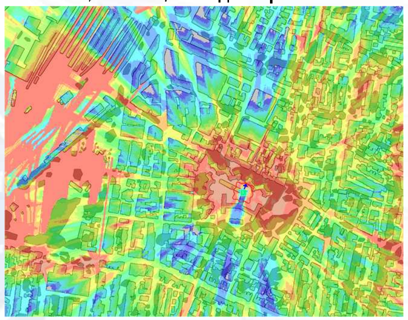
Принципы частотно-территориального планирования сетей DVB-H

Часть 4

Расчёт и анализ покрытия DVB-H

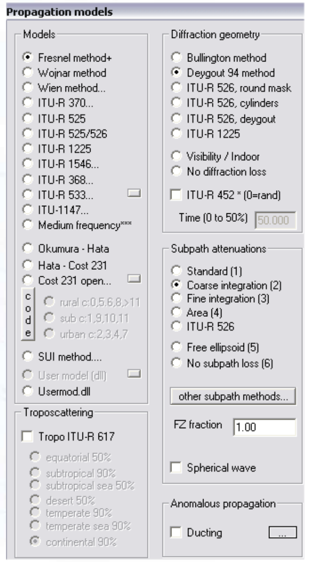
Семинар БРЭ МСЭ: «Переход от аналогового к цифровому вещанию»
г. Москва, Россия, 9-11 декабря 2008 г.



The propagation model

The choice of the propagation model depends on the goal to achieve:

- Deterministic methodologies
- Empirical methodologies
- Empirical coordination methodologies



The propagation model

Deterministic models (also called geometrical) models estimate the field strength (or signal power) directly from the path profile (profile of the terrain between the transmitter and the receiver). These methods adjust the terrain elevation to take account of the earth's curvature. In addition to free space losses, these models also take account of losses due to diffraction in cases where there is insufficient clearance between the radio path and the terrain (or structures on the terrain). Accordingly, geometrical models require a detailed knowledge of the terrain (e.g. from DTMs).

Free Space	Diffraction	Fresnel zone blocking
ITU-R P.525	Deygout 94	Standard
ITU-R P.525	ITU-R P.526	ITU-R P.526
Fresnel method+	Deygout 94	Coarse

Empirical models (also called statistical) were originally intended to provide estimations of field strengths (or power) in cases where there was insufficient knowledge of the terrain profile. These models were developed from data obtained from extensive measurements in different environments.. These models use simple equations with little dependence on the cartographic data, and are only valid for short ranges of frequencies and specific environments (urban, suburban, open/rural, sea, etc.).. Because of this reason using high resolution cartography is useless and medium resolution is more adequate.

DVB-H (UHF) empirical models
ITU-R P.1546
Hata-COST231
SUI method
ITM – Longley-Rice

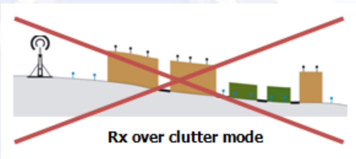
The propagation model: about the ITU-R P.1546

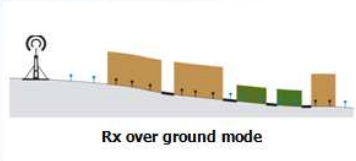
Path general methods such as **Recommendation ITU-R P.1546** are good for general planning and coordination. They can be used with the minimum of information about the propagation path and can be agreed easily between countries. However, as they take little account of terrain there can be significant prediction errors on individual paths. Thus, for detailed planning and coordination of specific transmitter locations there are considerable benefits in using deterministic prediction methods that take account the terrain.

Macro-scale mode: configuring the clutter file

The location of the DVB-H receiver can be defined according to the clutter level:

- The Rx over clutter mode places the receiver on top of the clutter. This mode should be avoided for DVB-H planning purposes
- The Rx over ground mode places the receiver into the clutter on top of the terrain. This mode should be used for DVB-H planning purposes

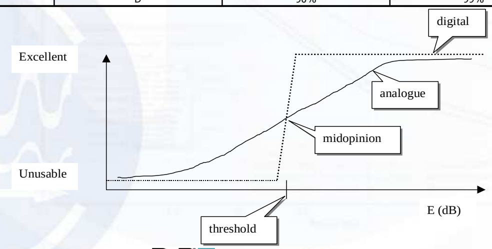




Macro-scale mode: should I tune the model ?

Yes !!! Tuning the model reduces the margin for the quality of coverage QC (section 1). It is necessary to consider these effects when considering DVB-H reception in a practical environment. In defining coverage it is indicated that due to the very rapid transition from near perfect to no reception at all, it is necessary that the minimum required signal level is achieved at a high percentage of locations.

Class		Acceptable reception	Good reception
Portable	A	70%	95%
	B1 B2	70%	95%
Mobile	C	90%	99%
	D	90%	99%



Macro-scale mode: Model tuning

Considering the received signal obeys a log-normal distribution, the quality of coverage margin is calculated as follow:

$$QC = \mu \,.\, (\delta o^2 + \delta\, i^2)^{1/2}$$

Where µ is a distribution correction factor according to the percentage of locations, and **δ** is the cumulative of the outdoor (**δ** o) and indoor (**δ** i) standard variations f the macro-scale propagation model.

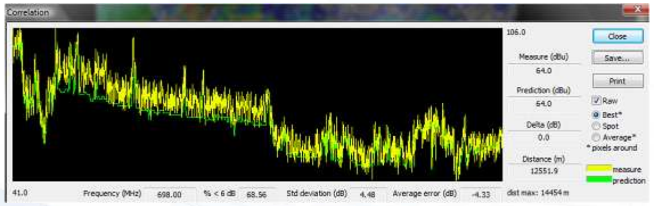
Percentage of locations	70	90	95	99
Distribution factor µ	0.52	1.28	1.64	2.33

Class	δo dB	δi dB	δ dB	QC margin acceptable dB	QC margin good dB
C - Mobile Roof-top	5.5		5.5	7.0	12.8
A - Portable outdoor pedestrian	5.5		5.5	2.9	9.0
D - Mobile in-car	5.5		5.5	7.0	12.8
B1 - Portable light indoor	5.5	5	7.4	3.9	12.2
B2 - Portable deep indoor	5.5	6	8.1	4.2	13.3

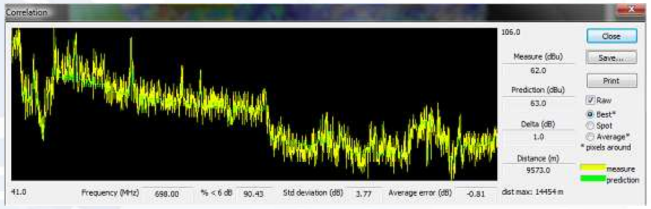
QC can be reduced by model tuning

Macro-scale mode: Model tuning

Before tuning



After tuning



Macro-scale mode: Model tuning

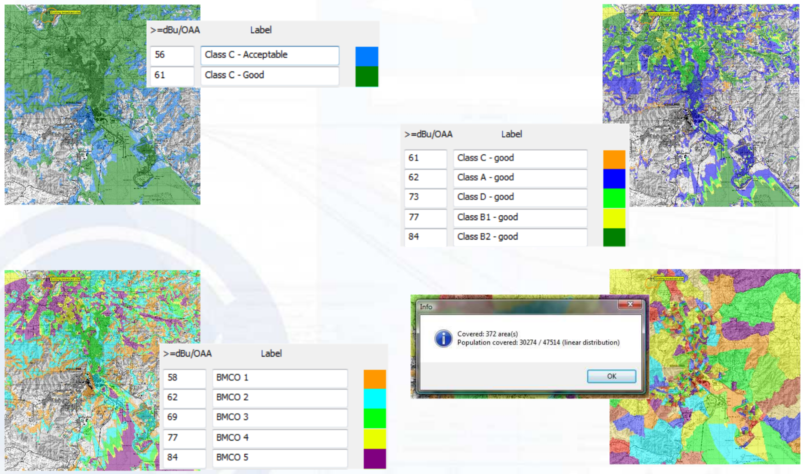
Class	δo in dB		δi dB	δ in dB		QC margin acceptable dB		QC margin good dB	
	Old	New		Old	New	Old	New	Old	New
C - Mobile Roof-top	5.5	3.8		5.5	3.8	7.0	4.8	12.8	8.8
A - Portable outdoor pedestrian	5.5	3.8		5.5	3.8	2.9	2.0	9.0	6.2
D - Mobile in-car	5.5	3.8		5.5	3.8	7.0	4.8	12.8	8.8
B1 - Portable light indoor	5.5	3.8	5	7.4	6.3	3.9	3.3	12.2	10.3
B2 - Portable deep indoor	5.5	3.8	6	8.1	7.1	4.2	3.7	13.3	11.6

Macro-scale mode: Model tuning

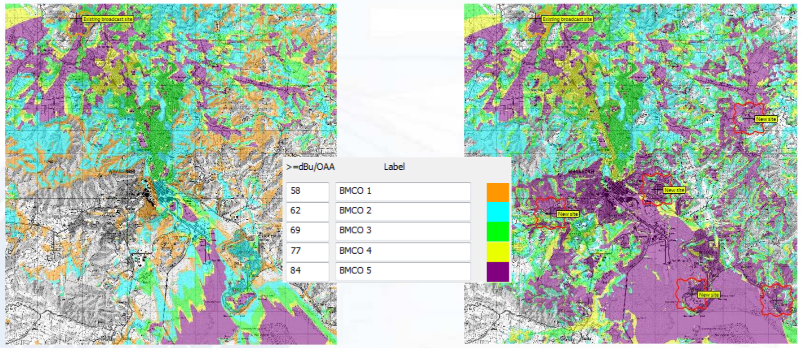
Class	Acceptable reception		Good reception	
	Using a 5.5dB δo	Tuned model	Using a 5.5dB δo	Tuned model
C - Mobile Roof-top	59 dBµV/m	56 dBµV/m	65 dBµV/m	61 dBµV/m
A - Portable outdoor pedestrian	59 dBµV/m	58 dBµV/m	65 dBµV/m	62 dBµV/m
D - Mobile in-car	71 dBµV/m	69 dBµV/m	77 dBµV/m	73 dBµV/m
B1 - Portable light indoor	71 dBµV/m	69 dBµV/m	79 dBµV/m	77 dBµV/m
B2 - Portable deep indoor	77 dBµV/m	74 dBµV/m	86 dBµV/m	84 dBµV/m

BMCO usage	Type	Using a 5.5dB δo	Tuned model
BMCO 1	Portable outdoor pedestrian – Acceptable Mobile roof-top - Acceptable	59 dBµV/m	58 dBµV/m
BMCO 2	Mobile roof-top – Good Portable outdoor pedestrian – Good	65 dBµV/m	62 dBµV/m
BMCO 3	Portable light indoor – acceptable Mobile in-car - Acceptable	71 dBµV/m	69 dBµV/m
BMCO 4	Mobile in-car - Good Portable deep indoor – Acceptable Portable light indoor – Good	79 dBµV/m	77 dBµV/m
BMCO 5	Portable deep indoor - Good	86 dBµV/m	84 dBµV/m

Macro-scale mode: Coverage analysis



Macro-scale mode: Fill the gaps



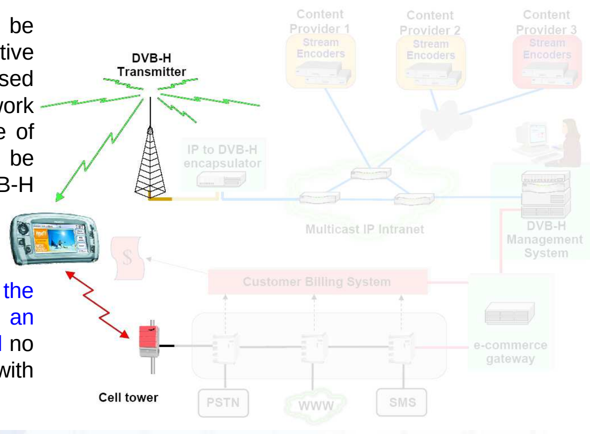
Initial coverage

Network densification in order to provide a BMCO3 in the urban environment

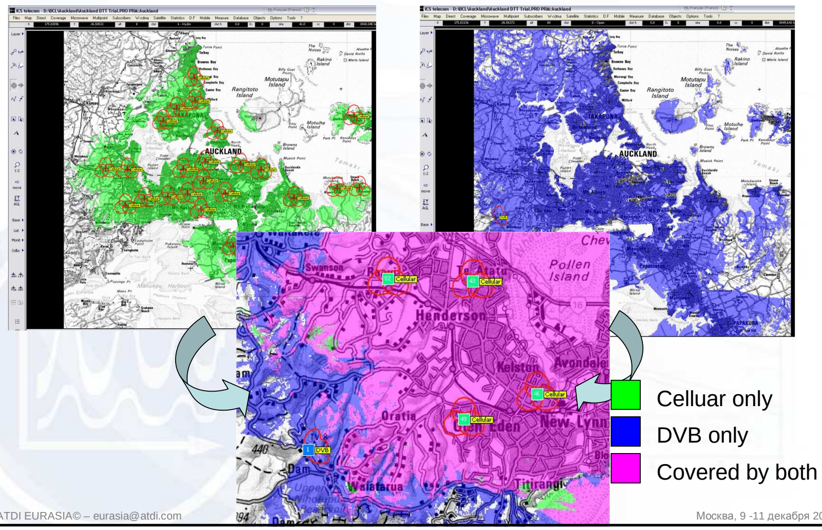
Macro-scale mode: the back-channel

The back-channel must be ensured for interactive services. It is usually based upon a cellular network infrastructure. The coverage of the cellualar network can be overlaid on the DVB-H coverage:

- By calculation
- By importing the coverage from an alternative planning tool no need to share the tool with the mobile operator



Macro-scale mode: the back-channel



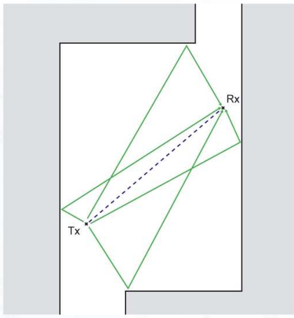
Micro-scale mode: the outdoor propagation

OFDM propagation : taking advantage of the reflexions

An OFDM enabled receiver can consider as a received input signal all sub-carrier signals, whether they are direct or not, as soon as the time difference between them is not to long.

OFDM propagation: the direct path (in blue) and the reflected paths (in green) not only do not interfere one with each other (as soon as the difference in time of arrival is not too long…) but also combine each other in order to

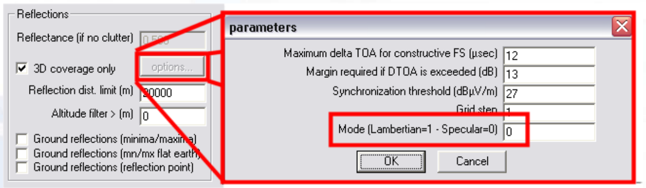
improve the reception.

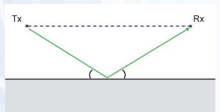


Micro-scale mode: the outdoor propagation

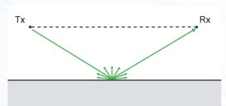
OFDM propagation : taking advantage of the reflexions,

and model the Inter-Symbol interference (ISI)





Specular



Lambertian

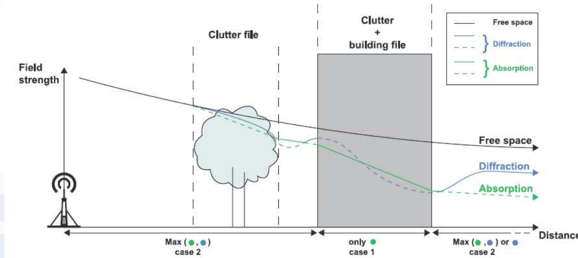
Micro-scale mode: the outdoor propagation

Reflected and direct paths : constructive and destructive field strength

Micro-scale mode: the outdoor/indoor propagation

Calculate the building penetration loss

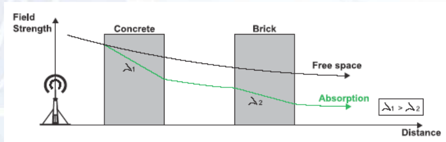
- Rx over clutter
- Rx over ground spot



Clutter parameters

Clutter code	Name	Attenuation (dB)
0	None	0.0
1		0.0
2		0.0
3		0.0
4		0.0
5	Foliage	220.0
6	Hydro	0.0
7		0.0
8		0.0
9	Building	500.0 dB/km
10	Main Road	0.0

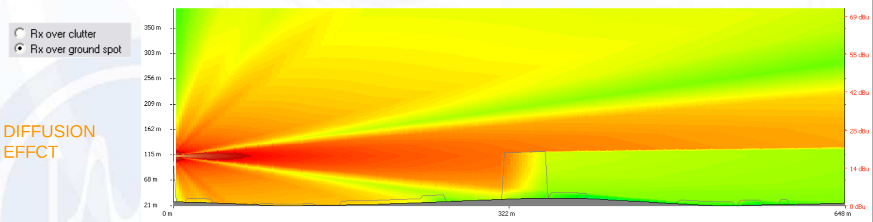
DIFFUSION EFFCT



$$L_{absorption}\,(dB) = \sum \lambda_i \times L_i\,(km)$$

Micro-scale mode: the outdoor/indoor propagation

Calculate the building penetration loss

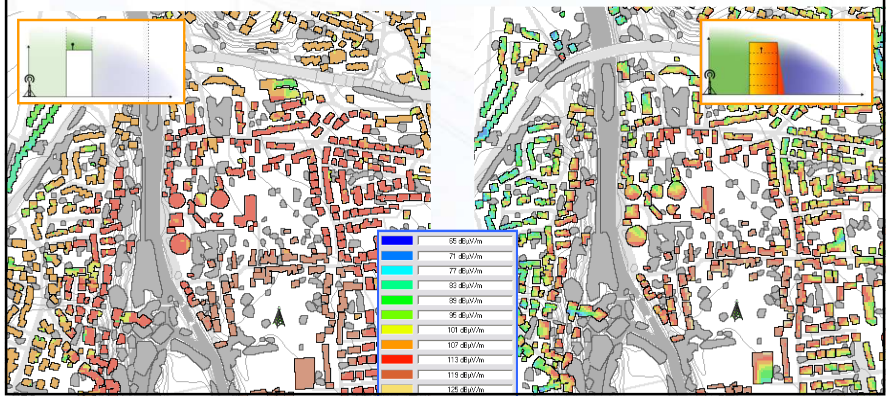


DIFFUSION EFFCT

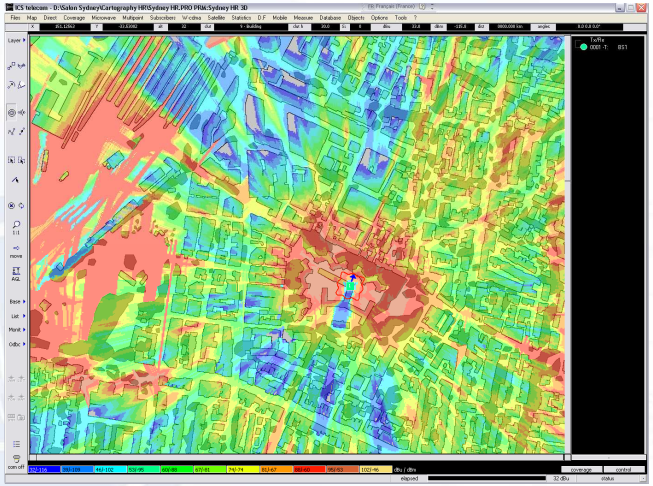
Micro-scale mode: the outdoor/indoor propagation

Rx antenna placed on the rooftop (DVB-T type)

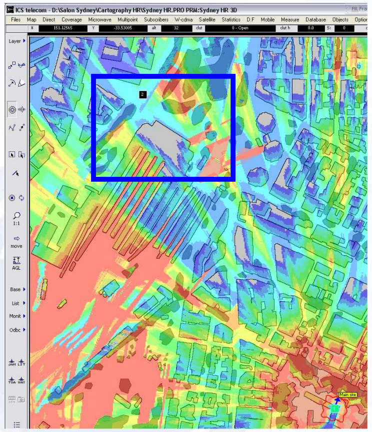
Rx antenna placed inside the building (DVB-H type)

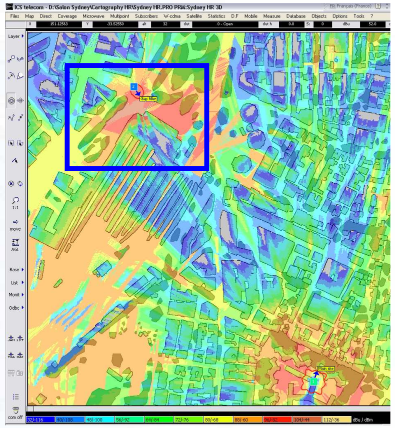


Micro-scale mode: the outdoor/indoor propagation



Micro-scale mode: addition of transponders for deep indoor coverage





Что следует?

Часть 5

Планирование DVB-H: аспекты связанные с использованием радиочастотного спектра