Frequency Planning for Digital Terrestrial Television

Interregional Seminar on Transition from SECAM to Digital Television Broadcasting

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RTV Slovenija OE Oddajniki in zveze

New ITU - R Study Group 6E

- Old organisation:

Study Group 10: Sound Broadcasting

Study Group 11: Television Broadcasting

- New organisation: Study Group 6: Sound and Vision Broadcasting
  - Working Party 6E contains former:
    - » Working Party 10 A sound < 30 MHz
    - » Working Party 10 B sound > 30 MHz
    - » Working Party 11C television
    - » Part of Working Party 11A modulation.

ITU - R Working Party 6E Rec.. on Television Planning I.

- Analogue systems:
  - BT. 417-4: Minimum field strengths for which protection may be sought in planning a television service,
  - BT. 655-6: Radiofrequency protection ratios for AM VSB terrestrial television interfered with by unwanted analogue vision signals and their associated sound signals
  - BT.419-3: Directivity and polarisation discrimination of antennas in the reception of television broadcasting,
  - BT.804: Characteristics of TV receivers essential for frequency planning with PAL/SECAM/NTSC television systems systems

ITU - R Working Party 6E Recommendations on Planning 2

- BT. 1123: Planning methods for 625 line terrestrial television in VHF/UHF bands,
- BT. 805: Assessment of impairment caused to television reception by a wind turbine

- Digital systems:
  - BT. 1125: Basic objectives for planning and implementation of digital terrestrial television broadcasting system,
  - BT. 1368-2: Planning criteria for digital terrestrial television services in the VHF/UHF Bands
  - BT. 1206: Spectrum shaping limits for digital terrestrial television broadcasting.

ITU - R Working Party 6E

In preparation:

Handbook on Digital Terrestrial Broadcasting

Second Part: Digital Terrestrial Television Planning

Document: ITU-R 6E/9

Digital Television Systems

- ATSC - North America
- DVB - Europe
- ISDB - Japan

Existing situation in EBA

European Broadcasting Area

- Frequency allocation according to Stockholm Agreement 1961
- over 58 000 stations in operation
- 3 channels in Band I, 8 channels in Band III,
- 49 channels in Bands IV and V

Existing situation in Europe

- Stockholm Agreement 1961:
  - still operational and active
- Technical characteristics of assignments
- Modification procedures based on coordination distances - Article 4

Existing situation in Europe

- An estimate of the number of TV sets in Europe is about 300 million, with value of approximately 250 000 million ECU.
- Broadcasting installations (studio, links, transmitters)
- Several hundred thousand people employed

Scenario of the Introduction of Digital Television

1998 - First digital terrestrial services introduced

2005 - Planning conference (e.g.revision of ST 61)

1998 - 20?? - Transition period (Simulcast period)

2008 - Start of phasing out of analogue service

2020 - Future use of television frequency spectrum (e.g. Band III)

Scenario of the Introduction of Digital Television

Year in which analogue services will be switched off:

- 2006 USA (FCC)*
- 2007 Germany
- 2008 Italy
- 2012 Spain
- 2008 UK

* By the year 2007 49% of American households will own digital receivers

Scenario of the Introduction of Digital Television

- Audio CD (one of the most successful digital components) has reached 50% penetration within 10 years
- In UK 405 line services have had 15 years simulcasting period

* By 2007 49% of American households will own digital receivers

Transition Period - Simulcasting

It is very likely that the simulcast period will last:

from 10 to 15 years

Limiting factors

The most critical limiting factors for future development and introduction of digital terrestrial television are:

- Receivers
- Frequencies

Digital Terrestrial Receivers

- Set top box
- Price similar to satellite set top box (300 ECU)
- Noise figure (including implementation margin): 8 dB
- Only one channel bandwidth (7 or 8 MHz) is economical

Frequencies

- Most of the frequency spectrum reserved for television is engaged.
- In some countries in Europe channels 61 to 69 are not used
- Also some other channels are used for other services (e.g. channel 37)
- Planning constrains (Rec. BT. 1123)

Digital Television Standards used in Europe

- DVB - T for terrestrial services
- DVB - C for cable systems
- DVB - S for satellite reception
- DVB - MC for MMDS < 10 GHz
- DVB - MS for MVDS > 10 GHz
- DVB - SFN mega frame for SFN
- DVB - SMATV for satellite Master Antenna TV distribution

DVB - T

- Possibilities for terrestrial reception:
  - fixed reception (outdoor antenna 10 m height)
  - portable reception - outdoor (built-in antenna)
  - portable reception - indoor (built-in antenna)
  - [mobile reception]

DVB - T

- OFDM number of carriers:
  - 2 k (UK)
  - 8 k
- Possible modulation:
  - QPSK
  - 16 QAM
  - 64 QAM

DVB - T

- Guard interval:
  - 1/4
  - 1/8
  - 1/16
  - 1/32

DVB - T

- Code rates:
  - 1/2
  - 2/3
  - 3/4
  - 5/6
  - 7/8

DVB - T

- Percentage of locations:
  - 70% of locations - “acceptable” reception
  - 95% of locations - “good” reception

  [90% of locations in UK]

  Location probability factor (ITU-R Rec.P.370-7)

  50% to 70% 2.9 dB

  50% to 95% 9.0 dB

DVB - T

- Gaussian channel (carrier predominant) for fixed reception,
- Ricean channel (carrier amplitude similar to noise) for portable outdoor reception,
- Rayleigh channel (carrier lost in noise) for portable indoor reception

DVB - T

Possible network configuration:

- Single Frequency Network
- Multiple Frequency Network
- Combinations MFN and SFN

DVB - T

- Typical request from broadcasters:
- Transition period:
  - 64 QAM, 2/3, fixed reception, good reception, 4 to 5 multiplex
- Final stage:
  - 64 QAM, 2/3, portable reception, good reception, 5 to 6 multiplex

Comparison Digital vs. Analogue Terrestrial Television Planning

- Minimum field strengths (ITU-R BT. 417)
  - analogue:
- Band III 55 dB µV/m
- Band IV 65 dB µV/m
- Band V 70 dB µV/m

Minimum Field strength Recommendation ITU-R BT. 417

Band	I	III	IV	V
Frequency (MHZ)	55	200	470	790
Input resistance (75Ω) thermal noise dB(μV)	1,5	1,5	1,5	1,5
Noise figure (dB)	9,5	8,5	11	12
Radio-frequency S/N (dB)	36	36	36	36
Minimum Rx input voltage dB(μV)	47	46	48,5	49,5
Dipole conversion factor and mismatch allowance (dB)	2	13	20,5	25
Antenna gain (dB)	3	7,5	10	12
Cable loss (dB)	1	1,5	3	4,5
Minimum usable field strength dB (mV/m)	**47**	**53**	**62**	**67**

Comparison Digital vs. Analogue Terrestrial Television Planning

64 QAM, fixed, good reception, 2/3 code rate, $\Delta = 1/4$, C/N cca 17 dB, 20MBit/s

Field strength:	Digital	Analogue
Band III:	45 dBµV/m	55 dBµV/m
Band IV:	50 dBµV/m	65 dBµV/m
Band V:	54 dBµV/m	70 dBµV/m

Comparison Digital vs. Analogue Terrestrial Television Planning

64 QAM, portable , good reception, code rate 2/3, $\Delta = 1/4$, C/N = 17 dB

Field strength:	Digital	Analogue
◆ Band III:	62 dBµV/m	55 dBµV/m
◆ Band IV:	69 dBµV/m	65 dBµV/m
◆ Band V:	73 dBµV/m	70 dBµV/m

Comparison Digital vs. Analogue Terrestrial Television Planning

64 QAM, portable indoor acceptable (or good) reception, code rate 2/3, $\Delta = 1/4$, C/N = 19 dB

Field strength:	Digital	Analogue
Band III:	73 dBµV/m	55 dBµV/m
Band IV:	83 dBµV/m	65 dBµV/m
Band V:	87 dBµV/m	70 dBµV/m

Comparison Digital vs. Analogue Terrestrial Television Planning

- Protection ratios:
  - co-channel case
  - upper adjacent channel case
  - lower adjacent channel case

Co-channel Interference

- Continuos Interference T < 50 %
- Tropospheric Interference T = 1-10 %
- Steady state Interference T = 100 %
- Precision Offset stability ± 1 Hz
- Non-precision offset ± 500 Hz

Comparison Digital vs. Analogue Terrestrial Television Planning

- Cochannel Protection Ratios: Rec. BT.655
- Analogue/Analogue Signals:

	Trop.	Cont.
Non-precision offset:	30 dB	40 dB
Precision offset:	22 dB	27 dB
Limit of perceptibility:	36 dB	43 dB

Comparison Digital vs. Analogue Terrestrial Television Planning

Adjacent channel analogue/analogue PR:

- Lower adjacent channel (B,G): -9 dB
- Upper adjacent channel (B,G): -12 dB

Comparison Digital vs. Analogue Terrestrial Television Planning

PR for digital/digital (64 QAM 2/3):

- Co-channel:
  - Gaussian: 19 dB *(22dB;27dB)*
  - Rice: 20 dB
  - Rayleigh: 22 dB
- Adjacent channel: -40 dB *(-9dB;-12dB)*

Comparison Digital vs. Analogue Terrestrial Television Planning

Protection Ratios digital interfered by analogue:

(PAL G/64 QAM,2/3)

- Co-channel: 4 dB (22;27 dB)
- Lower adjacent: -34 dB (-9 dB)
- Upper adjacent: -38 dB (-12 dB)

Comparison Digital vs.Analogue Terrestrial Television Planning

Protection Ratios analogue interfered by digital :

(64 QAM,2/3/ PAL G)

- Co-channel: 34(40)dB (22;27 dB)
- Lower adjacent: -7(-4)dB (-9 dB)
- Upper adjacent: -9(-7) dB (-12 dB)

Frequency Planning

- Chester Agreement - 97 (Technical Criteria, Coordination Principles and Procedures for introduction of DVB - T
- Reference situation - 0.3 dB degradation

Frequency Planning Strategy

- Select optimal option for your country (number of national, regional and local networks - multiplexes)
- Study possibilities for frequency planning during simulcast period
- Frequency plan for all digital situation
- Plan for transition from simulcast to all digital period - coordinated with neighboring countries

Future of television planning

- Mobile television
- Interactive television

Mobile television

- DVB - T
- ISDB - T
- Mobile reception in the case of DVB-T is limited by Doppler frequency shift.
- At the VHF the maximal velocity is higher as at the UHF.

Interactivity