



Принципы частотно-территориального планирования сетей DVB-H

Часть 5

Планирование DVB-H - аспекты связанные с использованием радиочастотного спектра

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The link between the transmitter and the receiver

The computation of the **C/N threshold** depends on the mode the DVB-H network is working:

- Multiple frequency network (MFN) mode

- Single frequency network (SFN) mode

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MFN: Frequency assignment

What is the goal ?

- Minimize the interference areas between the sites working in MFN (Multiple Frequency Network)
- Optimize the use of the spectrum by using the topography as a protection: in terms of coverage, the topography is a drawback, but in terms of interference, it is a major asset !

Risk of inter-channel Interference (ICI)

The topography is a natural protection:
The frequency can be re-used

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MFN: Frequency assignment

The frequencies of an MFN network can be assigned according to :

- a freq. band
- a freq. list
- a freq. Plan

Files Map Direct Coverage Microwave

Network calculation
Network analysis
Network interference
Network assignment...

frequency assignment

Mode

Band assignment

Multi-channels assignment

Minimum frequency spacing: 0.175 MHz
Maximum frequency spacing: 1e+007 MHz

Band: Number of frequencies: 0

Group assignment - multi-channels

Keep number of channels defined for each station
Start index assignment (Frequency Hopping mode)

Group: Number of groups: 0

List assignment

Multi-channels assignment

Minimum frequency spacing: 0.175 MHz
Maximum frequency spacing: 1e+007 MHz

List: Number of frequencies: 0

Tx plan assignment Multi-channels assignment

Minimum frequency spacing: 0.175 MHz
Maximum frequency spacing: 1e+007 MHz

Tx Rx Tx/Rx fixed spacing**

Polarization assignment: H/V Multi-channels interference

Assign selected station frequencies:

Station: Channel: Tx freq: Rx freq: MHz

Start Stop Delta F...

Rules

Apply frequency spacing on same site MHz: >= 0.0010

Tx/Tx Tx/Rx from TR

if azimuth spacing < 1

Forbid same polarization on site if az. spacing < 1

Forbid same frequency on same site

Site: Distance between stations <= 1 m

Organize Tx list - frequency isolation constraint

Organize Tx list - sector constant (delta=0°)

Organize Tx list - coverage size constraint

Assign polarization (H/V)

CA... Clutter... Number of pass: 3

Exhaustive method Assign all channels

Monte Carlo method Assign pilot channel

Heuristic method Assign traffic channels

Sequential method

Same Freq: Activated Tx Network ID Linked Tx

Overlapping rule (frequency reuse):

if Delta FS <= 0 dB

Delta Freq >= 0.01000 MHz Station list...

Rx ant disc: Wanted threshold: 37

none Threshold = wanted cover. [exit rad]

415/GE Global interference

useF Virtual mode

Unwanted coverage from FDU [path...]

Load... Save... Close

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DV: (*1 switch Tx/Rx frequencies, F) not saved
(**) signed duplex only used if fixed spacing

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MFN: Interference analysis

The **Nuisance field strength (NFS)** delivered by Tx2 at the receiver's location relatively to Tx1 is defined by the following formula :

$$\text{NFS (dB}\mu\text{V/m)} = \text{C2 (dB}\mu\text{V/m)} + \text{C/I}_{\text{Required}} \text{ (dB)} - \text{RXAPA (dB)} - \text{XPD (dB)}$$

Single interferer mode :

Tx1 is considered as interfered at the point M if

- $\text{C1 (dB}\mu\text{V/m)} > \text{Threshold (dB}\mu\text{V/m)}$

and

- $\text{C1 (dB}\mu\text{V/m)} < \text{Max}_{\text{per}} \text{ (NFS) (dB}\mu\text{V/m)}$

Summed interferers mode :

Tx1 is considered as interfered at the point M if :

- $\text{C1 (dB}\mu\text{V/m)} > \text{Threshold (dB}\mu\text{V/m)}$

and

- $\text{C1 (dB}\mu\text{V/m)} < \text{Sum}_{\text{per}} \text{ (NFS) (dB}\mu\text{V/m)}$

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MFN: Interference analysis

The MFN network interference analysis is based upon :

- The signal type of the victim
- The signal type of the unwanted signal
- the co-channel protection ratio
- the adjacent channel protection ratio
- ITU/EBU protection ratios

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MFN: Interference analysis

The MFN network interference analysis is based upon :

- The signal type of the victim
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- the co-channel protection ratio
- the adjacent channel protection ratio
- ITU/EBU protection ratios

Receiver: -27 dBμV/m		
Tx 0001	1552963 - 44.0 dBμV/m - Co 01 - 1468.51 MHz.C - CDV	Interfere 0001
Tx 0002	1553971 - 42.0 dBμV/m - Co 01 - 1465.77 MHz.C - CDV	Interfere 0002
Tx 0003	1553984 - 60.0 dBμV/m - Co 01 - 1465.02 MHz.C - CDV	Interfere 0003

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SFN: Interference analysis

In OFDM, the information is carried via a large number of individual carriers in a frequency multiplex. Each carrier transports only a relatively small amount of information, and high data capacities are achieved by using a large number of carriers within a frequency multiplex. Each carrier has a fixed phase and amplitude for a certain time duration, during which a small portion of the information is carried. This unit of data is called a **symbol**; the time it lasts is called the **symbol duration**. After that time period, the modulation is changed and the next symbol carries the next portion of information.

In an environment where several useful signals (either from multipath echoes or from other transmitters in an SFN) are available to the receiver, things become more complex. Usually, the signals arrive at different times at the receiver which, in the absence of a guard interval, makes correct synchronization to all the signals impossible.

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SFN: Interference analysis

In order to overcome the inter-symbol interference problem, part of the symbol is copied from the beginning of the symbol to the end, increasing its duration by a certain amount of time called the guard interval Δ .

Original symbol
 T_u

Extended symbol
 $T_s = T_u + \Delta$

The new increased symbol duration is denoted by T_s and the original symbol duration is often called the **useful symbol duration** T_u . The duration of the FFT window during which the symbol is evaluated is kept at the original value T_u . The orthogonally relationship is kept with the original symbol duration T_u , not the extended T_s .

Time

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SFN: Interference analysis

In the case of DVB-H, because of the pilot carriers that are needed for coherent demodulation, the total loss of constructive signal components occurs beyond a relative delay T_p .

Synchronization

Interfering component

Useful component

GI T_p

Files Map Direct Coverage Microwave Multipoint Subscribers Windows Satellite

- Network calculation
- Network analysis
- Network interference
- Network assignment...
- Traffic analysis
- Handover
- Gap filler planning...

C/I mode...
IRF mode...
Analog SFN...
Digital SFN (COFDM)...
Coverage + interference...

Coverage interference C/N+I (COFDM mode)

Action

First server method

Best server method

Guard interval (usec) 28

Usable symbol (usec) 448

Normal distrib % stdev (dB) 5.5

Unwanted = activated

Unwanted = de-activated and activated

Unwanted = de-activated

Display best server when C/N+I >=

median C/N+I 30 dB

Fix gain 0.00 dB

Noise -57 dBm

Margin 10 dB

Wanted threshold 65

Start

Cancel

- DVB 2K 1/4
- DVB 2K 1/8
- DVB 2K 1/16
- DVB 2K 1/32
- DVB 4K 1/4
- DVB 4K 1/8
- DVB 4K 1/16**
- DVB 4K 1/32
- DVB 8K 1/4
- DVB 8K 1/8
- DVB 8K 1/16
- DVB 8K 1/32
- DAB mode I
- DAB mode II
- DAB mode III
- DAB mode IV

Continue

SFN only - No rejection calculated

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SFN: Interference analysis

$$C = \sum_i W_i C_i$$

$$I = \sum_i (1 - W_i) C_i$$

Case 1 Full destructive field strength	$W_i = 0$ if $t \leq \Delta - T_p$
Case 2 Partial constructive field strength Partial destructive field strength	$W_i = \frac{(T_u + t)}{T_u}$ if $\Delta - T_p < t \leq 0$
Case 3 Full constructive Field strength	$W_i = 1$ if $0 < t < \Delta$
Case 4 Partial constructive field strength Partial destructive field strength	$W_i = \frac{(T_u + \Delta) - t}{T_u}$ if $\Delta < t \leq T_p$
Case 5 Full destructive field strength	$W_i = 0$ if $T_p < t$

The diagram shows a timeline starting with a 'Synchronization' point. A vertical dashed line marks the start of the interval. A horizontal axis 't' shows the following intervals: Case 1 (pink arrow, t ≤ Δ - Tp), Case 2 (green arrow, Δ - Tp < t ≤ 0), Case 3 (blue arrow, 0 < t < Δ), Case 4 (blue arrow, Δ < t ≤ Tp), and Case 5 (pink arrow, Tp < t). Key time intervals Tp, Tu, and Δ are also indicated.

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SFN: Interference analysis

The map displays signal strength contours in dB. A legend on the right maps dB values to colors: -100 dB (red), 11 dB (orange), 14 dB (yellow), 17 dB (green), 21 dB (light green), 31 dB (dark green), and 41 dB (blue). Several stations are marked with red boxes and labeled 'New site'.

>= dB	>= dBuV/m/C	Label
-100	auto	Below the C/N
11	auto	11dB C/N 0dB above
14	auto	14dB C/N 3dB above
17	auto	17dB C/N 6dB above
21	auto	21dB C/N 10dB above
31	auto	31dB C/N 20dB above
41	auto	41dB C/N 30dB above

The inset map shows a detailed view of the Marina and Riverside areas. A legend for this area includes: Station: 1 - FSR: 68.0 dBuV/m (COV); Destructive - St: 002 - FSR 23.0 dBuV/m - DTOA: 6 microseconds (COV); Destructive - St: 003 - FSR 67.0 dBuV/m - DTOA: 22 microseconds (COV); Destructive - St: 004 - FSR 62.0 dBuV/m - DTOA: 17 microseconds (COV); Destructive - St: 005 - FSR 52.0 dBuV/m - DTOA: 9 microseconds (COV); Constructive - St: 006 - FSR 37.0 dBuV/m - DTOA: 1 microseconds (COV); C/N4: 13 dB; C: 68 - I: 55 - N: 40 dBuV/m.

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Что следует?

Часть 6

Аспекты миграции от существующих систем к DVB-H

