

Methodology of White Space estimation in TV bands based on the ITU GE06 technical conditions

Dariusz Więcek
National Institute of Telecommunications, Poland

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Agenda

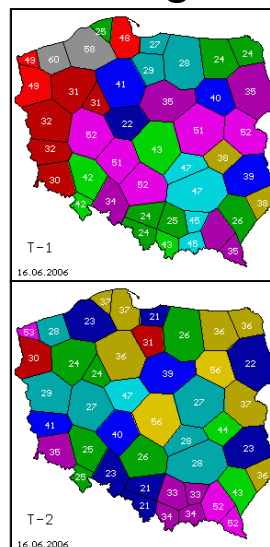
- Technical Rules of the ITU GE06 Plan
 - Technical basis for establishing ITU-R GE06 Digital Plan
 - Protection requirements for DVB-T GE06 allotments and assignments
- White space devices WSD Analysis approaches and parameters
- Protection areas estimation methodology for DVB-T allotments and assignments with co-channel and first upper/lower adjacent channels
- WSD interference calculations using GE06 propagation model
 - Numbers of available channels for different WSD parameters configurations
 - Maps of available channels based on presented methodology
- Conclusions

GE06 General Technical Rules

- GE06: the ITU International Treaty for Frequency Ranges: 174-230 MHz and 470-862 MHz
- Allotment and Assignment Planning
- Reference Networks (RN)
- Reference Planning Configurations (RPC)
- GE06 Plan established based on agreed and accepted interferences levels and protection criteria
- Propagation model used in GE06 Plan: ITU-R P.1546-2
- GE06 Rules are used for updating GE06 Plan

GE06 Allotments and Assignments planning

- Countries are divided into areas (allotments) with allocated channels that can be covered by different types of SFN DVB-T networks
- Additional frequency assignments (stations) written also in the Plan
- 7 (or more) allotment layers (coverage's) available in each country
- Interferences levels accepted in establishing the Plan



GE06 Reference Planning Configurations

RPCs for DVB-T

RPC	RPC 1	RPC 2	RPC 3
Reference location probability	95%	95%	95%
Reference C/N (dB)	21	19	17
Reference $(E_{med})_{ref}$ (dB(μV/m)) at $f_r = 200$ MHz	50	67	76
Reference $(E_{med})_{ref}$ (dB(μV/m)) at $f_r = 650$ MHz	56	78	88

$(E_{med})_{ref}$: Reference value for minimum median field strength

RPC 1: RPC for fixed reception

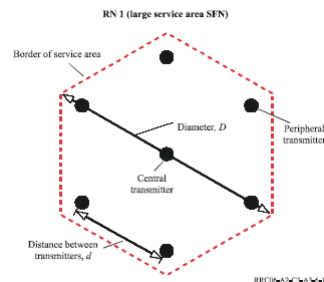
RPC 2: RPC for portable outdoor reception or lower coverage quality portable indoor reception or mobile reception

RPC 3: RPC for higher coverage quality for portable indoor reception

For other frequencies, the reference field-strength values in Table A.3.5-1 shall be adjusted by adding the correction factor defined according to the following rule:

- $(E_{med})_{ref}(f) = (E_{med})_{ref}(f_r) + \text{Corr}$;
- for fixed reception, $\text{Corr} = 20 \log_{10}(f/f_r)$, where f is the actual frequency and f_r the reference frequency of the relevant band quoted in Table A.3.5-1;

GE06 Reference Network



Parameters of RN 1 (large service area SFN)

RPC and reception type	RPC 1 Fixed antenna	RPC 2 Portable outdoor and mobile	RPC 3 Portable indoor
Type of network	Open	Open	Open
Geometry of service area	Hexagon	Hexagon	Hexagon
Number of transmitters	7	7	7
Geometry of transmitter lattice	Hexagon	Hexagon	Hexagon
Distance between transmitters d (km)	70	50	40
Service area diameter D (km)	161	115	92
Tx effective antenna height (m)	150	150	150
Tx antenna pattern	Non-directional	Non-directional	Non-directional
e.r.p.* (dBW)	Band III 34.1 Bands IV/V 42.8	36.2 49.7	40.0 52.4

The e.r.p. is given for 200 MHz in Band III and 650 MHz in Bands IV/V; for other frequencies (f in MHz) the frequency correction factor to be added is: $20 \log_{10}(f/200)$ or $f/650$ for RPC 1 and $30 \log_{10}(f/200)$ or $f/650$ for RPC 2 and RPC 3.

* The e.r.p. values indicated in this table incorporate an additional power margin of 3 dB.

Interferences calculations rules

- ITU-R P.1546-2 as a propagation model for interferences calculations:
 - 1% of time and 50% of location for interferences calculations
 - power-sum method (PSD) for interferences aggregation
 - Protection Ratios as agreed in the GE06 Agreement

GE06 Plan established

- Detailed allotments and assignments of the DVB-T (entries) included into the Plan
- Technical conditions for each entry included in the Plan (RN, RPC, coordinates, antenna characteristics etc.)
- Interferences levels coming from own country and other countries entries accepted
- GE06 Technical Rules should be used for Plan updating/extension

Calculation of the White Spaces areas in TV bands using CEPT ECC Report 159

- Very low levels of sensing levels causing very wide areas of protections – the sensing levels should not be used for a white space areas assessments
- No references to the GE06 Plan and current TV bands interference situations (protection of potential noise-limited coverage rather than protection of real case interference-limited coverage areas)
- Interference protection requirements for DVB-T reception much more stronger in case of WSD then new DTT
- Underestimation of channel availability in the TV bands which can be prepared knowing existing interference situations e.g. in case of preparation of geolocation database

Example of current real world DTT situation

- TV station coverage area limited due to interferences from other DTT (GE06 Plan) station (not as Emin (noise limited) for planning)
- Protection area from WSD calculated from sensing levels or DTT protection requirements taken from ECC Report 159 results as much more wider then noise-limited coverage
- Current existing interferences levels much more higher then there allows for new WSD

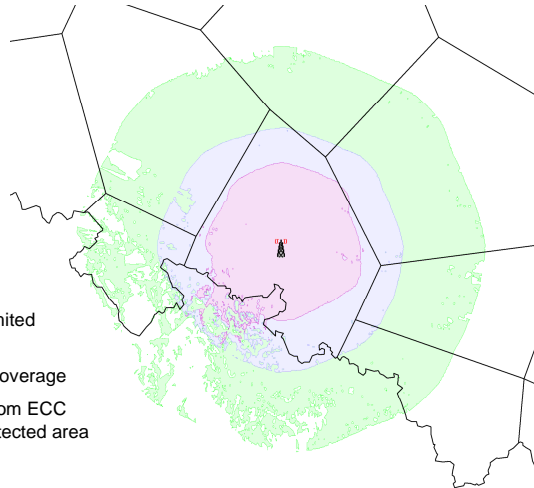
Example of real DTT station coverage

Colours:

Red – interference limited coverage

Blue – noise limited coverage

Green – calculated from ECC Report 159 WSD protected area (for 30 m 36 dBm)



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Example of real DTT station coverage

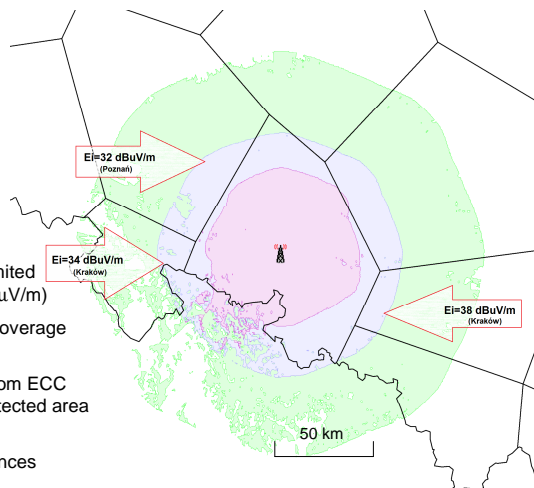
Colours:

Red – interference limited coverage (~60-65 dBμV/m)

Blue – noise limited coverage (E_{min} ~ 56 dBmV/m)

Green – calculated from ECC Report 159 WSD protected area (for 30 m 36 dBm)

E_i – existing interferences



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White Space areas calculations in the TV bands proposal

- WSD treated as an additional (similar as new DTT) transmitters which could be analysed as „new entries” into the Plan based on the GE06 technical rules:
 - Protection criteria for DVB-T based on GE06 allotments/assignments parameters (RN/RPC) for 95% of location, receiving antenna at 10 m. a.g.l. with directional antenna (fixed reception) or omnidirectional antenna (portable receptions)
 - Interferences calculations: propagation method ITU-R P. 1546-2 in 1% of time 50% of locations (GE06)
 - Aggregate interferences from WSDs not more than existing interferences from DTT

DTT protection conditions assumption for calculations

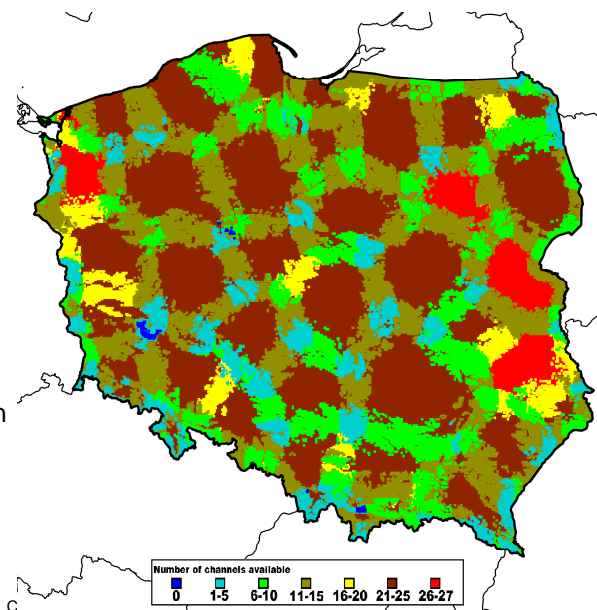
- Two types of reception protected:
 - Portable RPC2 (GE06):
 - Maximum permissible interfering level at DTT coverage areas: $78 \text{ dB}\mu\text{V/m} - 19 \text{ dB (PR)} - 13 \text{ dB (location probability correction)} - 10 \text{ dB (aggregation)} = 36 \text{ dB}\mu\text{V/m}$ at 10 m a.g.l.
 - Fixed reception RPC1:
 - Maximum permissible interfering level at DTT coverage areas: $56 \text{ dB}\mu\text{V/m} - 21 \text{ dB (PR)} - 13 \text{ dB (location probability correction)} - 10 \text{ dB (aggregation)} + 16 \text{ dB (receiving antenna discrimination)} = 28 \text{ dB}\mu\text{V/m}$ at 10 m a.g.l.
- Additionally first adjacent channels (n+1 and n-1) protected in their own allotments areas - the same rules as for co-channel

WSD interferences analysis characteristics

- 3 types of transmissions:
 - 30 m a.g.l with 36 dBm (BS type)
 - 10 m a.g.l with 30 dBm (CPE fixed type)
 - 1,5 m a.g.l with 20 dBm (CPE portable type)
- Checking all available channels in grid around 600000 points of the Poland territory (1 km raster)
- Analysis performed with DTM by the NIT planning and optimization software

Results of the analysis:

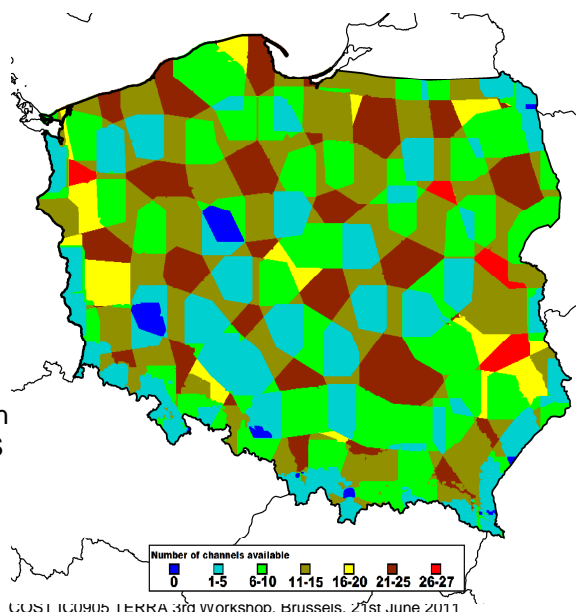
WSD channels availability in Poland for 1,5 m 20 dBm terminals



Results of the analysis:

WSD channels availability in Poland for 30 m 36 dBm BS stations

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Conclusions

- White Space areas assessments in TV bands (e.g. for geolocation databases) should take into account existing interference situation and should not be based on very low sensing levels or strong protection of noise limited (Emin) coverage's
- It is possible to establish methodology based on current interference levels in TV bands which can result in much more TV channels availability assuring protection to the GE06 Plan entries
- Based on such methodology it can be expected an average around 10-15 channels available in each country area depending on local conditions (from 0 to 30 channels) giving also full protection for first adjacent DTT channels (n+1, n-1)
- Proposed method may be introduced in the UHF band (470-790 MHz) but it can be also easily introduced especially in the VHF band (174-230 MHz) as well as in the broadcasting L-band (1,5 GHz) where the allotment planning methods are deeply involved
- In case of international objections such method may be used internally by the Administrations for establishing country geolocation database providing necessary separation distances from the borders

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Thank you for your attention

d.wiecek@il.wroc.pl