Update on Studies and Field Tests (DRM30)

EBU / DRM Workshop

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Agenda

1. Summary review of activities: 2004-2009

Activities 2004-2009

MW:

- Madrid 2004
- Mexico D.F. 2006
- Devon (UK) 2007
- New Delhi 2007
- Milan 2007
- Madrid 2008
- Bilbao/Vitoria 2009

26 MHz

- Dilliberg (Germany)
- Mexico D.F. 2005
- Brasilia 2006
- New Delhi 2007
- Italy 2008 - 2009

Conclusions

- DRM has been tested extensively below 30 MHz
- Available practical data for most of the broadcasting scenarios
- The DRM technology is ready: use it!
- .....
- Work still ongoing!

Agenda

1. Summary review of activities: 2004-2009
2. DRM 26MHz for Local Broadcasting
3. DRM MW
4. Conclusions

Agenda

Summary review of activities: 2004-2009
DRM 26MHz for Local Broadcasting:

- Coverage Prediction and Usable Thresholds
- Planning parameters
- Ionospheric interference issues
- Noise studies

DRM MW
Conclusions

Coverage Prediction

Studies carried out evaluating different prediction algorithms

- ITU-R P.1546
- Longley-Rice
- Diffraction effects (Deygout, ITU-R P.526)
- Other empirical for mobile reception (Okumura-Hata, ...)

Results based on empirical measurements (Mexico, India, Brazil and Germany)

No model outperforms in all situations: best candidate ITU-R 1546 (Rev. 3). Modifications/Adaptation to the 26 MHz band ongoing:

- Clearance angle
- Elevation
- Terrain profiles (diffraction)

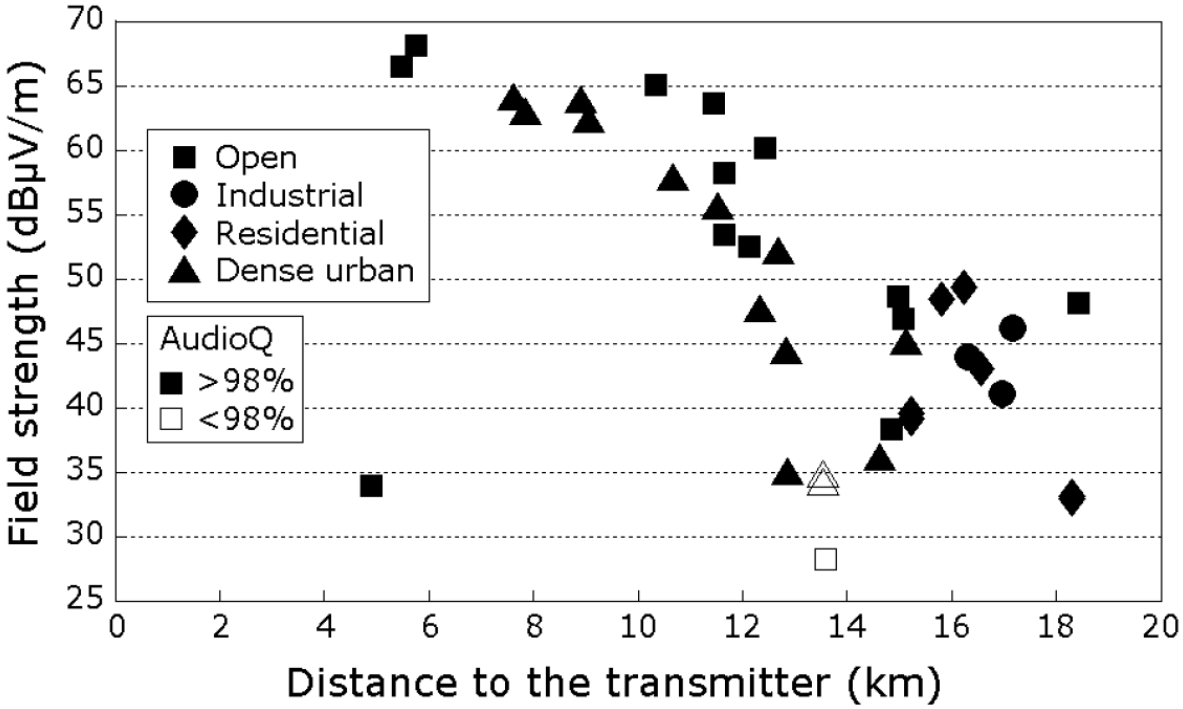
Close coverage: consider the ground wave

Thresholds

City	Mode	Static		
		Mean AQ [%]	SNR min [dB]	E min [dB(uV/m)]
Brasilia	*18K B 16 4 0.5 L*	99,73	13	37
Mexico	*18K B 16 4 0.5 L*	99,1	17	38
	18K B 16 4 0.5 L	96,34	23	39
	18K B 16 4 0.5 S	N. A.	N. A.	N. A.
	10K C 16 4 0.5 L	N. A.	N. A.	N. A.
	18K B 64 16 0.6 L	93,79	20	45
	18K A 64 16 0.6 L	96,08	25	45

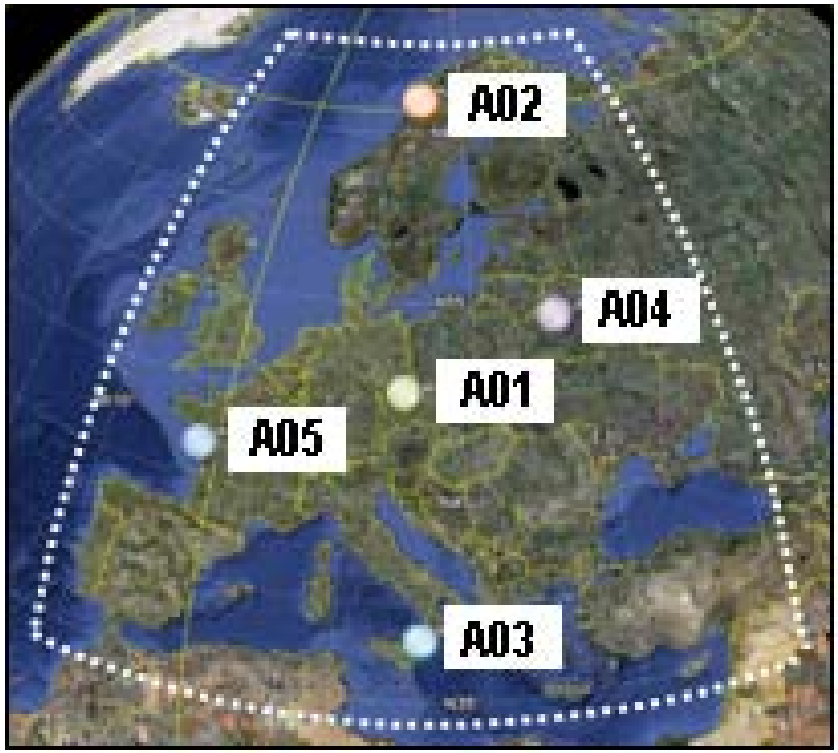
Coverage

Coverage Target: Service areas close to 15 km



Ionospheric interference (I)

Scenario



Ionospheric interference (I)

Simulated parameters and decission criteria

- Maximum Usable Frequency
  MUF ≥ 25.67 MHz

- Received electric field strength
  E ≥ 12 dB(μV/m)

Parameters affecting the ionosphere

- Input values
  SSN → 0 to 200, solar activity
  Season of the year
  Hour of the day

Ionospheric Interference (II)

Conclusions

- Regular ionospheric propagation IS a potential source of interference

Very probable ionospheric propagation	SSN ≥ 50 Any season 6:00 - 20:00 UT
Very probable critical interference	SSN ≥ 125 Feb, Mar, Oct, Nov. 8:00 – 16:00 UT

- Transmitters from North-East of Europe cause the highest interference
- The use of antennas designed to reduce unwanted ionospheric would lessen the potential interference

Noise

Statistic				External Noise Figure Median Value	Time Variation Upper Decile Deviation	Spatial Variation Upper Decile Deviation
ITU VALUES	Rural			28.06	9.20	6.80
	City			37.66	11	8.40
	Residential			33.36	10.60	5.80
EMPIRICAL VALUES	Mexico	City / Residential	25.620 MHz	< 37.0 (*)	-	9.40
	Brasilia		25.885 MHz	42.7	< 2	5
	Nuremberg		26.000 MHz	48.7	1.80	5.40
			26.020 MHz	52.7	2	3.40
			26.300 MHz	48.6	4.80	2
		Rural	26.000 MHz	< 35.7 (*)	1.13	1.90
			26.020 MHz	< 37.7 (*)	2	4.10
			26.300 MHz	< 36.1 (*)	2.30	3.60

Time variation: Empirical deviations lower than ITU variations because of short recording time (minutes vs hour)

Spatial variation: Empirical deviations lower than ITU variations because of limited number of locations

(*) Values influenced by the internal noise level of the measurement system

Further details on 26 MHz available:

[1] *Matias et al.,* "Location correction factor for coverage planning tools for DRM in the 26MHz band" IEEE Broadband Multimedia Systems and Broadcasting 2008. Las Vegas (USA)

[2] *Matías et al.,* "DRM (Digital Radio Mondiale) local coverage tests using the 26 MHz broadcasting band" IEEE Transactions on Broadcasting. March 2007

[3] *Matías et al.,* "DRM (Digital Radio Mondiale) Test Results for Mobile Reception in 26 MHz Band for Local Coverage". IEEE Broadband Multimedia Systems and Broadcasting 2009. Bilbao (Spain)

[4] *Peña et al.,* "Study of the Ionospheric Interference for Planning DRM Local services using the 26 MHz Band". IRST 2009. Edimburgh, Scotland, UK.

[5] *Peña et al.,* "Analysis of the ITU-R P.1546-2 Prediction Method Accuracy for DRM Local Coverage Using the 26 MHz Band" IEEE BTS Annual Symposium. Washington DC. 2007. USA.

[5] *Peña et al.,* "Digital Radio Mondiale field trials in Brasilia for local radio coverage using the 26 MHz band". IEEE Broadband Multimedia Systems and Broadcasting 2007. Las Vegas (USA)

[6] *Matías et al.* "Local Radio Coverage Using the Digital Radio Mondiale International Standard: Time Variability Characterization"

[7] *Lauterbach et al.,'*Local Radio using Digital Radio Mondiale (DRM) in the 26 MHz Band – A Résumé at the end of the Nuremberg/Dillberg field trial" *September 18 – 19, 2008, Fraunhofer Institute for Integrated Circuits IIS Erlangen, Germany.*

[8] *Lauterbach et al.,* Is DRM on 26 MHz an Option for Local Digital Broadcasting? Results from a Field Trial in Nuremberg, Germany. *5th Workshop Digital Broadcasting, Erlangen, 23./24.9.2004*

[9] *DRM Consortium.* ITU-R WP6E Document 6E/274-E"Digital Radio Mondiale: Local coverage using the 26 MHz broadcasting band

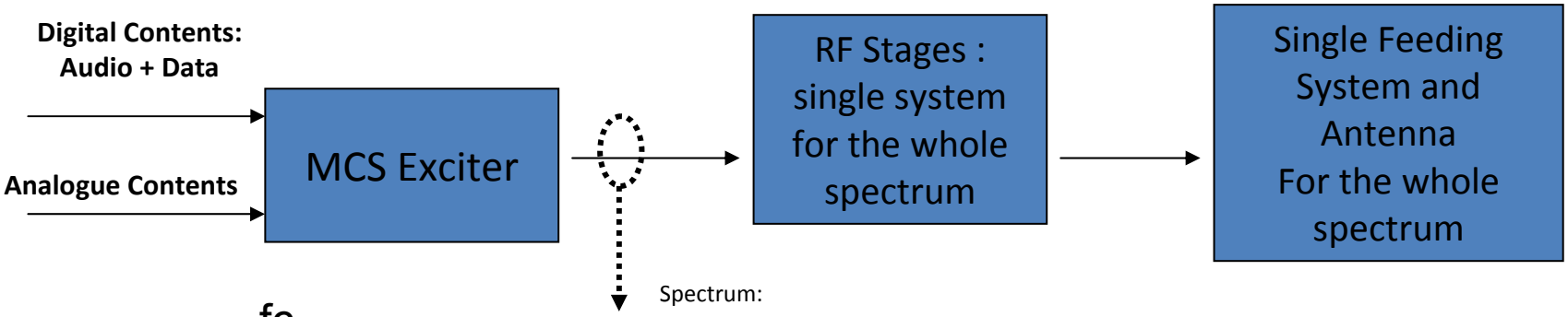
Agenda

Summary review of activities: 2004-2009
DRM 26MHz for Local Broadcasting
DRM MW

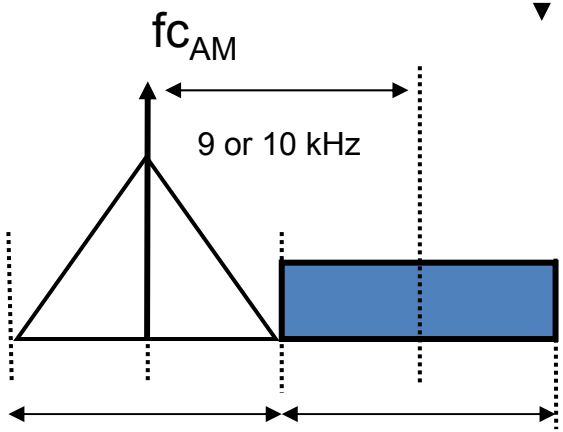
- MW 20 kHz simulcast
- Urban Coverage
- Indoor Reception
- Noise

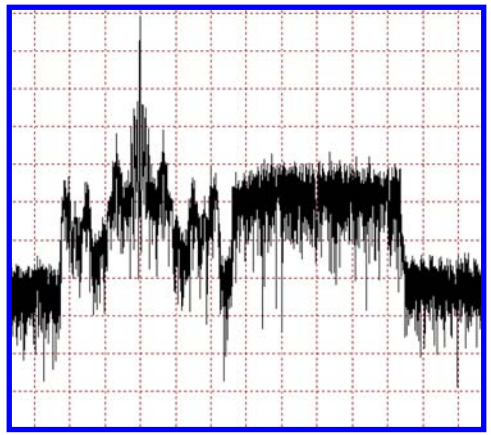
Conclusions

Simulcast System Concept:



Spectrum:





Real measured spectrum

Simulcast (I)

Experiences from

Mexico: A_64_16_05_L (2006) → 3 Month field trial

Madrid: A_64_16_06_S (2008) → 6 Month field trial

Delhi: A_64_16_06_L (2007) → 1 Week

Back-off ratio: 16 dB

Level thresholds	Theoretical (BS.703)	Mexico Fixed	Madrid 07 Fixed	Delhi Mobile
AM electric field strength [dB(uV/m)]	60	103	-	-
DRM electric field strength [dB(uV/m)]	38,6	85,9	43	65
DRM SNR [dB]	14,7	16,6	18	19

Simulcast (II)

Power ratio and receiver influence (Madrid 07)

Power Ratio [dB]	16	11,8	7,2	1,5
AM peak power [kW]	10	7,5	4	1,25
DRM rms power [kW]	0,25	0,5	0,75	1
Receiver	%Reception OK	%Reception OK	%Reception OK	%Reception OK
High-end	100	100	60	100
High-end mid-range	100	50	0	0
Mid-range	100	50	20	20
Mid-range	100	50	0	0
Mid-range	0	0	0	0
Mid-range	20	0	0	0

High-end receivers: good reception with 3-9 dB back-off
Mid-range receivers: depends on the model with 12-16 dB BO
Low-end receivers: at least 16 dB BO needed

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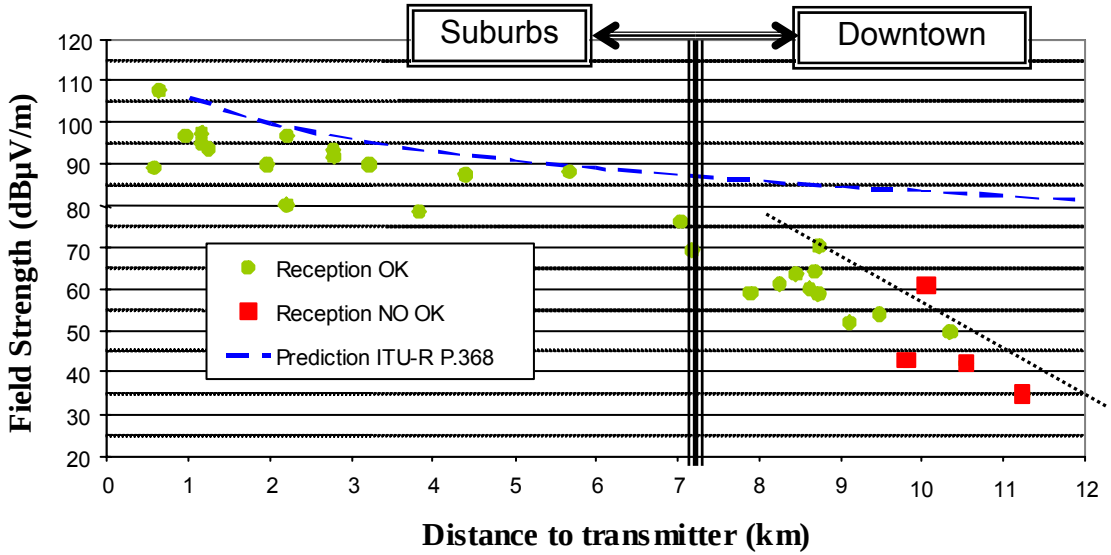
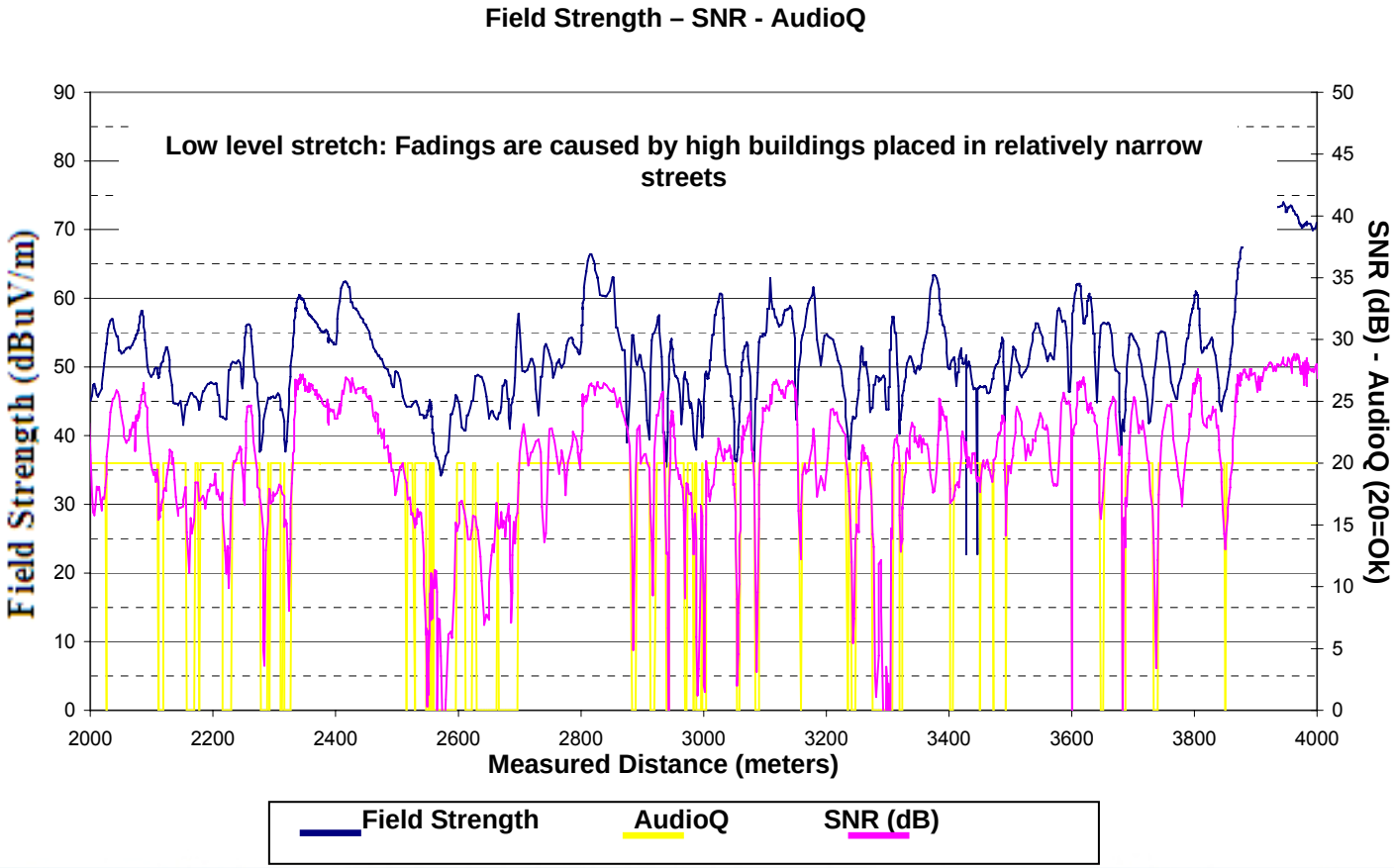
Urban Coverage (I)

Coverage and environment influence

- Madrid: 0.25 kW → ~9.5km
- Mexico: 1.22 kW → ~25km



Urban Coverage (II)

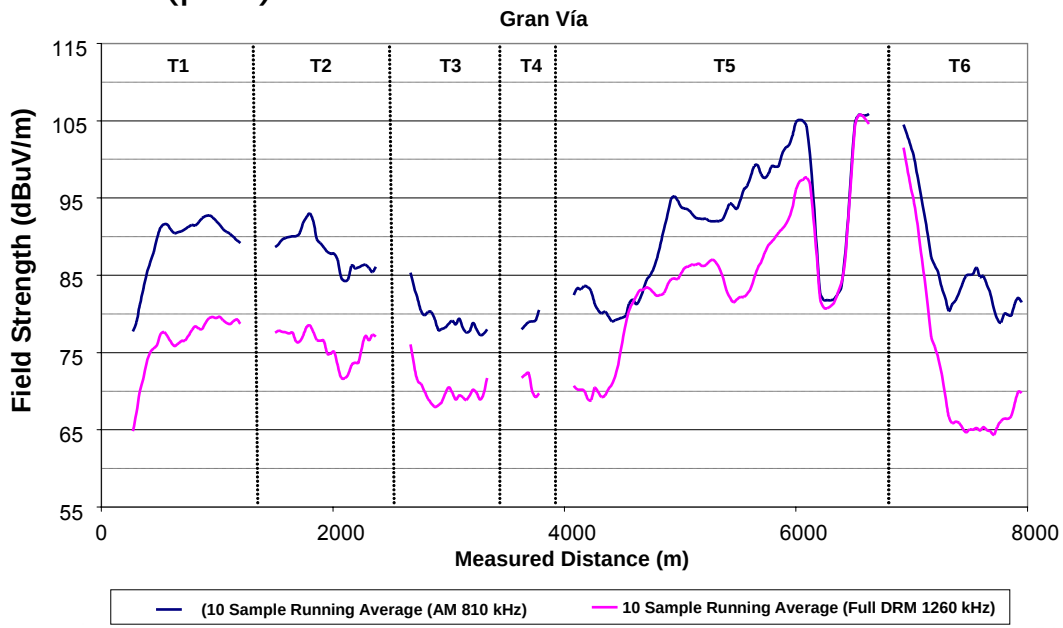


Urban (III)

Frequency dependency

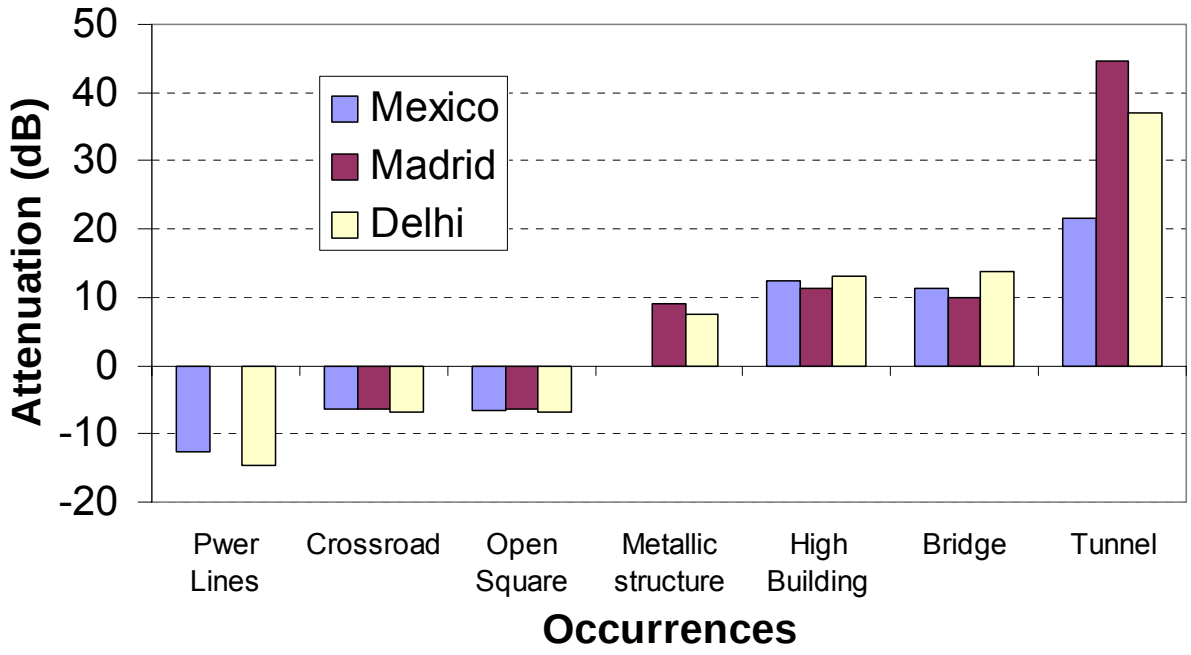
- Madrid 07
  - 810 kHz (blue)
  - 1260 kHz (pink)

Field strength differences between the two frequencies		
Environment	***Mean [dB]***	***Std Dev [dB]***
Narrow streets, high buildings	12,08	5,42
Wider streets	10	5,95
Irregular heights, medium widths	8,96	4,48
Mixture	8,24	4,49
Whole Madrid city	*9,82*	*5,08*



Urban (III)

Currently working on models for predicting urban coverage



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Indoor (I)

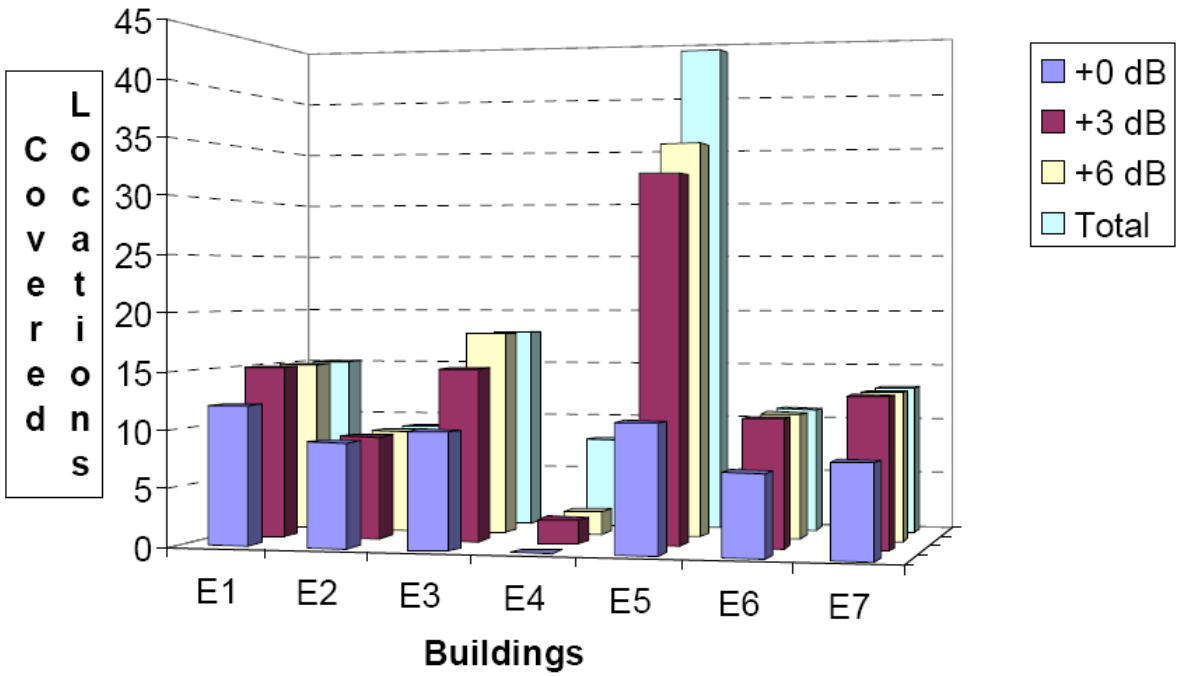
Indoor Coverage Tests

- Madrid 07: Transmitted power 10kW
- 117 Measurement locations in different buildings

Building	Private				Commercial		
	E1	E2	E3	E4	E5	E6	E7
Environment	Urban Non Dense	Urban Non Dense	Urban Dense	Urban Dense	Urban Dense	Industrial	Urban Dense
Width of street	Narrow	Narrow	Wide	Wide	Wide	Wide	Wide
# of floors	3	3	7	10	10	2	6
Distance to Tx [km]	13,8	10,2	7,9	13,2	8,9	16,9	9,9
Correct points (%)	80	100	56	0	25	64	62
E [dB(μV/m)]	78,95	93,79	74,31	68,08	79,51	70,8	83,99
MER [dB]	25,04	27,17	20,44	5,08	15,25	21,19	20,93
N [dB(μV/m)]	43,81	53,32	51,54	64,61	64,17	52,72	62,13

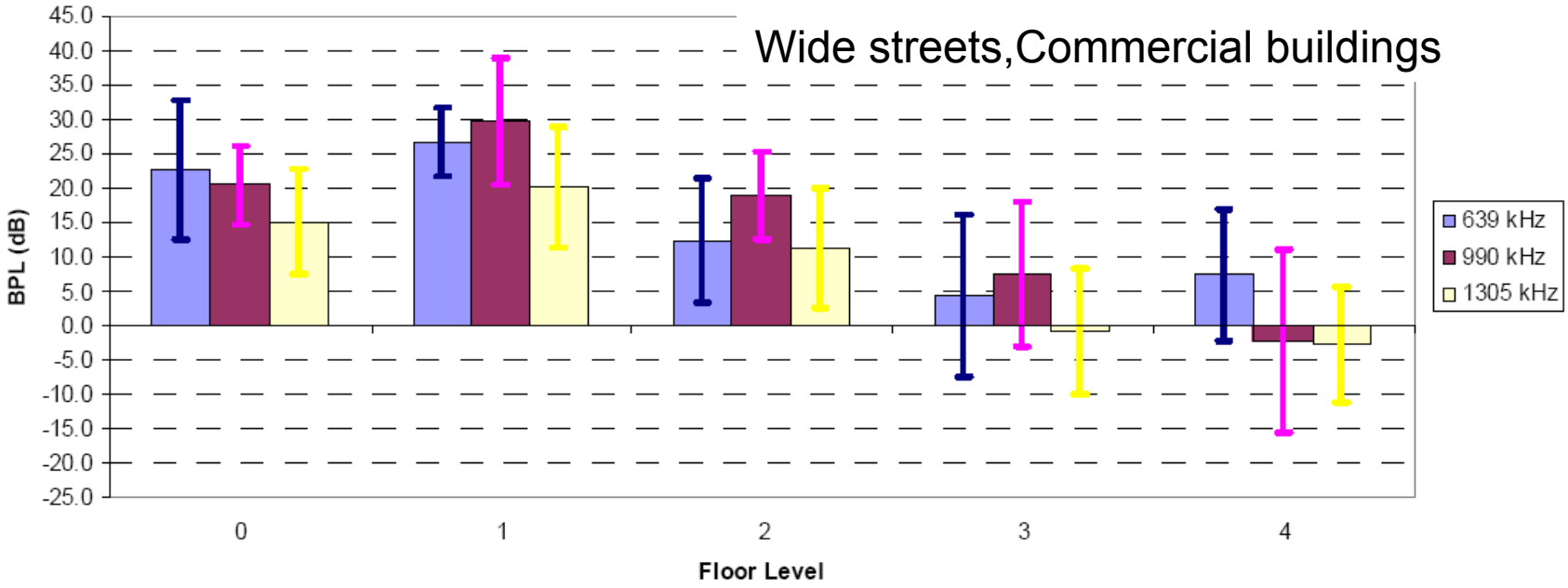
Indoor (II)

Indoor Coverage Tests:
Can Tx power increase improve the coverage?



Indoor (III)

Currently working on building penetration Loss



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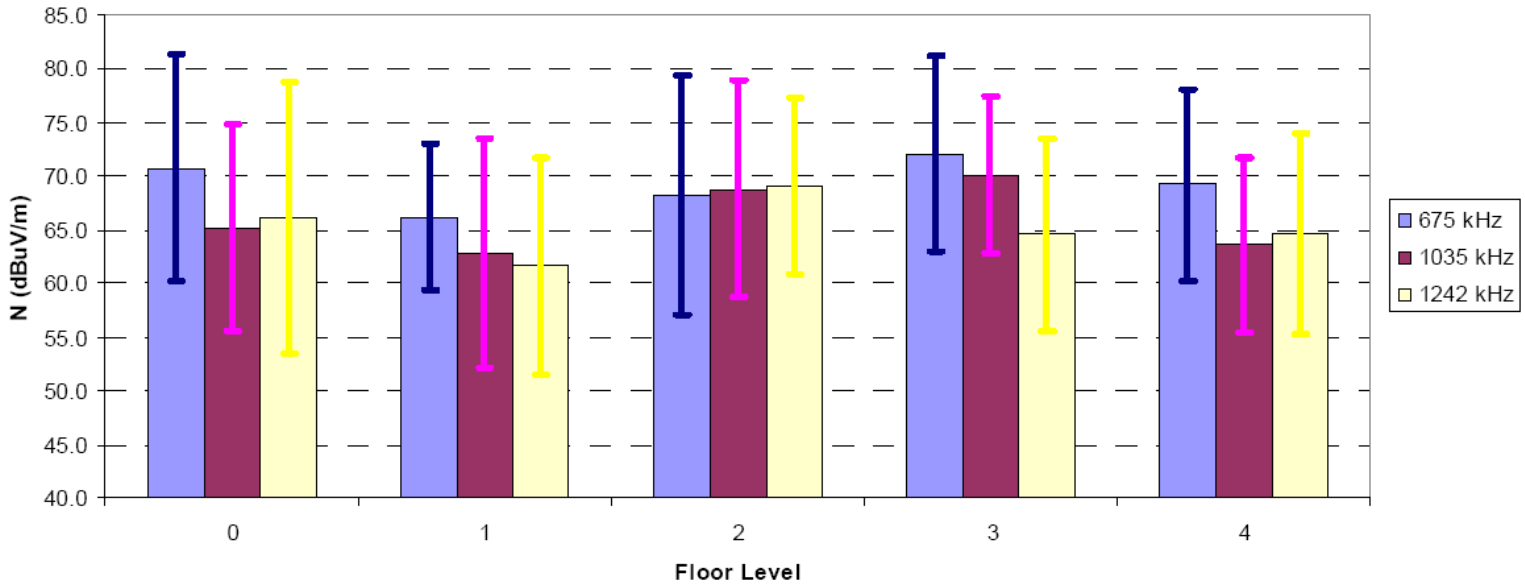
Noise (I)

Urban Indoor Noise: Bilbao 2009
Values higher than in ITU-R P.372 [9.9-19.8dB(μV/m)]

Dense Urban Environments, commercial buildings



Further details on MW :

[1] *Gil et al., "*Medium Wave Field Strength Spatial Variability in Urban Environments" European Conference on Antennas and Propagation. March. 2009

[2] *De la de Vega et al.* "Irregular Terrain Attenuation in the Medium Frequency Band: Planning for Digital Radio Systems" IEEE Transactions on Antennas and Propagation. August 2008.

[3] *De la Vega et al.* "Statistical characterization of the field strength location variability for the new digital radio services in the medium wave band". May 2009.

[4] *Gil et al.,* "DRM 20 kHz Simulcast Field Trials in the Medium Wave Band in Mexico D.F" IEEE Transactions on Broadcasting. March 2008.

[5] *Guerra et al*. "Medium Wave Digital Radio Mondiale (DRM) Field Strength Time Variation in Different Reception Environments"IEEE Transactions on Broadcasting. Dec. 2006

[6] *Guerra et al.,* "Medium Wave DRM Field Test Results in Urban and Rural Environments".IEEE Transactions on Broadcasting. Dec. 2005

[7] *Prieto et al.*"Minimum C/N Requirements for DRM Reception based on Field Trials" IEEE Communications Letters. Oct. 2005

[8] *Digital Radio Mondiale (DRM), Asia-Pacific Broadcasting Union (ABU).* ITU-R 6D/10-E Results of DRM trials in New Delhi: simulcast medium wave, tropical band, NVIS and 26 MHz local broadcasting. March 2008.

[9] *Digital Radio Mondiale (DRM)* Document 6E/403-E MWDigital Radio Mondiale (DRM): Simulcast tests in Mexico D.F. August 2006

[10] *European Broadcasting Union (EBU).* Technical Bases for DRM Services Coverage Planning. Group B/LMS. Ebu-tech. 3330. June 2008

Agenda

Summary review of activities: 2004-2009

DRM 26MHz for Local Broadcasting

DRM MW

Conclusions

Conclusions

DRM has been tested extensively below 30 MHz

Available practical data for most of the broadcasting scenarios

Work currently ongoing on:

- Urban and indoor coverage MW
- Noise characterization
- Night-time NVIS
- Planning tools for 26 MHz

The DRM technology is ready: use it!

Update on Studies and Field Tests

EBU / DRM conference

26 November 2009

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eman ta zabal zazu

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