Our topics

Leaving the Dead-end Street:
New Ways for the Digitisation of the VHF-FM Sound Broadcasting with DRM+

drm+

Part I	**Field trials on DRM+ coverage in VHF band II**
Part II	First results on compatibility and coverage analyses of DRM+ single frequency networks (SFN) in VHF band II
Part III	Investigations on the deployment of DRM+ in VHF band III

Prof. Dr.-Ing. Andreas Steil; Dipl.-Ing. (FH) Felix Schad; Martin Köhler
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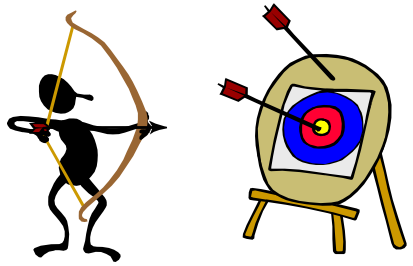
Dipl.-Ing. Joachim Lehnert
(Landeszentrale für Medien und Kommunikation Rheinland-Pfalz)

Contents Part I

Objective and Concept



Objective:

- Evaluate the **'real' coverage of DRM+** (Part I)
- Propose **planning paradigms for DRM** + (Part II)

Starting point:

- Definition of coverage criteria ongoing …
- Reference implementation not yet available …

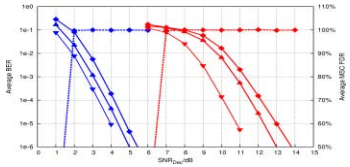
The concept:

- **Preparatory work:**
  1. Evaluate characteristic system parameters
  2. Measure protection ratios FM → DRM+
  3. Predict DRM+ coverage areas
  4. Define quality criteria

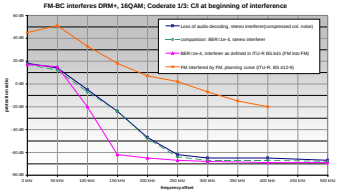
- **Field measurments to validate lab results and assess coverage**

Quick outline of preparatory work ...

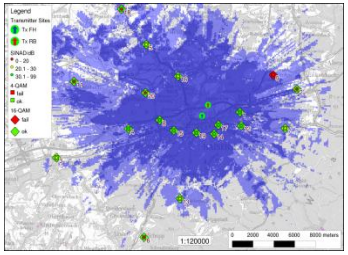
1. System parameters: Calibrate the **complete DRM+ chain** (e.g. RX BER performance, RX sensitivity, RX noise figure, phase noise figures)



2. Measure **protection ratios FM → DRM+** for different modulation schemes and reception conditions based on audio quality: **coded BER** and **audio failure**



3. Predict **DRM+ coverage aeras** for stationary recepetion (4/16 QAM) to identifiy suitable test points/route



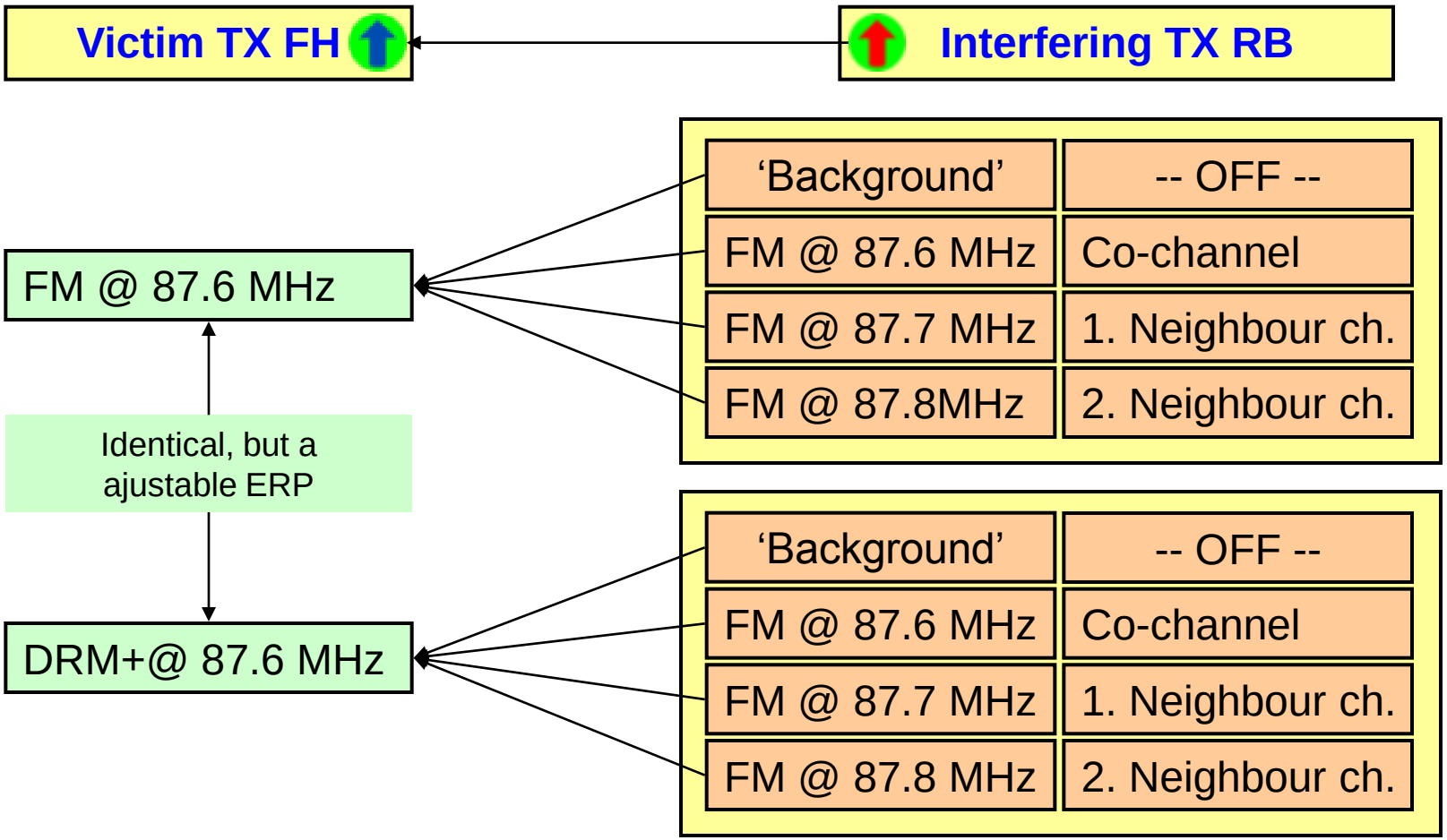
4. Define the **criteria** for ‘real’ coverage based on audio quality:

FM SINAD / dB	DRM+ Coded BER	Coverage assertion	Colour representation
(-∞ ... 20]	> 10^{-4}	No	Red
(20 ... 30]	----	Not really	Yellow
30 ... ∞)	<= 10^{-4}	Yes	Green

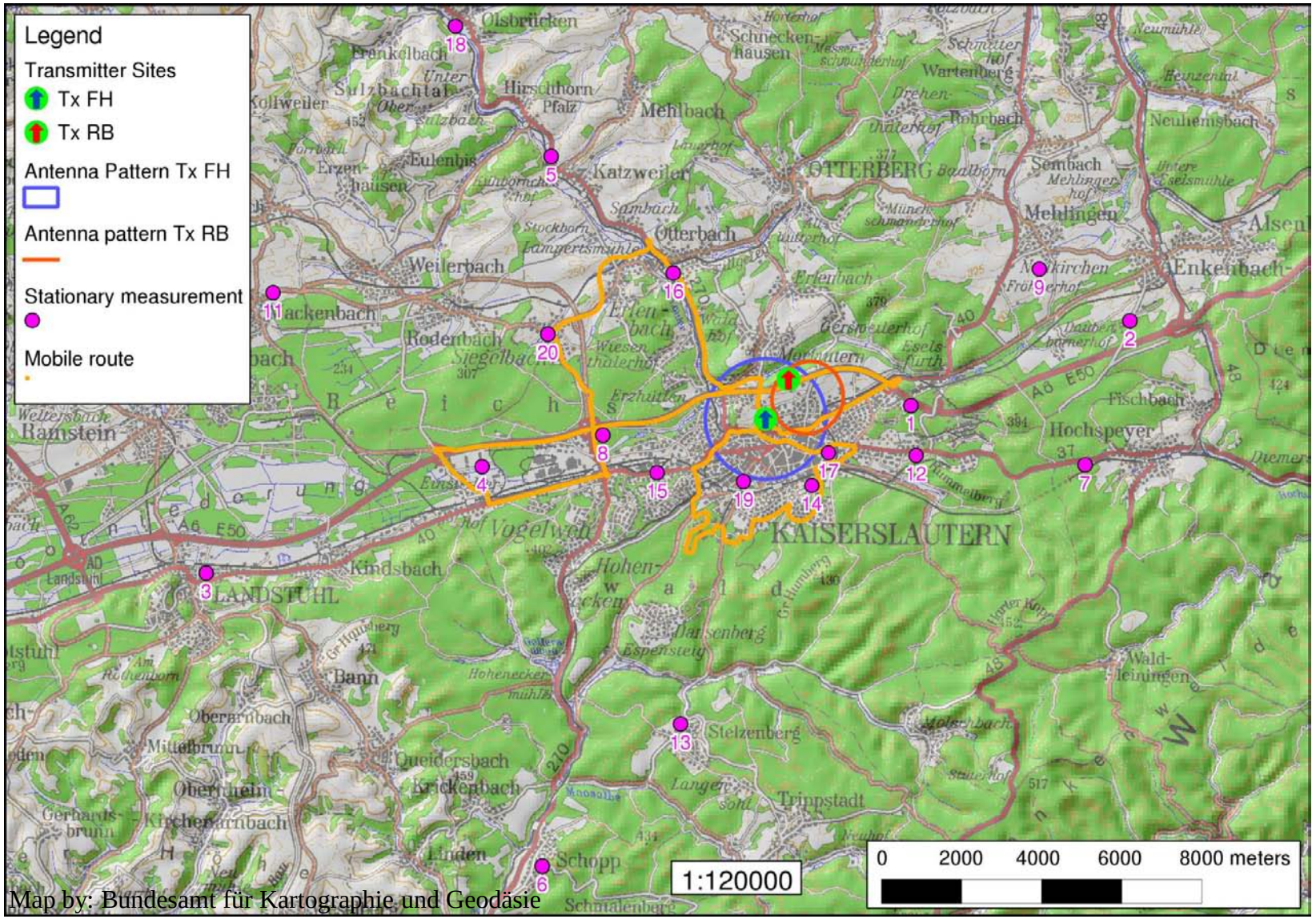
TX characteristics

	`Victim` TX FH		`Interfering` TX
Site location Geographical data	`Am Kaiserberg` FH Kaiserslautern, Morlauterer Str. 31 07E 46 49 / 49N 27 10 [PD] 274 m hasl, Antenna: 30 m agl		`Rotenberg` SWR-loc. Kaiserslautern Rotenberg 07E 46 19 / 49N 27 39 [PD] 321 m hasl, Antenna: 30 m agl
License Period	Until 31.12.2009		Until 31.12.2009
Modulation	FM: 0 dBr @ 26 kHz	DRM+: 4/16 QAM 0.25/0.25 SDC 0.4/0.33 MSC	FM: 0 dBr @ 75 kHz
RF Carrier Frequencies	87.6 MHz		87.6 ... 88.1 MHz
Radiated Power (ERP)	0 … 35 W (ERP)		0 … 35 W (ERP)
Antenna	ND		Directional (4-Elem. Yagi K 52 4017)
Polarisation	vertical		vertical
Content	500 Hz (L=R) no RDS	2 services: - sync. PRBS - Audio	Coloured noise (stereo) no RDS

Frequency constellations (stationary & mobile)

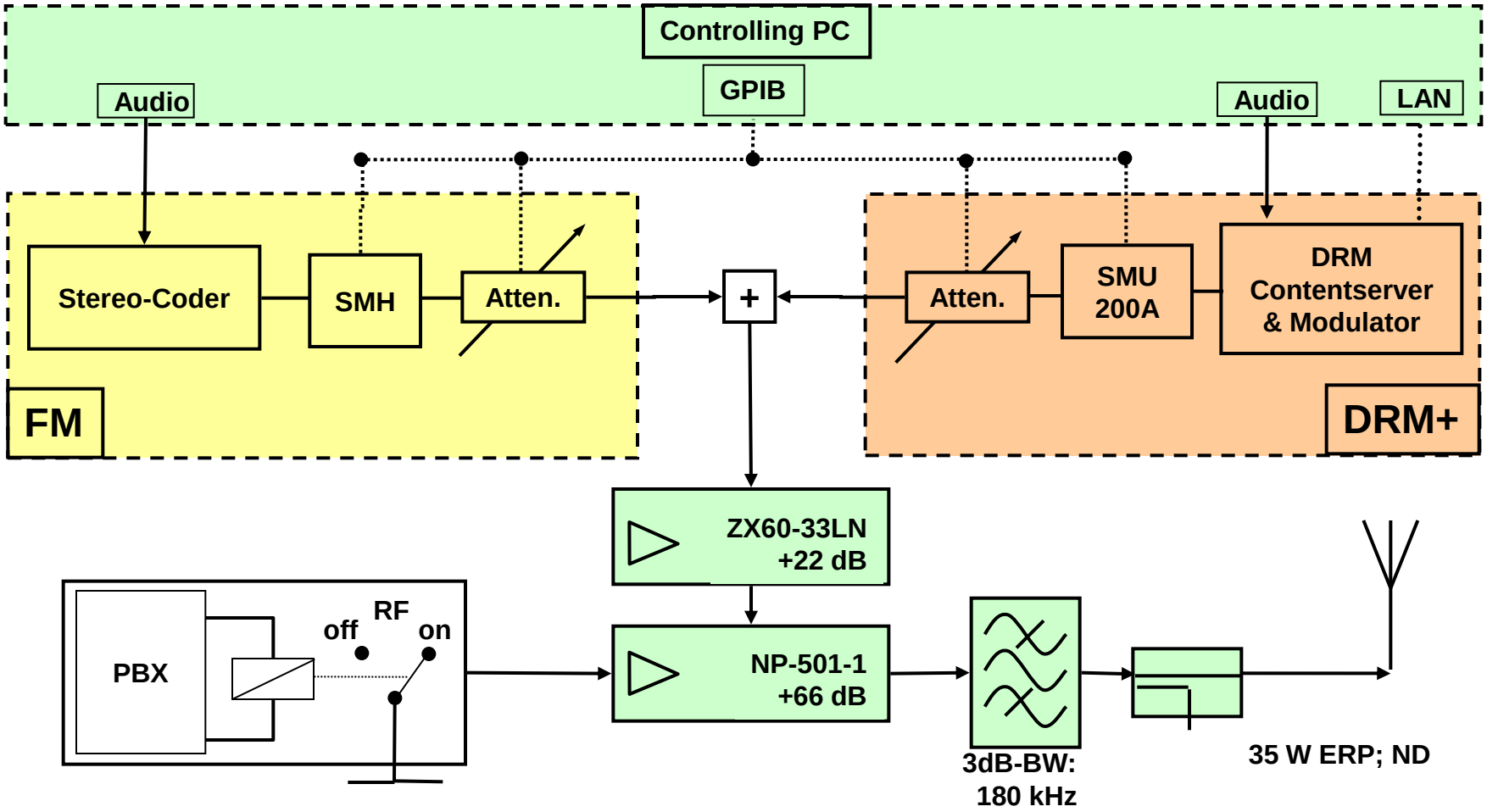


TX locations, measurement points (fixed) & measurement route (mobile)

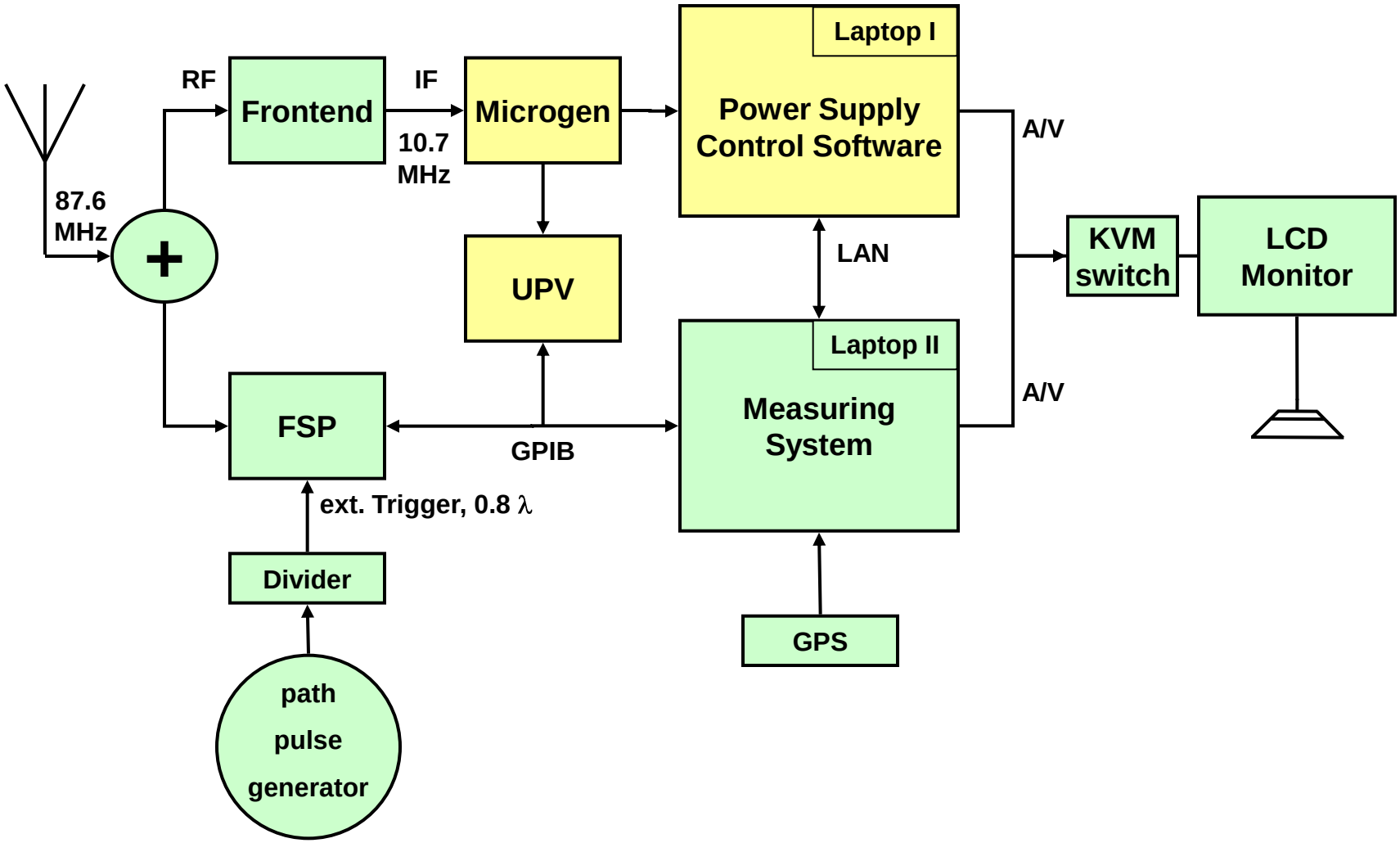


Contents Part I

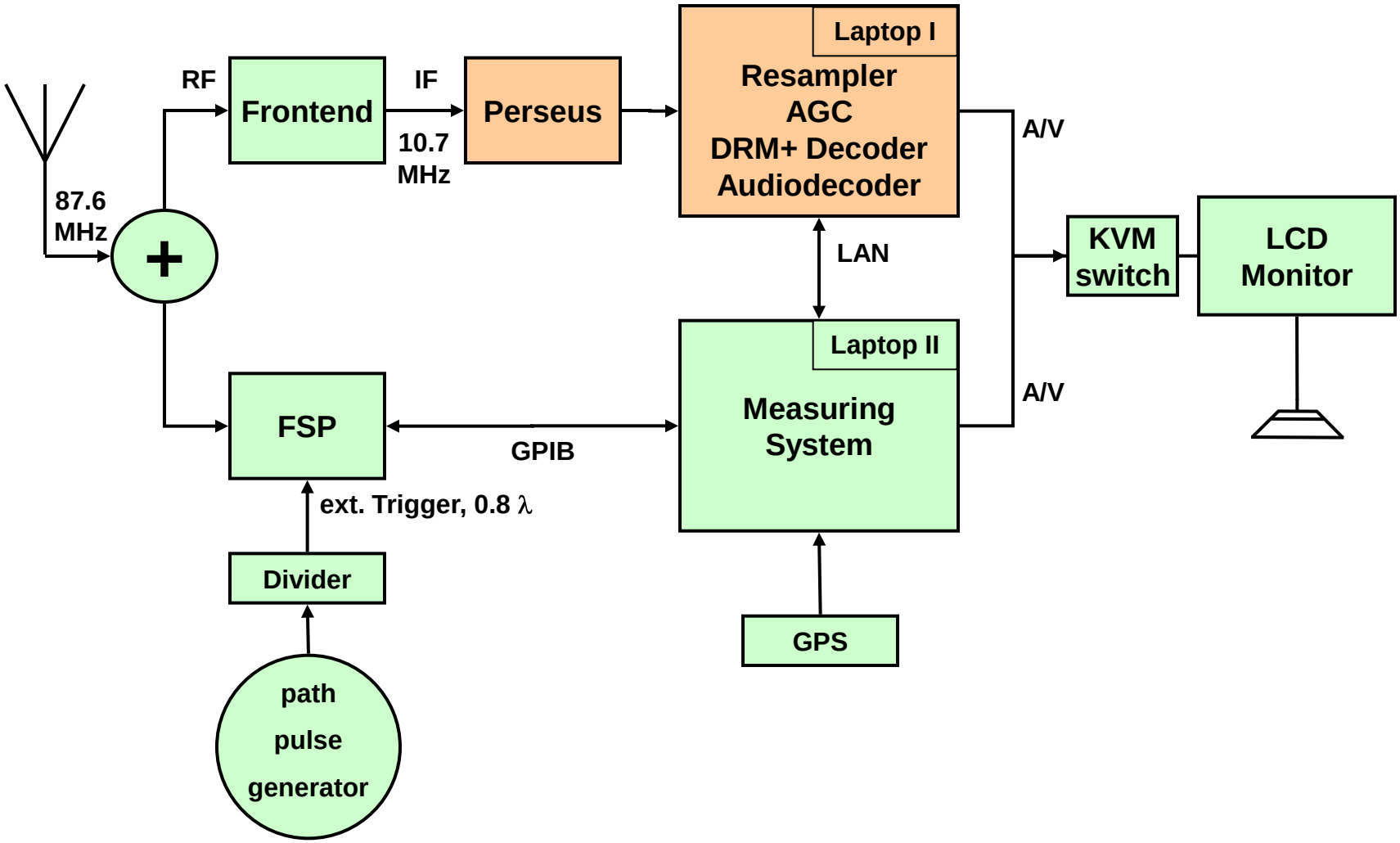
Schematics of hybrid TX `Am Kaiserberg`



Schematics of (mobile) FM RX

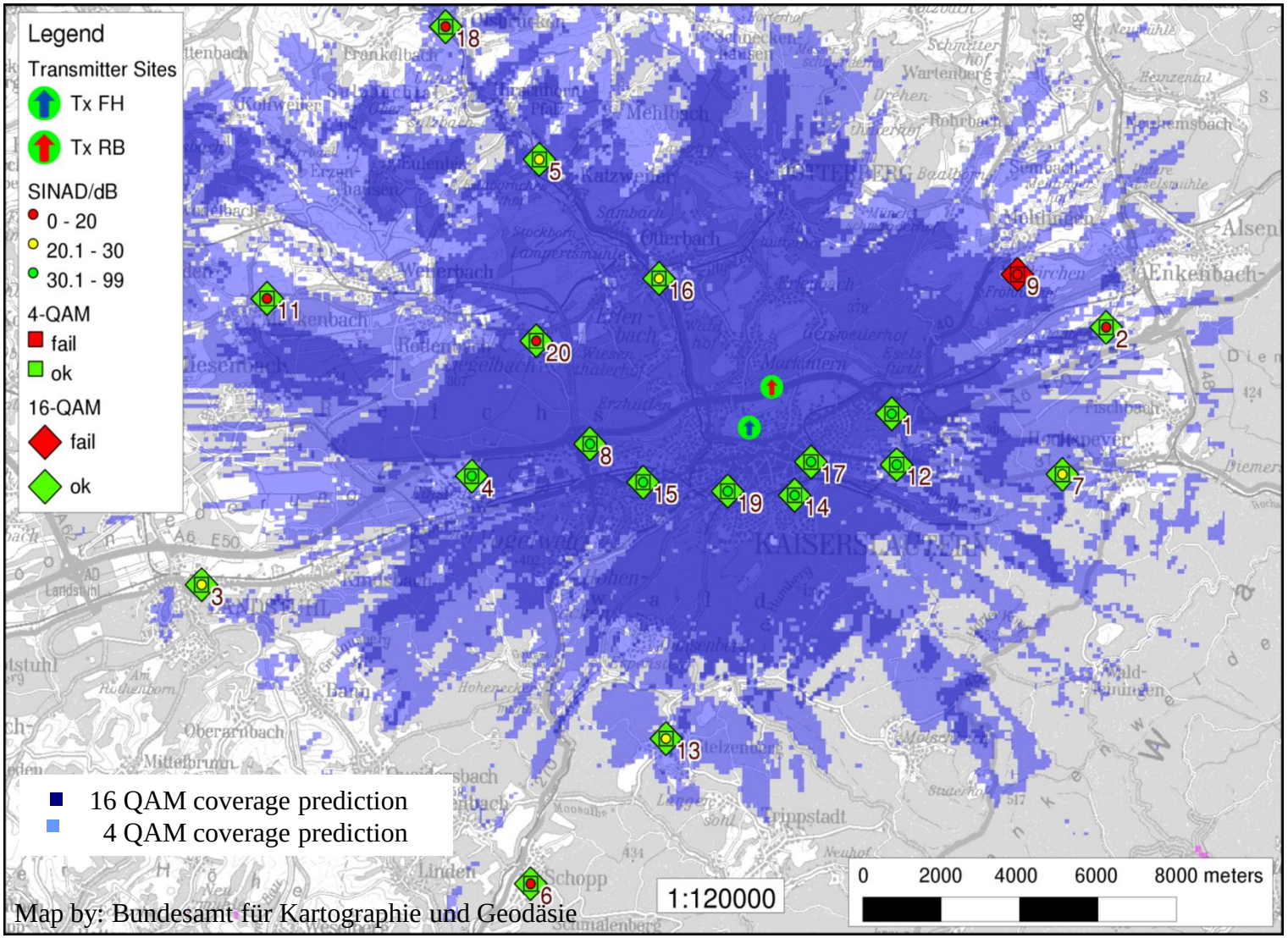


Schematics of (mobile) DRM+ RX

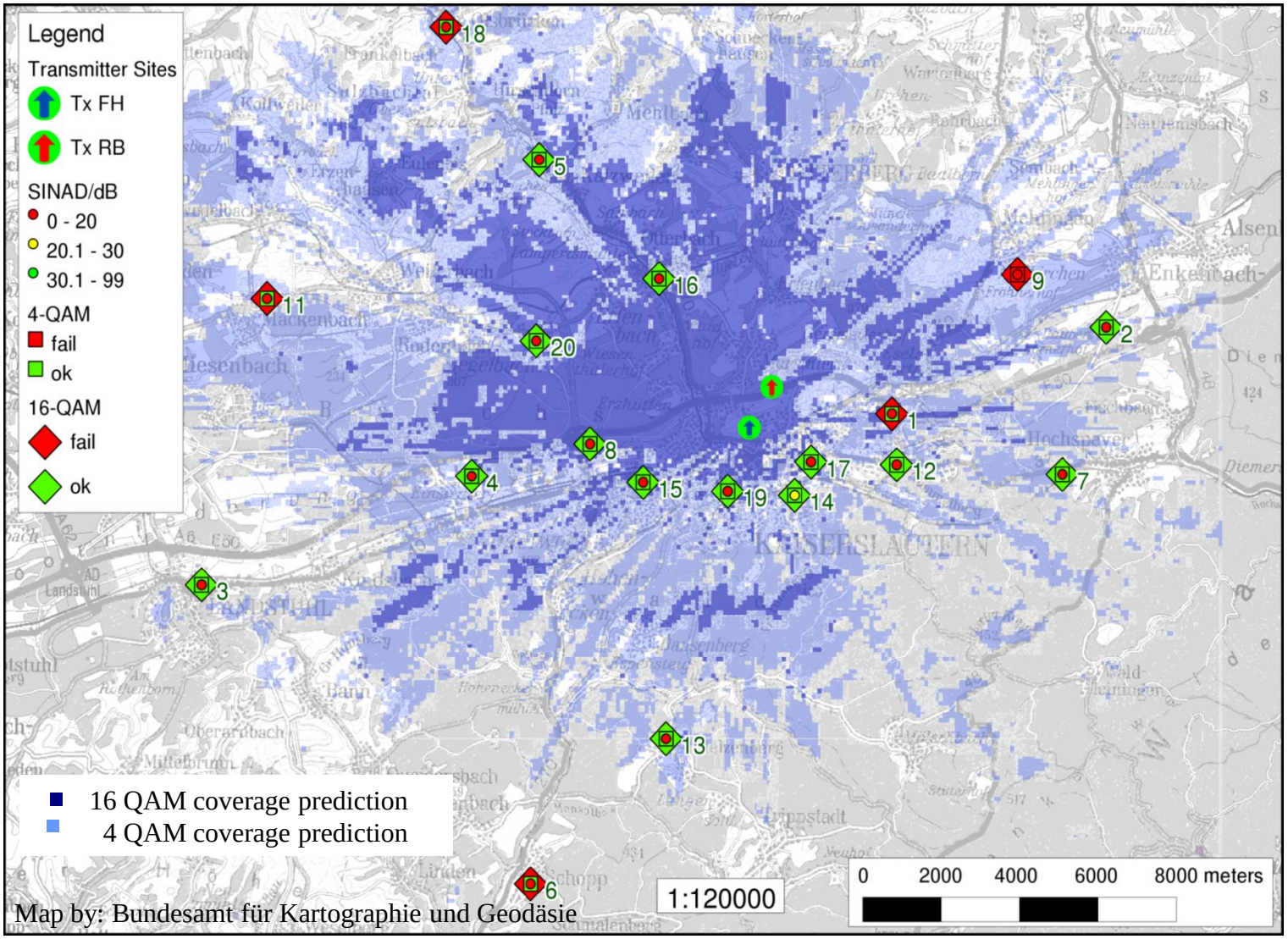


Contents Part I

Fixed FM/DRM+ Coverage -- *OFF* --

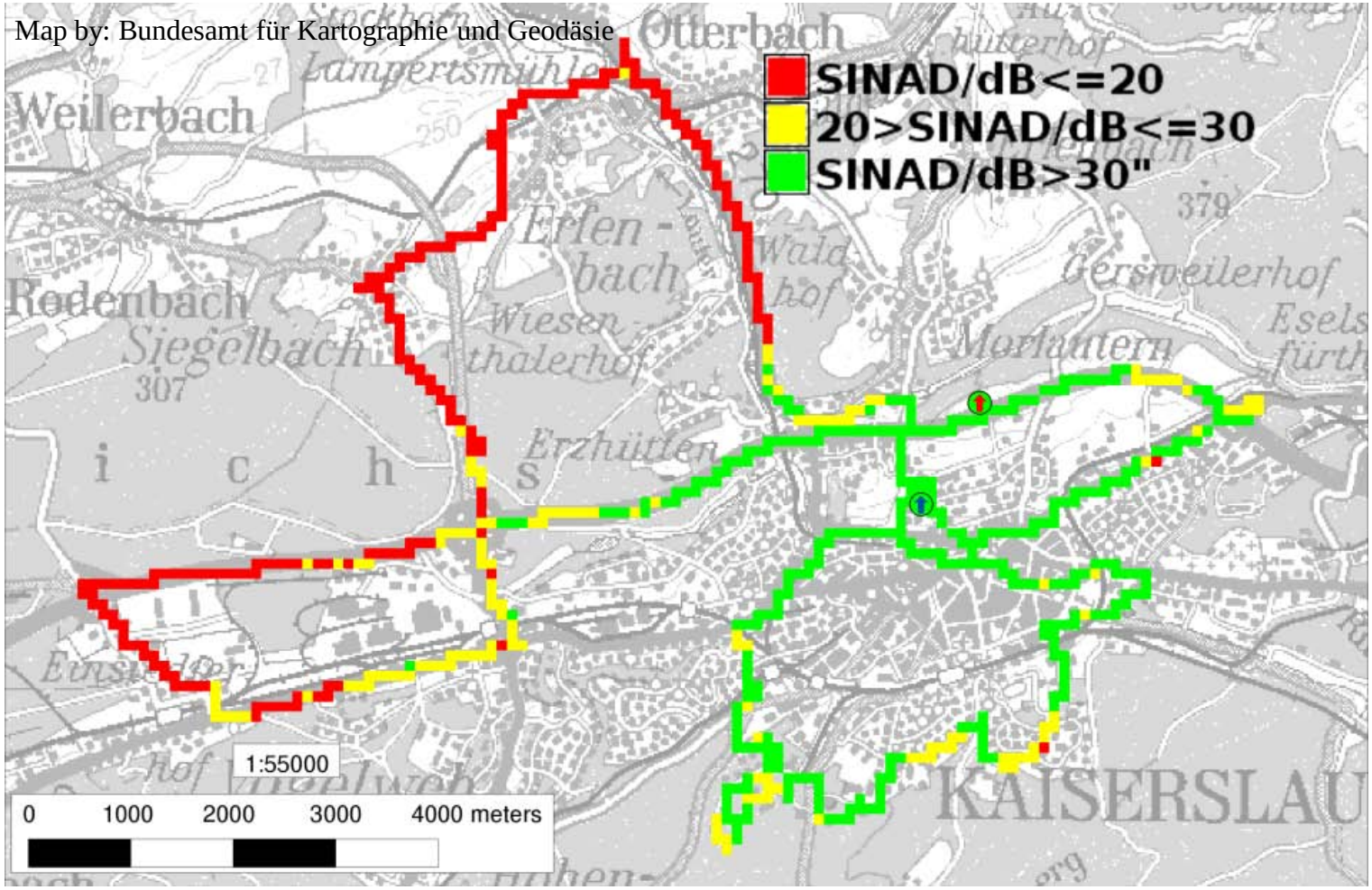


Fixed FM/DRM+ Coverage 1. adjacent channel (87.7 MHz)

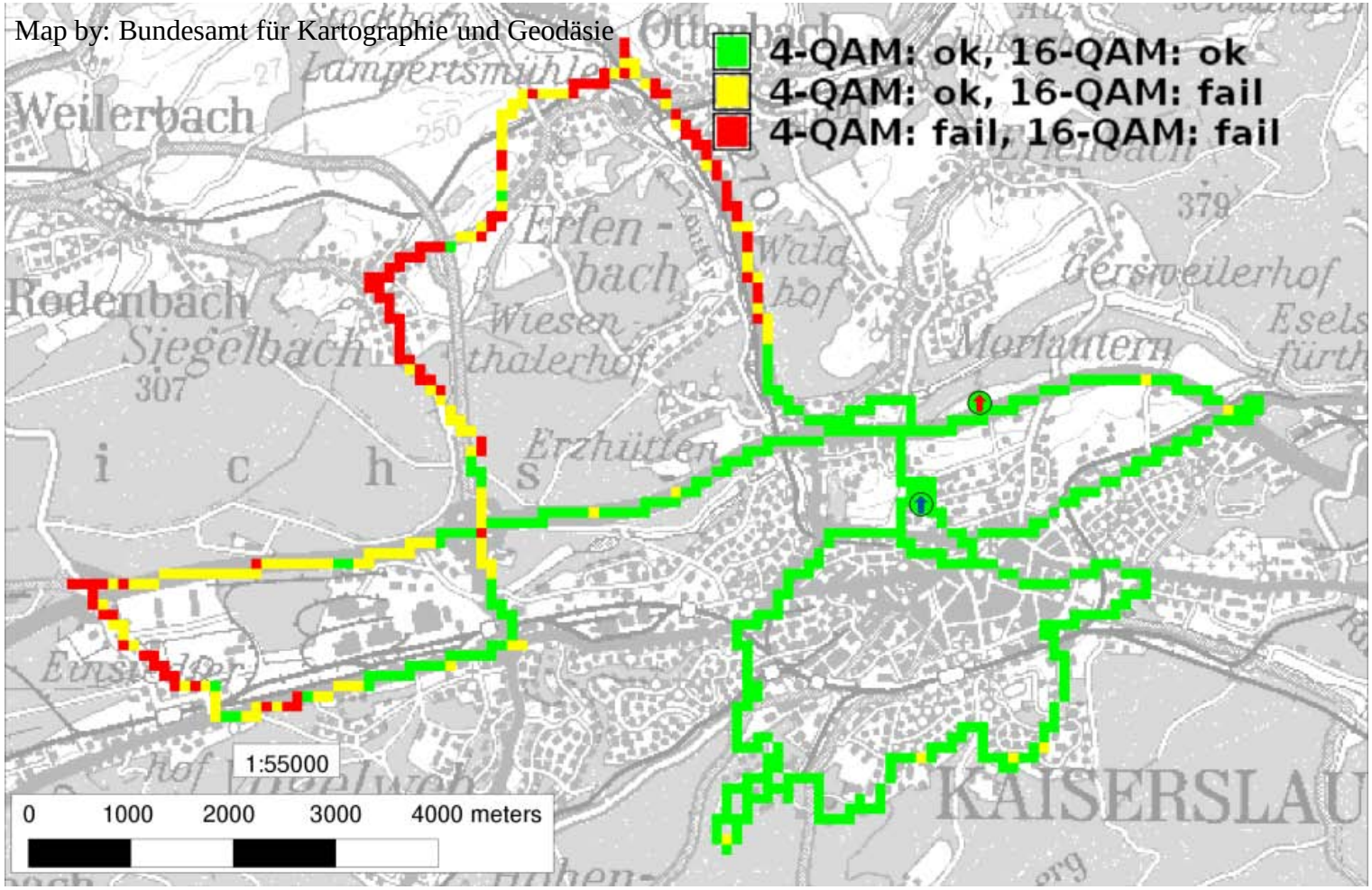


Contents Part I

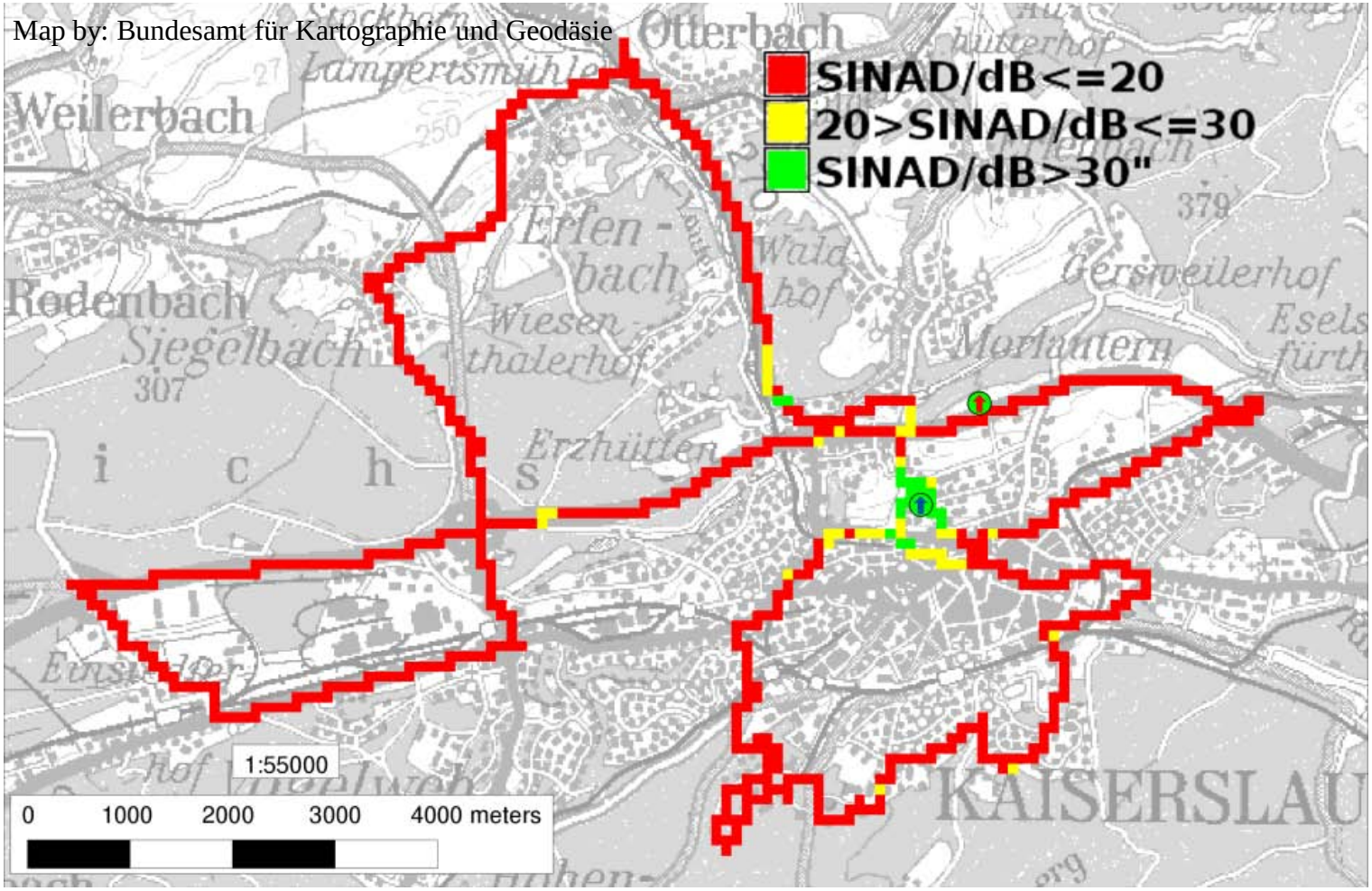
Mobile FM Coverage -- *OFF* --



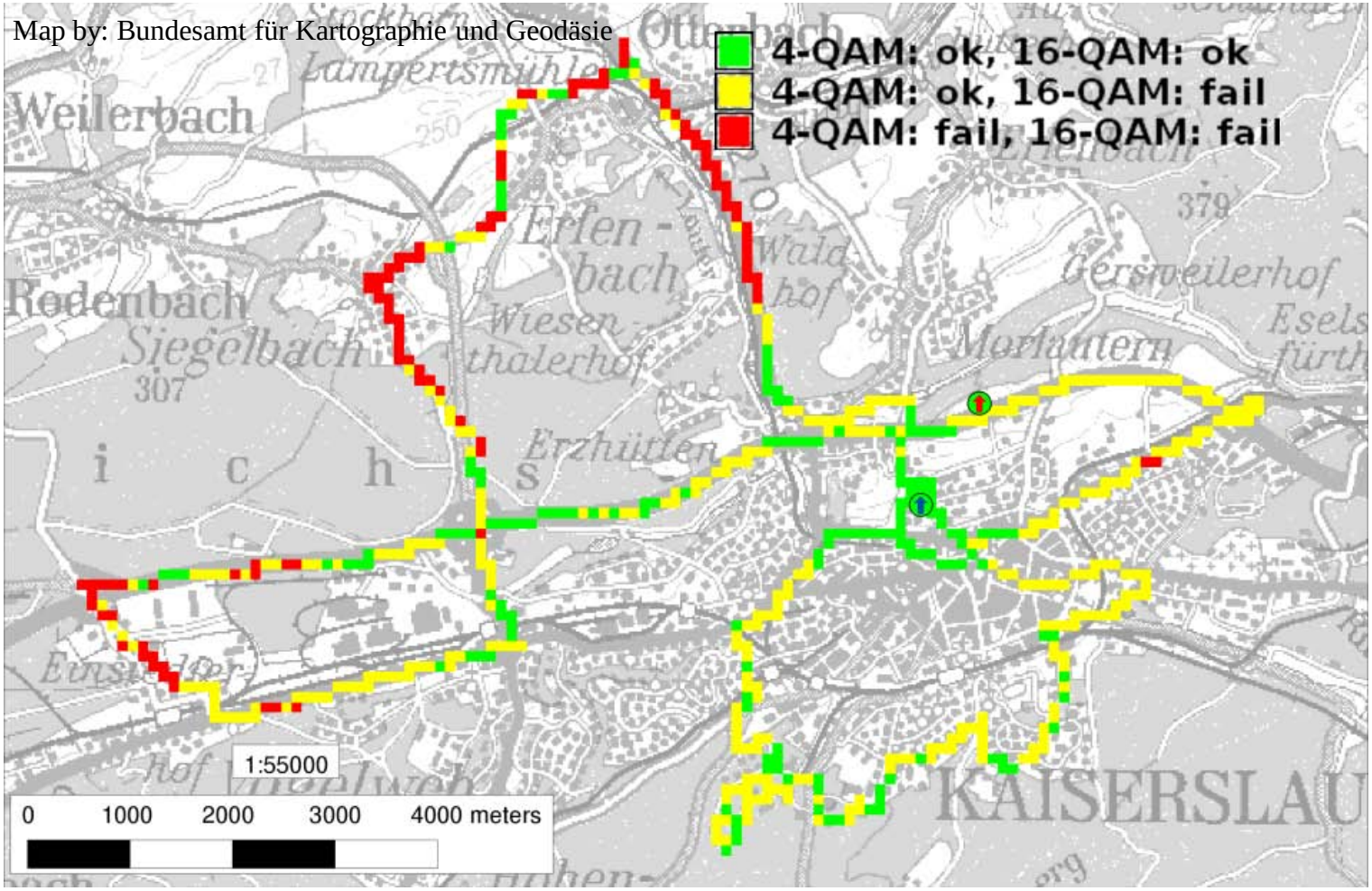
Mobile DRM+ Coverage -- *OFF* --



Mobile FM Coverage 1. adjacent channel (87.7 MHz)



Mobile DRM+ Coverage *1. adjacent channel (87.7 MHz)*



Contents Part I

Further findings and conclusion on DRM+ coverage

Some words to the wise:

1. **In the co-channel case (TX ↑ operating at full power on 87.6 MHz), both FM and DRM+ coverage break down.**

2. **In the 2. adjacent channel case, (TX ↑ operating at full power on 87.8 MHz), DRM+ coverage is the same as if TX ↑ is switched off.**

3. **DRM+ stationary coverage reserve was found to be > 20 dB as compared to FM.**

Conclusion: Our first measurement analyses propose that

DRM+ has a substantially higher coverage potential as compared to FM.

Our topics:

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New Ways for the Digitisation of the VHF-FM Sound Broadcasting with DRM+

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Review to the 9th WSDB

9th Workshop Digital Broadcasting September, 18-19 2008, Erlangen

Leaving the dead-end street:
New ways to digitise the
VHF-FM sound broadcasting with DRM+

Part II: ***First results on compatibility planning of DRM+ and HD Radio™ in the VHF ban***

Results of the investigations:

- **in general, a existing FM TX can replaced by a DRM+ TX by lowering the ERP by 5 dB to protect existing FM services,**
- **the coverage of a DRM+ TX is better than before with the FM TX, in spite of the power reduction of 5 dB.**

Outlook to the presentation on the 10th WSDB

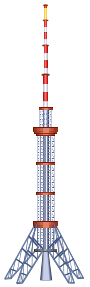
10th Workshop Digital Broadcasting September, 16-17 2008, Ilmenau

First-time analyses of *DRM+ Single Frequency Networks* (SFN) in the VHF band II with high power GE84 TX stations in the existing FM environment

Based on:

- the **measurement results** of the University of Applied Sciences of Kaiserslautern,
- the **legal radio regulation and coordination procedures** of ITU-R, Final Acts of GE84 and German BNetzA.

Made with: FRANSY FREQUENZANALYSESYSTEM



Computer based frequency and network plannings software **‚FRANSY‘** (modified for calculations with DRM+)

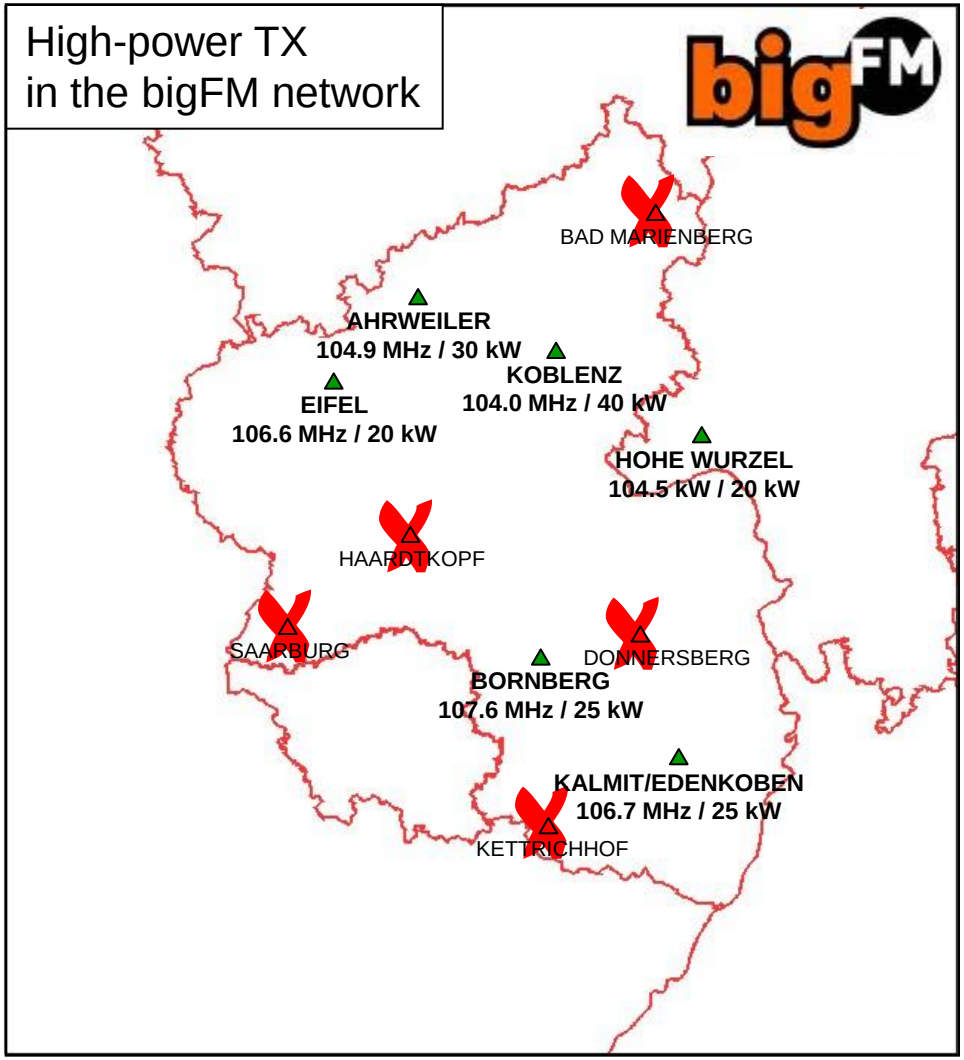
Scenario for the planning exercise

Description of the scenario:

For this DRM+ SFN planning exercise, the high power FM TX from the Geneva Plan 1984 (GE84) in the 2nd commercial FM network of Rhineland-Palatinate, Germany, assigned to bigFM, were used (*bigFM-NET)*.

Constraints of GE84 for the bigFM network:

- Only 6 high-power TX with GE84 frequencies,
- 5 TX sites without GE84 frequencies (incidently, the SWR and RPR.1 networks have high power frequencies at these or neighbored sites).



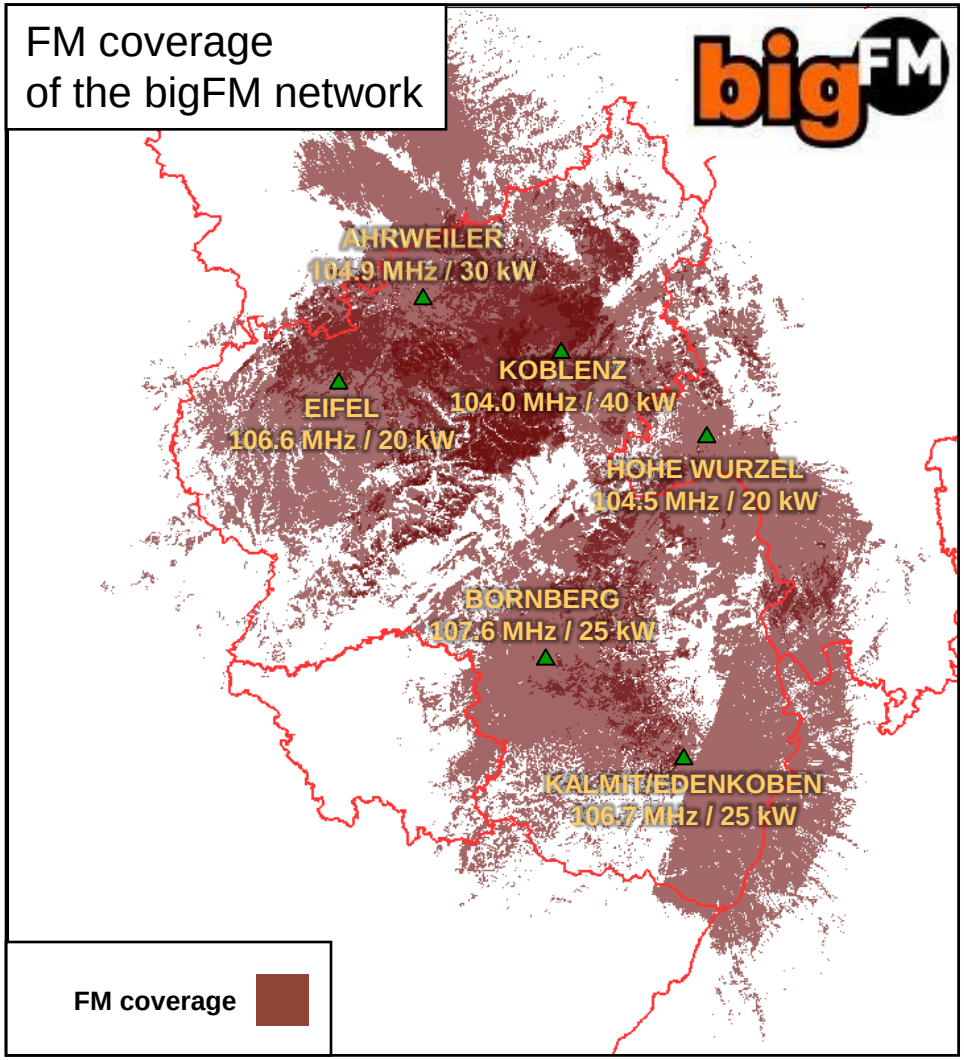
FM coverage of the bigFM-NET

Result of the FM coverage:

As a reference for the DRM+ investigations the FM coverage of all 6 basic TXs of the *bigFM-NET* with the transmission characteristics as defined in GE84 was determined (without aeronautical radio constraints).

Disadvantages due to missing frequency resources at 5 TXs:

- substantial coverage gaps,
- mobile reception is not coherent in spite of RDS.



Coverage of the bigFM-NET after direct conversion from FM to DRM+

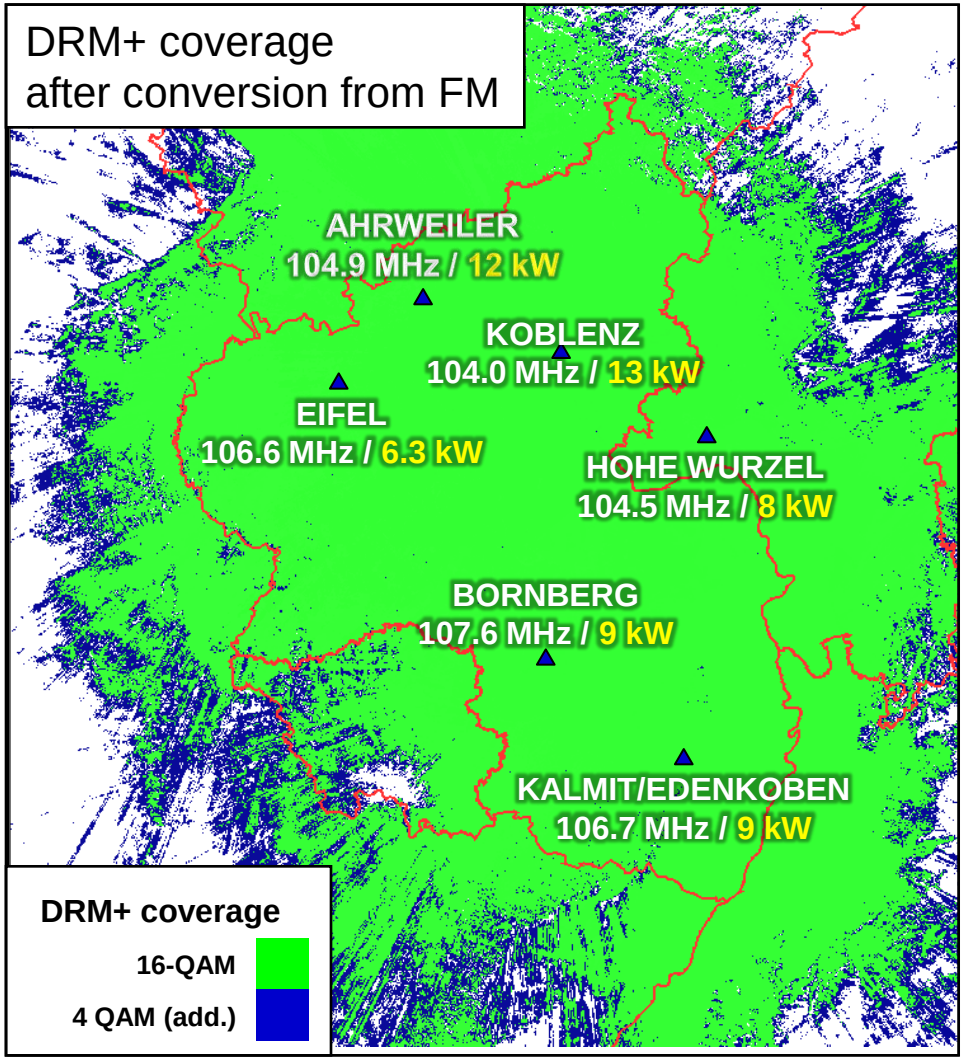
Result of the coverage after direct conversion from FM to DRM+

State wide coverage is reachable with DRM+:

- with up to 5 dB reduction of the FM ERP (as shown at the WSDB in 2008),
- with same aerial pattern as FM transmission (no change of antenna infrastructure needed).

Disadvantages of the Multi-Frequency Network (MFN):

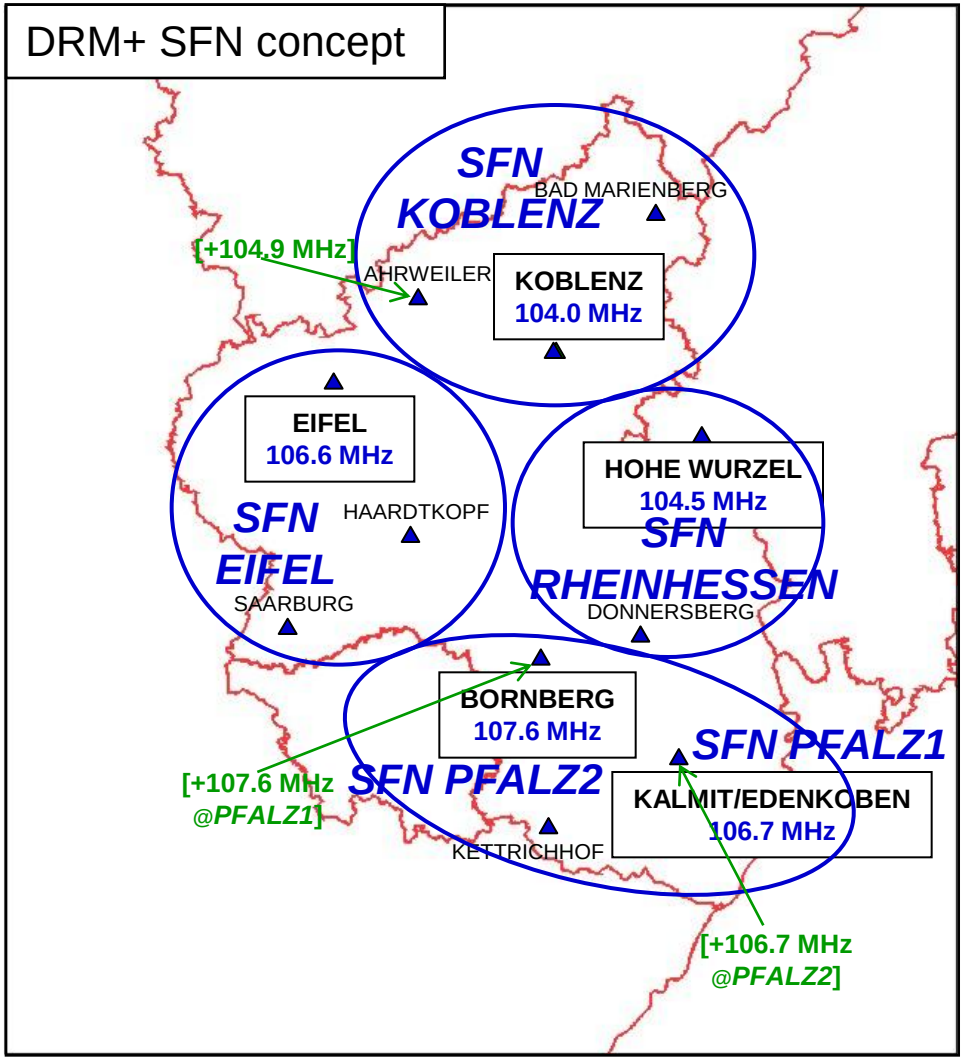
- ERPs of the TX are still high,
- coverage reliability is not basically improved for mobile reception due to hilly aeras,
- no frequency economy.



Concept of DRM+ SFN for the bigFM-NET

Regional DRM+ SFN concept with GE84 frequencies:

- 4 regional SFN are formed (with two variants for the SFN 'PFALZ'),
- the master TX of a region gives the SFN frequency,
- the other TXs in the SFN use this frequency,
- if one TX has still a GE84 plan frequency, it becomes free for other purposes,
- TX sites without GE84 plan frequency are to be merged into a fitting regional SFN.

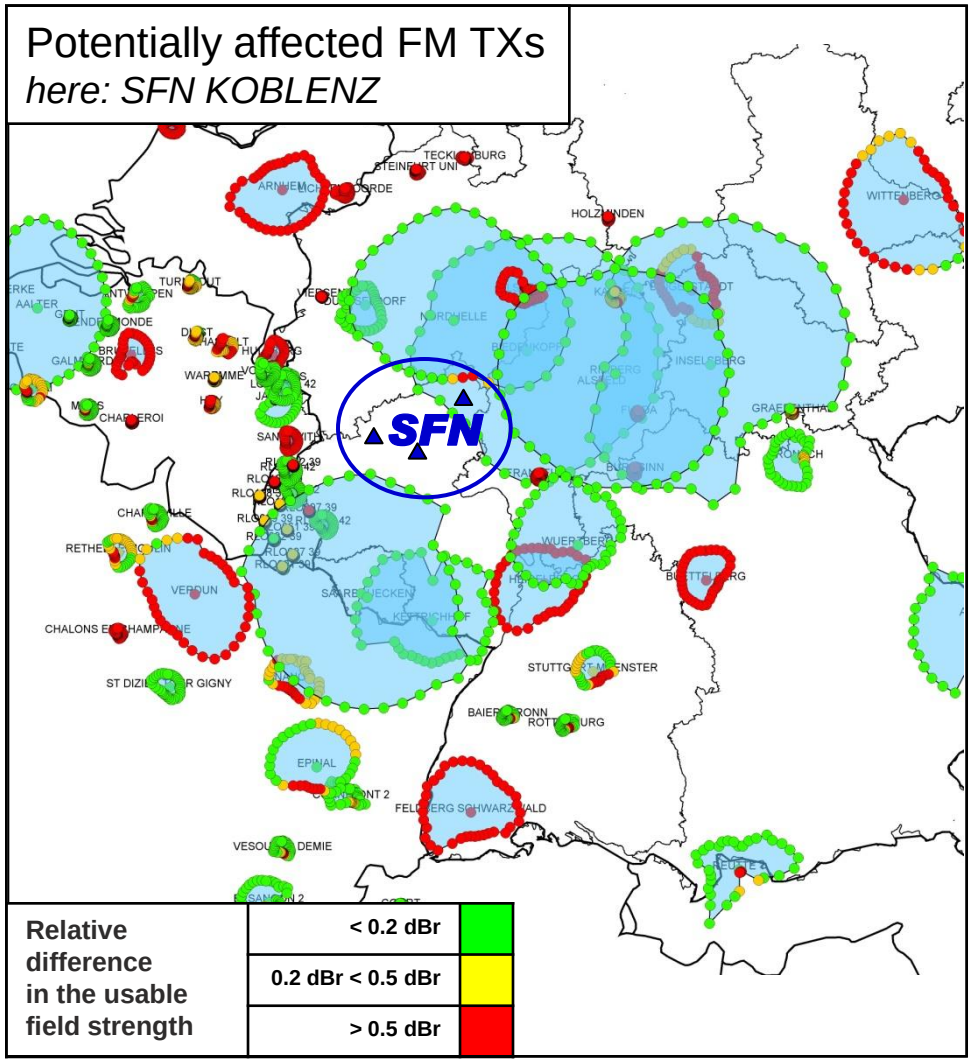


Compatibility analyses for the DRM+ SFNs

Method of the compatibility analyses:

The DRM+ SFN TXs characteristics were specified with a compatibility analysis relying on the increase of the potentially affected TXs' usable field strength by comparing the interference situation before and after the change-over:

- *BEFORE:* impact of the master TX of a SFN with its FM GE84 characteristics as reference situation,
- *AFTER:* impact of all DRM+ Txs in a SFN with GE84 characteristics, but DRM+ modulation.

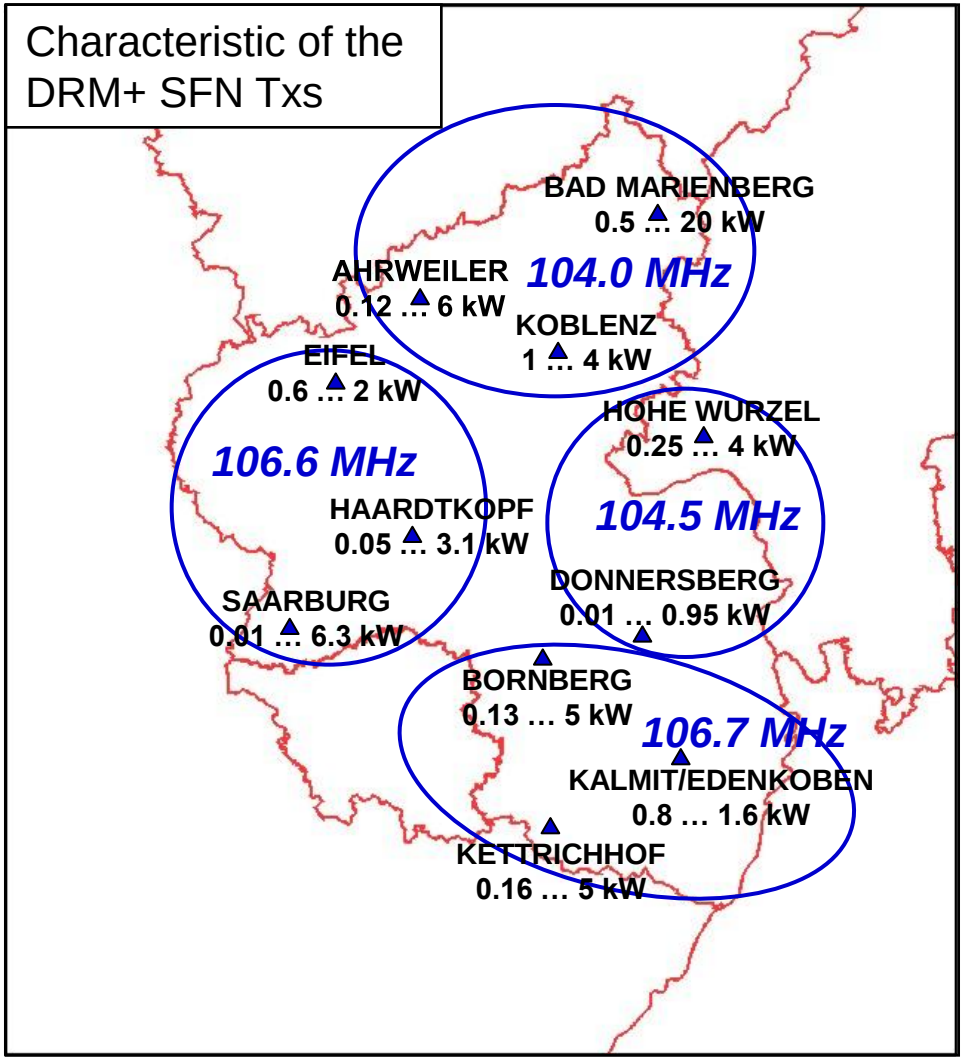


Characteristics of the DRM+ SFN TXs

DRM+ SFN TXs characteristics

Based on the legal limitation of the interference situation to protect existing FM TXs (the increase of the usable field strength of the affected FM TX must be less than 0.2 dBr) sets of valid DRM+ TX (reduced) powers and radiation patterns (in a first approach all are non directed) were calculated.

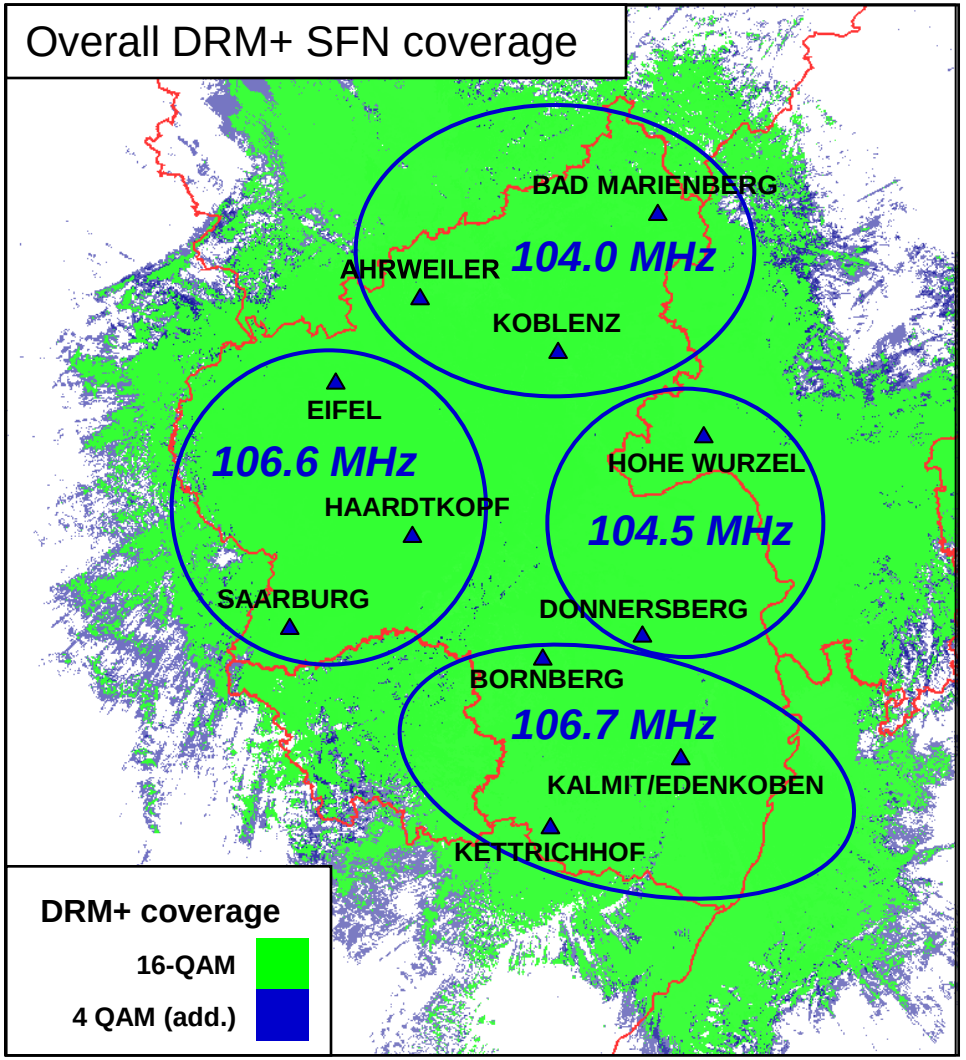
The protection ratios in the compatibility analyses (FM is interfered with by DRM+) were taken from the measurement results of the University of Applied Sciences of Kaiserslautern.



TX characteristics and coverage predictions of the DRM+ SFNs

The coverage predictions of the DRM+ SFNs based on the following parameters:

- DRM+ modulation
  16-QAM, R=1/2 and
  4-QAM, R=1/3,
- fixed reception (conditions as for FM planning),
- protection ratios (DRM+ is interfered with by FM) were taken from the measurement results of the University of Applied Sciences of Kaiserslautern.

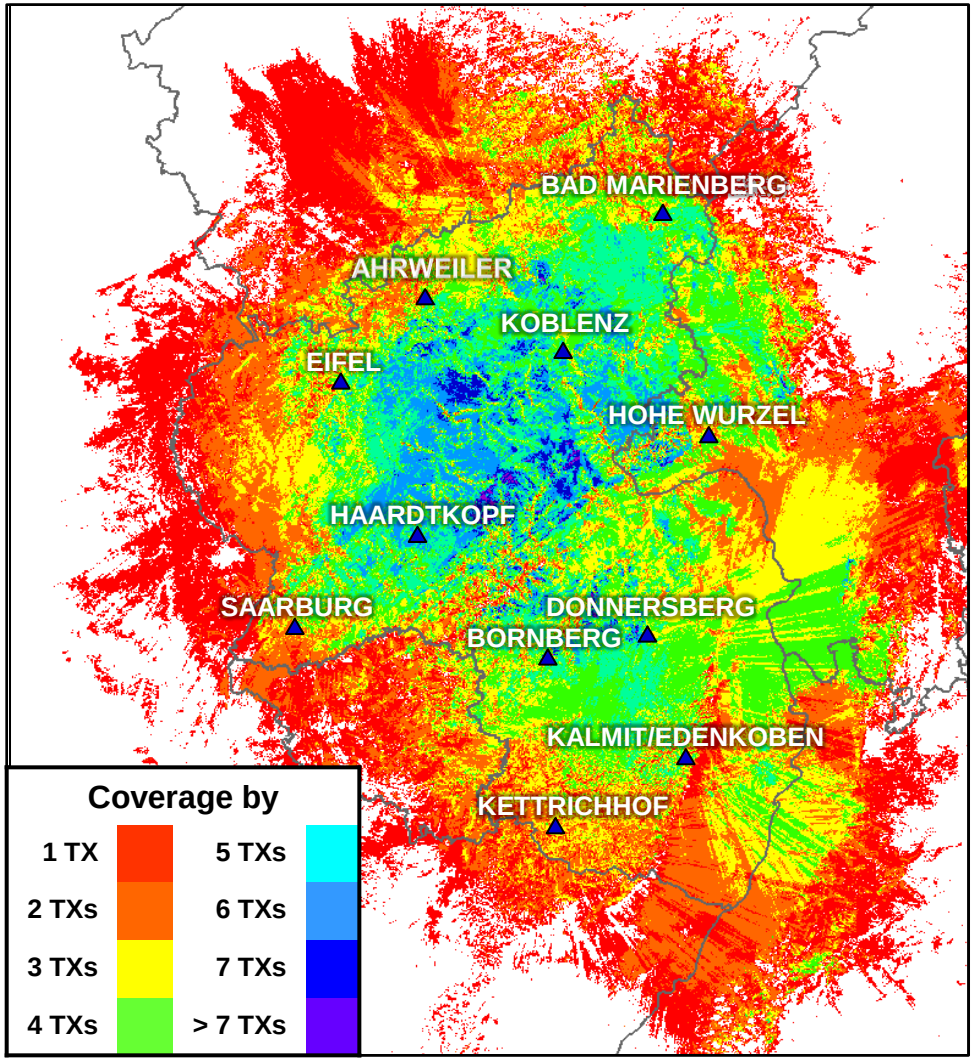


Multiple coverage of all DRM+ SFNs

Multiple coverage inside the DRM+ SFN / network gain:

Most of the locations within the state of Rhineland-Palatinate are covered by a minimum of 3 SFN TXs

This improves the coverage reliability, esp. for mobile reception, in contrast to the pure DRM+ FM switch-over in a MFN.



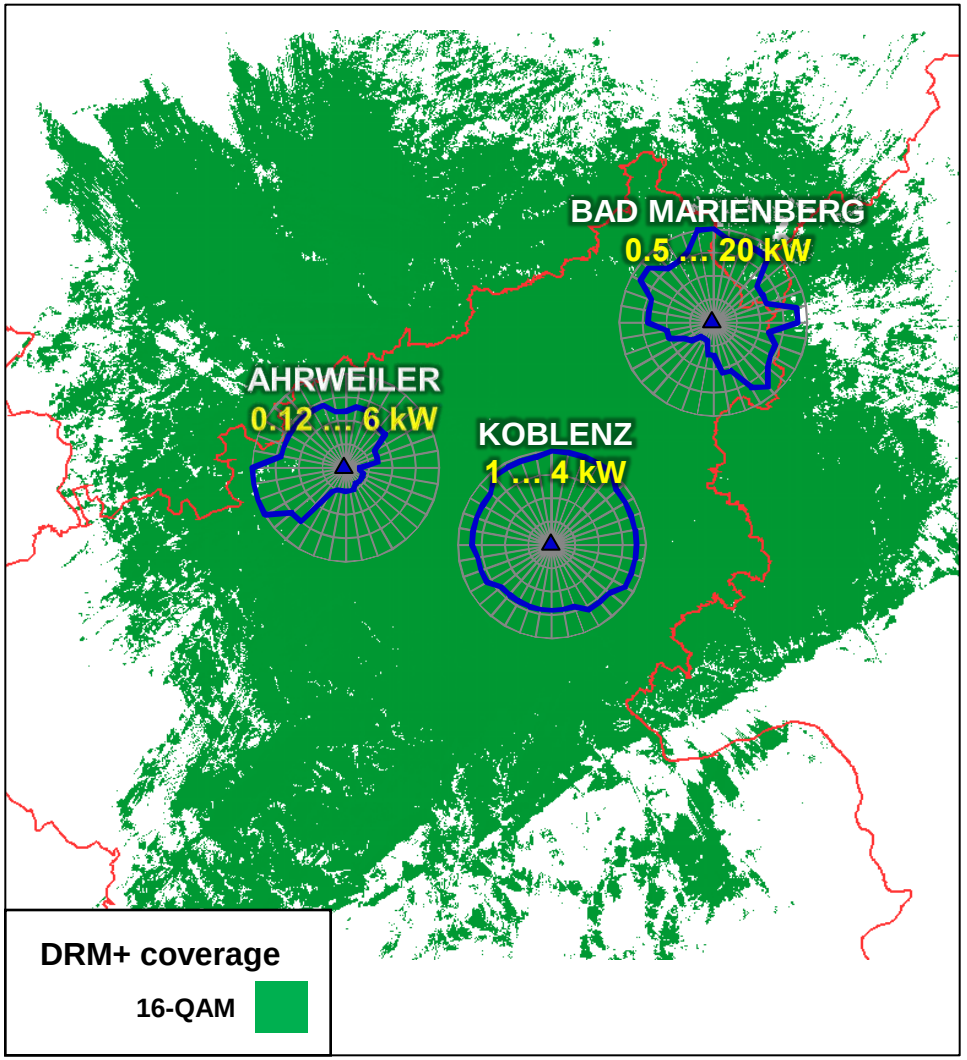
TX characteristics and coverage of DRM+ SFN KOBLENZ 104.0 MHz (1)

Automatically generated TX characteristics of the DRM+ SFN stations in 'FRANSY'

In the compatibility analysis tool of 'FRANSY', the valid sets of DRM+ TX characteristics are calculated automatically.

The result shows that the automaticlaly generated aerial patterns can practically not be implemented.

Therefore, manual adjustment of theses results is necessary to obtain feasible antenna patterns.

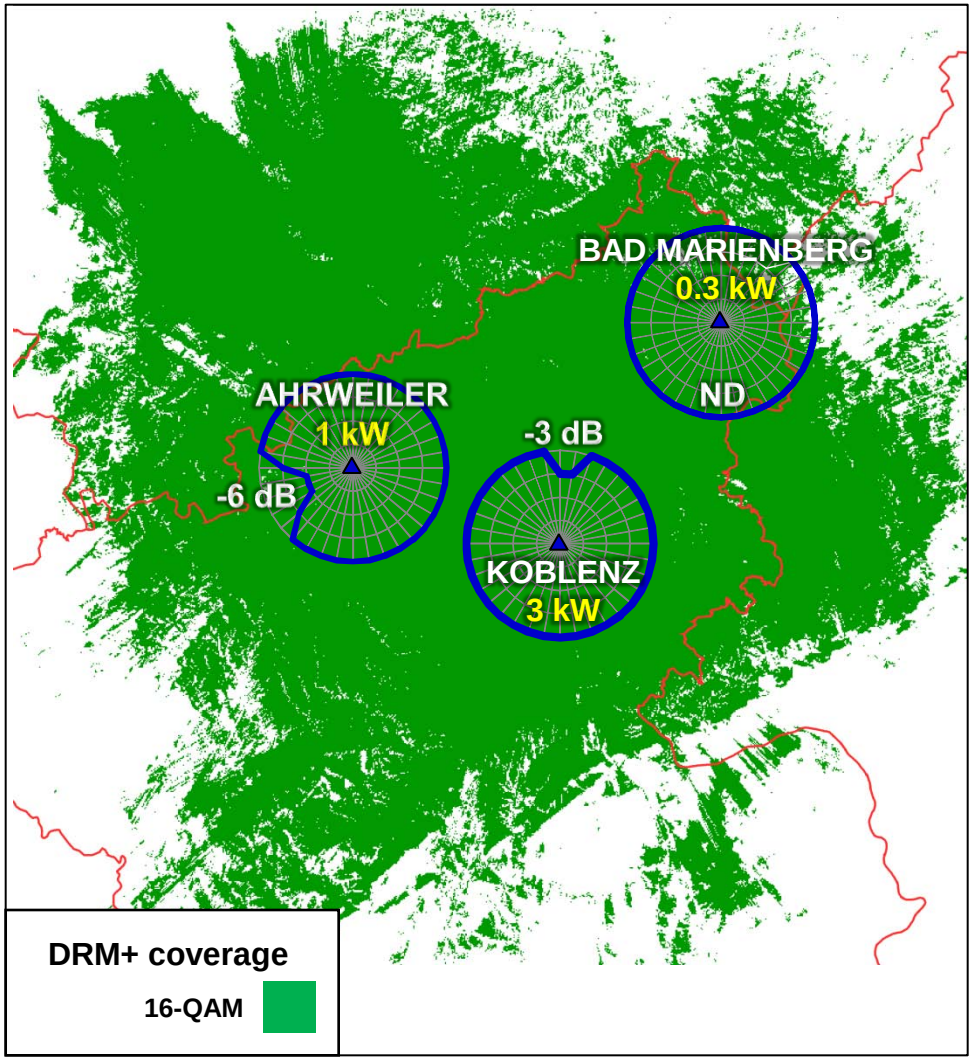


TX characteristics and coverage of DRM+ SFN KOBLENZ 104.0 MHz (2)

Manually modified TX characteristics of the DRM+ SFN stations in 'FRANSY'

The result prove that aerial patterns are feasible in a DRM+ SFN which is compatible with the existing FM environment.

The solution shown here is only one of many solutions due to the freely adjustable combinations of the radiation powers of three DRM+ TX SFN stations.



Summary

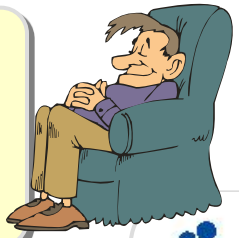
The planning exercises show that DRM+ Single Frequency Networks (SFN) created with high power FM GE84 TX stations can be deployed in a compatible way in the VHF band II with the existing FM environment!

Clear advantages of the DRM+ SFN as compared to the FM network are e.g.

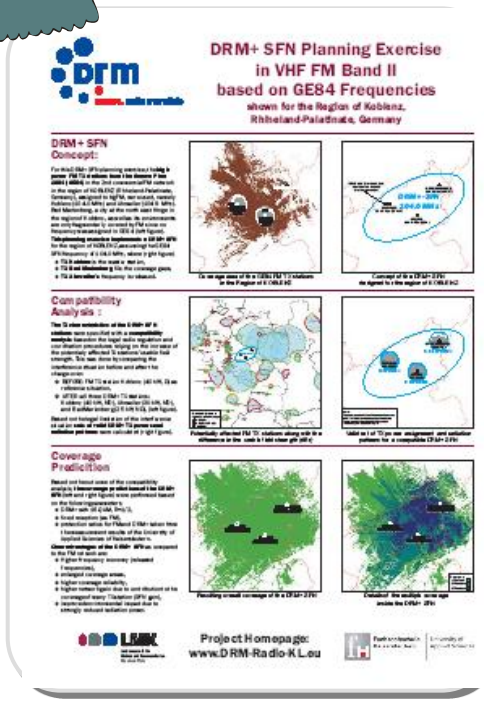
- ✓ **higher frequency economy (released frequencies),**
- ✓ **enlarged coverage areas,**
- ✓ **higher coverage reliability,**
- ✓ **higher network gain due to contribution to the coverage of many TX station (SFN gain),**
- ✓ **reduced environmental impact due to reduced radiation power.**

The end ???

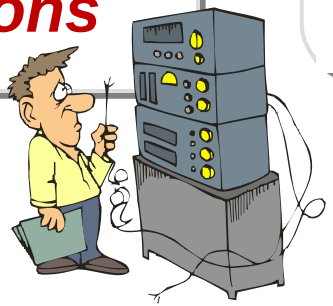
Thank for paying attention to my part of the presentation …



For more information:
See our poster
in the session later on



… now, we proceed with part III – and Band III investigations



Structure

10th Workshop Digital Broadcasting
September 16-17, 2009

Leaving the Dead-end Street:

New Ways for the Digitisation of the VHF-FM Sound Broadcasting with DRM+

Part I	Field trials on DRM+ coverage in band II
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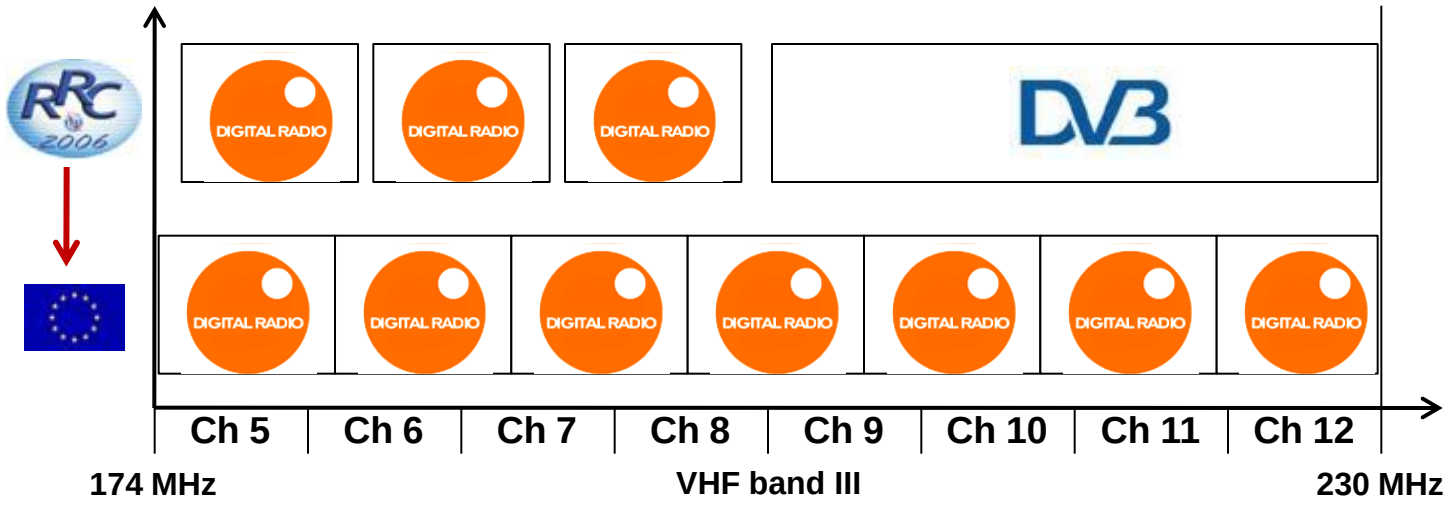
T-DAB in VHF Band III

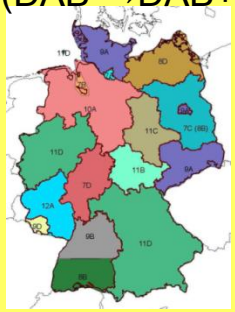
Final Acts of ITU Regional Radio Conference Geneva 2006 (GE-06):

- Frequency allocation and allotments for the transmission of DVB-T and T-DAB services in frequency Band III (174-230 MHz) and DVB-T services in frequency Bands IV/V (470-862 MHz).
- Generally, 3 T-DAB and 1 DVB-T 'coverage layers' in the Band III and 7-8 DVB-T layers in Bands IV/V.
- **national re-planning in Europe afterwards:**
  only T-DAB in Band III with 6-7 'layer' for DAB+ and DMB;
  DVB-T only in Band IV/V.



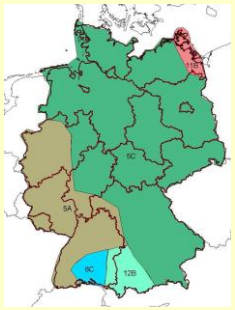
Concept in Germany for T-DAB block allocations and ‚layer' in VHF Band III

(DAB →DAB+)



State-wide layer
in use (WI95)

(DAB+ from 2010?)



Nation-wide layer
in progress

(DAB+ from 2010?)

State-wide layer
in progress
(in some states)

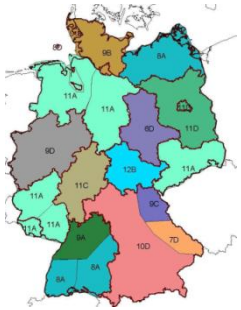
(DAB+ from 2010?)

Regional layer
in progress
(in some states)

(DMB from 2012?)

State-wide layer
in consideration

(DMB from 2012?)

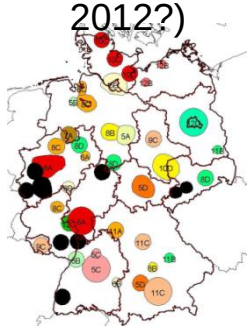


Interstate layer
in consideration

(DMB from 2012?)

Interstate layer
in consideration

(DAB+/DMB from 2012?)



Metropolitan layer
in consideration

The future of VHF band III for broadcasting services

The future of DAB in VHF band III

- VHF-Band III (174 – 230 MHz) is uniquely assigned to **digital sound broadcasting**,
- with DAB+ in MPEG-4 an average of 16 digital sound programmes can be broadcasted in one DAB multiplex signal; therefore less 'layers' are needed for the same bundle of sound programmes as with DAB in MPEG-1,
- DMB (also DVB-H) had failed in the market for mobile broadcasting, and DVB-T2 is in approach,
- DAB cannot map local or regional coverages for single sound programmes.

Conclusion: The original intention of entirely filling band III with DAB will not become reality: today, it is obvious that **only a portion of band III will be used by DAB**. Who will use the rest – is this a potential 'Digital Dividend' for other services?

Therefore, also to save spectrum for broadcasting services:

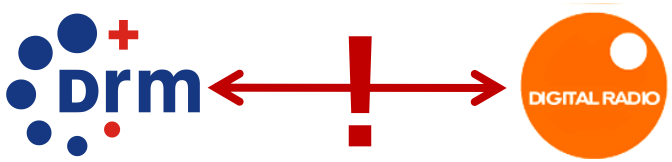
Is it possible, that single radio stations with clear regional and/or local focus could be planned as DRM+ stations in appropriate free DAB blocks?

Short-list of non-technical advantages

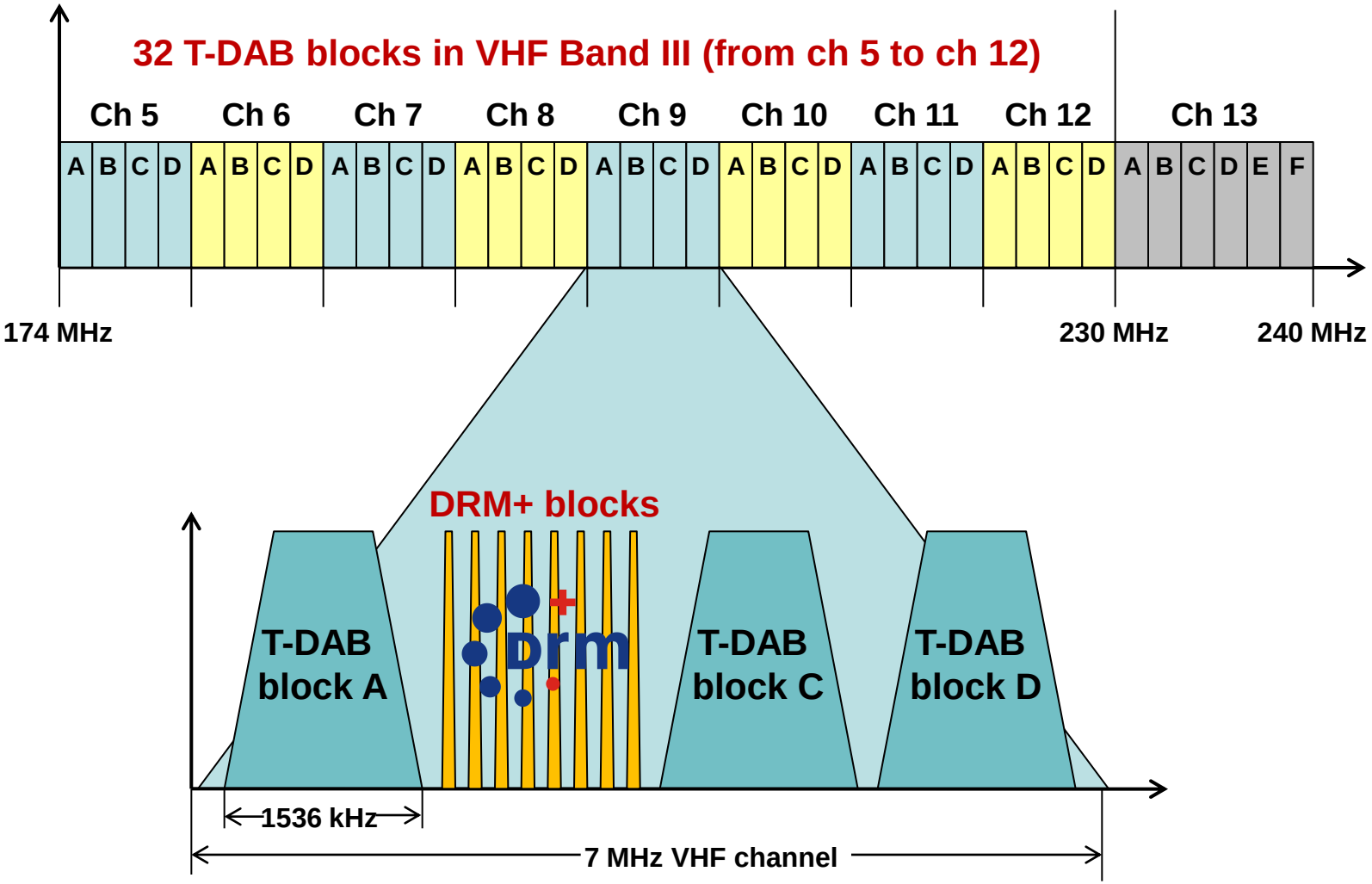
Advantages of DRM+ in VHF band III

- The non solved **legal** and still pending **compatibility testing procedures** between digital systems in band II and the **aeronautical services** – which today prevent DRM+ from being introduced in band II in the near future – are of minor concern in band III, except for the upper part, i.e. for frequencies > 223 MHz.
- Since in VHF band III, only digital systems are deployed, coordination issues are much easier to solve than those encountered if, in band II, a mixed analogue-digital scenario becomes reality. This applies especially to **international coordination** and agreements on protecting existing FM services.
- Since the DAB family and DRM+ have a great technical deal in common, i.e. MPG4-AAC, OFDM modulation, …, building **cost efficient digital RX** should be possible.

So: It's worth having a look at DRM+ in band III!



T-DAB frequency blocks VHF Band III



Outlook to future works with DRM+ in VHF band III

Objects of future measurements and field trail with DRM+ in VHF band III

- Validate the use of DRM Mode E (DRM+) in band III, esp. for portable and mobile reception.
- First fundamental protection ratio measurements to evaluate compatibility issues.
- Conduct field trials (using the existing 2 sites: DRM+  , DAB ) to validate the mutal interference potential in the field.
- Perform both fixed and mobile measurements to assess coverage issues.

And now it is really the end!

RheinlandPfalz
Wir machen's einfach.

drm

Thank you for your attention…

… further information on www.DRM-Radio-KL.eu