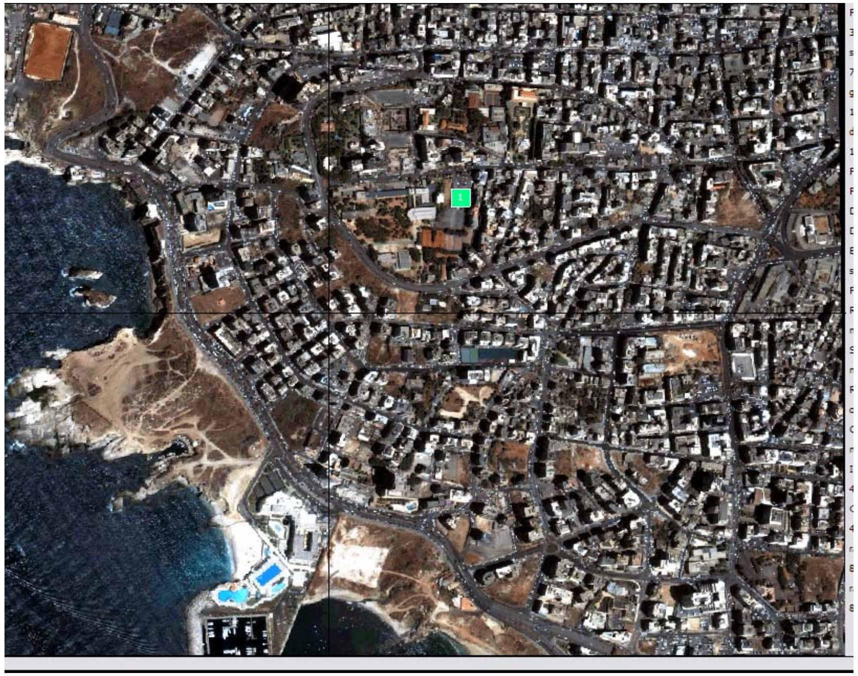
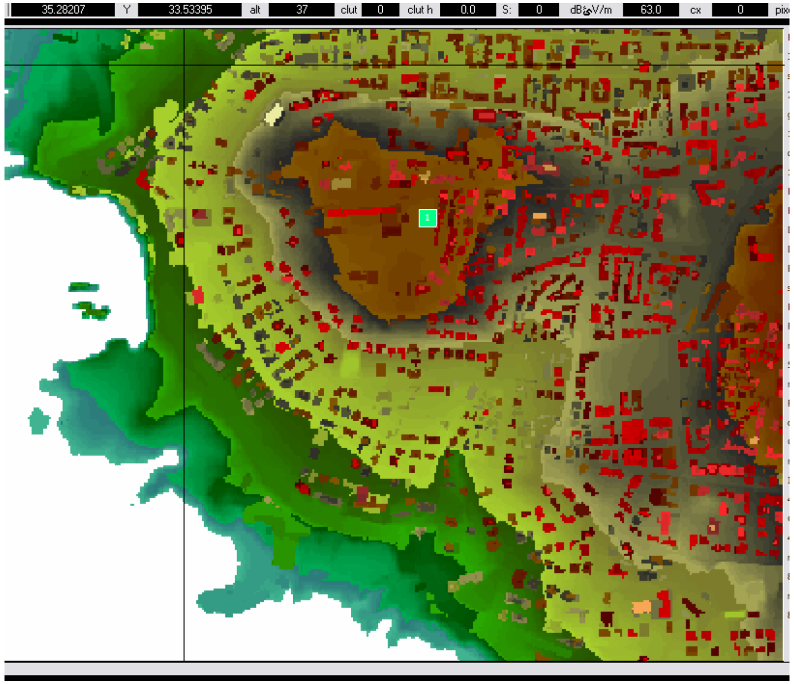
Applied Digital Broadcast Planning and Implementing

Essential in planning Maps

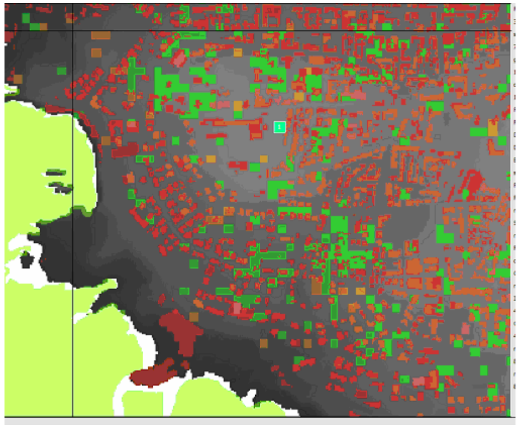


Aerial View

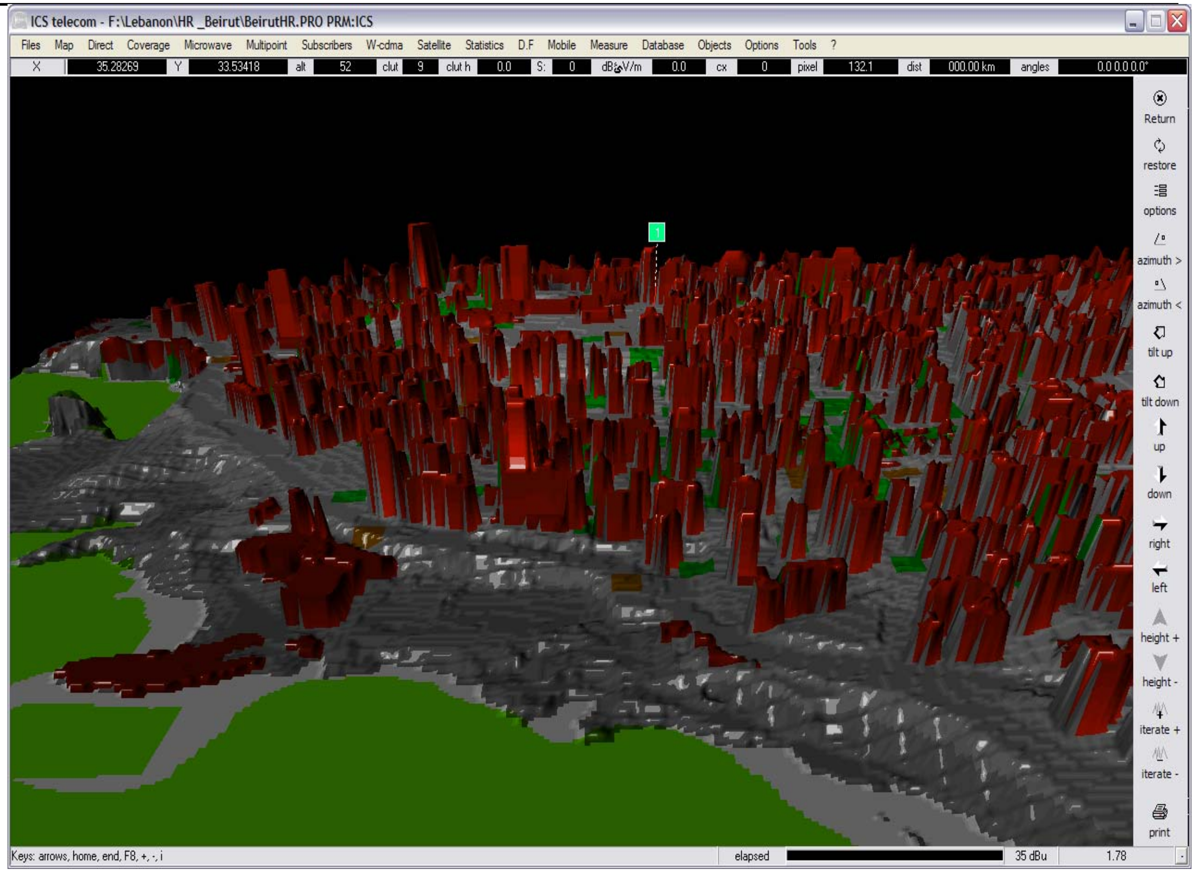


DEM View

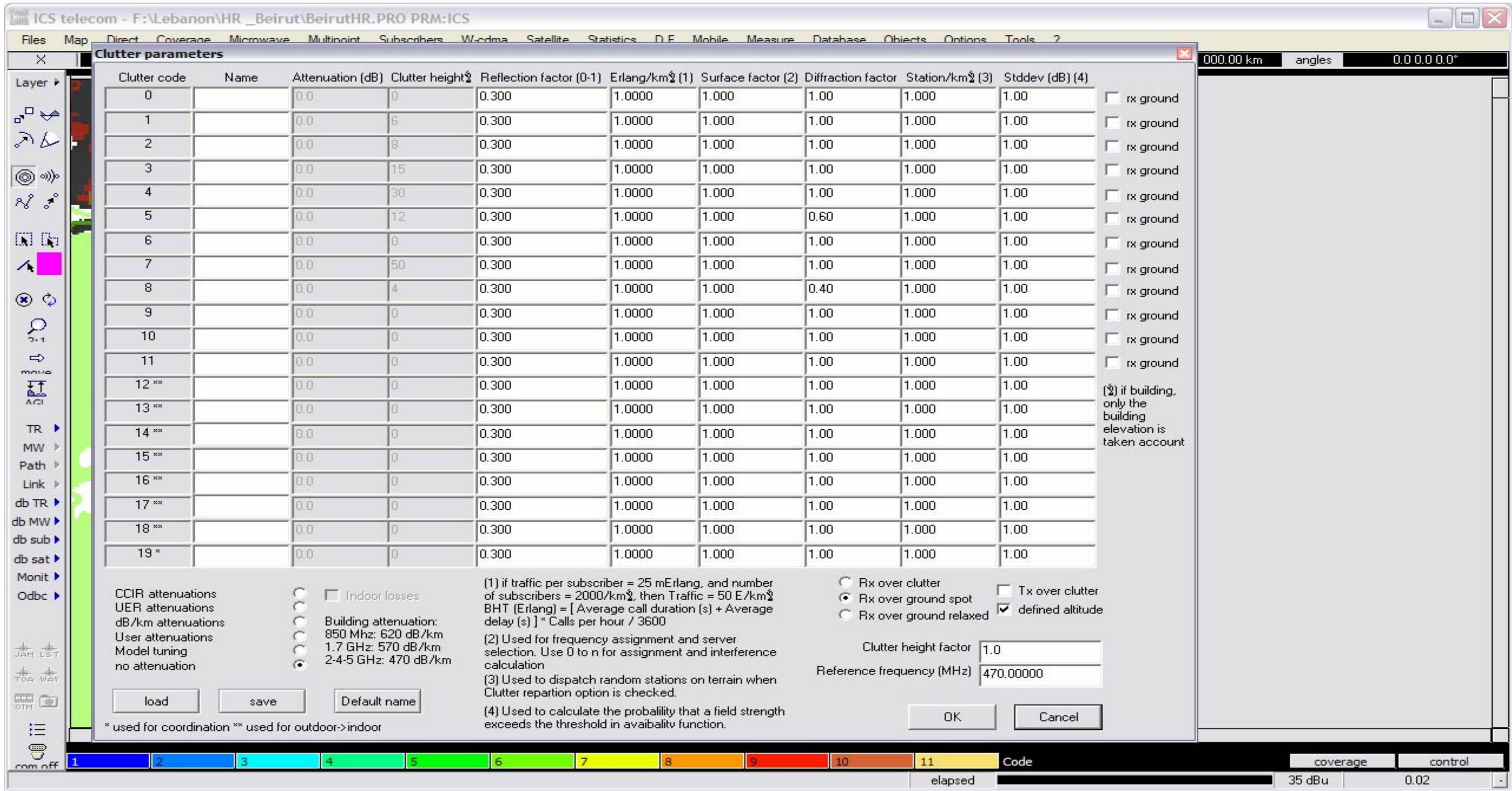
Essential in planning Maps



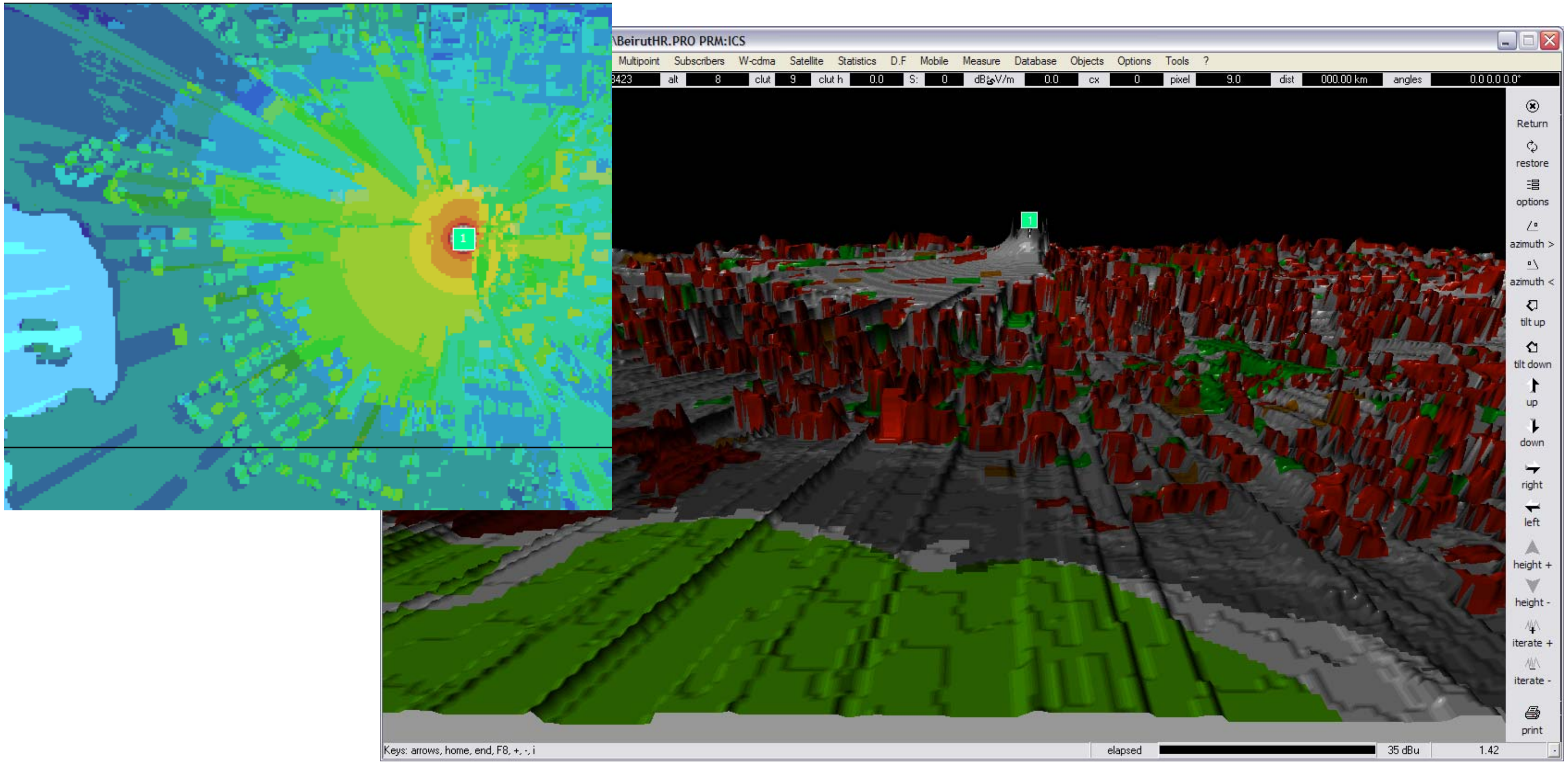
Clutter View



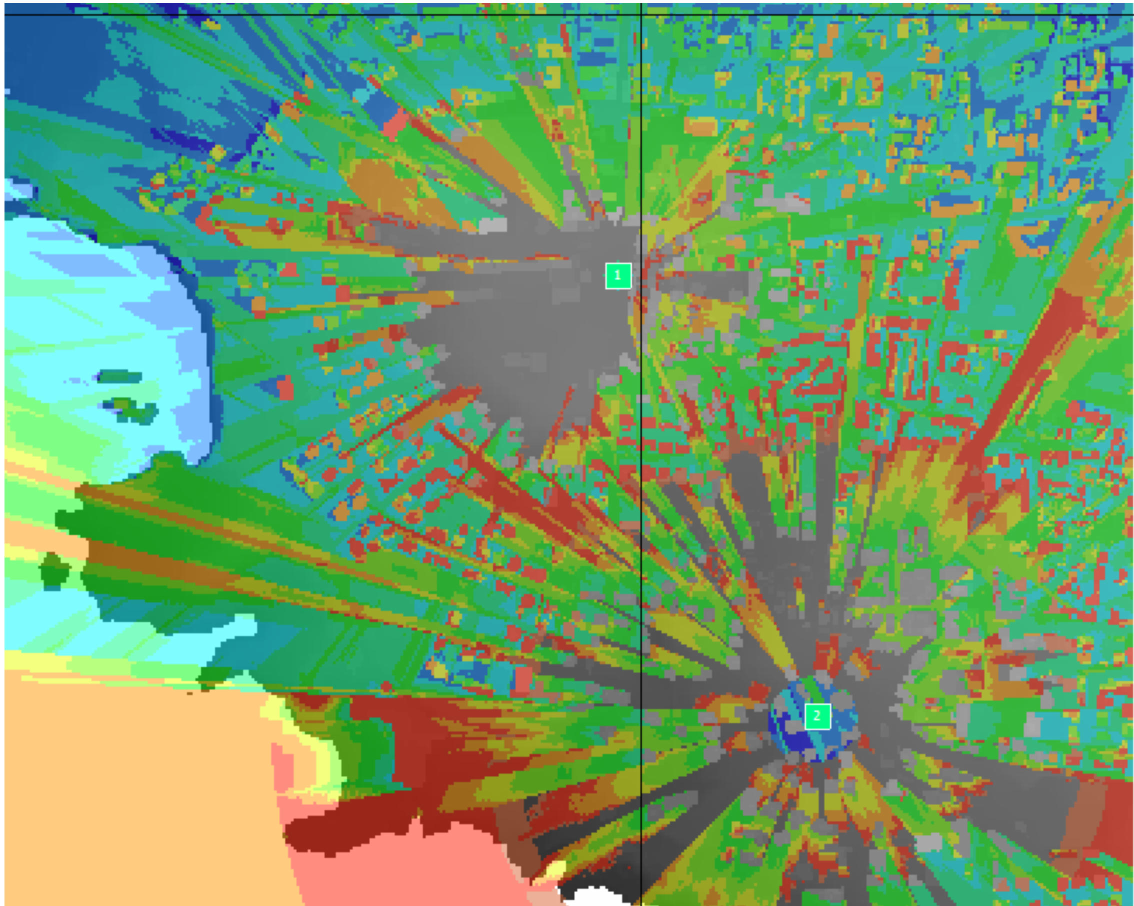
Clutter definable options



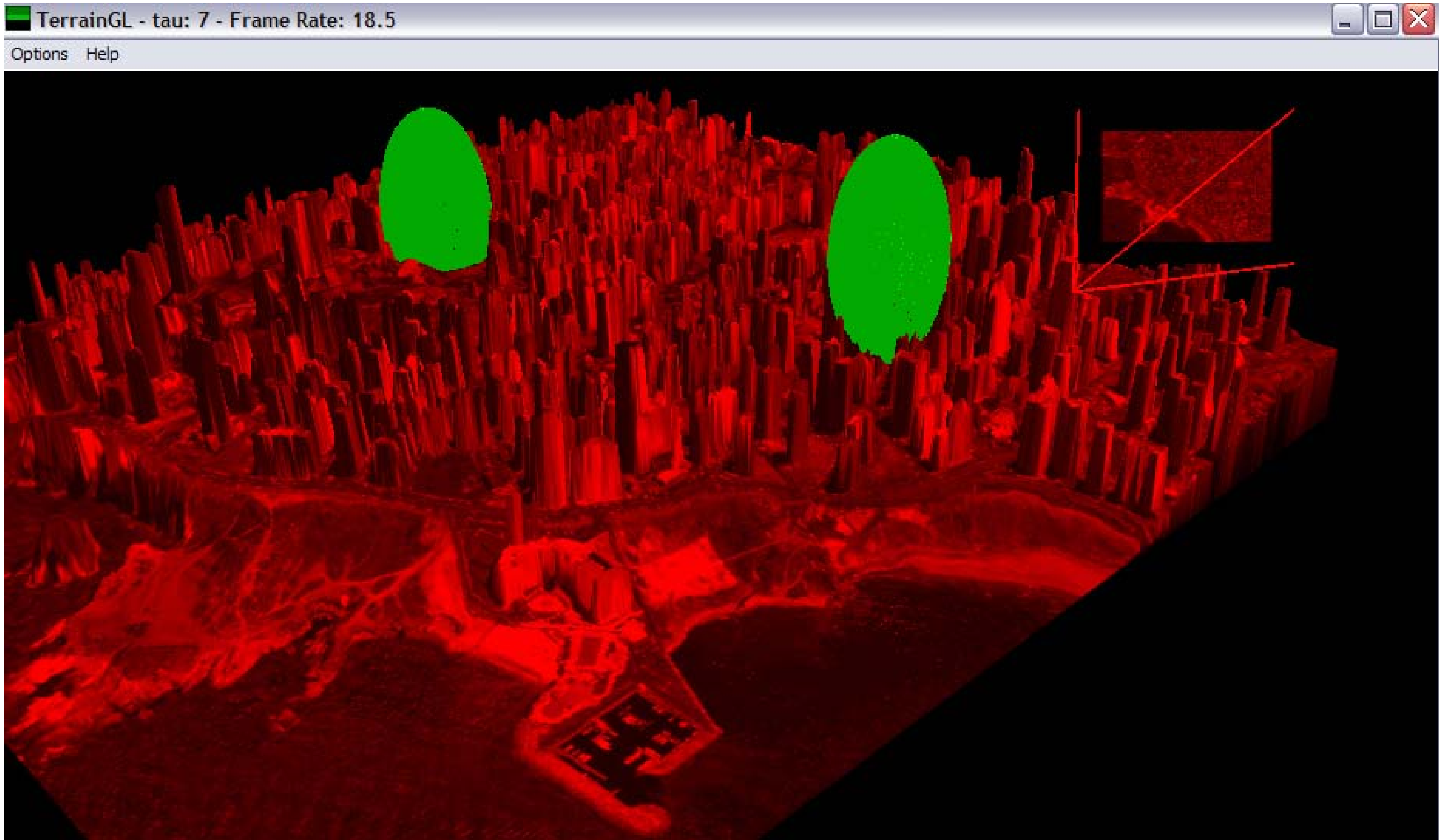
Coverage View 3D/2D



Percentage Layer



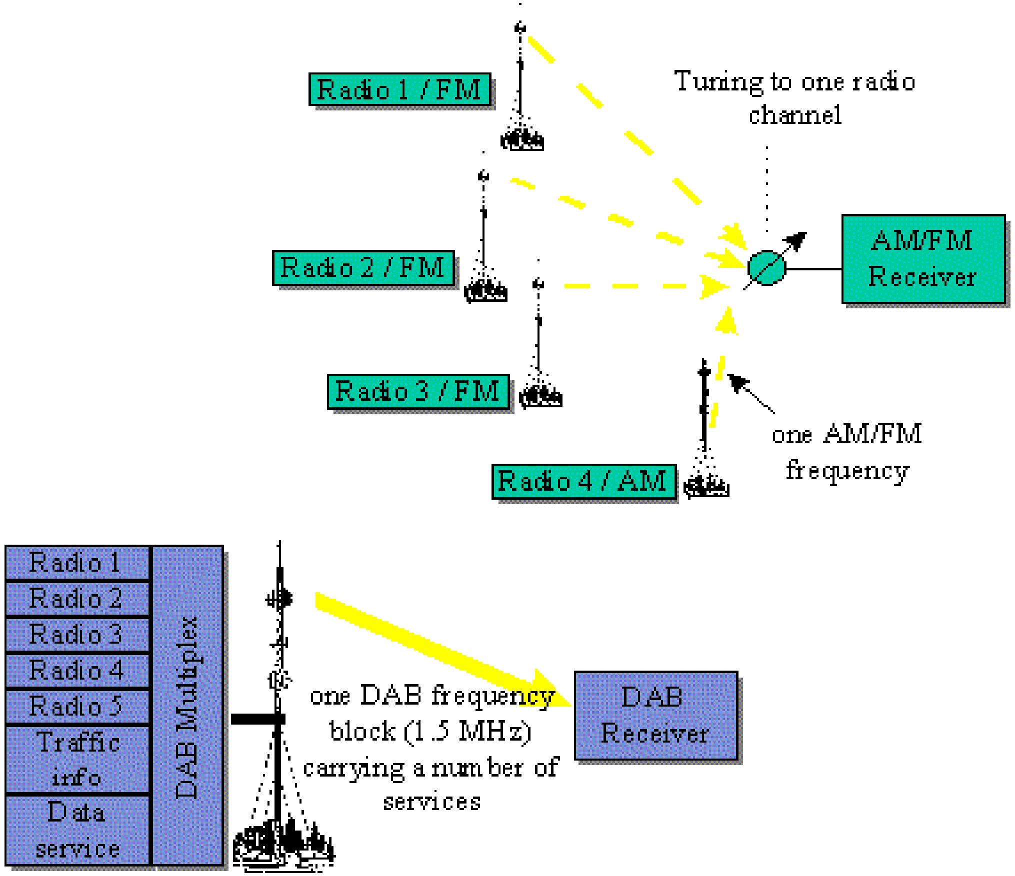
Full 3D navigation



Case in planning digital Broadcasting

BBC DAB
Planning for Mauritius Island
Planning France Digital Broadcasting

DAB with FM Broadcasting



The BBC Network

- 4 Radio Channels in Stereo coded with 192kbits/s
- 1 Radio Channel in Mono coded with 96kbits/s
- Speech-based programs at lower rates (typ. <96kbits/s)
- 12.5MHz of Band III allocated to DAB (217.5-230MHz)

BBC network availability

Key Concept

- MUSICAM - MPEG Layer 2
- OFDM
- FEC CODING
- GAP FILLERS
- SFN
- FLEXIBILITY

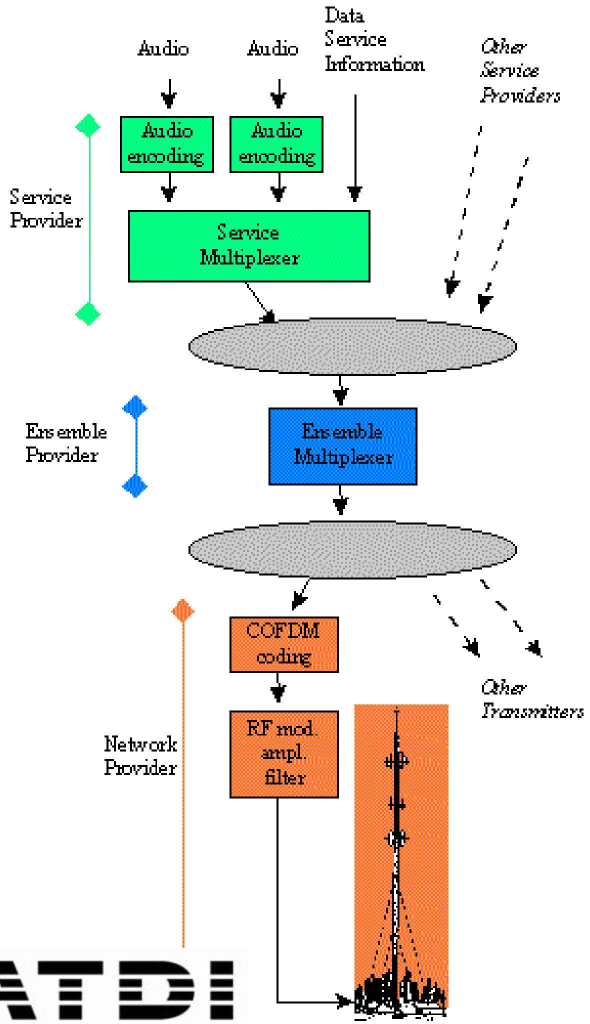
Time		
0000 - 1059	1100 - 1859	1900 - 2359
Radio 1 (192 Kbit/s)		
Radio 2 (192 Kbit/s)		
Radio 3 (192 Kbit/s)		
Radio 4 (192 Kbit/s)		
Radio 5 (96 Kbit/s)		
Unused	5 Live Sport+ (80 Kbit/s)	Unused
Parliament - currently unavailable		
World Service (80 Kbit/s)		
BBC Xtra (192 Kbit/s)	BBC Xtra (112 Kbit/s)	BBC Xtra (192 Kbit/s)

BBC Implementation

- 4 MODES OF OPERATION (I TO IV) :
  - Mode I : for terrestrial SFN (greater site spacing)
  - Mode II : for single-station broadcast and hybrid networks up to 1.5GHz
  - Mode III : satellite broadcast and earth dispatch, up to 3GHz
  - Mode IV : for optimal SFN in L band

SEVERAL FREQUENCY RANGES (UHF/VHF/L Band)
Feasibility of SFN and gap fillers
Simple Quasi-Omni RX Antennas

BBC DAB Network



Radio freq properties	Mode I	Mode II	Mode III	Mode IV
Bandwidth	1.536MHz			
Number of carriers	1536	384	192	768
Guard Interval	246µs	62µs	31µs	123µs
Distance between TX in SFN	<=60km	<=20km	<=10km	<=30km
Carrier spacing	1kHz	4kHz	8kHz	2kHz

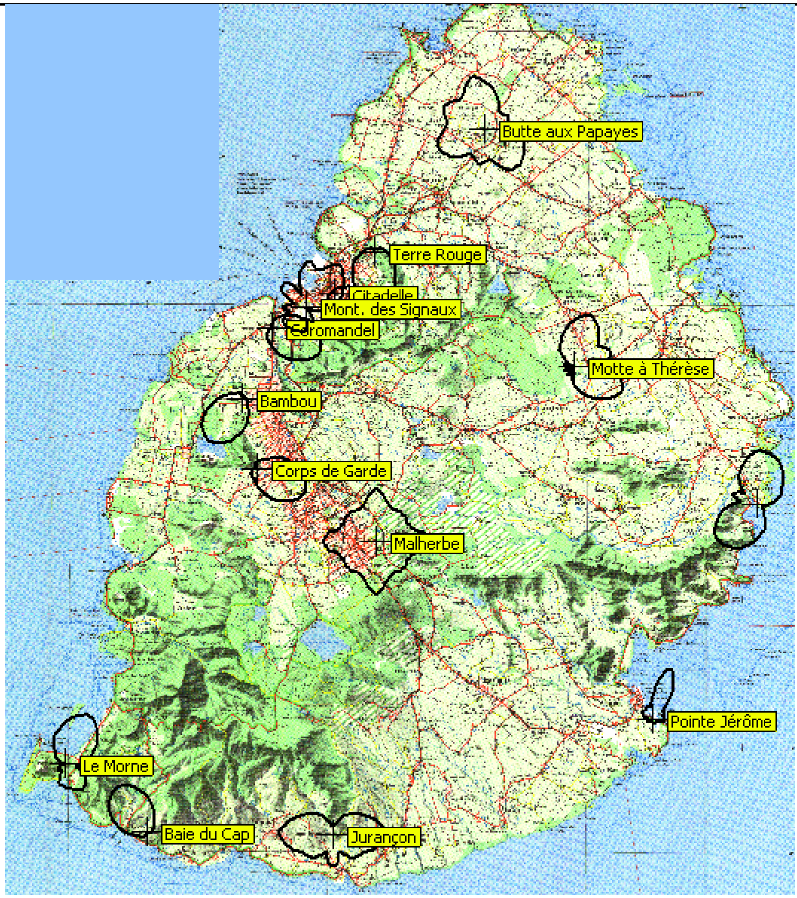
MUSICAM Audio Coding (8 to 384kbits/s), sampling @48 or 24kHz

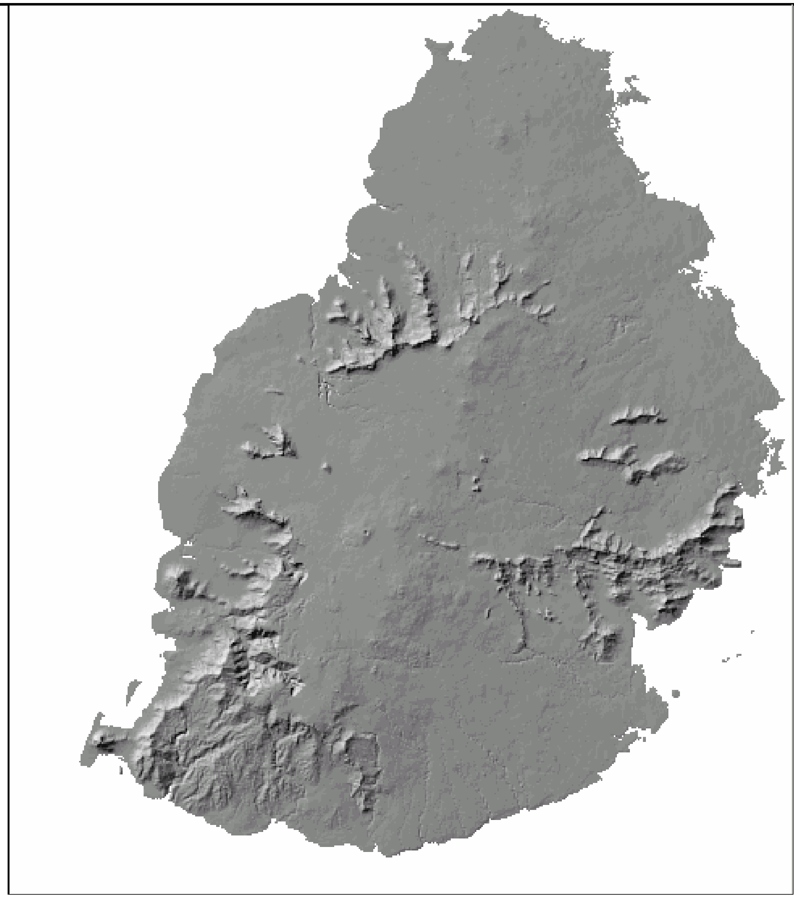
Scrambling

FEC + Time & Frequency interleaving

COFDM up to 1536 carriers, spaced 1kHz

Example of DVB-T network planning Mauritius island (Indian ocean)



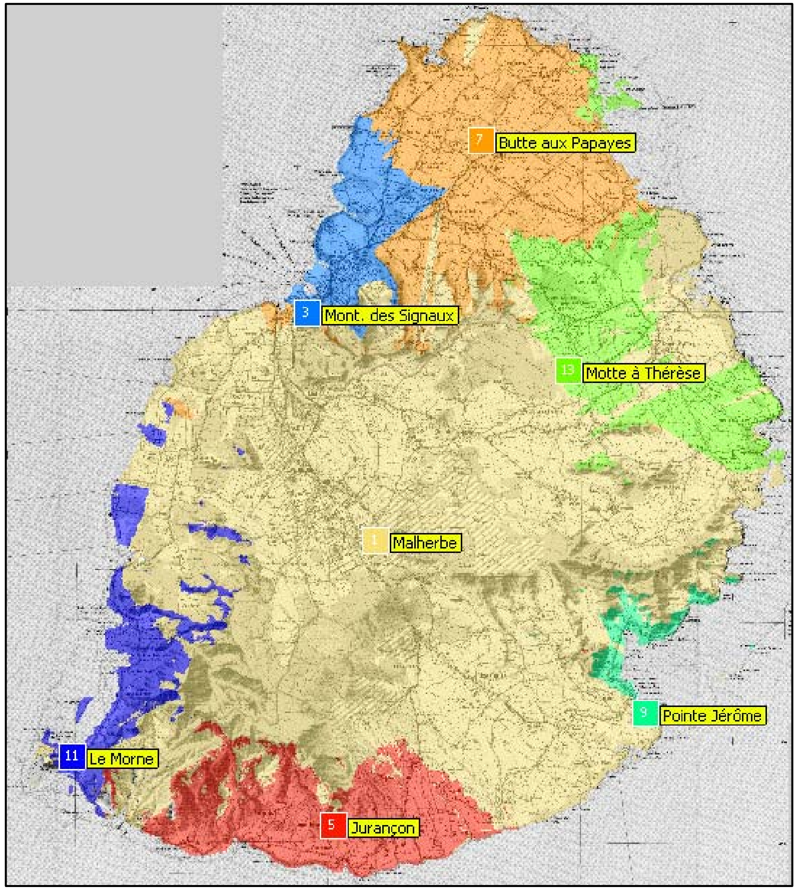


Planning a new digital broadcast
(Step 1/4)

- One of the existing analog network is « duplicated »:
- Same sites :
  - 14 sites for the analog program
  - Only 7 for the digital multiplex
- Same transmitting antennas
- Same powers
- Same frequencies

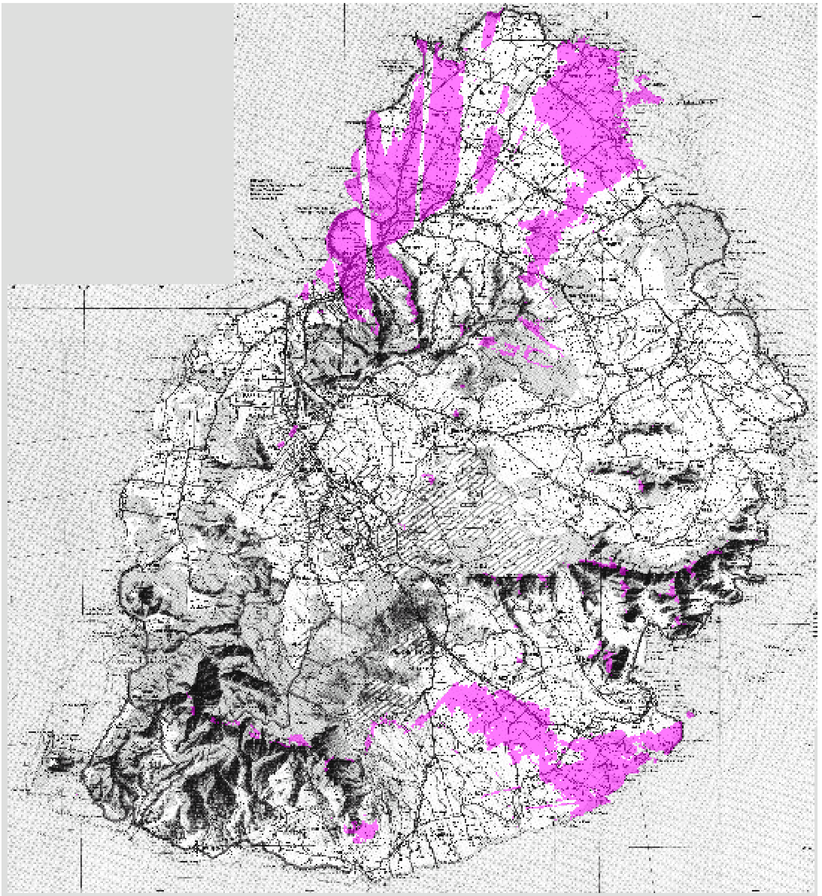
Planning a new digital broadcast
(Step 2/4)

- The coverage of the digital transmitters are computed
- The powers of the digital transmitters are adjusted to ensure the coverage of the whole island
- A lower power is required :
  - Typically 1000 W for the analog program
  - Only 100 W for the digital multiplex (lower thresholds)



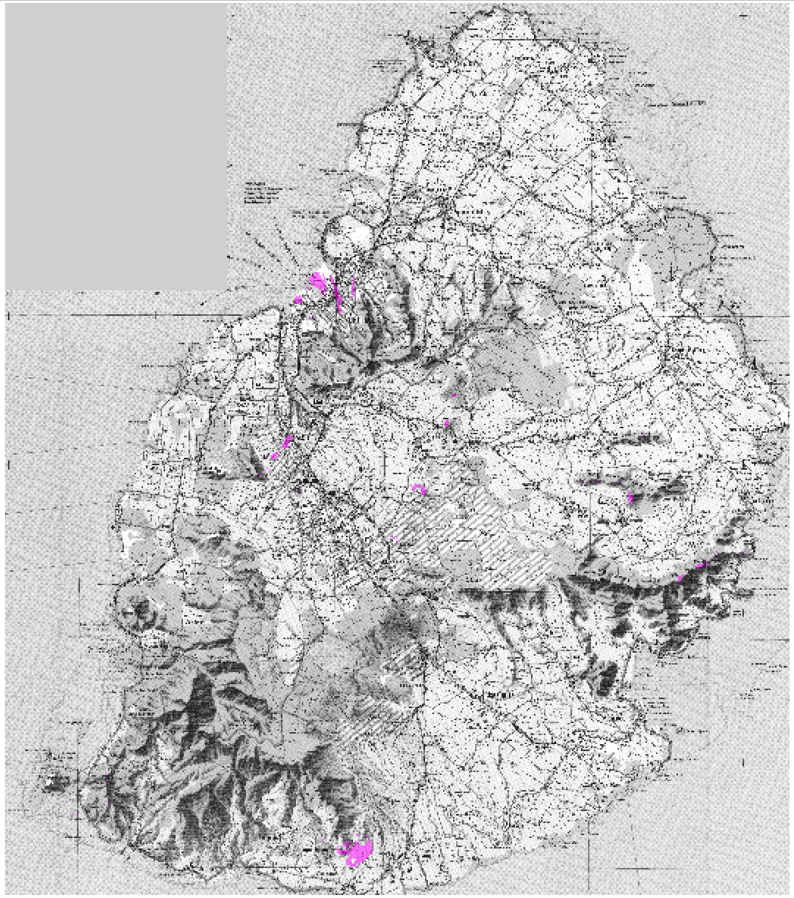
Planning a new digital broadcast
(Step 3/4)

- A channel N-1 or N+1 is randomly attributed per site.
- Analog program:
  - channel 27 of the analog frequency plan
- Digital Multiplex :
  - channel 26 or channel 28 of the digital frequency plan
- Digital signals are extremely robust
- Hence interferences caused by digital signals on analog signals



Planning a new digital broadcast (Step 3/4)

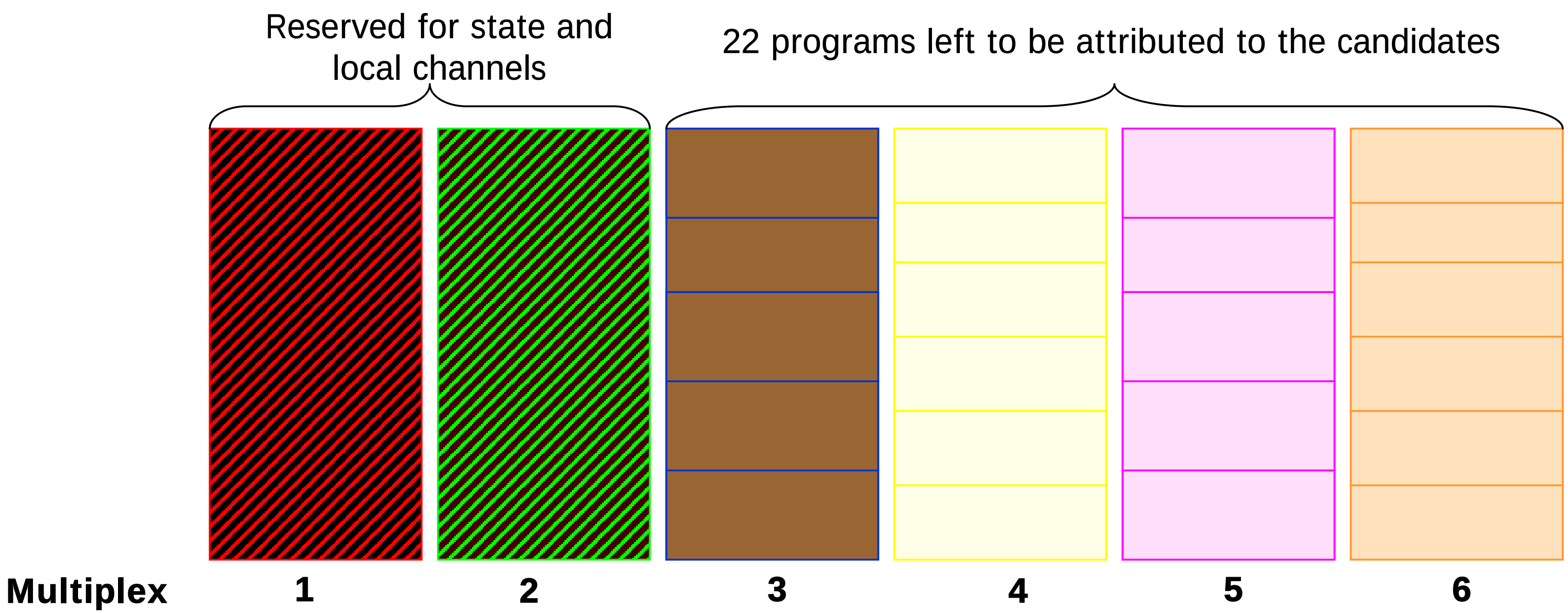
- The digital transmitters causing interferences are isolated
- They are transferred from channel N-1 to channel N+1 or vice versa
- It is then possible to avoid almost any harmful interference
- The new network is now being tested



CSA's requirement in France

– **6 multiplex (= 6 frequencies)**
– **5 or 6 programs per multiplex**

→ **33 programs**

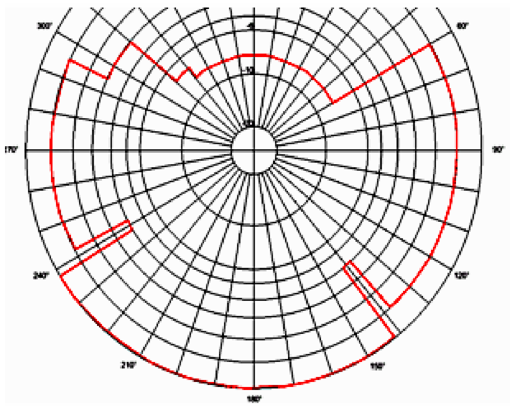


CSA’s requirement in France

- 29 sites located around the main cities in France
- On each site, 6 transmitters (1 per multiplex)
- For each one of the 174 transmitters, the main technical characteristics :

LISTE DES FREQUENCES IDENTIFIEES DANS LA PREMIERE PHASE DE LA PLANIFICATION

Principale ville desservie	Zone du site	Altitude maximale de l'antenne (m)	P.A.R. maximale (kW) (1)	Canal / fréquence	Observations	Réseau
Ajaccio	Baie d'Ajaccio	715	16	26		R2
Ajaccio	Baie d'Ajaccio	715	16	29		R1



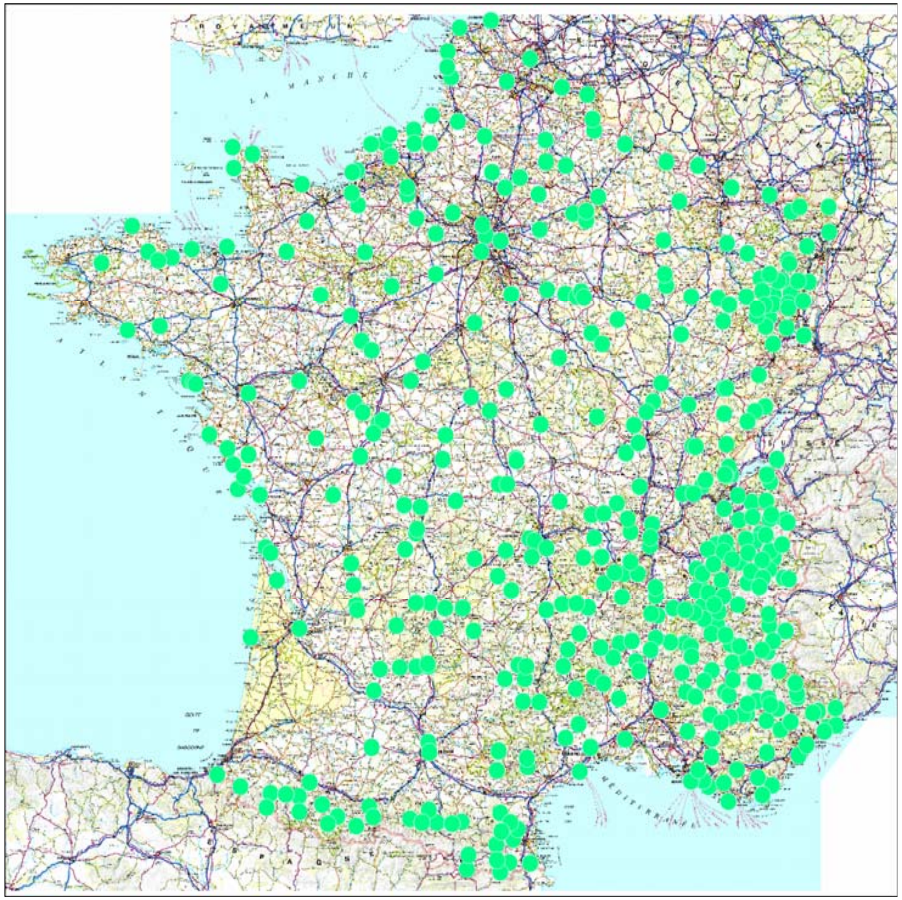
For each one of the 174 transmitters, an antenna pattern

CSA's requirement in France

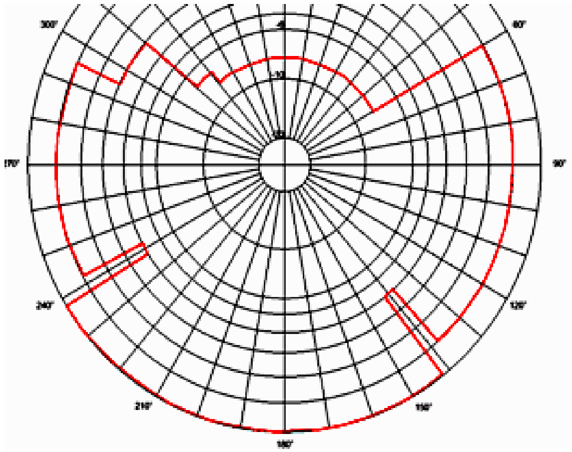
- 28 sites + 1 in Corsica
- 6 transmitters on each site
- Sites located around the main cities
- The East and North parts of France have few transmitters
- Problems of coordination with neighboring countries

Present Analogue Network

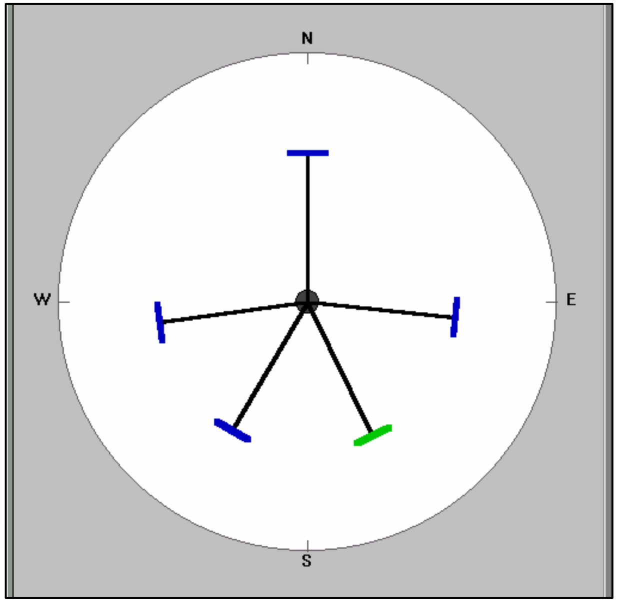
- **The existing analog network**
  - 1.000 mains transmitters
  - 11.000 sub or re-transmitters



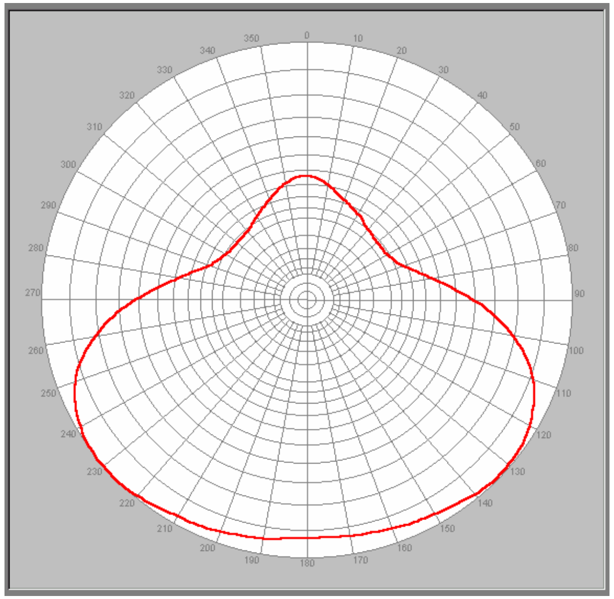
Response to technical specifications



Gauge specified by the CSA



Mast simulation

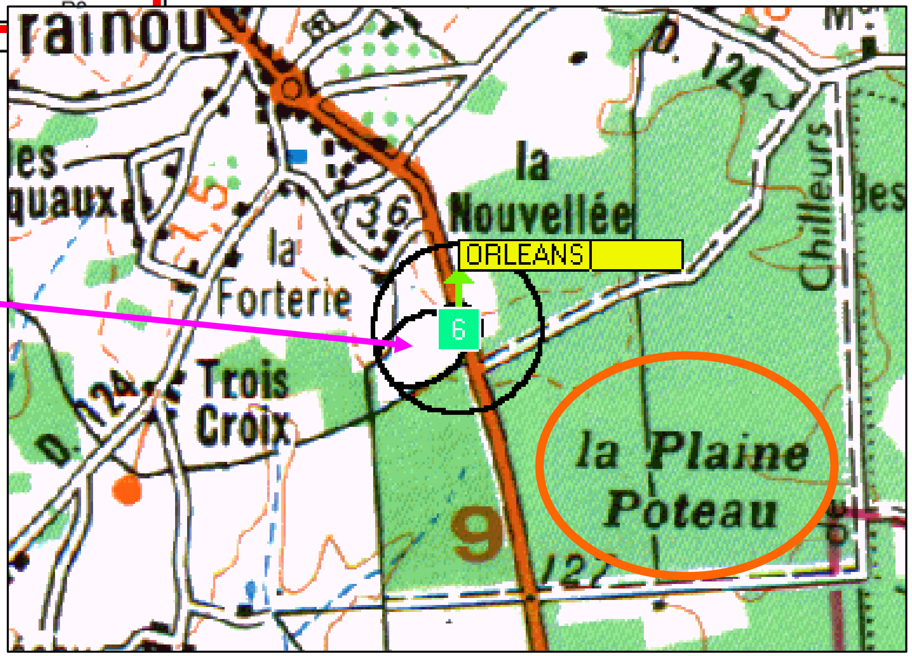


Pattern matching the gauge

Site Locations

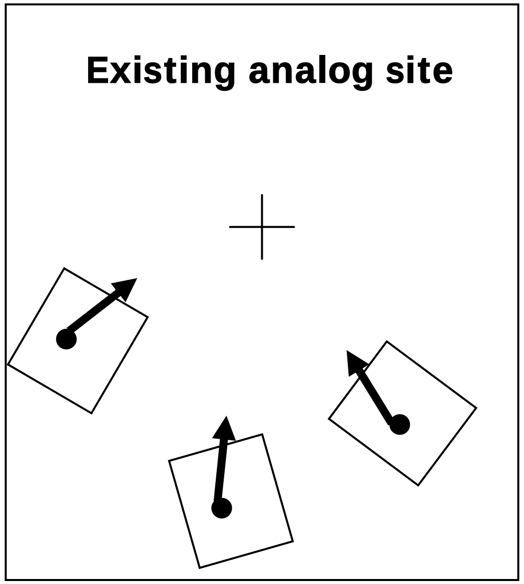
Niort	Canton de Melle	490	25	59	(2)	R2
Niort	Canton de Melle	490	25	62		R3
Orléans	La Plaine Poteau	321	2	38	(3)	R2
Orléans	La Plaine Poteau	321	2	40	(2)	R4
Orléans	La Plaine Poteau	321	2	46	(2)	R6
Orléans	La Plaine Poteau	321	2	48		R5
Orléans	La Plaine Poteau	321	2	51	(3)	R1
Orléans	La Plaine Poteau	321	2	63		[illegible]
Paris	Tour Eiffel	358	20	21	(3)	[illegible]
Paris	Tour Eiffel	358	20	24	(3)	[illegible]

Site found in the european coordination file

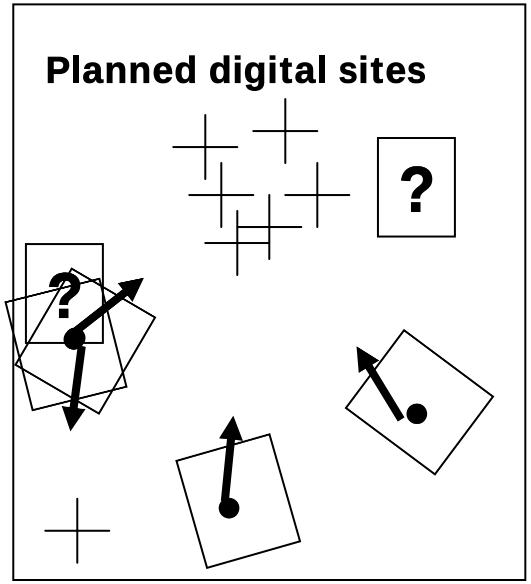


All areas specified by the CSA already contain an existing site

Why were the existing sites privileged ?



Today



Tomorrow ?

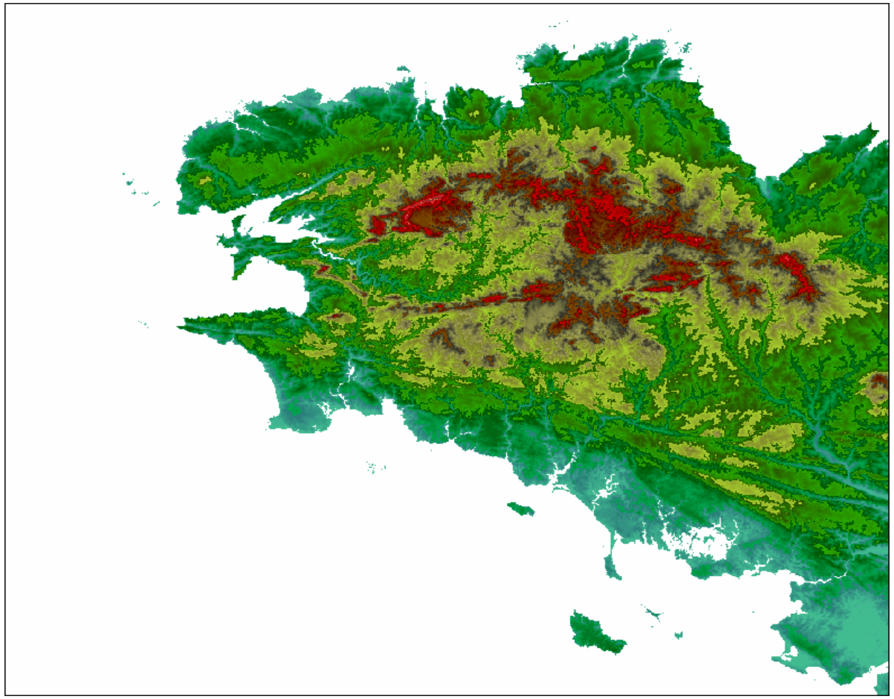
Expected Problem

- Digital broadcasters will probably be obliged to rent the existing analog sites to **TDF**, sole owner of all existing analog sites

- Problem of fair competition :
  - the new broadcasters will be clients & competitors of TDF

The Maps

2D map sample (image)

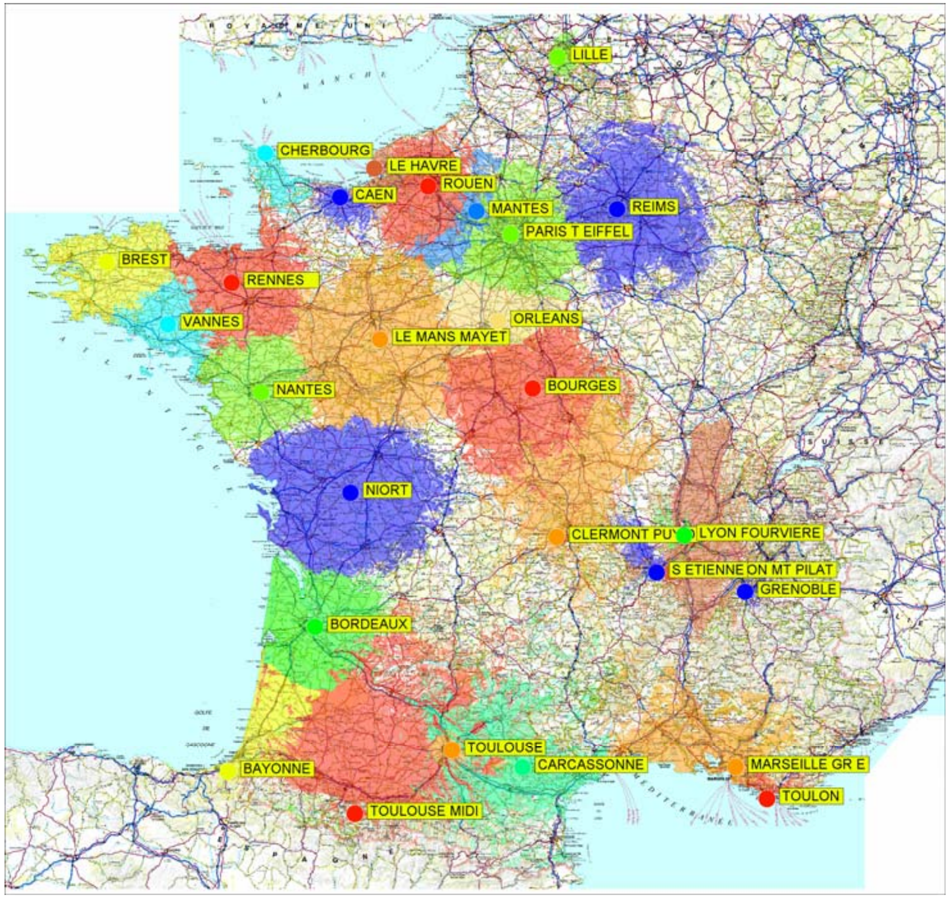


Corresponding 3D map (MNT)

Resulting coverage

Coverage of 1 out of the 6 multiplex

- Partial coverage of the country, smaller than the analog coverage
- Global analysis of the covered surfaces
- Global analysis of the covered populations
- Detailed analysis, city per city

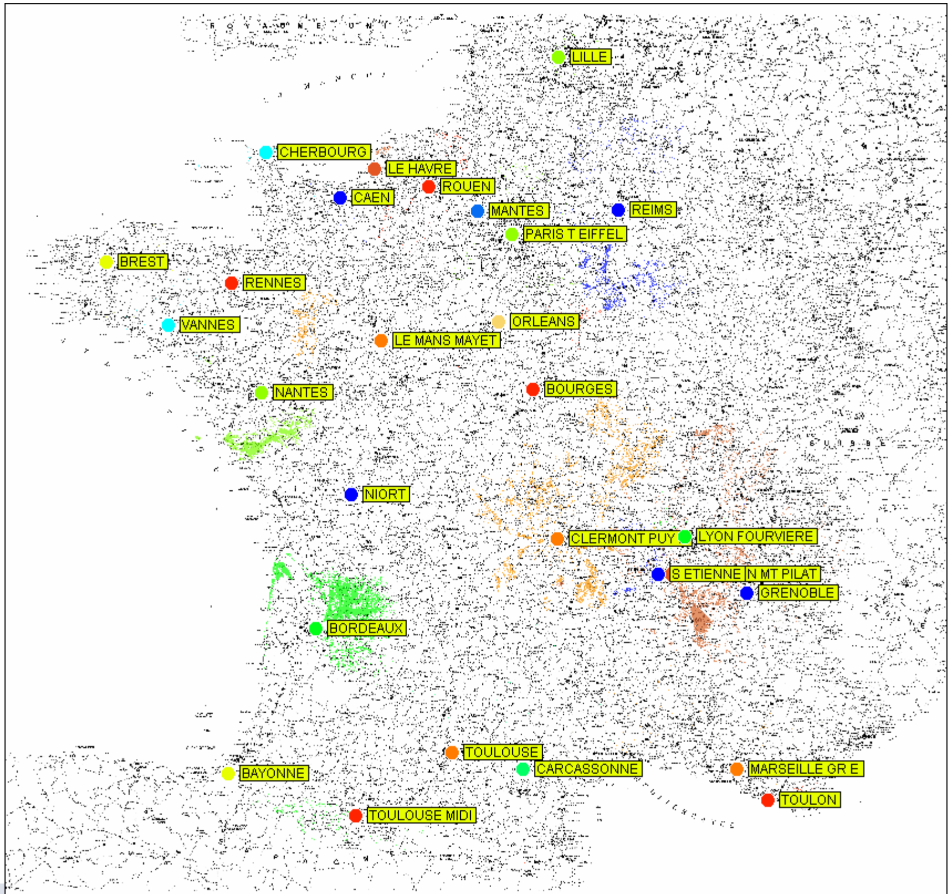


Economic model

- The new programs are supposed to be financed by advertisement only
- It requires to cover a large population
- It is necessary to simulate and to compare the performances of the multiplex

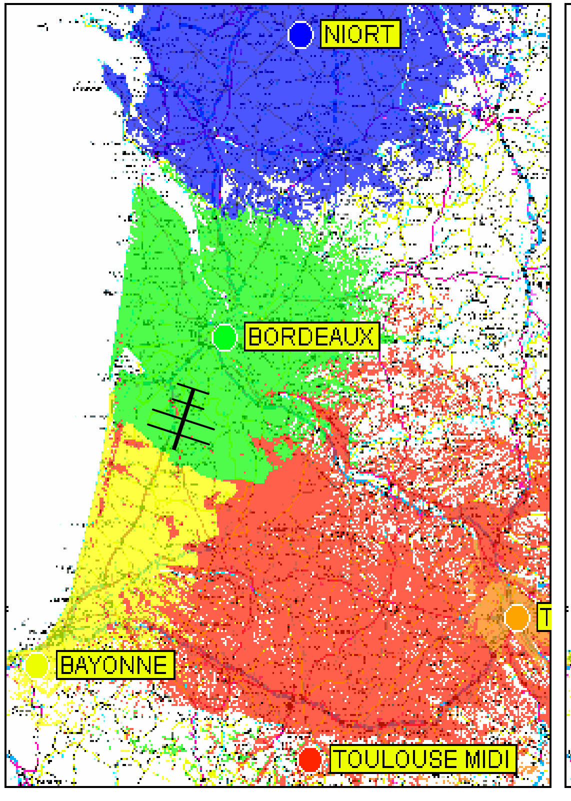
Differences between the multiplex

- Some multiplex are slightly better than others
- All in all, they are fairly equivalent
- Technical parameters have been adjusted so that no multiplex is privileged

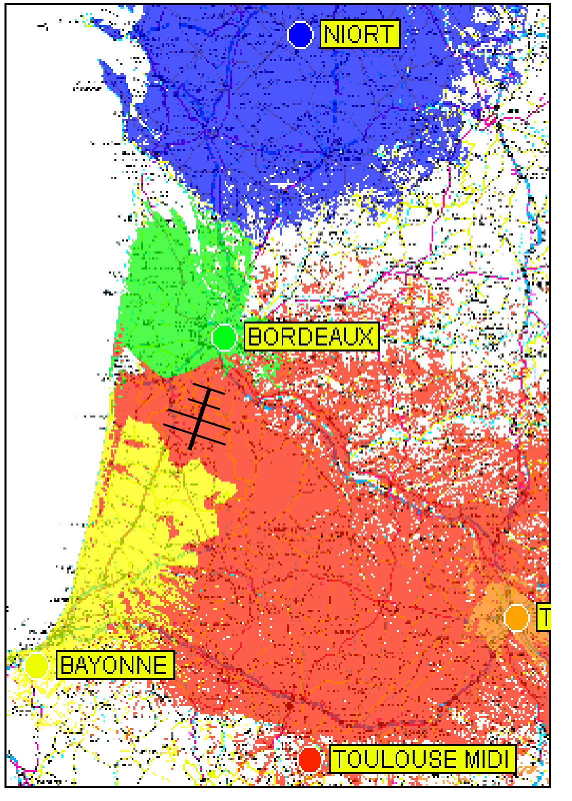


User's advantages

- Already pointing towards an analogue transmitter
- Re-orientation should be avoided as far as possible
- This orientation allow to receive with a single antenna all the digital multiplex and all the analogue programs



Multiplex R1



Multiplex R2

Conclusion of the migration

- **Advantages**
  - Availability of these sites
  - Limitation of the problem of initialization for the receiving antennas
  - Easier to determine an adequate frequency plan of the network
- **Disadvantages**
  - Problem of fair competition between existing and new broadcasters
  - Sometimes, for historical reasons, the sites locations are not optimized

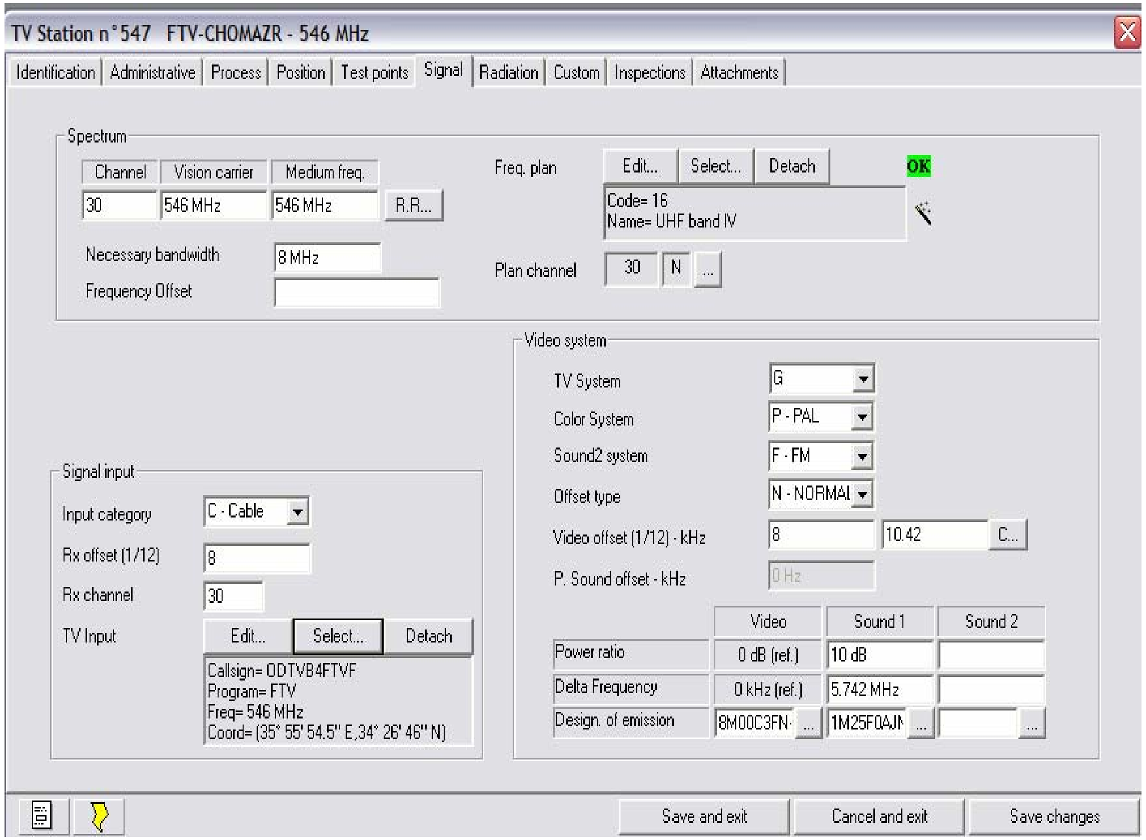
Market issue

Key issue to ensure the success of the new programs

- to concentrate around the main cities
- To adjust the technical parameters so that all multiplex cover a sufficient and equivalent population
- to perform intensive calculations considering
  - The coverage's of the transmitters
  - The population figures

Recording a station parameter

- Spectrum allocation
- Channel assignment
- Video system used
- Signal input

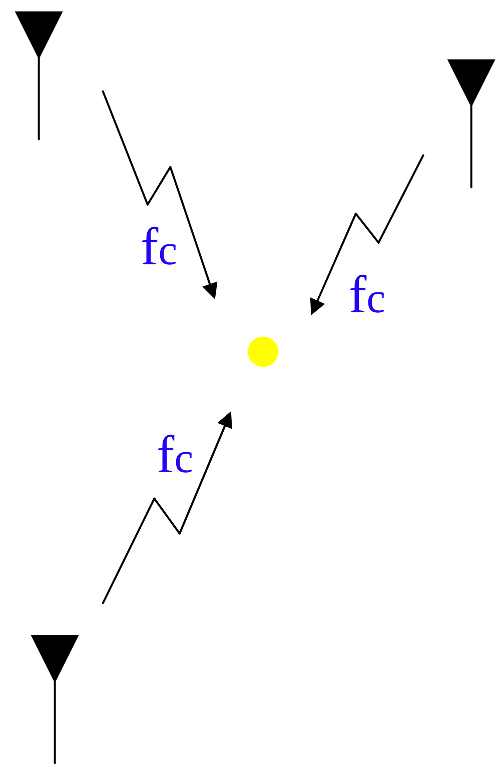


Single Frequency Networks Overview

What are they?
Terminology
Simple technologies
Complex modulation SFN
ATDI Modelling tools

SFN Principle

- Multiple transmitters
- Shared channel
- Same information
- Common modulation
- Simultaneous launch



Advantages

- Increased availability
- Can be spectrally efficient
- Single channel receivers (e.g. paging)

Disadvantages

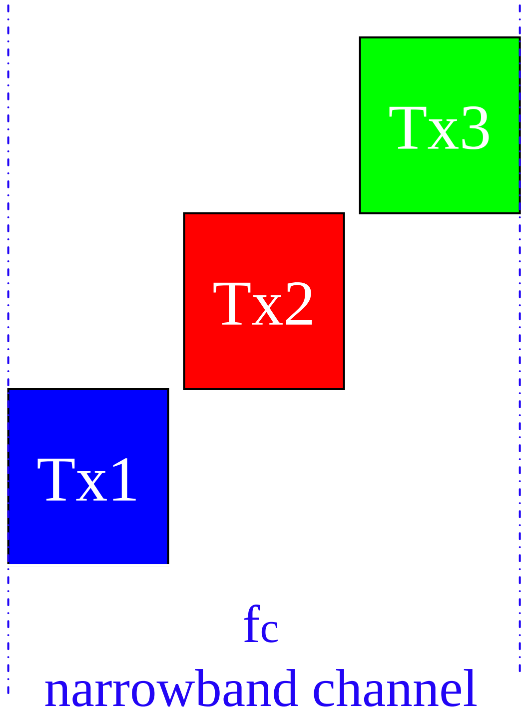
- Symbol rate / audio band must be less than DS
- Destructive interference if DS or flight times are too great
- Synchronised emission
- Frequency stability
- Generally limited to broadcast or low capacity traffic delivery systems

Technologies

- AM spaced carrier
- FM offset carrier
- Complex modulation (Broadcast OFDM)

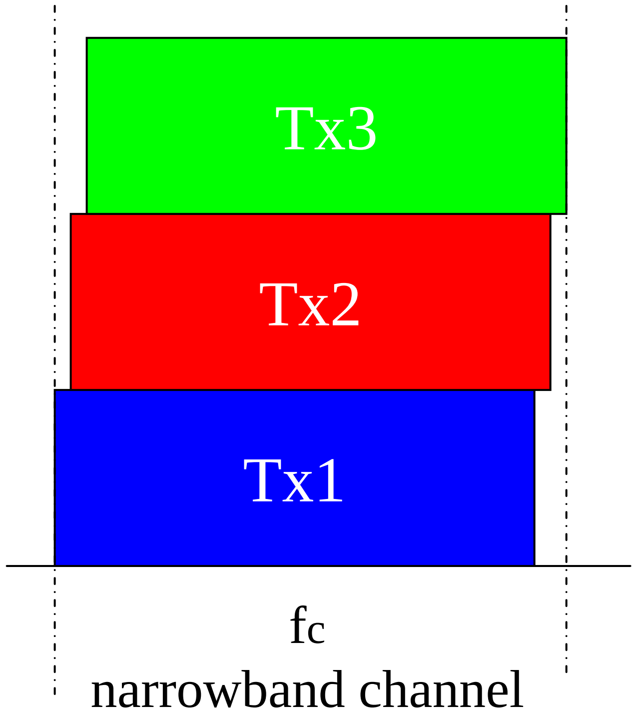
AM Spaced Carrier

- Carriers spaced within channel.
- Heterodyne outside audio passband
- Not as efficient due to large offset of carriers
- Limited number of tx possible
- Used in Airband



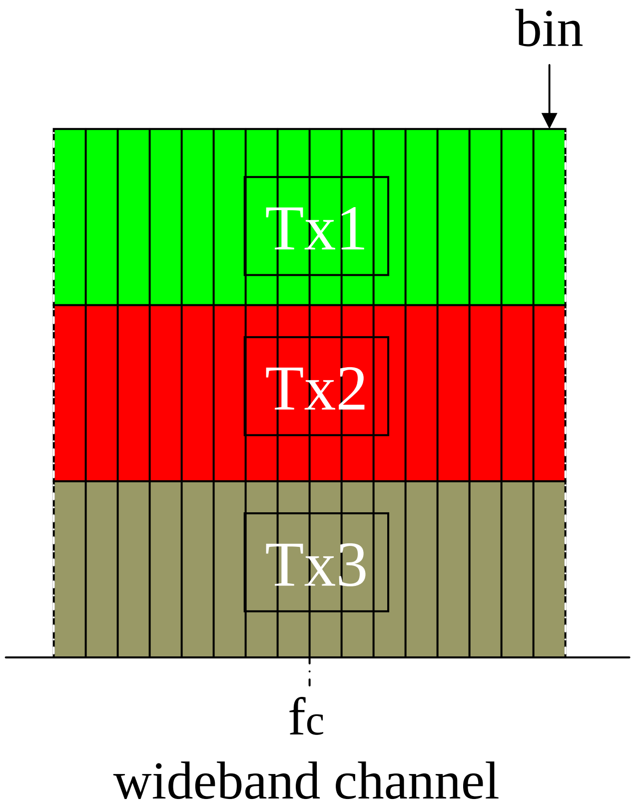
FM Offset Carrier

- Carriers slightly offset to avoid static nulls
- Heterodyne below audio passband
- Receiver captures strongest signal
- Large number of tx possible
- Used in Paging (data), PMR (voice)



Complex Modulation (OFDM)

- Channel split into narrowband bins
- Information rate high overall but slow symbol rate in each bin
- DSP equalises delay spreads over channel.
- Guard interval approx ¼ t_{symbol} to prevent ISI
- Tolerant to selective fading & multi-path if DS less than t_{guard}
- SFN's are a case of multi-path
- Network possible gain due to decorrelated paths
- Used in DVB, DAB.

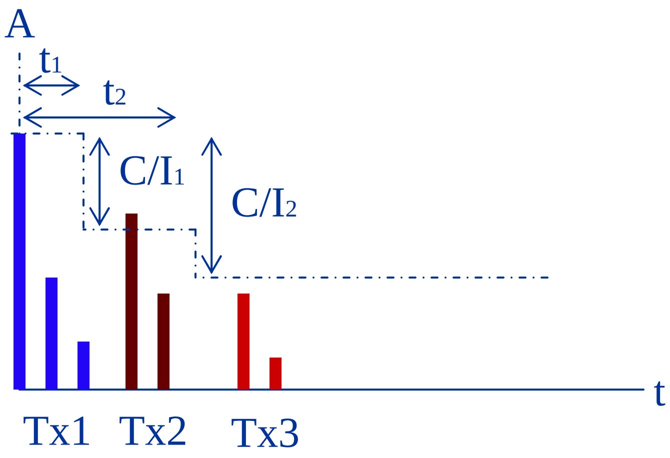


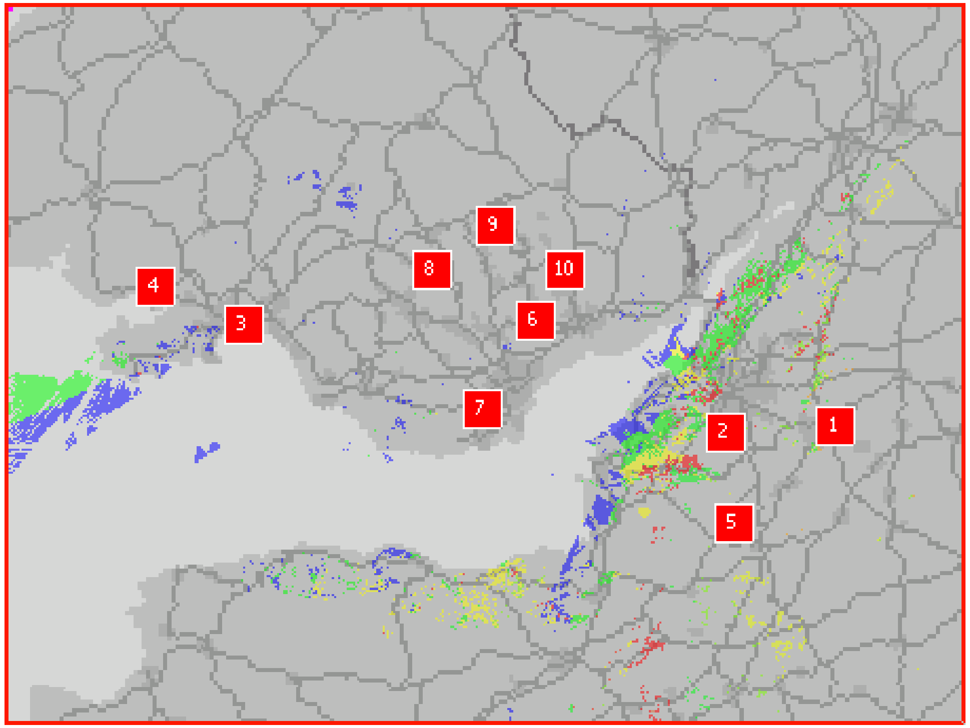
ATDI Modelling Tools

- Composite coverage plans
- Frequency offset plans
- SDS interference assessment
- Launch delay optimisation
- Network gain areas
- Network gain calculation

SDS Interference Assessment

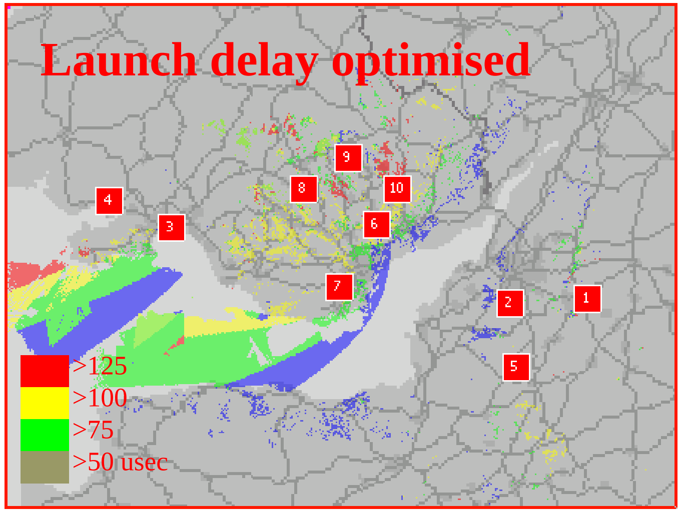
- Power delay protection mask
- Quantify interference over populated zones





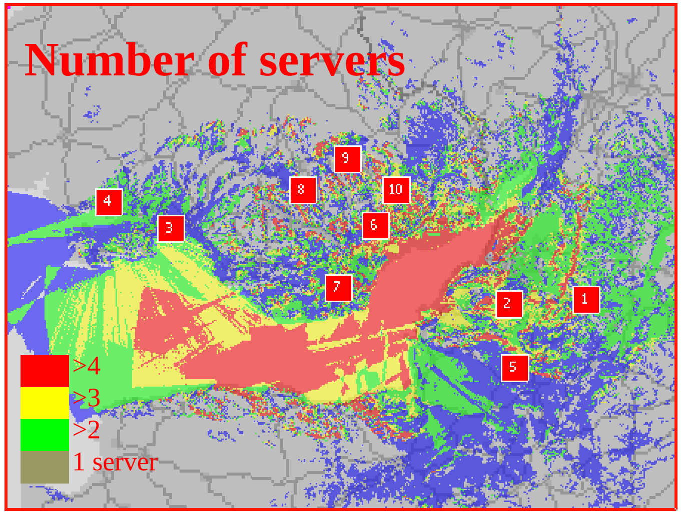
Launch Delay Optimisation

- Interference optimised by shifting into unimportant regions using launch delay
- Areas specified with % importance
- Other optimisations
  - Power reduction
  - Antenna height drop
  - Antenna pattern change (e.g.downtilt)

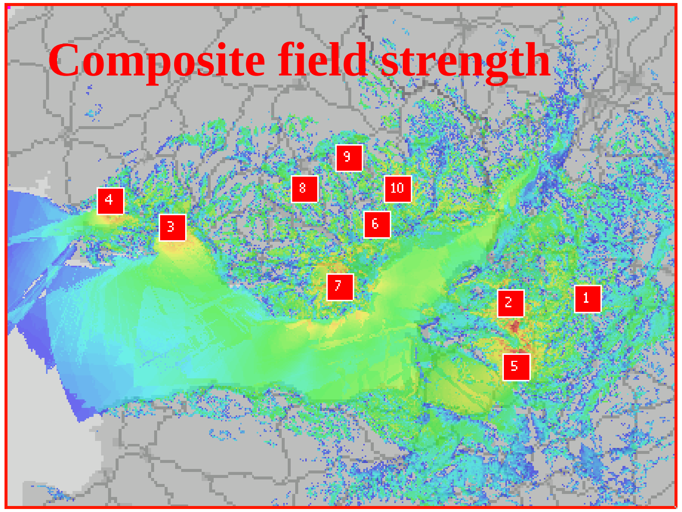


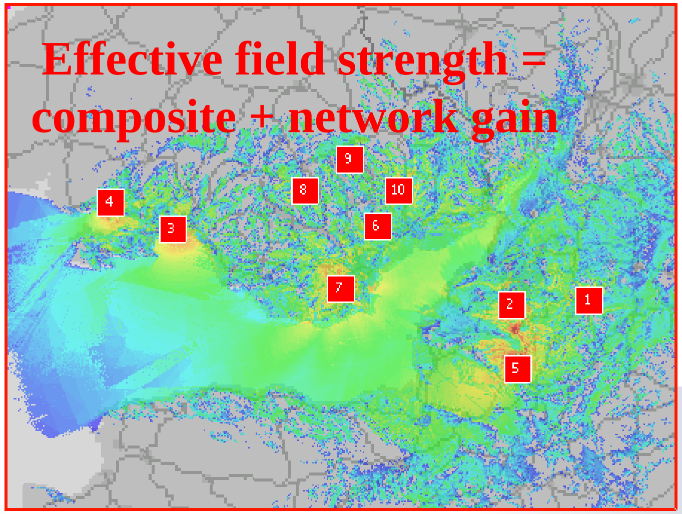
Network Gain Areas

- Simple tool to analyse no of servers
- Maximum gain can added to server areas



Network Gain Calculation





- SFN gain up to 14dB for 99% locations
- Depends on relative levels and delays and number of servers
- T-DAB model

Conclusion

- Overall aim increase network availability
- 2 simple examples and an example of a complex scheme.
- Suite of planning tools to help for examples above