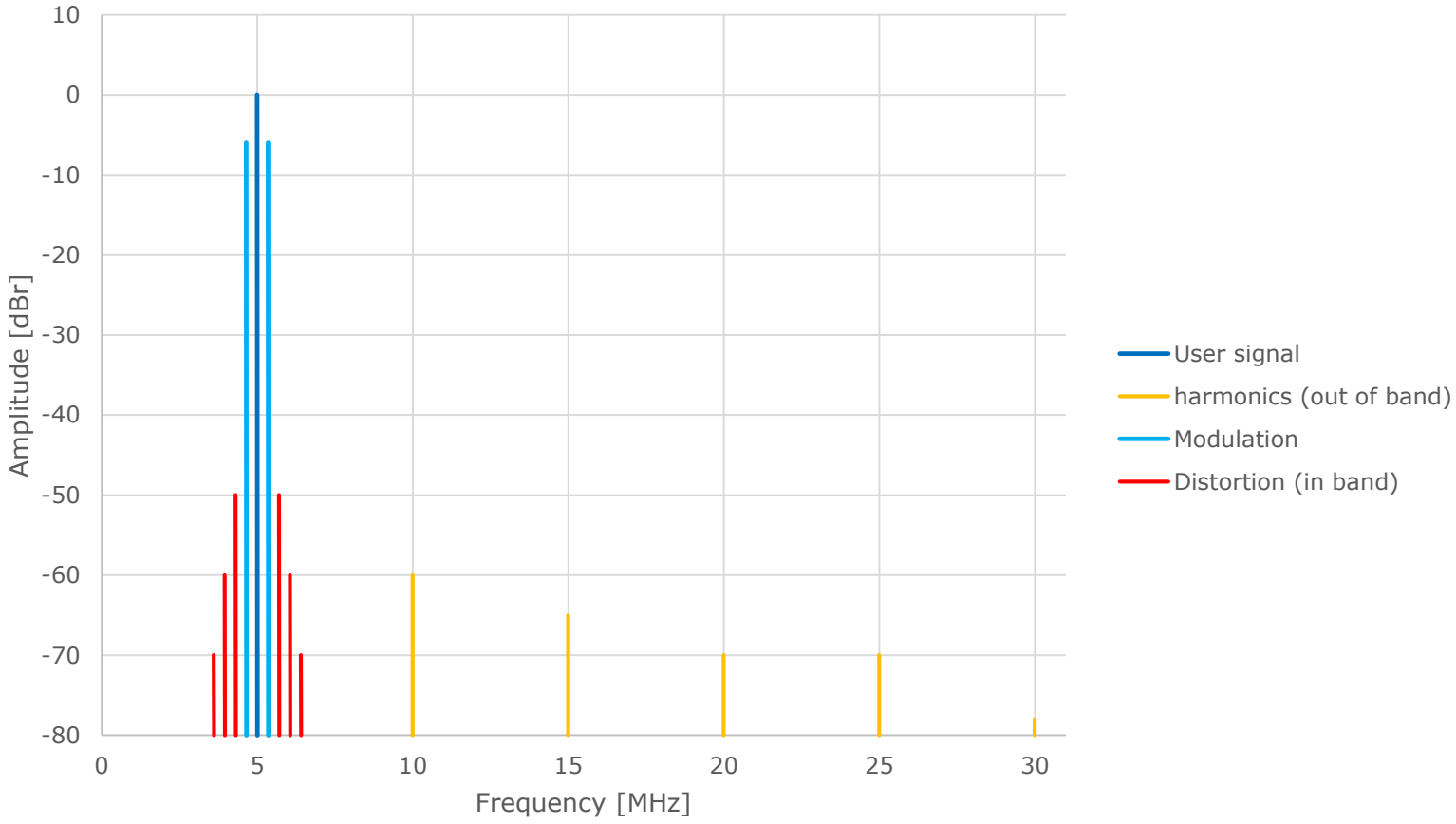




Key Characteristics:

- Small RF input signal, large RF output signal
- Can **amplify** any kind of modulation
  (Quality depends on linearity)

Output of an Amplifier



- Usable amplifier. Output filters-harmonics elimination-Distortions thanks to amplifier linearity.

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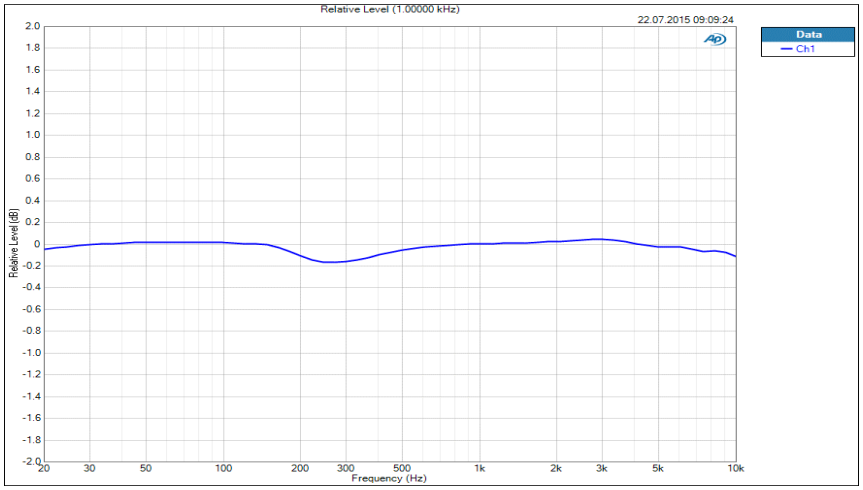
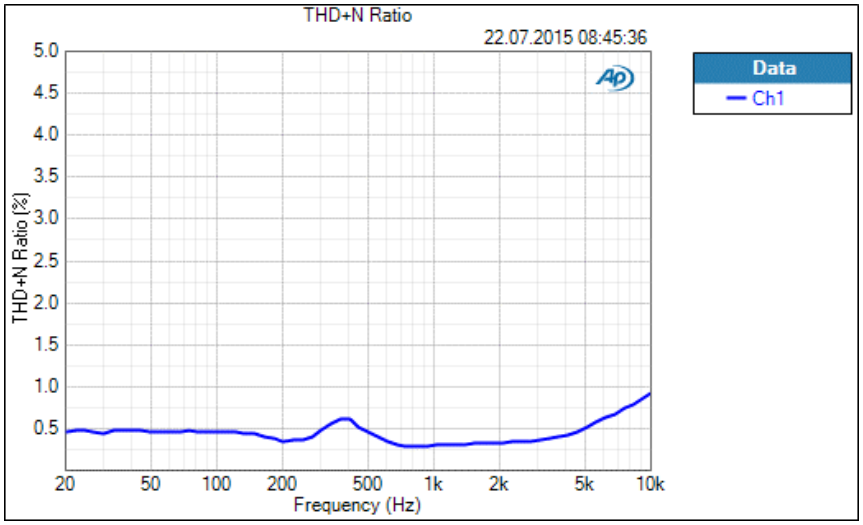
Audio Quality measurement



- Excellent
  Audio level within
  10 kHz bandwidth.
  Linear response



- Excellent
  THD+N
  Audio distortion and Noise figure

Future of SW Digital transmission

- Gradually traditional SW Radio broadcasting is being replaced with FM broadcast technologies. Thanks to DRM, new SW applications and opportunities are possible.

- This is freeing up bandwidth in the SW spectrum and providing opportunities for others (other applications).

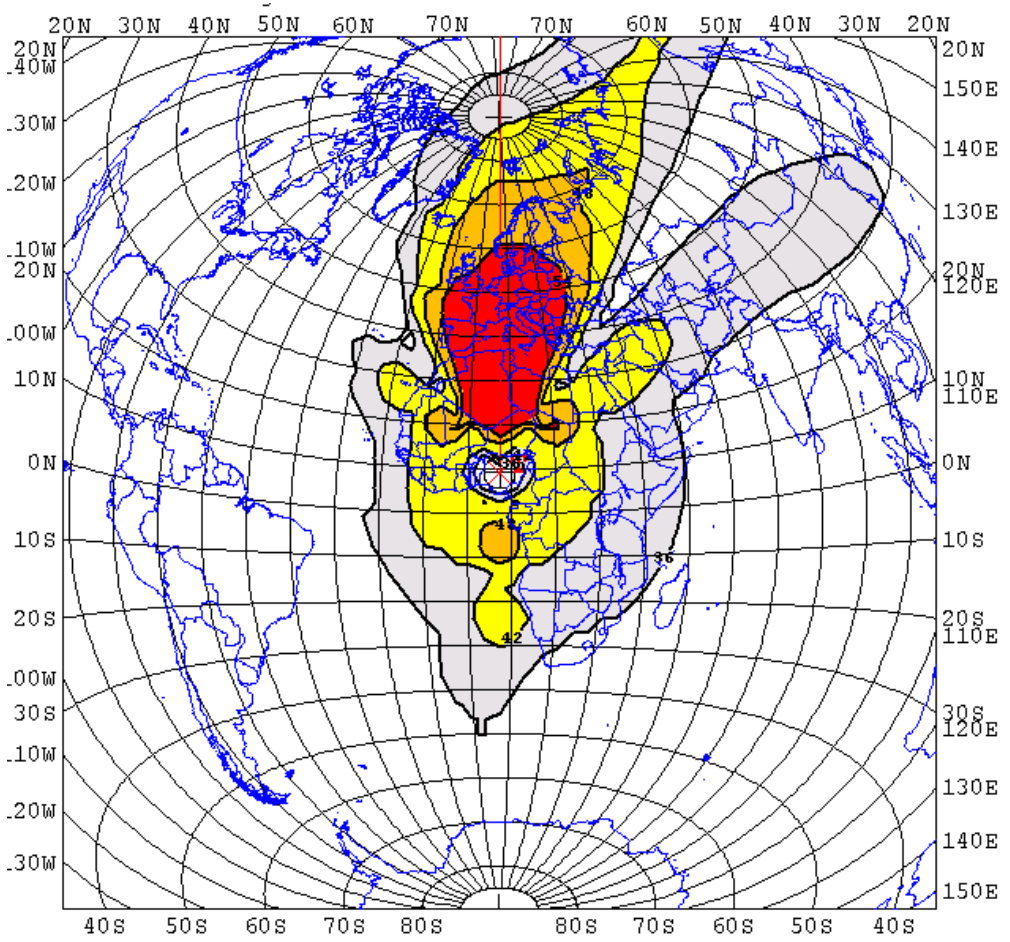
- Digital DRM radio has the potential to further compress channels and over very large distances up to thousands of miles with minimal costs.

- To transmit the same amount of information, DRM saves about 60% of the electricity bill. It consumes much less energy than analog transmission to cover the target area and with much higher quality.

- Shortwave offers incredible potential as a communication medium, but what could we do with it?

Strengths of Shortwave

- Voice of Nigeria
  500 kW/Abuja-Target Europe
- SW can propogate over intercontinental distances.
- Broadcaster can be remote from infinite numbers of receivers
- Minimal infrastructure required+Min. Costs
- Immediate data transmission: Extremely fast transmission



Strengths of Shortwave

Shortwave Band Chart		
BAND	**MEGAHERTZ (MHz)**	**KILOHERTZ (KHz)**
120 m	2.300-2.500 MHz	2300- 2500 KHz
90 m	3.20-3.40 MHz	3200- 3400 KHz
75 m	3.90-4.00 MHz	3900- 4000 KHz
60 m	4.750-5.060 MHz	4750- 5060 KHz
49 m	5.950-6.20 MHz	5950- 6200 KHz
41 m	7.10-7.60 MHz	7100- 7600 KHz
31 m	9.20-9.90 MHz	9500- 9900 KHz
25 m	11.600-12.200 MHz	11600-12100 KHz
22 m	13.570-13.870 MHz	13570-13870 KHz
19 m	15.10-15.80 MHz	15100-15800 KHz
16 m	17.480-17.90 MHz	17480-17900 KHz
13 m	21.450-21.850 MHz	21450-21850 KHz
11 m	25.60-26.10 MHz	25600-26100 KHz

- Zero fixed infrastructure required for receiver network.
- Broadcasts are freely available to hundreds / thousands / millions of undefined, mobile locations.

- Hundreds of channels with 9/10 kHz bandwidth.
- Future possibility of double bands for increased data rate?
  Transmitters are capable of double band broadcast.

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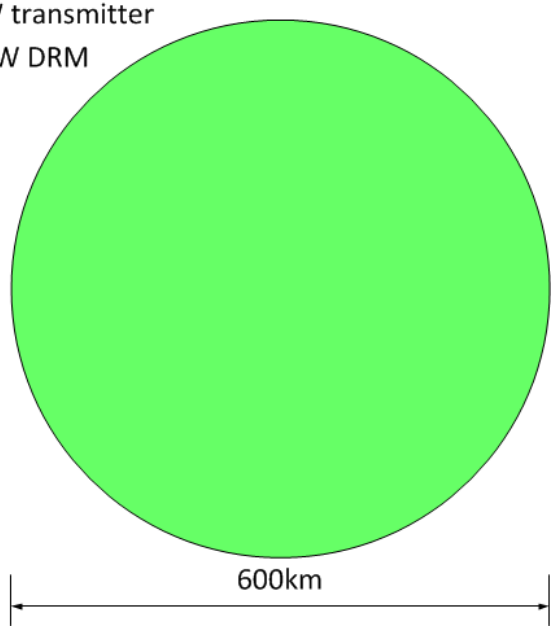
Coverage area comparison FM vs DRM30

100kW SW or MW: DRM is compressed to get an ~ FM quality: 32 kbits /s

1 Transmitter

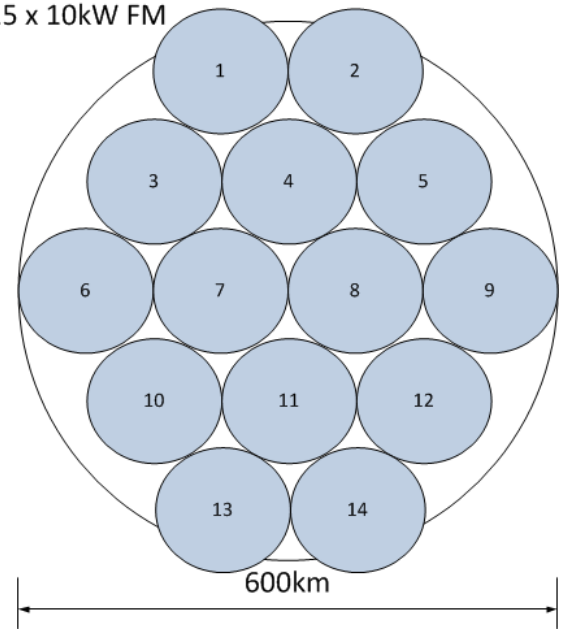
DRM Coverage
100kW transmitter
-> 40kW DRM

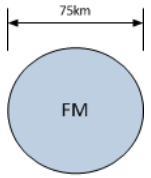


40kW @ 80% efficiency
Digital error correction

Min. 15 FM Transmitters

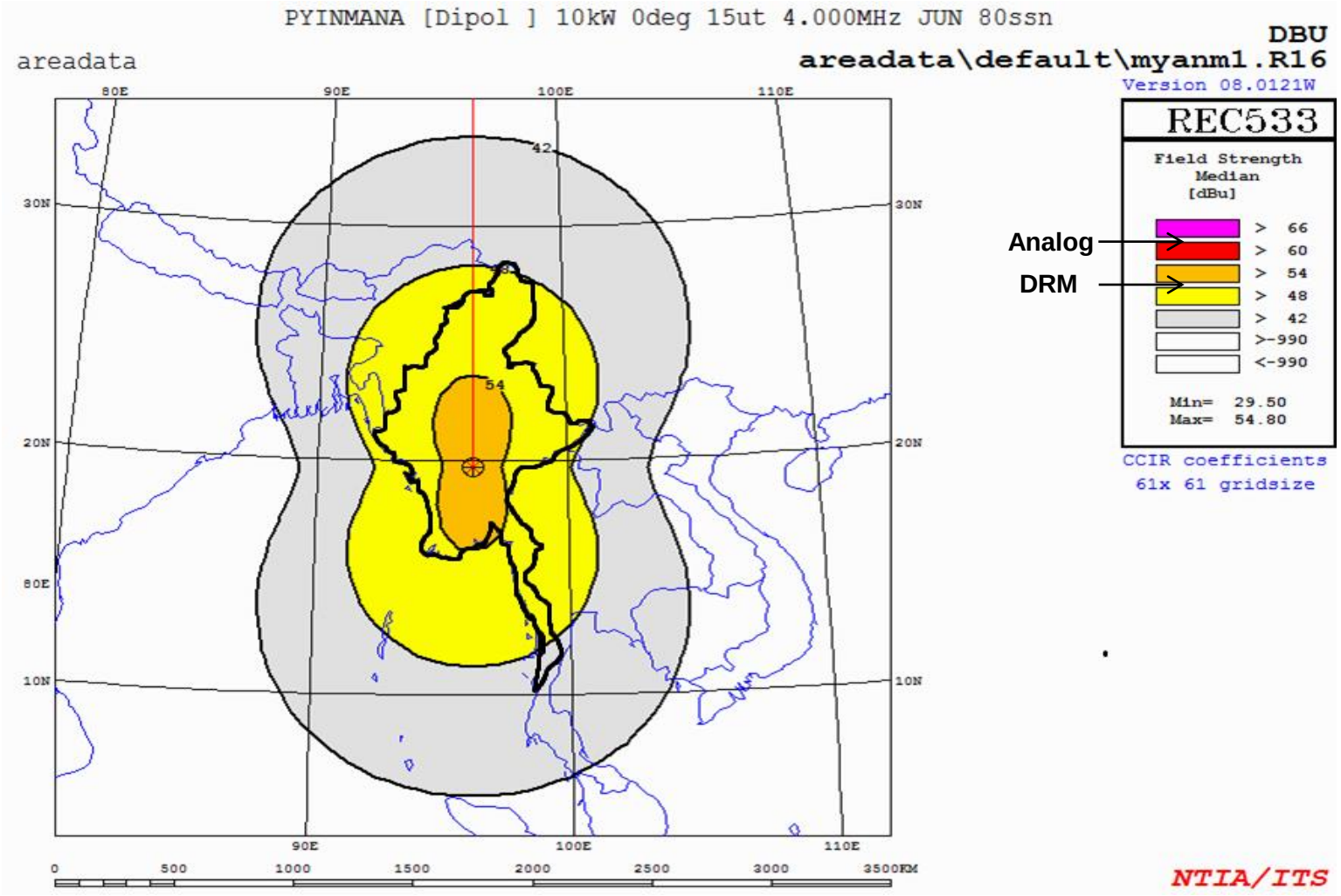
FM Coverage
Min. 15 x 10kW FM





150kW @ 60% efficiency

Digital SW coverage study: Myanmar: 10 kW Tx



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Rapid Intercontinental Data Communication

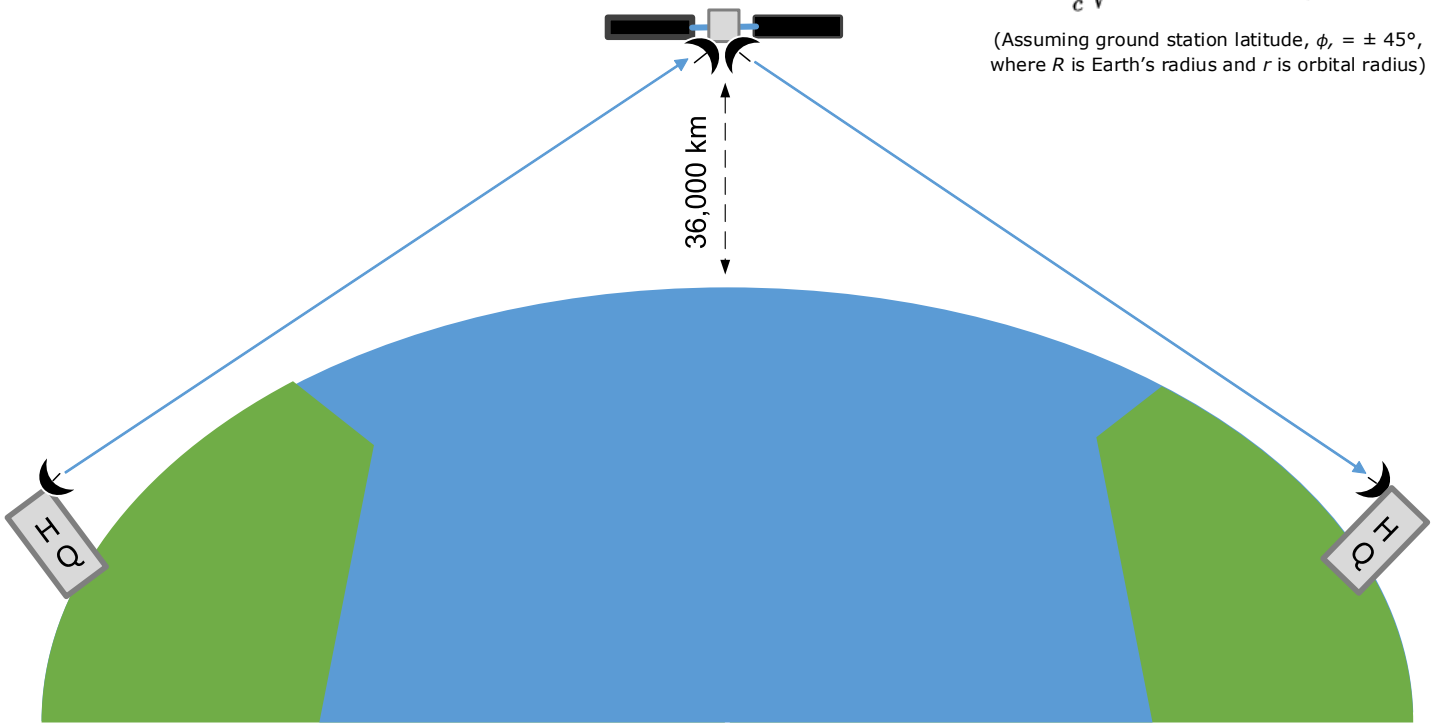
- Transport
- Education
- Radio programs
- Military

Rapid Intercontinental Data Communication (1/4)

- 1965 - present
- Technology: Satellite communication
- Typical Message Transmission time: 250ms (+ signal processing)
- Application: High bandwidth TV and data
- Limitations: Expensive bandwidth, orbital distance limits speed

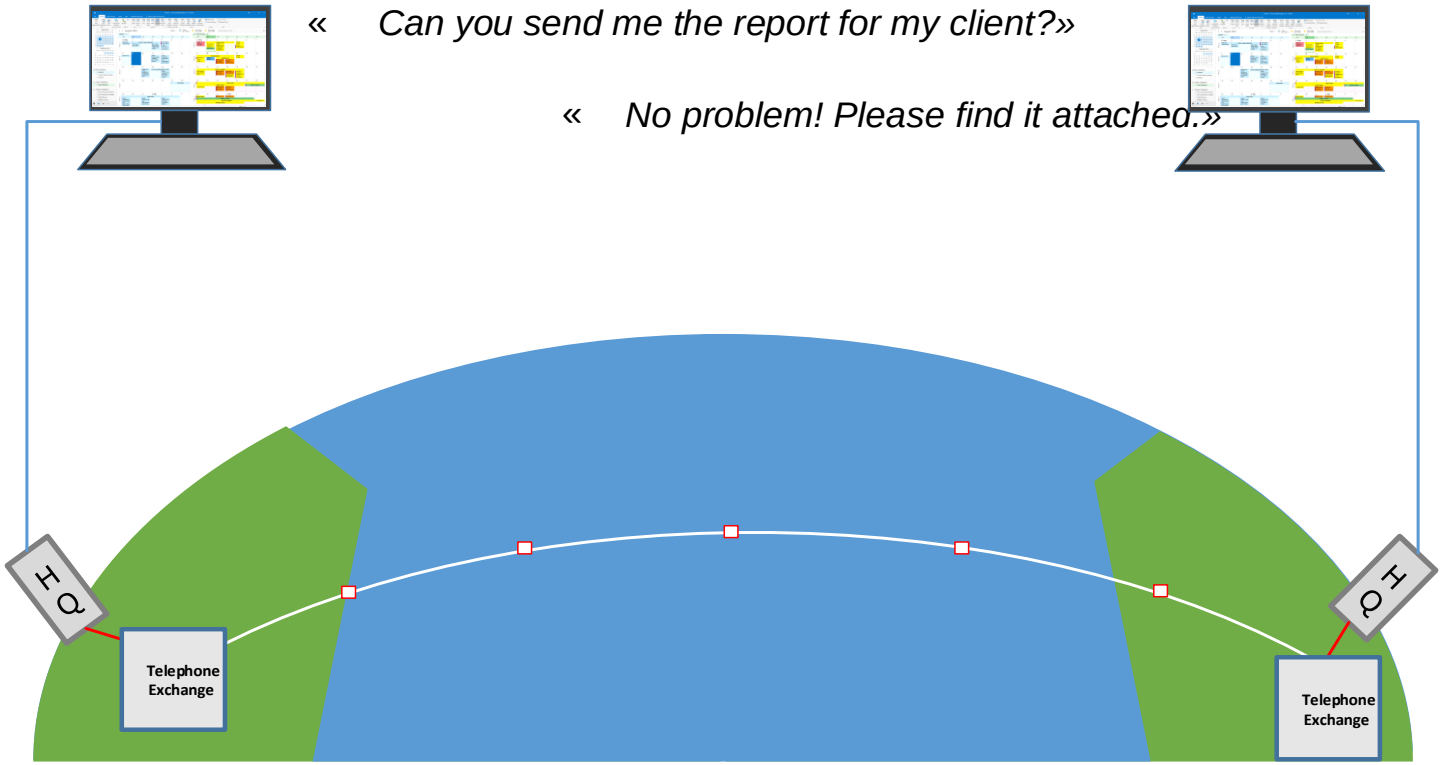
$$\Delta t = \frac{2}{c}\sqrt{R^2 + r^2 - 2Rr\cos\varphi} \approx 253 \text{ ms.}$$

(Assuming ground station latitude, ϕ, = ± 45°, where R is Earth's radius and r is orbital radius)



Rapid Intercontinental Data Communication (2/4)

- 1988 – present
- Technology: Fibre-optic cable
- Typical Message Transmission time: 60ms - 100ms (+infrastructure delay)
- Application: Speech, TV and high bandwidth data
- Limitations: Repeaters, data security



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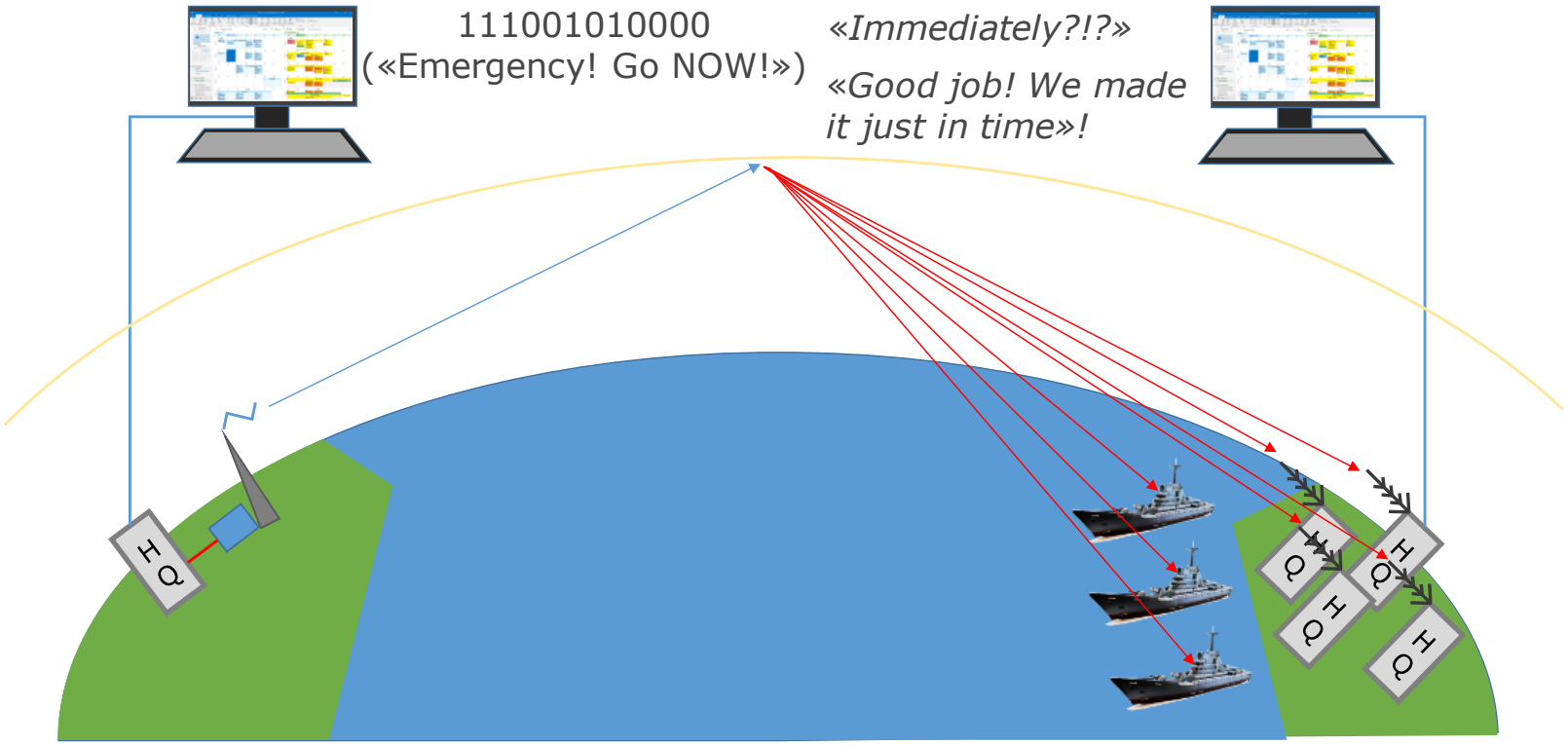
Rapid Intercontinental Data Communication (4/4)

- 2016 - ?
- Technology: Digital SW transmission
- Typical Message Transmission time: <20ms (+ signal processing)
- Application: Encoded digital data
- Advantages: High speed, secure, digital error correction possible



Automotive communications

- Shortwave's strengths: Existing technology allows broadcast to wide ranging, dispersed, mobile targets, without fixed infrastructure.

- A single large transmitter with an appropriate antenna could broadcast high quality digital audio and data to every car travelling in an entire country or continent! Software updates can cost billions!
- A simple SW message could do it within minutes for every single car within the broadcast footprint.

Built-In Car Receivers (examples)

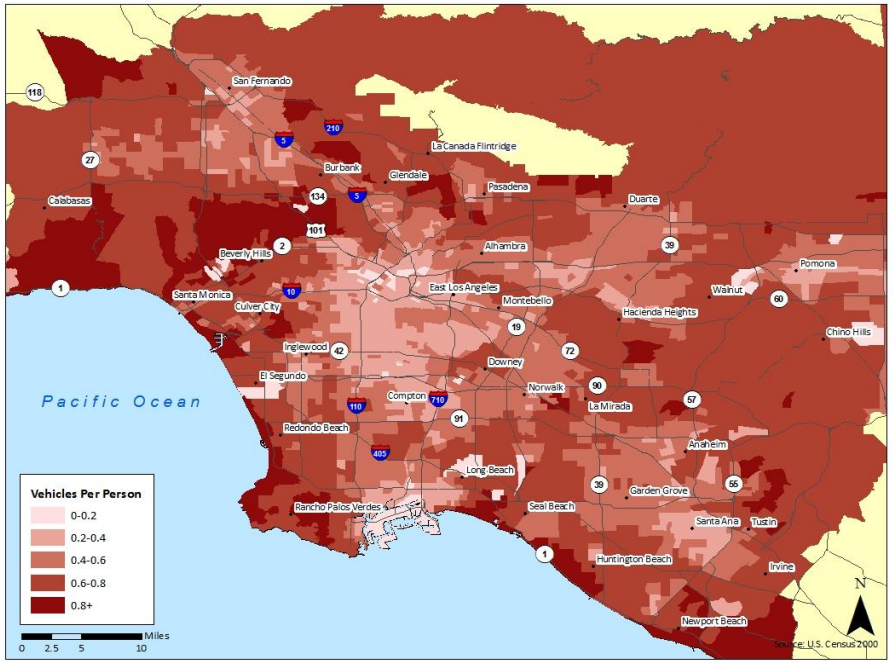
- Car Manufacturers in India launch new models with line-fit DRM Receiver at no extra cost

Automotive Communication

- Even in large cities, a good antenna with the smallest SW transmitter would cover every vehicle within 20 miles and more

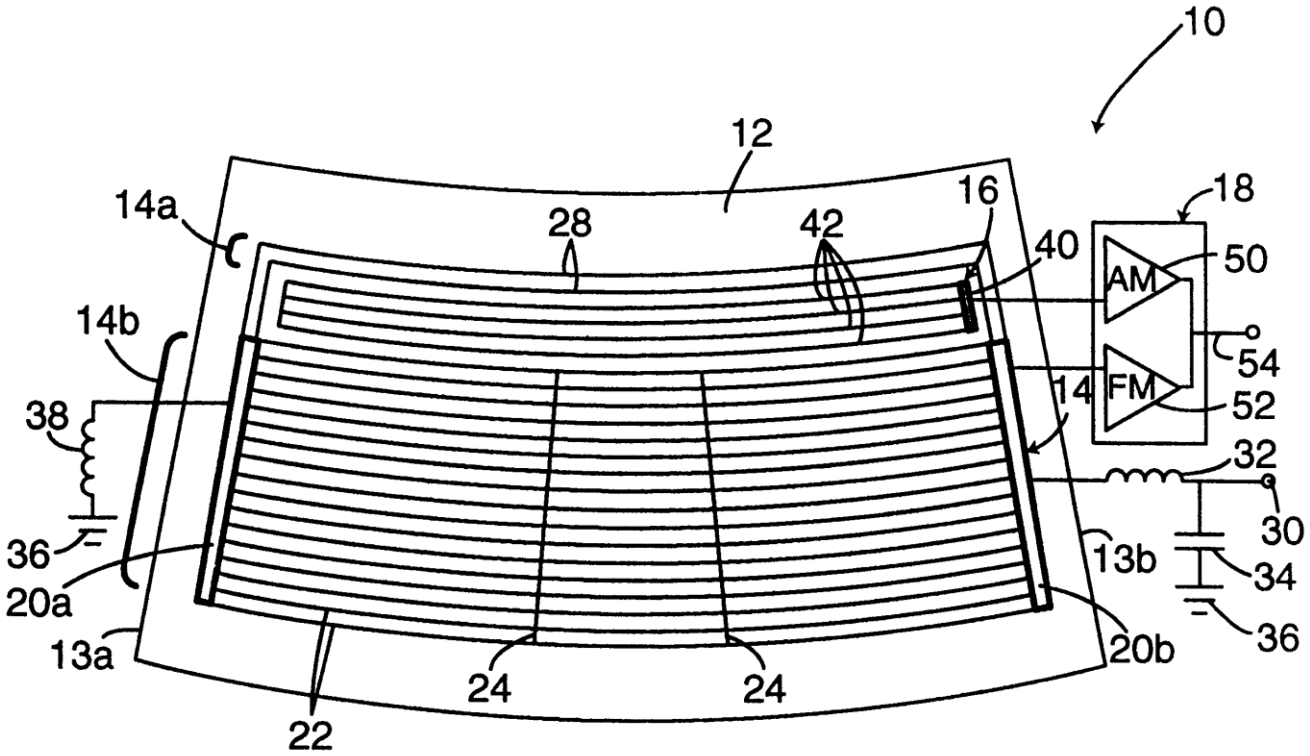
- Using PACTOR IV mode data compression, 1MB software update can be transmitted in about 3min.

- Error correction means that after perhaps 3-6min, the update could be received and installed.



- Following the Diesel Emissions Scandal of 2015/16, VW set aside €6.8bn to recall cars. Of 8.5M vehicles in Europe needing to be recalled, the majority of these ONLY needed to update engine management software!

Automotive SW antennas



- Cars have had passive antennas inside rear windows for decades! The antenna is also the window heater!

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Small SW Transmitter can be mobile for Sites?


+

+

=
Mobile Transmitter


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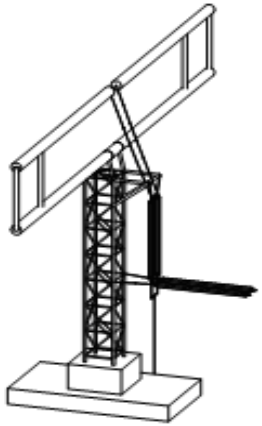
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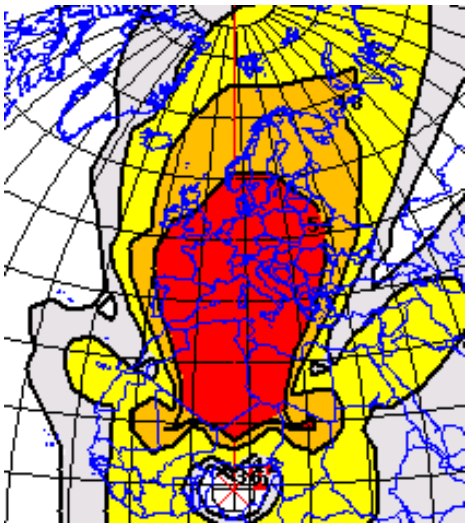
Mobile Antenna

Mobile Transmitter + Mobile Antenna + =
Redundancy or Emergency/Crisis Management System

Summary of Opportunities

New digital shortwave technology is fast approaching for digital data applications with:

- Requirements for rapid data transmission with min. Investment costs
- Receivers without fixed infrastructure
- Expensive third-party data connections are avoided
- Enormous numbers of targets
- Regional, national or even continental coverage
- The potential for profitable business in this field is enormous! What could **YOU** use it for?



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Worldwide Broadcast Systems References

Selection of Consortium Members

- The non-profit DRM Consortium supports and promotes the DRM Standard and it takes up globally.

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DRM Transmission Schedules Online

TIME IN UTC/GMT	BROADCASTER	FREQ in kHz	DAYS	LANGUAGE	TARGET	TRANSMITTING SITE	Power kW	Antenna beam degrees
TO EUROPE								
0100-0057	Radio France International	3965	Daily	French	France	France, Issoudun	1	Non Directional
0559-0700	BBC World Service	3955	Daily	English	NW Europe	UK, Woofferton	100	114
0500-0530	Radio Romania International	7330	Daily	French	W. Europe	Romania, Galbeni	90	285
0530-0600	Radio Romania International	7330	Daily	English	W.Europe	Romania, Tiganesti	90	307
0600-0630	Radio Romania International	7330	Daily	German	W.Europe	Romania, Tiganesti	90	307
0900-1200	Radio France International	6175 occasional tests	Daily	French	Europe + N.Africa	France, Issoudun	100 + 100	153 + 267
0945-1325	Radio Kuwait	15110	Daily	Arabic	Europe	Kuwait, Sulaibiyah	200	310
1000-1700	WINB	11670	Mon-Fri	English and Spanish	Europe	USA, Red Lion, PA	15	62
1700-1800	Radio Romania International	9760	Daily	English	W.Europe	Romania, Tiganesti	90	307
1800-2000	Voice of Nigeria	15120 suspended for maintenance	Daily	English	W.Europe	Nigeria, Abuja Lugbe	250	7
1800-2100	Radio Kuwait	15540	Daily	English	W.Europe	Kuwait, Sulaibiyah	200	310
1800-1830	Radio Romania International	5910	Daily	Italian	Italy	Romania, Saftica	90	270
1800-1900	Radio Romania International	6090	Daily	German	Germany	Romania, Tiganesti	90	307
2000-2030	Radio Romania International	9535	Daily	French	France	Romania, Galbeni	90	285
2030-2100	Radio Romania International	9535	Daily	English	W.Europe	Romania, Galbeni	90	300

Thank you!

Science MedTech Industry Broadcast