GATESAIR

Connecting What's Next

Economic Advantages of DAB+

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About Harris

Harris is the largest transmitter manufacturer world wide

DTV & DAB
Transmitter
VHF, UHF

FM, DRM+, HD Radio
Transmitter
VHF

AM, DRM, HD Radio
Transmitter
Medium Wave

Economical Advantages of DAB+ introduction

Main cost factors of Radio operation

- Equipment — Capital Expenses (CAPEX)

- Distribution
- Energy
- Cooling
- Floor space
- Service & maintenance
- License fee

— Operational Expenses (OPEX)

- Simulcast period, operation of analog and digital Radio in parallel

Summary economical advantages of DAB+

In summary, the study shows **for 18 DAB+ Digital Radio service** on a single antenna, the cost per service for DAB+ is:

Cost factor	DAB+ costs compared to FM	DAB+ cost compared to DRM+
Equipment	< 10% of FM (11 times lower)	< 30% of DRM+ (3,5 times lower)
Energy	2,5% of FM (41 times lower)	25% of DRM+ (2,4 times lower)
Cooling	5% of FM (18 times lower)	50% of DRM+ (2 times lower)
Footprint	6% of FM (18 times lower)	17% of DRM+ (6 times lower)
Maintenance	55% of FM (1,8 times lower)	83% of DRM+ (1,2 times lower)
Overall Opex	**DAB+ costs between 6 and 13 times less**	**DAB+ costs between 2 and 4 times less**

Summary economical advantages of DAB+

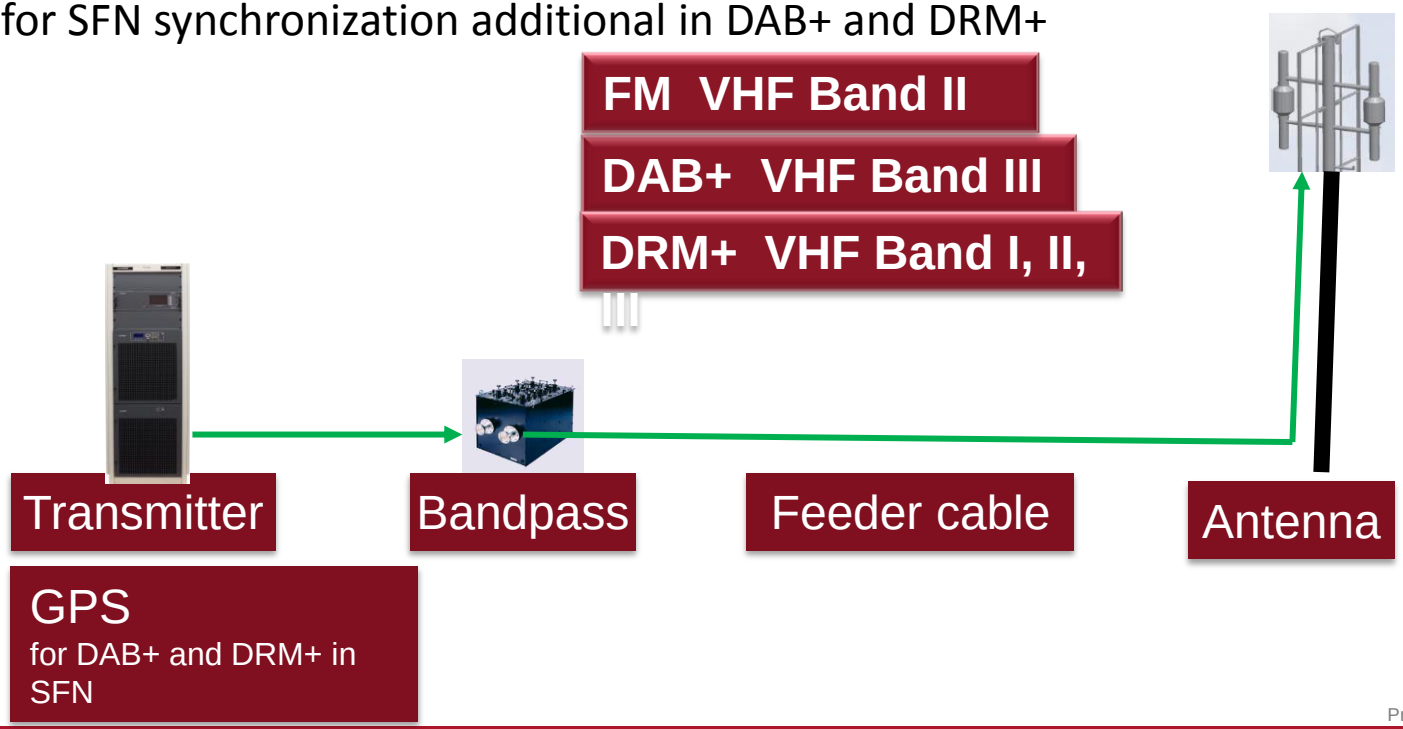
Drastic cost reductions using DAB+ compared to FM and DRM+ for areas which have 18 or more services:

- For metropolitan sites
  - DAB+ Opex costs approx 1/12 of FM
  - DAB+ Opex costs approx 1/4 of DRM+
- For regional sites
  - DAB+ Opex costs approx 1/9 of FM
  - DAB+ Opex costs approx 1/3 of DRM+
- For owned and self operated sites
  - DAB+ Opex costs approx 1/6 of FM
  - DAB+ Opex costs approx 1/2 DRM+

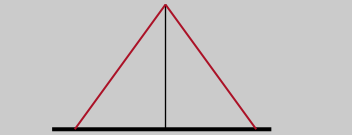
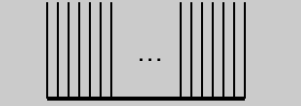
Introduction
DAB+, DRM+, FM

Transmission System FM, DRM+, DAB+

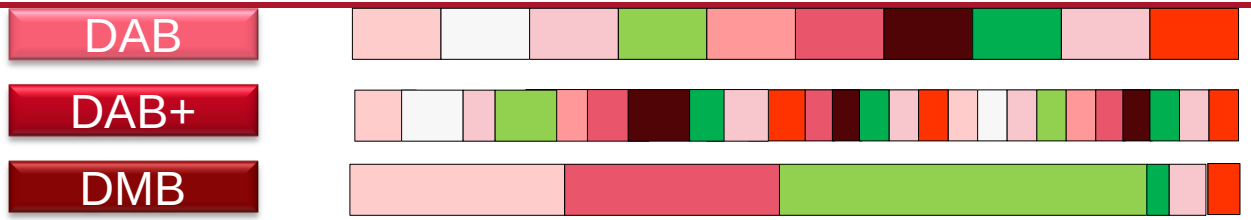
- Same general system components in FM, DAB+, DRM+
- Different frequencies & modulation standards
- GPS for SFN synchronization additional in DAB+ and DRM+



Differences between DAB+ and 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	Analoge 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 

DAB family of standards - no difference for the transmitter

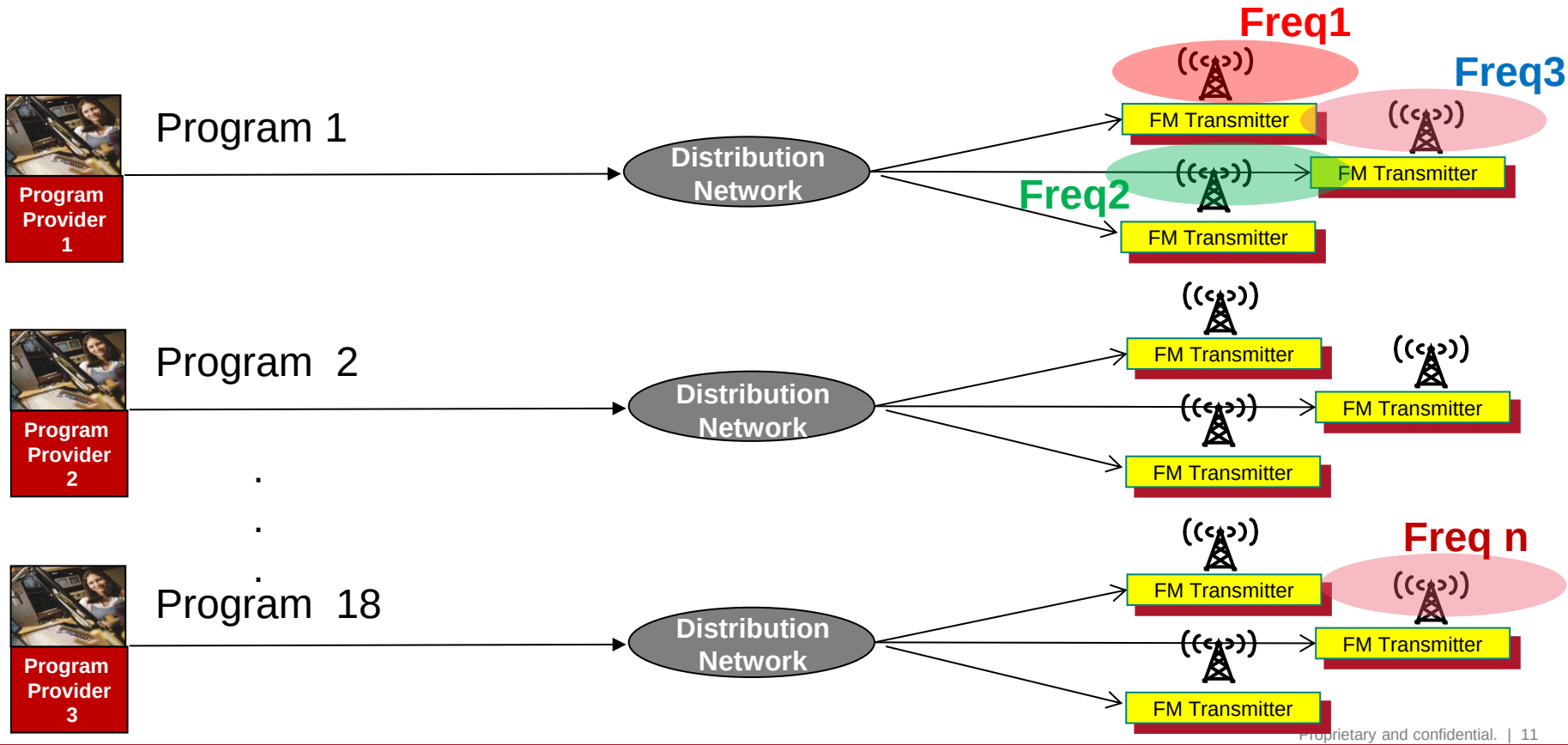


- Net data rate of 1.152MBit/s for commonly used rate ½ FEC coding
  - Flexibility for data rate / transmission power trade off from 576kbps to 1.728Mbps
- Each DAB transmitter can operate DAB, DAB+, DMB without changes
- There is **no** difference in Hardware or Software for the transmitter !

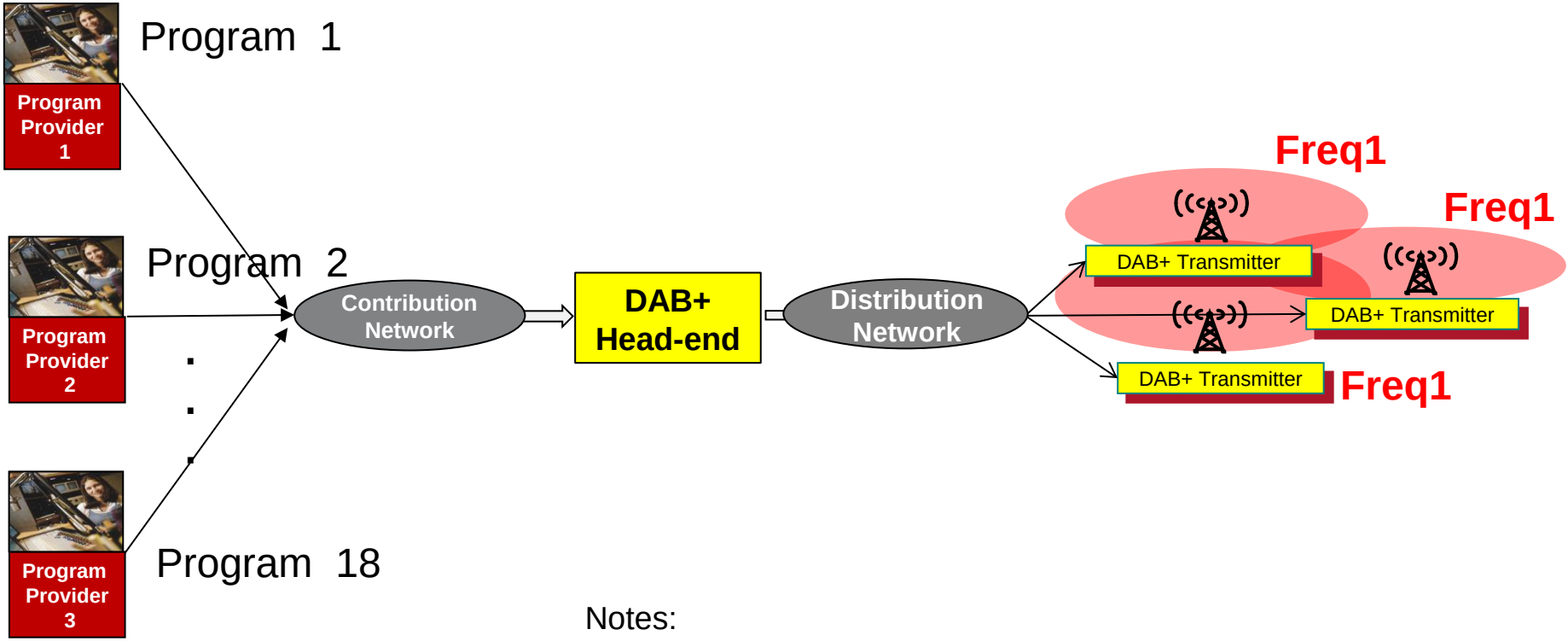
- The differences are managed by the Play-Out equipment
  - audio encoding
  - video encoding (DMB)
  - data server
  - error protection

Distribution Effort Studio-Transmitter

FM - one complete network per program
- Each transmitter needs another frequency

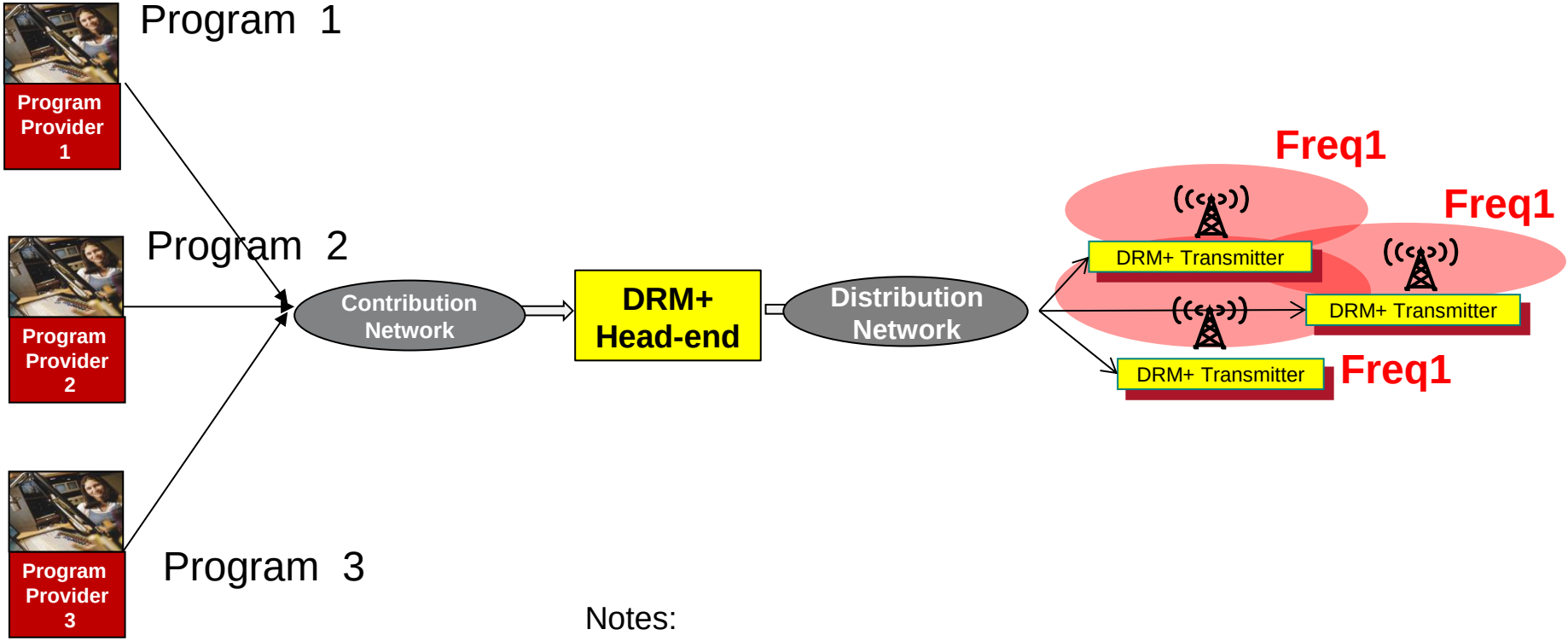


DAB+ one network / one frequency for up to 18 Radio programs



Notes:
18 programs assumes 64kbps each, DQPSK, FEC=0.5
24 programs could be included but at the lower bit rate of 48kbps

DRM+ one network / one frequency for up to 3 Radio programs



Notes:
3 programs assumes 62kbps each, 16QAM, FEC=0.62
4 programs could be included but at the lower bit rate of 46kbps

The Assumptions used in following comparisons are:

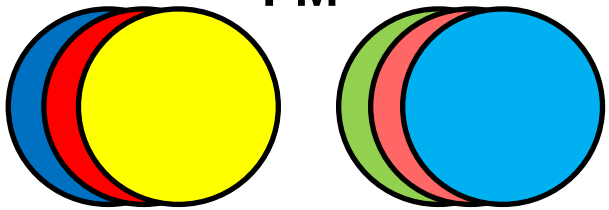
- The comparison is for cost per service
- The coverage area is the same for all radio types, DAB+, FM, DRM+
- The area to be covered has at least 18 services
  - 18 services is used as the basis of this comparison
- All services are 64kbps,
  - i.e. good quality audio / music

The comparison is based on cost information available in January 2014.

Cost efficiency of FM, DAB+ and DRM+

Example: 18 Radio Programs same coverage

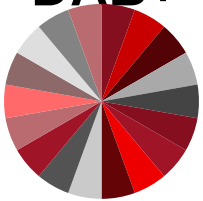
FM



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+

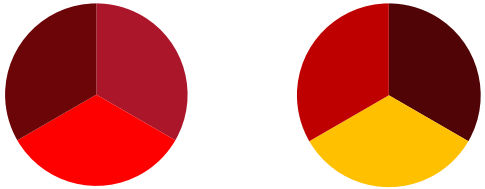


Tx 1 carries 18 programs

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.

DRM+



Tx 1, …….. 6 carries 18 programs

6x DRM+ Transmitter
6x Frequency
6x Frequency License fee
6x Studio-Transmitter Link (STL)
6x DRM+ Head-End
6x Large antenna system

NOTE: DRM+ has a maximum capacity of 186kbps which is equivalent to 62kbps per service using 16QAM and FEC code rate 0.62

Equipment Costs

Transmitter investment costs FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage

Transmitter	FM	DRM+	DAB+
Power	10 kW peak	1 kW rms	2,5 kW rms
Price per Transmitter	50.000 USD	45.000USD	80.000 USD
Transmitter	18	6	1
Price all Transmitter	**900.000 USD**	**270.000 USD**	**80.000 USD**

- **DAB Transmitter investment costs**
  11x lower compared to FM
  3x lower compared to DRM+
- TX investment / USD
- FM power is for stereo coverage
- With an antenna gain of around 10dB the coverage area is expected to have a radius of approximately 50km depending on the antenna height above ground level and receive area terrain – enough to cover a moderate metro city or major regional area.

Notes:
DRM+ transmitter cost based on DVB-T Tx of same power
The cost excludes installation and other head-end equipment

Energy Costs

Energy consumption transmitter FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage

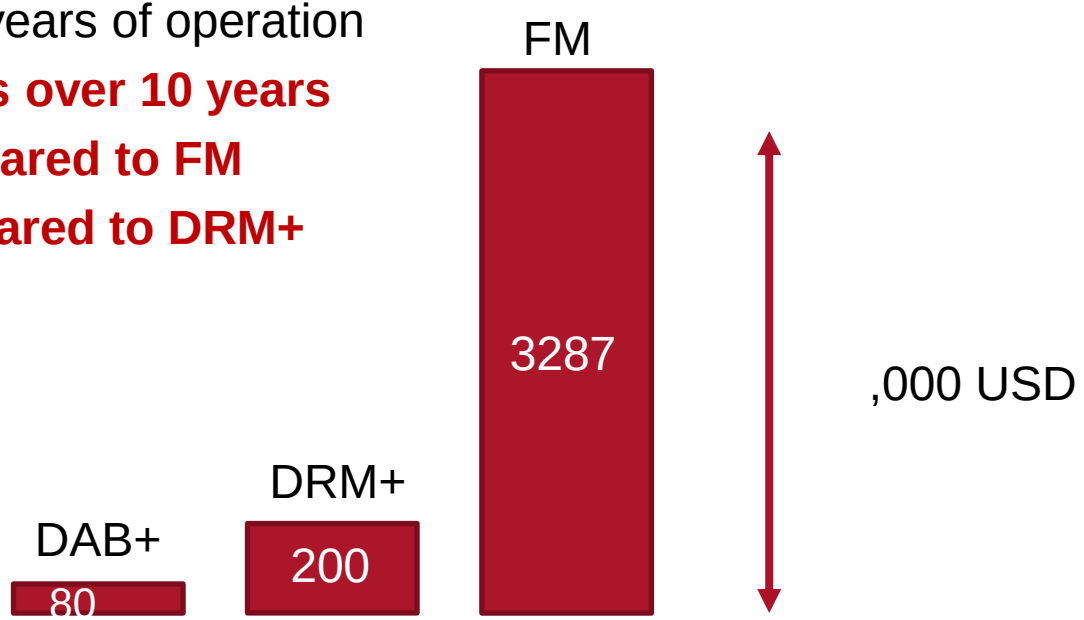
Transmitter	FM	DRM+	DAB+
Power	10 kW	1 kW rms	2,5 kW rms
Efficiency	72%	40 %	40%
Energy consumption per Transmitter	13,9 kW	2,5 kW	6,25 kW
Transmitters	18	6	1
Energy all Transmitters	**250 kW**	**15 kW**	**6,25 kW**
Annual cost of energy	**328.500**	**20.000**	**8.000**

- **DAB+ energy savings**
  41x lower compared to FM
  2,5x lower compared to DRM+
- Power consumption in kW
- Assumes 0,15 USD per kWh
- rms power is ½ peak power for a sinewave

Energy costs FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage

- Energy costs over 10 years of operation
- **DAB+ energy savings over 10 years**
  3.207.000 USD compared to FM
  120.000 USD compared to DRM+



Assumes 0,15 USD / kWh

Cooling Effort

Energy saving for room cooling FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage

1x DAB+ Transmitter

6 x DRM+ Transmitter

18 x FM Transmitter

Energy saving for room cooling FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage

Transmitter	FM	DRM+	DAB+
Power	10 kW	1 kW rms	2,5 kW rms
Power consumption (rms)	13,9 kW	2,5 kW	6,25 kW
Dissipated Power	3,9 kW	1,5 kW	3,75 kW
Transmitter for 18 Radio programs	18	6	1
Dissipated power for 18 programs	**70,2 kW**	**9 kW**	**3,75 kW**
Cost per annum	**92.250 USD**	**11.800 USD**	**5.000 USD**

- **DAB+ heat dissipation**
  18x lower compared to FM
  2x lower compared to DRM+

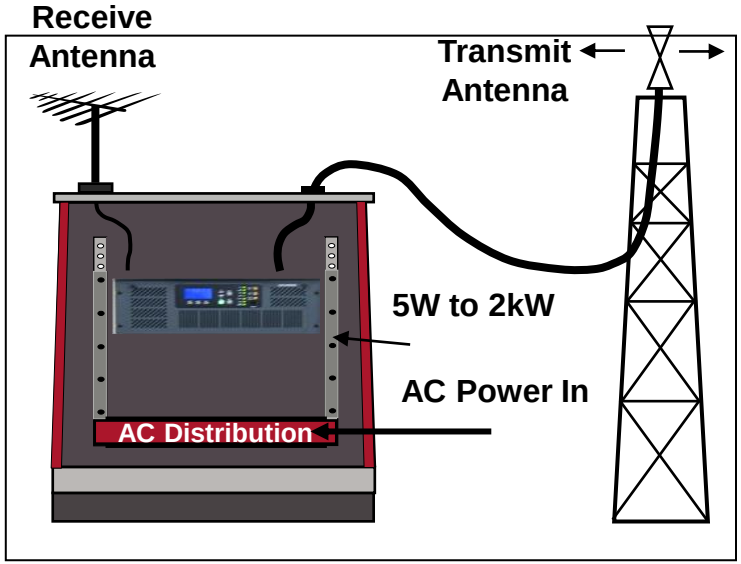
- Heat dissipation in kW
- assumes 0,15 USD / kWh
- cooling energy efficiency ratio of 5

Power Saving cooling installations – air cooled

- Ducted Air racks
- Evacuate the heat from the building
- Reduces Cooling costs

- Outdoor shelter
- Reduces site costs
- Fast deployment

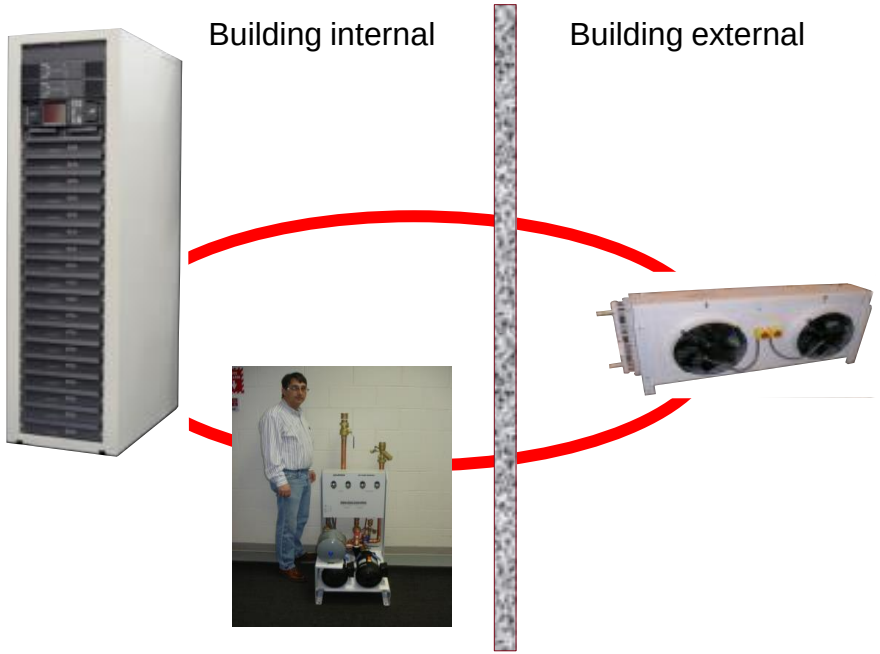
- Both solutions operating



Power saving cooling installations - Liquid cooled

Further savings using transmitter with liquid cooling system

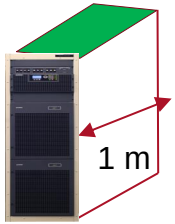
- Drastic reduced building cooling costs
- Directly evacuate heat out side of the building
- Reduced space & installation effort
- Variable speed fans and pumps
- to reduce power consumption
- Flexible hose for easy installation
- Redundant system can support multiple transmitters
- Silent, low acoustic noise
- Low maintenance effort



Space in Equipment Room and on Towers

Space savings on transmission site FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage



0,6 m²

1x DAB+ Transmitter

	FM	DRM+	DAB
Occupied floor space 1 program	0,6 m²	0,6 m²	0,6 m²
Occupied floor space 18 programs	**14,4 m²**	**3,6 m²**	**0,6 m²**

6 x DRM+ Transmitter

18 x FM Transmitter

18x less occupied floor space with DAB+ compared to FM

Save tower & antenna space with DAB+

Analoge FM, DRM+

- Many towers
- Interferences

DAB+

- Single Antenna
- No interferences

Cost of space

- Typical cost of floor space in transmitter hall and antenna aperture on the transmission tower can vary significantly :
  - When the facilities are owned by the broadcaster there will always be some component cost to maintain the facility
  - The location of the facility will impact the cost, facilities for major cities often cost significantly more than for rural facilities
  - The amount of space required, particular the antenna aperture

- The costs below are typical costs for a single installation for both antenna aperture and transmitter hall space:
  - $5k pa if the antenna, transmission tower and building is owned by the broadcaster (contribution to site maintenance and on-costs)
  - $35k USD pa for low cost sites in regional areas
  - $75k USD pa for high cost sites in major cities

The Cost of Space

Cost comparison for combined antenna aperture on the transmission tower and transmitter hall space

Transmitter	**FM**			**DRM+**			**DAB+**		
Situation	Owned	Regional site	Metro site	Owned	Regional site	Metro site	Owned	Regional site	Metro site
Cost per annum ,000s USD	5	35	75	5	35	75	5	35	75
Number of transmitters	18	18	18	6	6	6	1	1	1
Cost per annum ,000 USD	**90**	**630**	**1,350**	**30**	**210**	**450**	**5**	**35**	**75**

- **The cost of DAB+ transmitter tower and hall space is**
  18x lower compared to FM
  6x lower compared to DRM+

Service & Maintenance

Reduced Service & Maintenance Cost FM, DRM+ and DAB+

1x DAB+ Transmitter

6 x DRM+ Transmitter

18 x FM Transmitter

Drastic Service cost reductions using DAB+

- reduced spare part stock
- reduced part diversity
- reduced maintenance effort

Reduced Service & Maintenance Cost FM, DRM+ and DAB+

Example: 18 Radio Programs same coverage

There are a number of options for operations and maintenance including

- Broadcaster provides internal staff to conduct the work, often the case for commercial broadcasters
- A managed service is used, often the case for multiplexes which have multiple broadcasters, e.g. DAB+
- A mixture where the operations aspects are conducted by the broadcaster but maintenance is done by a contract organization, this occurs in large metro transmission sites as well as remote sites

Transmitter	**FM**			**DRM+**			**DAB+**		
Situation	Owned	Regional site	Metro site	Owned	Regional site	Metro site	Owned	Regional site	Metro site
Weeks of effort per annum		2			4			12	
Cost per annum ,000s USD	5	5	5	10	10	10	50	50	50
Number of transmitters		18			6			1	
Cost per annum ,000 USD	**90**	**90**	**90**	**60**	**60**	**60**	**50**	**50**	**50**

The cost of DAB+ maintenance is approximately the same as DRM+ and 1/2 of FM

Service & repair of DAB+ transmitter

Light & universal parts for cost effective repair & logistic

RF Pallet
identical for
Air cooled and
Liquid cooled

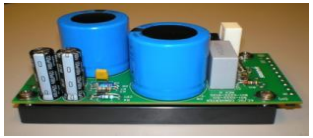
500 g

Power Amplifier
Air cooled

2 kg

Power Supply
Air cooled
Liquid cooled

1 kg



250 g

- Low spare part costs
- Low shipment costs
- Low import fee
- Easy to carry and replace

Summary economical advantages of DAB+

Drastic cost reductions using DAB+ compared to FM for:

1. Equipment
2. Distribution
3. Energy
4. Cooling
5. Space
6. Service & Maintenance
7. RF transmission License Fees

- The cost comparison will often involve higher power systems than used in the example in this presentation and hence the cost savings when using DAB+ rather than FM or DRM+ for multi-service radio delivery will scale accordingly.

Summary economical advantages of DAB+

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

	Transmitter	FM			DRM+			DAB+		
	Situation	Owned	Regional site	Metro site	Owned	Regional site	Metro site	Owned	Regional site	Metro site
	Number of transmitters		18			6			1	
,000 USD	**Capex**: Cost of transmitters		900			270			80	
,000 USD **pa**	**Opex**									
	Power		163			20			8	
	Cooling		45			12			5	
	Space	90	630	1,350	30	210	450	5	35	75
	Maintenance		90			60			50	
,000 USD **pa**	**Total Opex**	**385**	**925**	**1,645**	**122**	**302**	**542**	**68**	**98**	**128**

DAB+ Opex costs less between 5,7 and 12,8 x less for FM and between 1,8 and 4,2 x less for DRM+

Summary economical advantages of DAB+

- The Opex cost of FM and DRM+ in metro cities is dominated by the cost of space on the transmission tower and in the transmitter hall. Regional sites are also highly influenced by the cost of space. In contrast, as DAB+ only requires a single shared site which carries 18 programs the cost of space is much less.
- The cost of energy, cooling and maintenance are less for DAB+ in all situations
- The approximate Opex cost **SAVINGS** of operating 18 services over a 10 year period using DAB+ are:

OPEX Savings	DAB+ vs. FM	DAB+ vs. DRM+
Metro site	15.000.000 USD	4.000.000 USD
Regional site	8.000.000 USD	2.000.000 USD
Owned site	3.000.000 USD	500.000 USD

Summary economical advantages of DAB+

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

- For metropolitan sites
  - DAB+ Opex costs approx 1/12 of FM
  - DAB+ Opex costs approx 1/4 of DRM+
- For regional sites
  - DAB+ Opex costs approx 1/9 of FM
  - DAB+ Opex costs approx 1/3 of DRM+
- For owned and self operated sites
  - DAB+ Opex costs approx 1/6 of FM
  - DAB+ Opex costs approx 1/2 DRM+

Simulcast period

Simulcast period most costly for program provider

- Transition period from analog to digital for Radio is longer than for TV
- Broadcaster cannot compensate all additional costs of simulcast operation by more revenue

1. Simulcast costs are critical for acceptance & motivation of broadcaster
2. Clear road map of analog to digital transition helps to secure planning
3. Cost compensations for broadcaster during simulcast period

While the cost of transmission during the simulcast period will be approximately 10% more relative to FM operation, that period not only allows the broadcaster to build their listening audience but also encourages switch-over to a system which is much cheaper.

Thank you for your attention!

It's time for DAB+ !