



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 band

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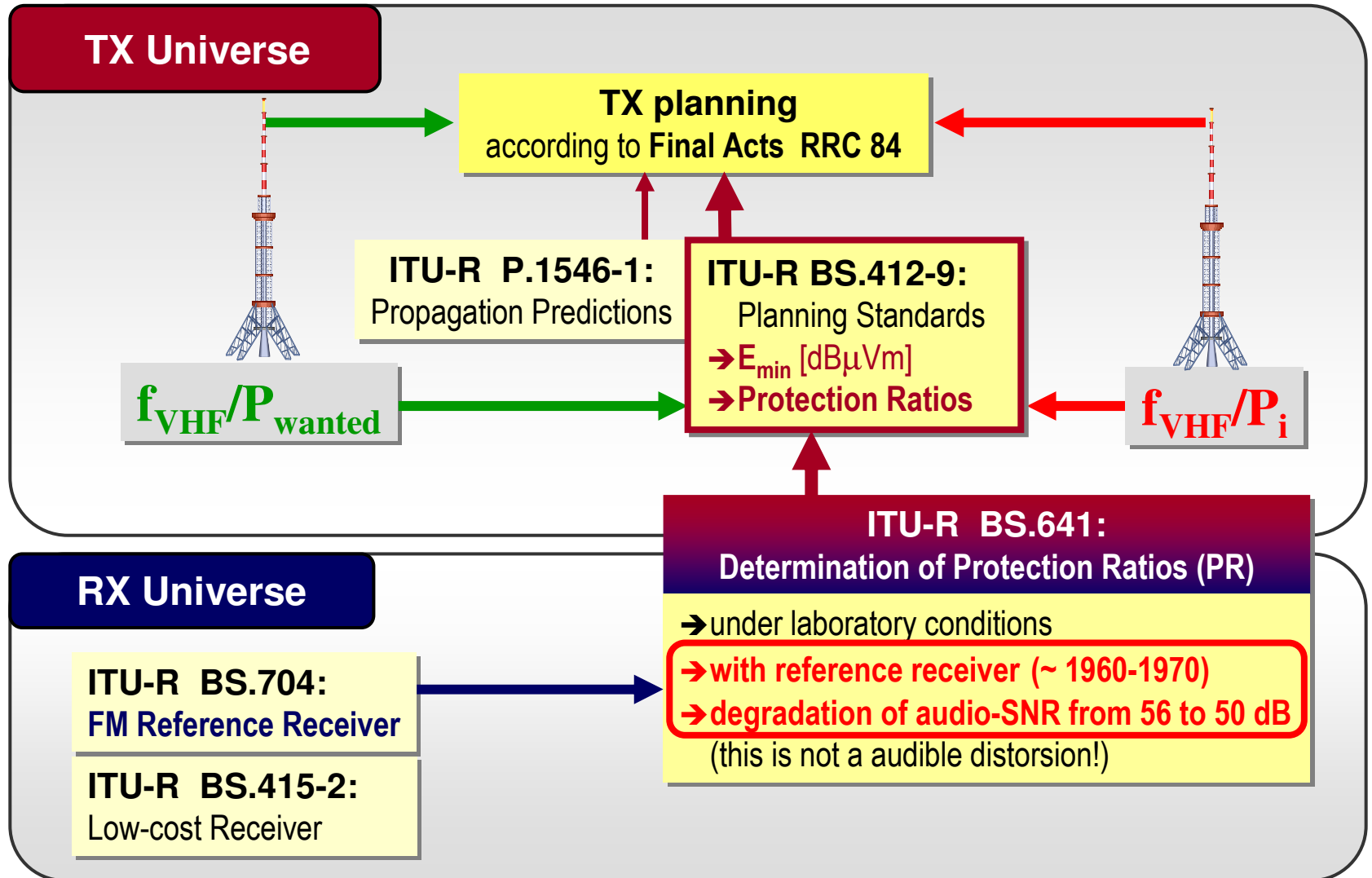
► **Outline**



**First results on compatibility planning
of DRM+ and HD Radio™ in the VHF band**

- 1 Principles of frequency planning in VHF FM Band**
- 2 Frequency planning with DRM+**
- 3 Frequency planning with HD Radio™**
- 4 Leaving the dead-end street with *DRM+ Hybrid Mode?***
- 5 Summary: problems and approach to solutions**

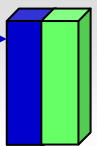
► Principles of frequency planning from the beginning of FM broadcasting on



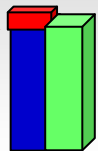
► **Principle of VHF FM frequency planning**

1st: Calculation **without** new TX:
 Determination of the interference contour
 (wanted field strength = „usable field strength“)

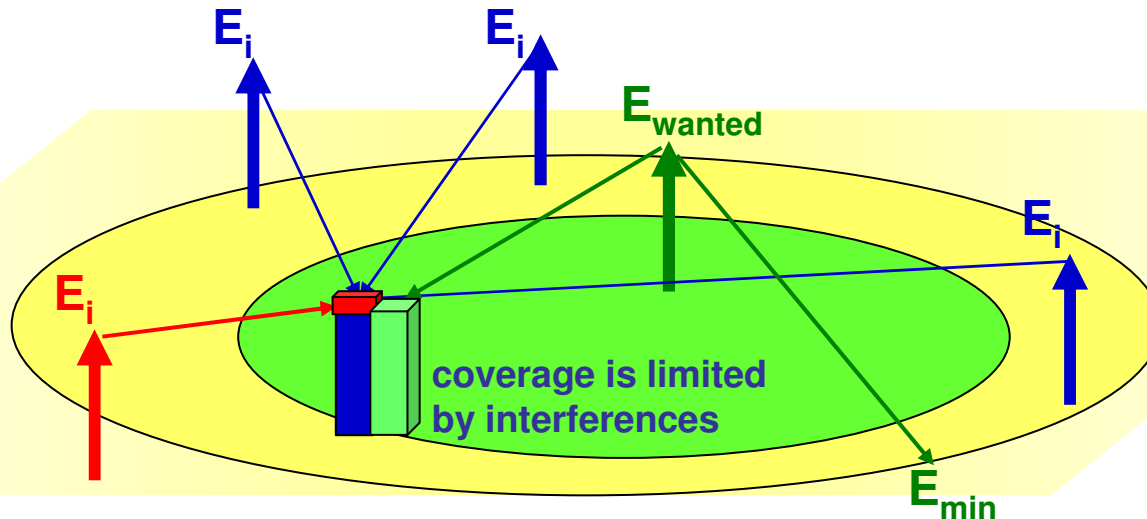
$$E_{U, before} = \prod_{i=1}^m (E_{i, 1\%}^i + PR_{\Delta f}^i [+G_E^i])$$

$$E_{wanted, 50\%} = E_{U, before}$$




2nd: Calculation **with** new TX :
 Calculation of „usable field strength“ with new TX
 at the interference contour and at TX site :

$$E_{U, new} = \prod_{i=1}^{m+1} (E_{i, 1\%}^i + PR_{\Delta f}^i [+G_E^i])$$


TX planning Criterion: new TX interferes if: $E_{U, new} > E_{U, before} + 0.5dB$



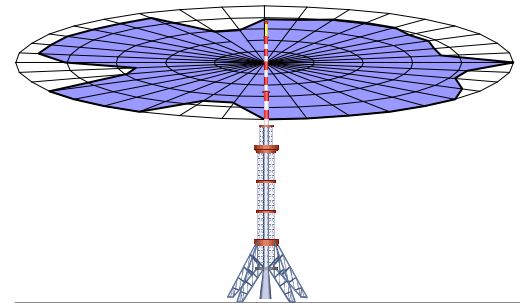
► **Frequency and network planning software „FRANSY“**

Computer based frequency analyses with frequency and network planning software „FRANSY“ (modified for calculations with HD Radio™ und DRM+) **and ITU-R BS.412-9 as basis**

Interference analysis to identify the impact of the new TX planning onto existing FM services
according to the ITU recommendations

Compatibility analysis to identify the constraints for the new TX to protect existing FM services
based on the so called 'Administrative Proceeding of Potentially Concernment' of the German BNetzA



transmission characteristics of new TX, esp. radiation pattern

Coverage analysis to identify the service area of new TX
according to the ITU recommendations

► **Analysed VHF FM TXs**

VHF FM TXs which serve Kaiserslautern

SWR1 / 90.8 MHz / 25 kW
SWR2 / 93.9 MHz / 25 kW
SWR3 / 97.5 MHz / 25 kW
SWR4 / 99.6 MHz / 0.5 kW
RPR1 / 103.1 MHz / 25 kW
BigFM / 107.6 MHz / 25 kW

Bornberg

Donnersberg

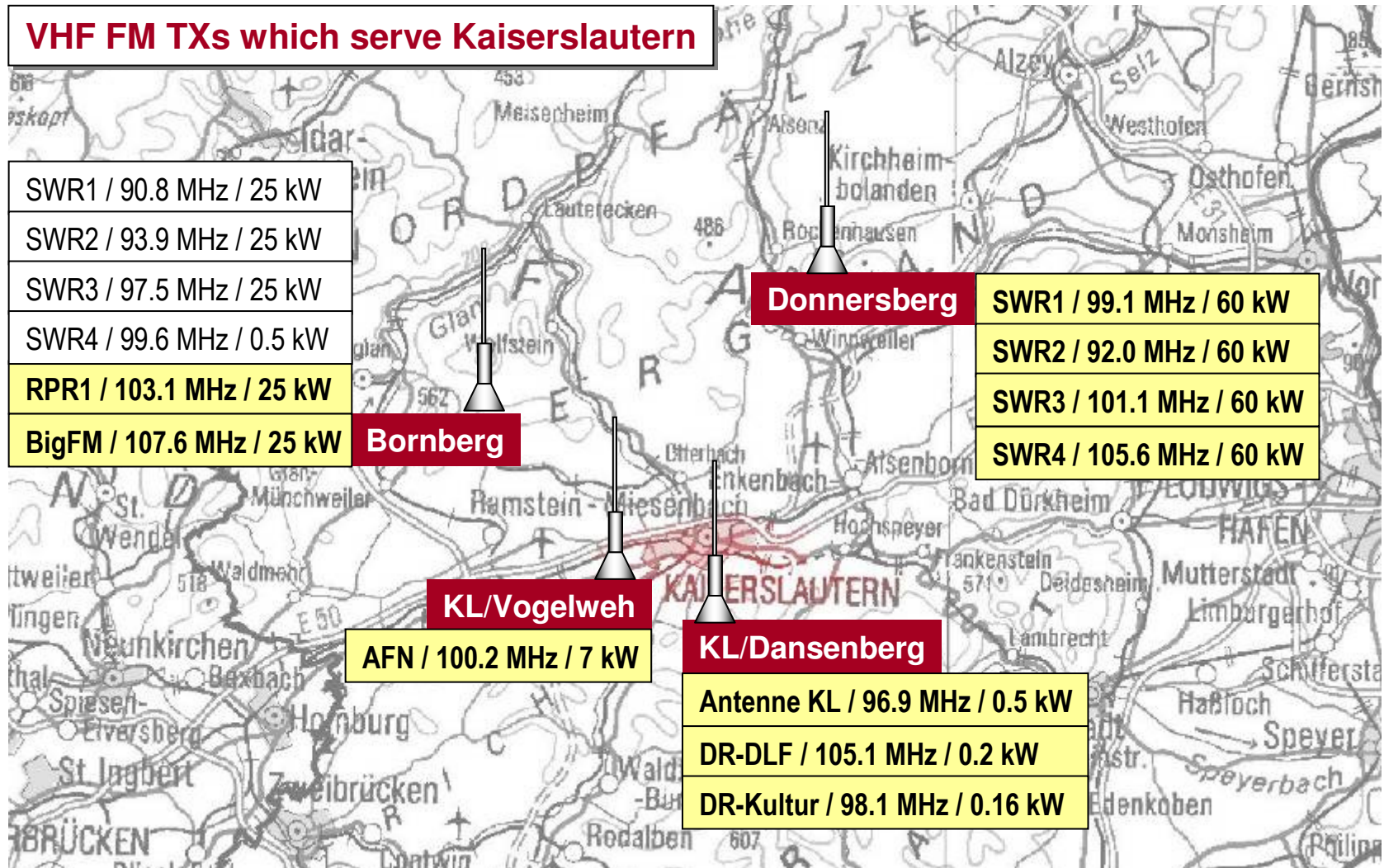
SWR1 / 99.1 MHz / 60 kW
SWR2 / 92.0 MHz / 60 kW
SWR3 / 101.1 MHz / 60 kW
SWR4 / 105.6 MHz / 60 kW

KL/Vogelweh

AFN / 100.2 MHz / 7 kW

KL/Dansenberg

Antenne KL / 96.9 MHz / 0.5 kW
DR-DLF / 105.1 MHz / 0.2 kW
DR-Kultur / 98.1 MHz / 0.16 kW



Map by: German Bundesamt für Kartographie und Geodäsie

► **Outline**



**First results on compatibility planning
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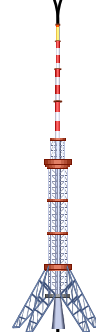
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► Protection ratios for the analyses with DRM+

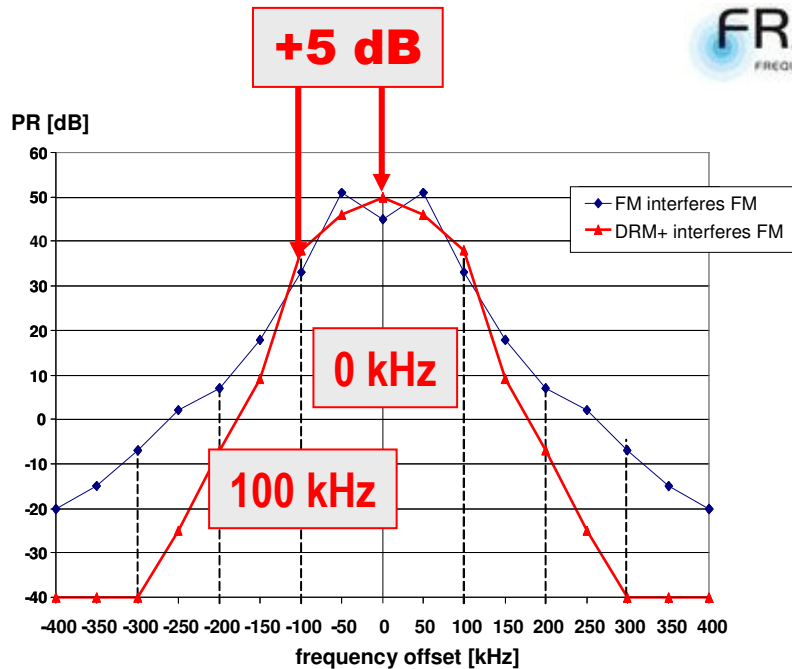
FM

Protection ratio for FM interfered with by DRM+

based on the results of the laboratory measurements and the field trial in 2007/08 and on ITU-R BS.412-9 and ITU-R BS.641-2

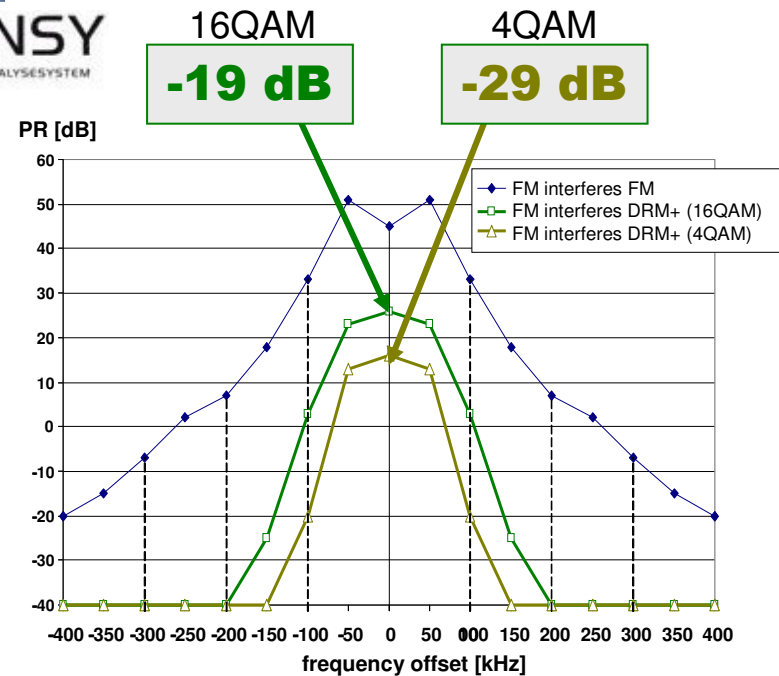


FRANSY
FREQUENZANALYSESYSTEM




Protection ratio for DRM+ interfered with by FM

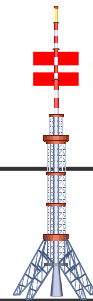
based on latest studies in 2008



► *First results of compatibility analyses for DRM+*

	Kaiserslautern				Bornberg		Donnersberg			
f [MHz]	98.1	105.1	96.9	100.2	103.1	107.6	99.1	92.0	101.1	105.6
P _{FM} [kW]	0.16	0.2	0.5	7	25	25	60	60	60	60
P _{DRM+ - FM} [dB]	-4.3	-2.5	-2.6	-3.9	-4.7	-4.7	-4.7	-4.7	-4.6	-4.6

FM - 5 dB = 

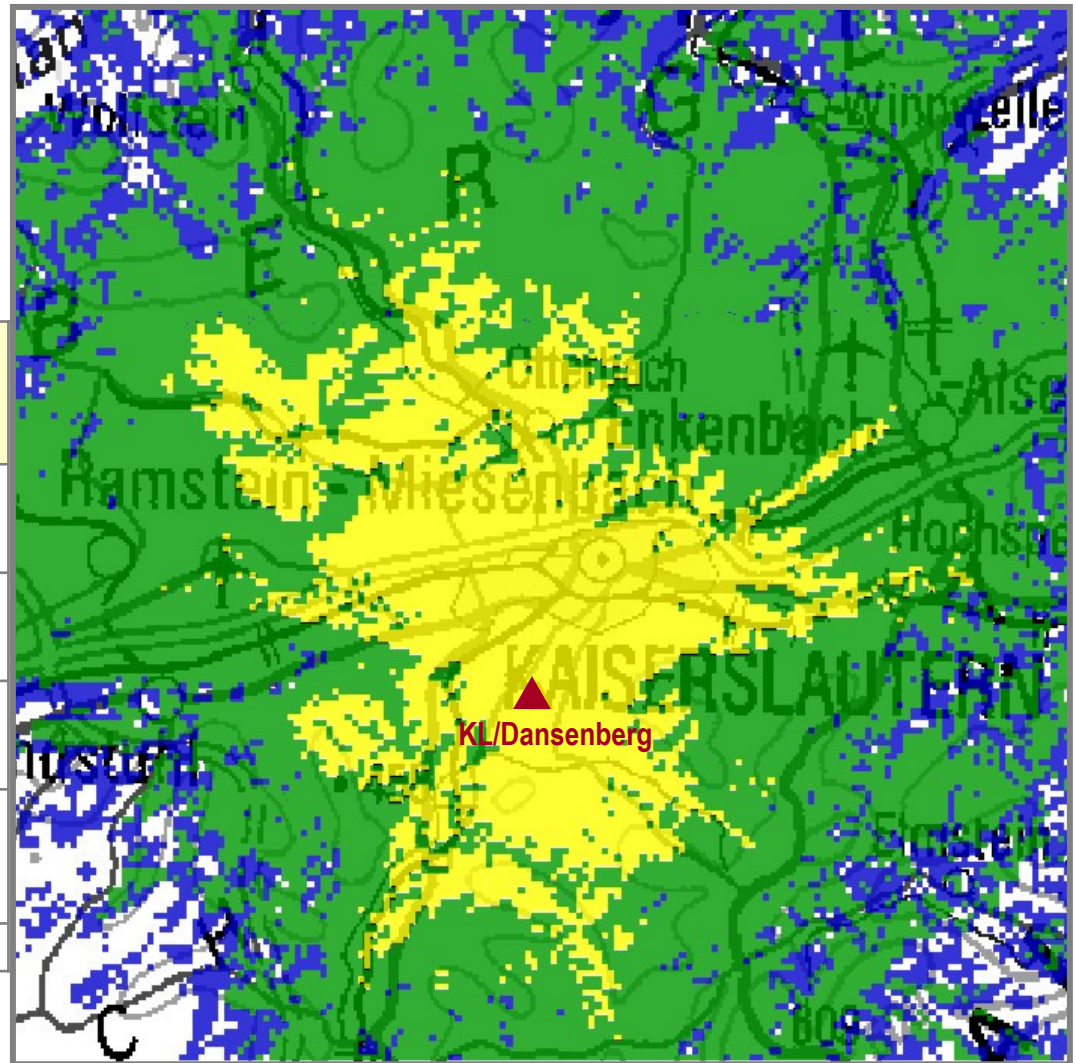


These results suggest that
 → in general, **a existing FM TX can be replaced by a DRM+ TX by lowering the ERP by 5 dB** to protect existing FM services


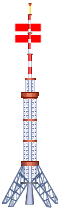
► *Example of coverage analysis for converting a TX from FM to DRM+*




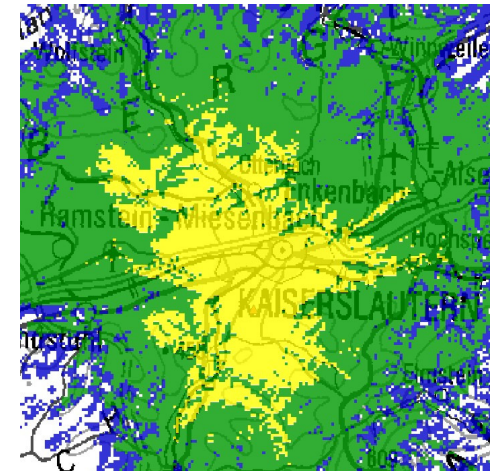
Coverage area of the TX ,Kaiserslautern Dansenberg' 96.9 MHz (Antenne KL)	
FM / 0.5 kW	$E_{\min FM} = 54 \text{ dB}\mu\text{V/m}$
DRM+ 16QAM / 0.16 kW	$E_{\min DRM+} = 25 \text{ dB}\mu\text{V/m}$
DRM+ 4QAM / 0.16 kW	$E_{\min DRM+} = 15 \text{ dB}\mu\text{V/m}$
Coverage according to ITUR BS.412-9 (aerial G=6 dB, 10m) considering the 20 strongest interferers	
Map by: German Bundesamt für Kartographie und Geodäsie	



► *First results of coverage analyses for DRM+*

with **FM - 5 dB** = 


Coverage_{FM} < Coverage 

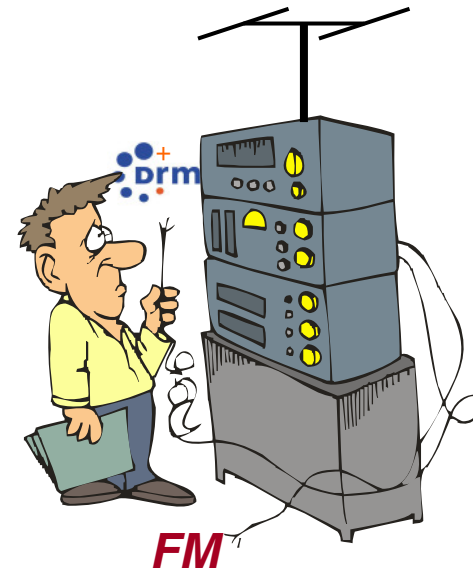


Map by: German Bundesamt für Kartographie und Geodäsie

This output and the other coverage analysis results suggest that

- the **coverage of a DRM+ TX is better** than before with the FM TX, **in spite of the power reduction of 5 dB** (This effect stems from the low protection ratio for FM into DRM+, yielding a low value of the usable field strength, and, therefore, a low interference impact),
- **coverage reserve of a DRM+ TX within the service area is higher** than those of the former FM TX,
- **DRM+ coverage area using 4QAM is larger** than using 16QAM.

► *Problem to switch over a FM TX to DRM+*



No FM broadcaster will turn off his FM TX to realize a DRM+ transmission for the simple reason that he would lose all his FM listeners, esp. in the early stage of digitisation.

► **Outline**



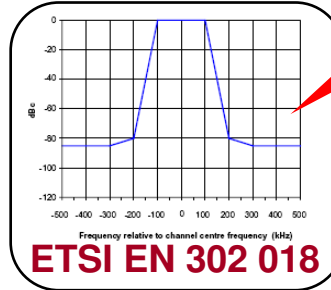
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► **Protection ratios for the analyses with HD Radio™**

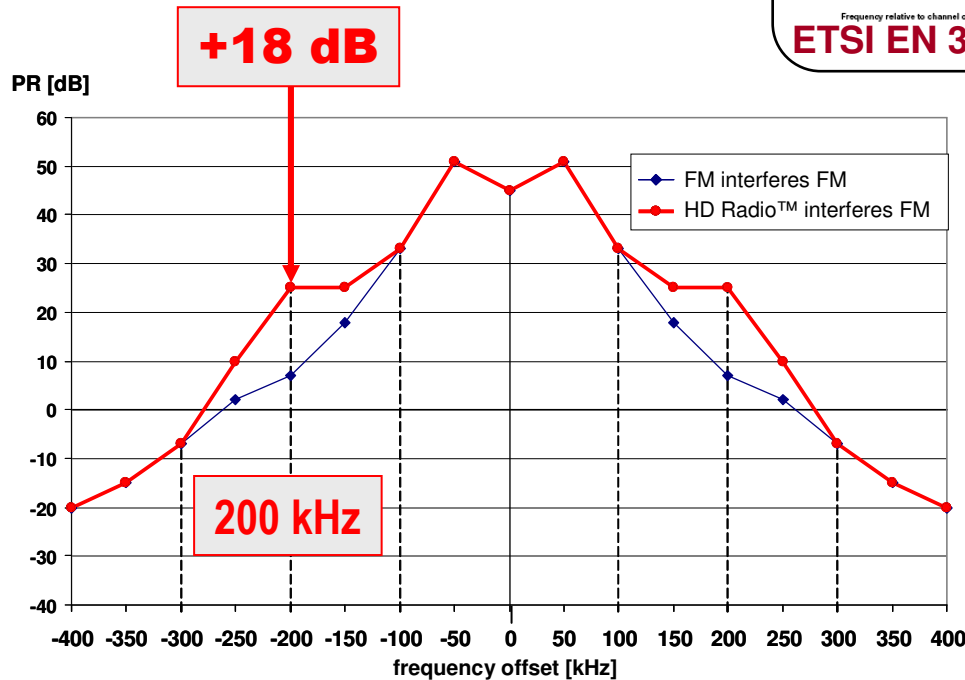
FM

**Protection ratio
for FM interfered with by HD Radio™**
based on the results of the laboratory
measurements and the field trial in 2007/08
and on ITU-R BS.412-9 and ITU-R BS.641-2



HD Radio™

**violates the
European FM
spectrum mask!**



**The protection ratio
for HD Radio™
interfered with by FM
is still not determined,
so no coverage analyses
could be made**

FRANSY
FREQUENZANALYSESYSTEM

► *First results of compatibility analyses for HD Radio™ Hybrid Mode*

	Kaiserslautern				Bornberg		Donnersberg			
f [MHz]	98.1	105.1	96.9	100.2	103.1	107.6	99.1	92.0	101.1	105.6
P _{FM} [kW]	0.16	0.2	0.5	7	25	25	60	60	60	60
P _{HD Radio™ - FM} [dB]	0.0	0.0	-16.6	-7.7	-16.5	X	-16.7	-16.6	-16.8	-17.2



FM - {0...17} dB = HD Radio



These results suggest that the use of HD Radio™ Hybrid Mode

- with a low power TX (less than 1 kW) is **sporadically possible** without any power reduction, but **in all other cases** only possible with power reductions up to 17 dB and thus **with loss of existing FM coverage**,
- with a mid power and high power TX is **only possible with power reductions** up to 17 dB due to the high interference in the 200 kHz adjacent channel and thus **with loss of existing FM coverage**,
- **is not possible above 107.5 MHz** due to increasing interference into aeronautical radio navigation services located on the frequency range above 108 MHz.

► *Problem to use HD Radio™ Hybrid Mode*



No FM broadcaster will simulcast FM and HD Radio™ when he has to reduce his TX power for the simple reason that he would lose most of his FM listeners.

► **Outline**

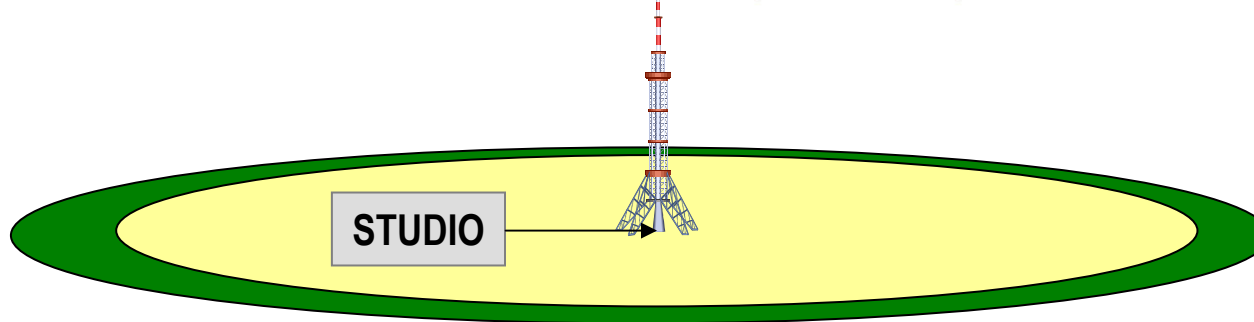


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► *Proposal for conditions of DRM+ Hybrid Mode*

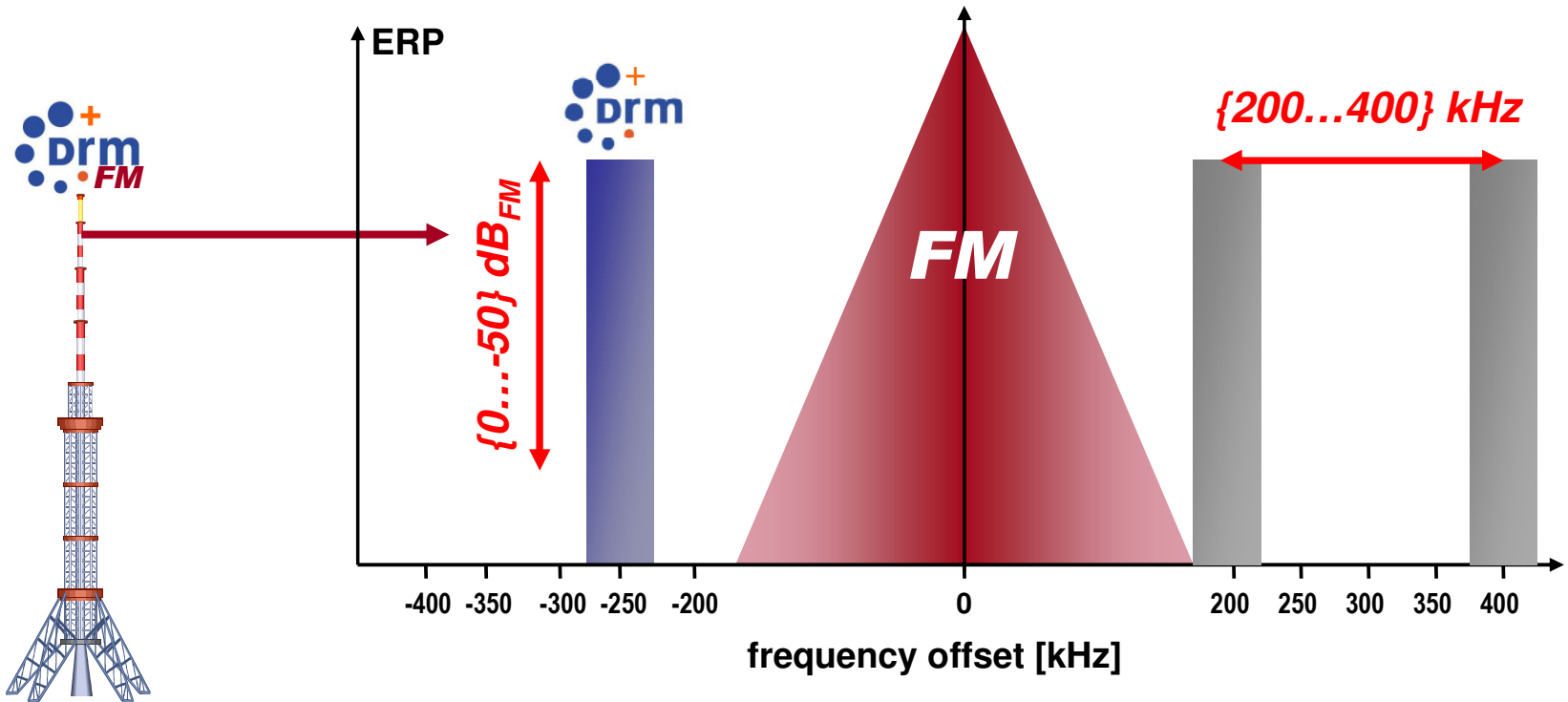
DRM+ Hybrid Mode: **FM**   = 



DRM+-Hybrid-Mode = Simulcast of FM and DRM+ with following conditions:

- broadcasting both signals over the same TX and antenna
- FM power remains unchanged and so the service area remains the same
- receiving both signals in the same service area
- the well known broadcasting frequency will be used furthermore
- receivable with a „one frontend VHF FM/DRM+ combined receiver“ with an automatic analogue/digital switchover
- important due to economical considerations particular at the beginning of VHF FM digitisation

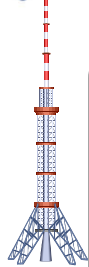
► *Proposal for parameters of DRM+ Hybrid Mode*



FM	TX power remains unchanged
$\Delta f_{(FM - DRM+)}$	flexible frequency offset: $\pm [200 \text{ kHz} - 400 \text{ kHz}]$, $\Delta f = 50 \text{ kHz}$ planning DRM+ in that channel with the lowest interference impact
DRM+	4QAM modulation flexible TX power as high as compatible to existing FM services

► *First results of compatibility analyses for DRM+ Hybrid Mode*

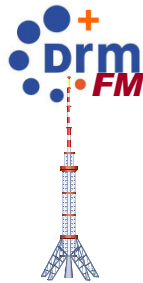
	Kaiserslautern				Bornberg		Donnersberg			
f [MHz]	98.1	105.1	96.9	100.2	103.1	107.6	99.1	92.0	101.1	105.6
P _{FM} [kW]	0.16	0.2	0.5	7	25	25	60	60	60	60
$\Delta f_{\text{DRM+ - FM}}$ [MHz]	200	250	-350	250	-250	-250	-250	-300	250	350
P _{DRM+ - FM} [dB]	-15.9	-3.2	-12.3	-12.8	-34.7	-36.2	-40.3	-43.4	-40.1	-45.1
P _{DRM} [W]	4	96	29	375	8	6	6	3	6	2



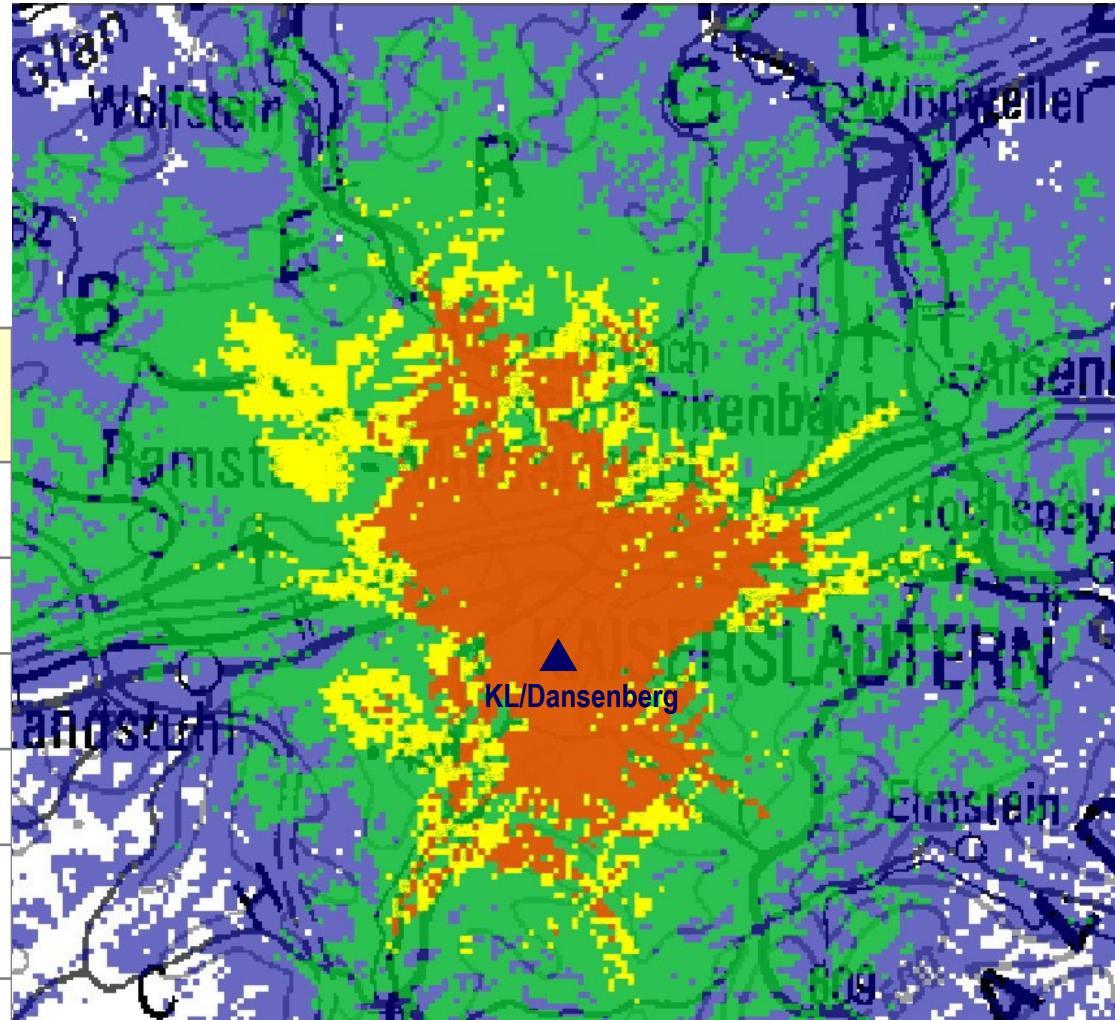
The results propose that

- the determined **TX power reductions** of the DRM+ Hybrid signal **are in the lower watt range** (similar to the digital part of a HD Radio™ Hybrid signal),
- in some cases, **a quite high DRM+ signal power can be reached**,
- the required **power reduction** is obviously **not as high for low power TXs** as for high power TXs

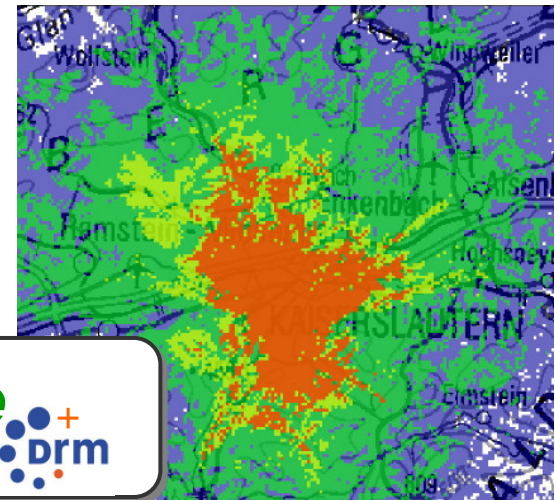
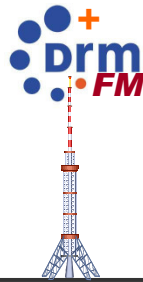
► *Example of coverage analysis for DRM+ Hybrid Mode*



Coverage area of the TX ,Kaiserslautern Dansenberg' 96.9 MHz (Antenne KL)	
	FM / 500 W (0 dB) $E_{\min FM} = 54 \text{ dB}\mu\text{V/m}$
	DRM+ 4QAM / 160 W (-5 dB) $E_{\min DRM+} = 15 \text{ dB}\mu\text{V/m}$
	DRM+ 4QAM / 5 W (-20 dB) $E_{\min DRM+} = 15 \text{ dB}\mu\text{V/m}$
	DRM+ 4QAM / 0.05 W (-40 dB) $E_{\min DRM+} = 15 \text{ dB}\mu\text{V/m}$
Coverage according to ITUR BS.412-9 (aerial G=6 dB, 10m) considering the 20 strongest interferers	
Map by: German Bundesamt für Kartographie und Geodäsie	



► *First results of coverage analyses for DRM+ Hybrid Mode*



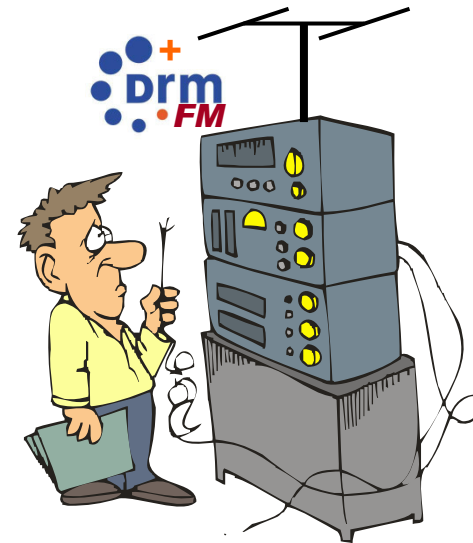
Coverage_{FM} < ? > Coverage_{Drum}

Map by: German Bundesamt für Kartographie und Geodäsie

This output and the other coverage analysis results propose that the DRM+ coverage with 4QAM

- **is still greater as the existing FM coverage if the DRM+ power reduction is higher than 20 dB** (which is a similar power difference as for a HD Radio™ Hybrid signal),
- **but is smaller than the FM coverage with a power reduction of 40 dB or more.**

► *Problem to deploy DRM+ Hybrid Mode*



The DRM+ Hybrid Mode
gives a chance for local or regional coverage areas
but is currently not more than just a good idea.
Investigations are pending*).
Concepts for TX and RX have still to be developed.

*) first compatible tests had been conducted by University of Hannover in August 2008

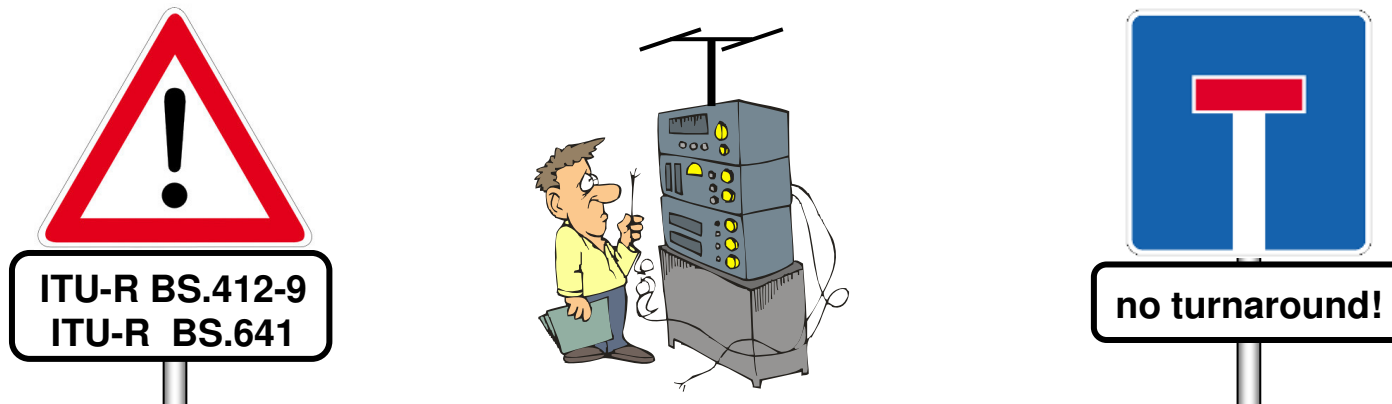
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► *ITU planning recommendations as barriers*



On the basis of the ITU planning recommendations for FM VHF systems the introduction of a new OFDM TX into the existing VHF FM environment involves high or even insurmountable barriers – this is a dead-end street!

- **HD Radio™** can generally only be planned with loss of existing FM coverage
- **DRM+** can only be planned with high coverage if the existing FM TX is replaced with DRM+
- **DRM+ Hybrid Mode** gives a chance for local or regional coverage areas, but this mode has still to be developed

► *Gap between interferences in TX planning and RX reality*

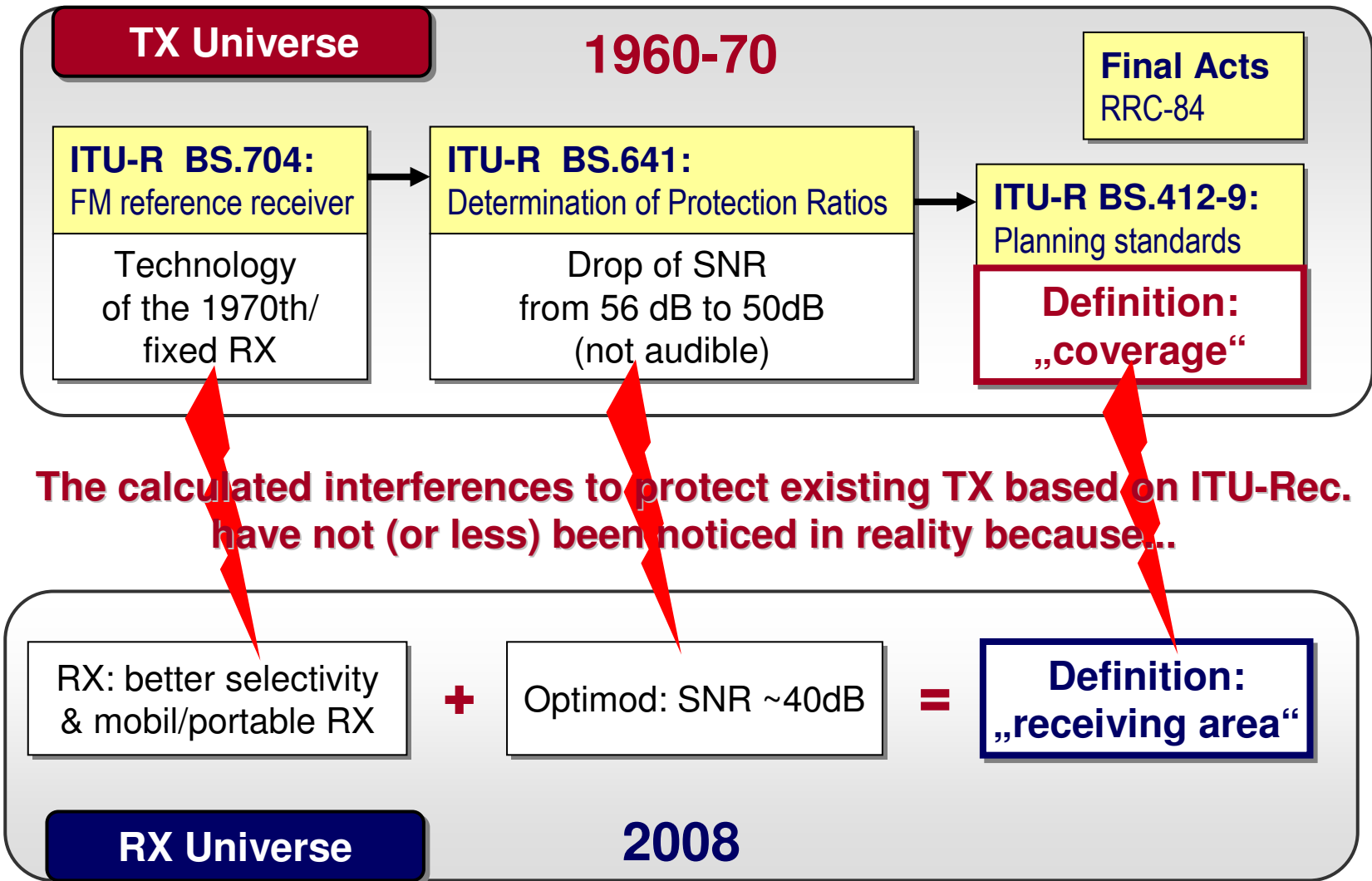


**BUT: Experiences from the field trails
with HD Radio™ and DRM+ and
from daily FM receiving say:**

***The determined interferences based on the
ITU Recs. have not (or less) been noticed in reality!***

Why is there this difference ...?

► *Gap between coverage and receiving area*



► *First step for the digitisation of the VHF FM Band*



Free passage!



**Out of the dead-end street
with a fair solution for everybody!!!**

(for the existing FM broadcaster and the future digital network operators):

***Adjustment of the ITU planning recommendations
for the VHF FM band et al.
so that today's real receiving world is reflected properly
– also taking into account mobile and portable reception -,
i.e. that planned and real world no longer diverge.***

► **Adjustment of ITU recommendations**

ITU-R BS.704: FM reference receiver...

- Adjustment of the reference receiver parameters to the today state of the art
- Amplification to specify the different receiving scenarios
- Supplement of digital reference receivers



ITU-R BS.641: Determination of Protection Ratios...

- Supplement to identify interferences from and onto digital broadcasting systems
- Modification of the measurement method from SNR to a criterion which refers to perceptible audible distortion: i.e. SINAD

ITU-R BS.412-9: Planning standards...

- Revised protection ratios based on a new measurement method (SINAD) with new reference receivers (modified ITU-R BS.641).
- Supplement of protection criterions between analogue and digital TX and digital-digital

ITU-R BS.1114-5: Systems for ... digital sound broadcasting in ... 30 - 3000 MHz

- Supplement of DRM with the Mode E (DRM+)

ITU-R SM.1140: Test Procedures for ... Aeronautical Receiver ... in ...108-118 MHz

- Supplement of compatibility criterions for digital VHF systems

► *On the way to the digitisation of VHF FM band*

There are a lot of construction sites on the roadmap to digitise the VHF FM band in Europe (with DRM+ as favorite)



**FM45(08)055 – 03.07.08:
Initial Draft for an ECC Report
“Future Possibilities for the Digitalisation of Band II”**

... a bundle of questions ...

**Thank you for your
attention ...**

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

