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Airport Communications Network Design Using HTZ Communications



ADVANCED SOLUTIONS IN RADIOCOMMUNICATIONS

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1.1 INTRODUCTION

ATDI solutions address radio navigation and telecom experts involved in wireless systems deployed in Airports and RF spectrum management.

The ATDI's solutions dedicated to CNS (Communications, Navigation and Surveillance) allows to ensure :

- Radio planning and optimization activities for all wireless systems deployed in airports;
- Aeronautical frequency spectrum management in order to ensure sufficient access to the resource for the provision of aeronautical communication, navigation and surveillance services in an efficient and safe manner.
- Administrative and technical spectrum management procedures ;
- Consistency with international obligations and standards ;
- Efficient management and coordinated assignment of frequencies at national and regional level

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1.2 ATDI in a few words

Military/Security/Civil Spectrum management Solution with over 30 years experience

Provides software and services in radio communication

- Radio planning and spectrum engineering
- Spectrum management and monitoring
- Digital cartography
- Communication electronic warfare

A significant number of clients

More than 2 000 clients in every sector of radio from regulation , Civil Aviation Authorities, military and civil networks

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1.3 Solutions in Radio Communication

ATDI provides software and services in all area of radio communications

- Radio network planning & management (civil & military)
- Communication electronic warfare
- Spectrum management
- Digital cartography

Main markets

- Telecom operators / Broadcasters
- Regulators / Civil Aviation Authorities
- Military forces / Emergency services
- Telecom Equipment Manufacturing
- Engineering Services consulting firms



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1.4 Active member of ICT organizations

Our team of experts fully supports your organization addressing all spectrum management issues

ATDI is a full member of many information and communications technology (ICT) organizations:

- Working Group on HCM (“Harmonised Calculation Method”)
- ITU (International Telecommunication Union)
- Working Group NATO - STCCT (Spectrum Tools Configuration Control Team)
- EBU (European Broadcasting Union)
- Working Group - COPIC/ANFR
- Working groups for new technologies (IoT, 5G, ITS, etc.)
- Partnerships with around thirty universities worldwide (CNAM, INSA, ISEP, etc.)



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1.5 ATDI contributions in Spectrum Management domain

ATDI is a regular participant of ITU events, international meetings and regional ITU Telecom exhibitions, and gives the company greater influence over ITU-T policy, scope of study groups. Spearheading ATDI's involvement is company spectrum.

ATDI has played a role in the work of ITU-R which deals with issues such as spectrum management, cognitive radio, and propagation. ATDI is also a member of ITU-D which works to advance radio systems in the developing world. ATDI's contribution to the world's radio communications has been recognized by the International Telecommunication Union.



The organization honored ATDI for the company's "long-time participation and support to ITU Telecom World events" with a certificate of appreciation presented at ITU Telecom World 2017 at Busan, Korea.

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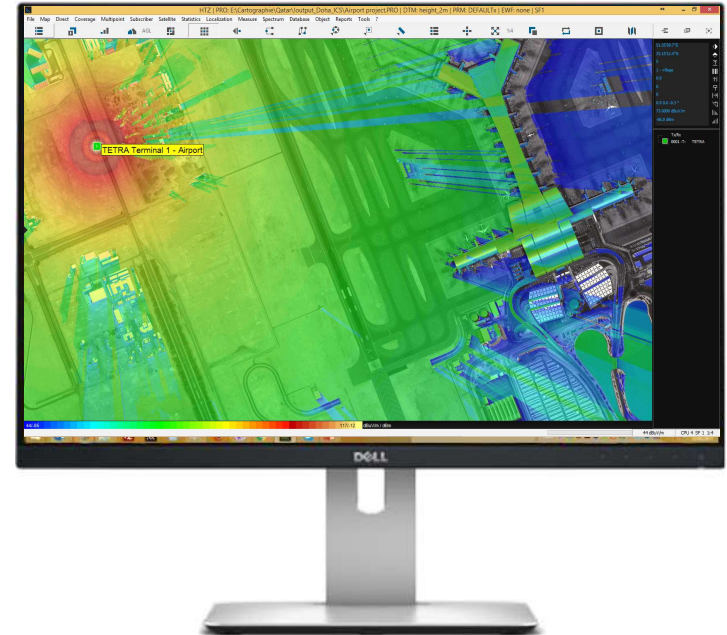
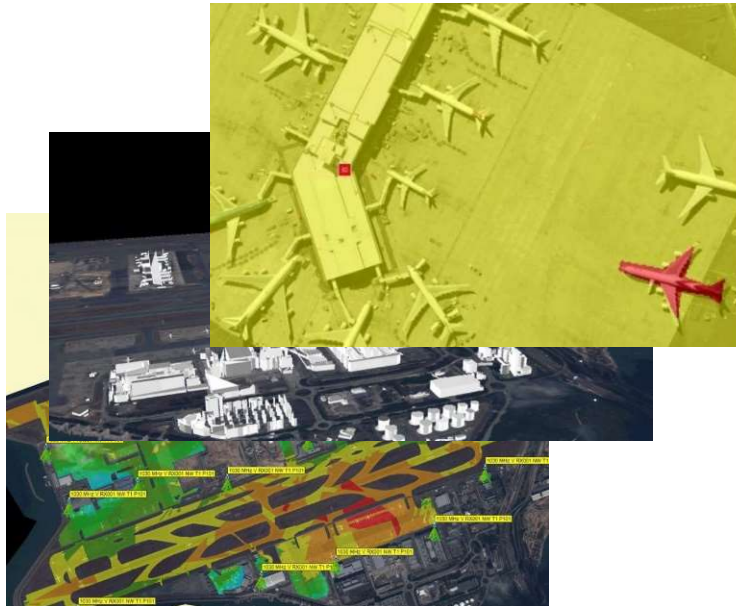
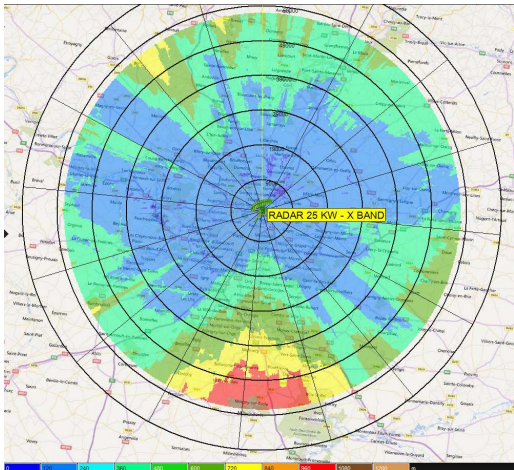
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2.3 HTZ communications – General overview (1/3)

DUE TO ITS ARCHITECTURE, HTZ COMMUNICATIONS IS TECHNOLOGY-NEUTRAL AND ANY TYPE OF SYSTEM WITHIN THE RADIO SPECTRUM RANGE CAN BE SIMULATED AND STUDIED.

HTZ communications is the first airport network planning solution for Radio Communications, Navigation, Surveillance (Aircraft and Ground Stations systems) and spectrum management.



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2.3 HTZ communications – General overview (2/3)

Technologies

- Very High Frequency (VHF) communication
- High Frequency (HF) / LF/MF communications
- Microwave links, Point To Multi-Point
- Mobile technology (2G/3G/4G/TETRA/PPDR)
- Instrument Landing System (ILS)
- Conventional VHF Omnidirectional Range (CVOR)
- Doppler VHF Omnidirectional Range (DVOR)
- Distance Measuring Equipment (DME)
- Primary Surveillance Radar (PSR)
- Secondary Surveillance Radar (SSR)
- Multilateration/Wide Area Multilateration (WAM)
- Satellite, Sensors, IoT,
- Ground Based Augmentation System (GBAS)

Technical capabilities

- Reports generation for analysed networks and systems or technologies.
- CNS systems base station configuration
- CNS systems database management
- Coverage analysis for CNS systems sites/base stations
- CNS systems networks analysis
- Obstacles evaluation (due to new buildings)
- Harmful interference, Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC), Wind farms impact evaluation, Coexistence SM1009, Out Of Band, coexistence between different systems.
- Capacity and traffic analysis
- Automatic Frequency Assignment
- Radio Network Optimisation

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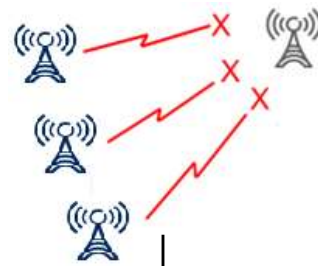
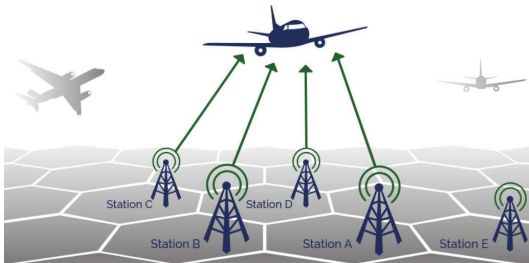
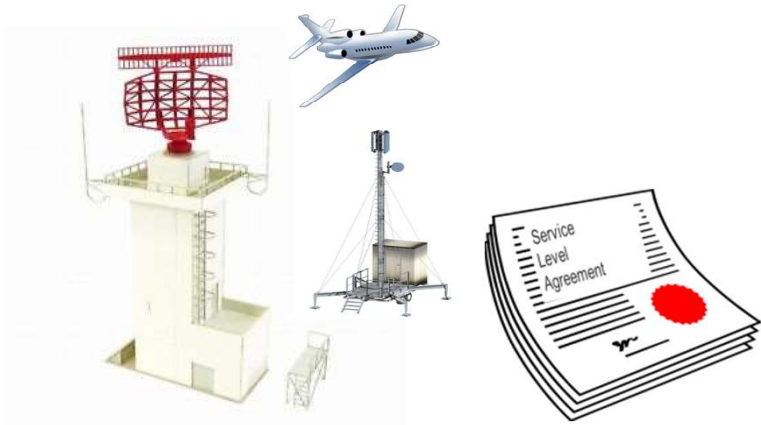
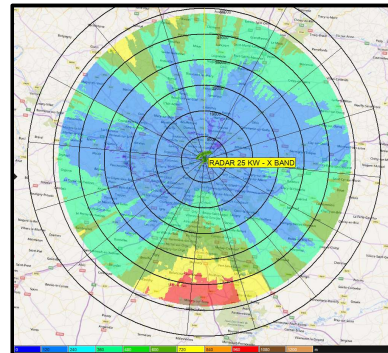
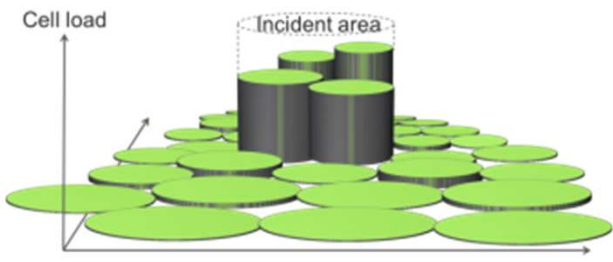
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2.3 HTZ communications – General overview (3/3)



Traffic/capacity & reliability

MLAT analysis

Coverage and radio planning network analysis

Frequency management planning

Co-ordination for Radar and Navigational Aids.

Co-ordination of services in the communications band

Any systems covering the spectrum band from Few KHz until 350 GHz

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HTZ communications

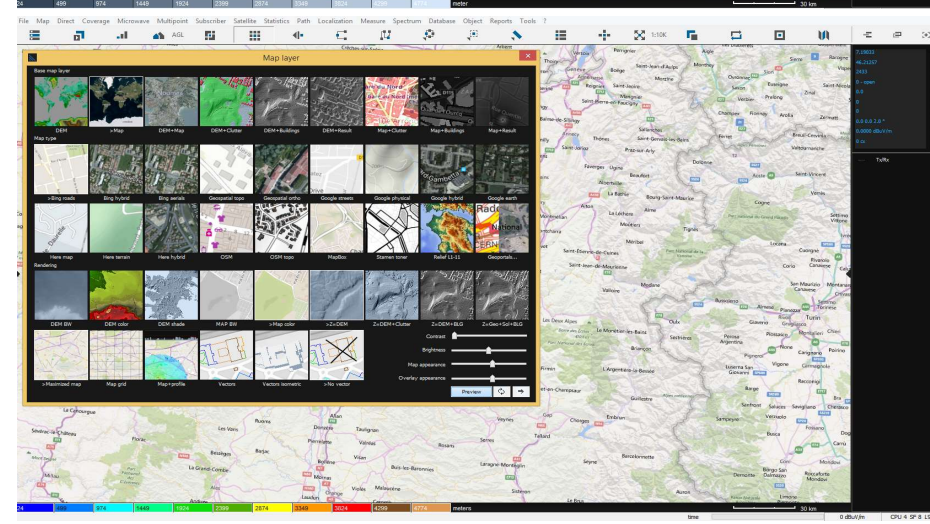
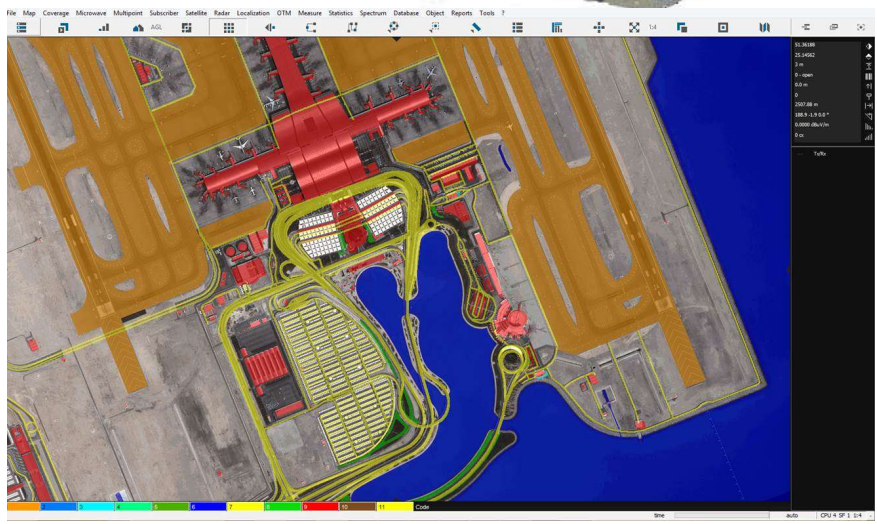
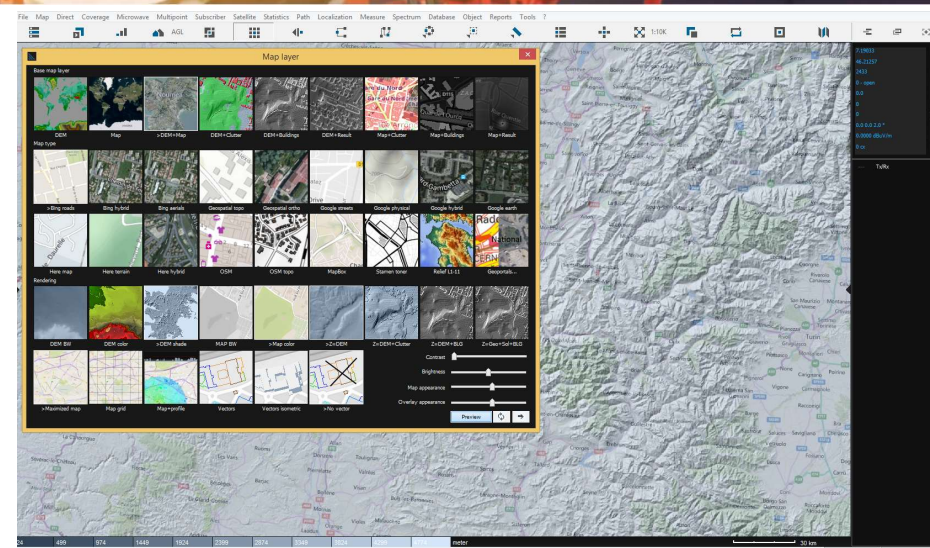
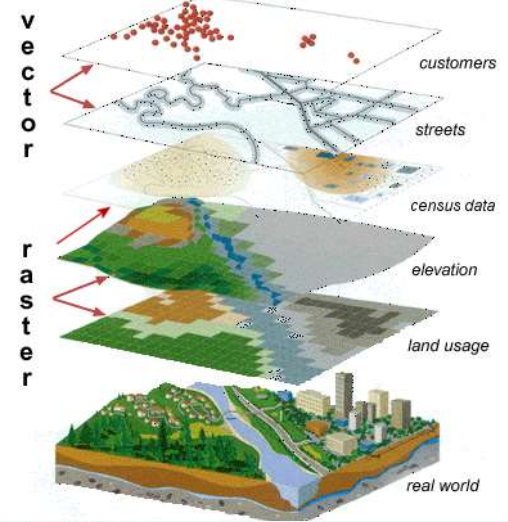
- 3.1 . GIS interface
- 3.2 . Propagation models
- 3.3 . Aeronautical Communication Systems
- 3.4 . Navigation systems (ILS/VOR/DMS...)
- 3.5 . Surveillance (Radar) and Multilateration systems
- 3.6 . EMC/Harmful interference capabilities
- 3.7 . Coexistence analysis
- 3.8 . Frequency assignment
- 3.9 . Protection against intrusive drones inside airports



3.1- GIS Interface – Cartographic layer (1/2)

HTZ communications can manage up to 5 cartographic layers that are necessary for the propagation calculation and display:

- Digital elevation models
- Raster Images
- Clutter files
- Vector files



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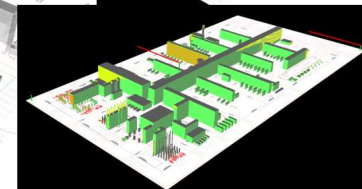
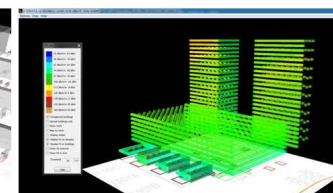
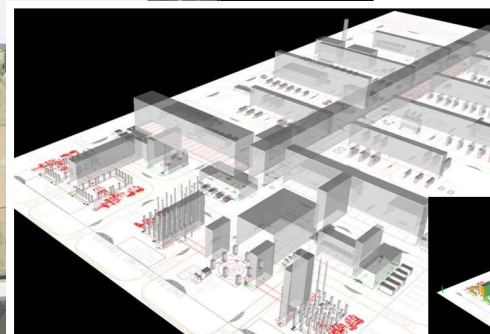
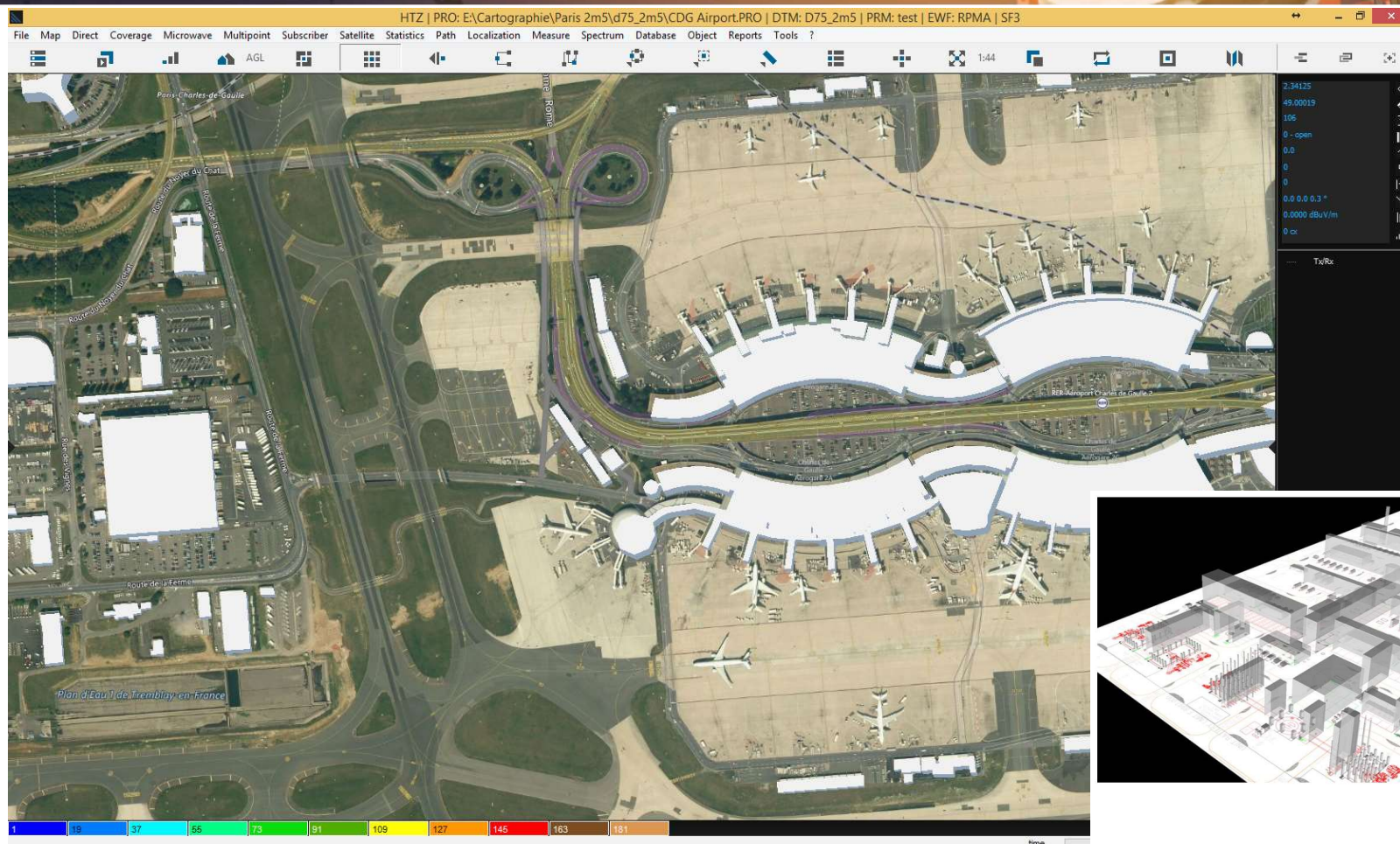
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3.1 - GIS Interface – 3D Building layer (2/2)



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3.2- PROPAGATION MODELS

HTZ has a complete propagation model library including all ITU-R recommendations and industry standards such as 3GPP, COST models. It supports 3D ray-tracing in various modes and atmospheric effects also can be simulated. If one has a customised propagation model, it can be imported in .dll.

1. Free Space model
2. Diffraction models
3. Tropo-scattering models
4. Deterministic ITU Recommendations
5. Industry standard models including aeronautical models
6. Specific/external & custom-built models
7. HF conductivity model

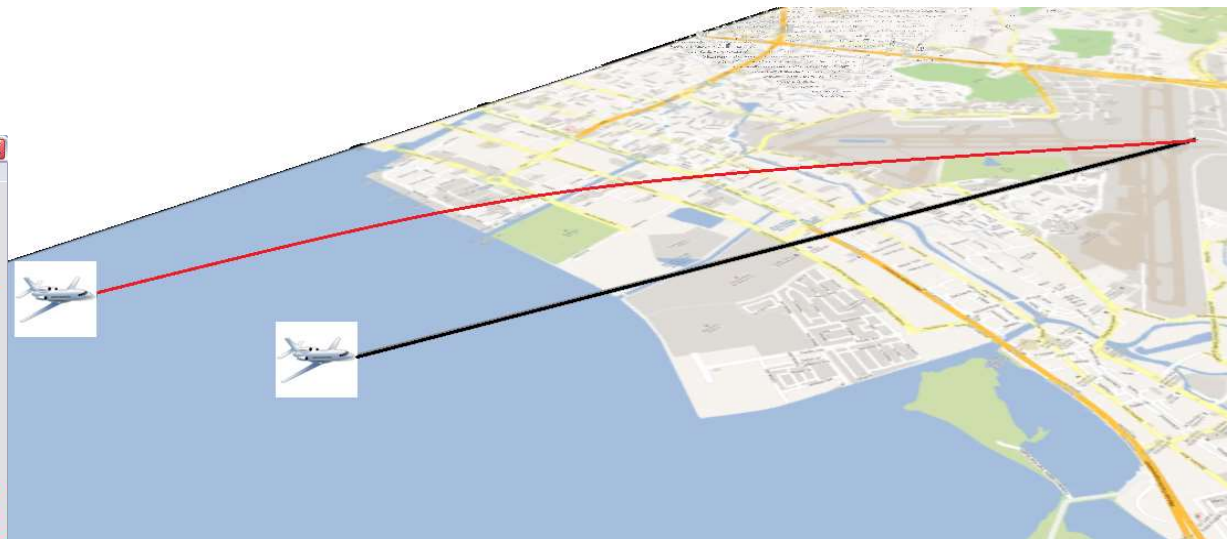
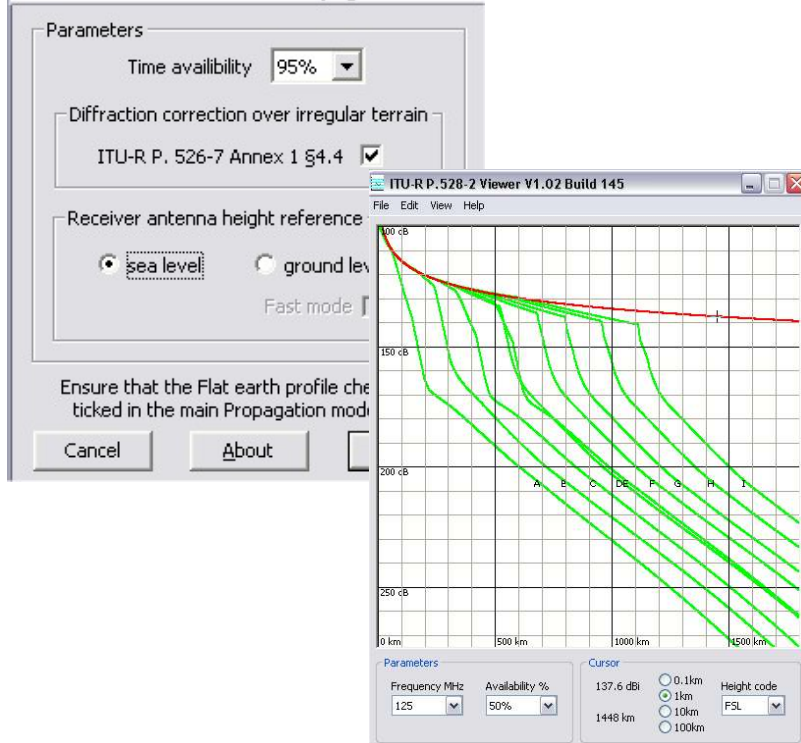
The screenshot shows the 'Propagation models' dialog box in HTZ software. The interface is divided into several sections, with numbered callouts (1-7) pointing to specific features:

- 1:** Points to the 'Free space loss' option under 'Propagation losses'.
- 2:** Points to the 'Diffraction geometry' section, which includes options like 'Deygout 94-2', 'Deygout 94-1', 'Deygout 66', 'Deygout 91', 'Bullington', 'Delta Bullington', 'ITU-R 526, round mask', 'ITU-R 526, cylinders', 'Visibility / Indoor', and 'No diffraction loss'.
- 3:** Points to the 'Attenuation by atmospheric gases and rain' section, which includes options for 'Gas ITU-R 676 (1-1000 GHz)', 'Gas ITU-R 1820 (47-48 GHz)', 'Vapour', 'Water', 'Fog ITU-R 840 (> 10 GHz)', and 'Duststorm (< 115 GHz)...'.
- 4:** Points to the 'Propagation methods' section, which lists various ITU-R and industry standard models such as 'ITU / FCC (empirical and half determ.)', '3GPP / COST (empirical)', and 'Specific / External'.
- 5:** Points to the '3GPP / COST (empirical)' section, which includes options like 'Durkin', '3GPP-LTE urban (0.9-2 GHz)', '3GPP-LTE rural (0.9-2 GHz)', 'SUI method (2.5-2.7 GHz)', 'Okumura-Hata (150-1500 MHz)', 'Hata - Cost 231 (150-2000 MHz)', 'Extended Hata (30-3000 MHz)', 'Cost 231 open...', 'Walfisch-Ikegami (800-2000 MHz)', and 'Modified Hata model by ACMA'.
- 6:** Points to the 'Specific / External' section, which includes options like 'BR method (uV)', 'Wojnar method (1-1000 MHz)', 'CCIR - MF (550-1700 kHz)', 'Eg1 (V/UHF)', and 'Ext. model (DLL)'.
- 7:** Points to the 'Global parameters' section, which includes options for 'Earth radius km land', 'Earth radius km sea', 'RMS wave height (m)', 'Location', 'Time', and 'Conductivity...'.

3.2 - AERONAUTICAL MODEL (1/3)

ITU-R P. 528-2 + ITU-R P.526-7 (diffraction)

ITU-R P.528-2 Aeronautical Propagation Model



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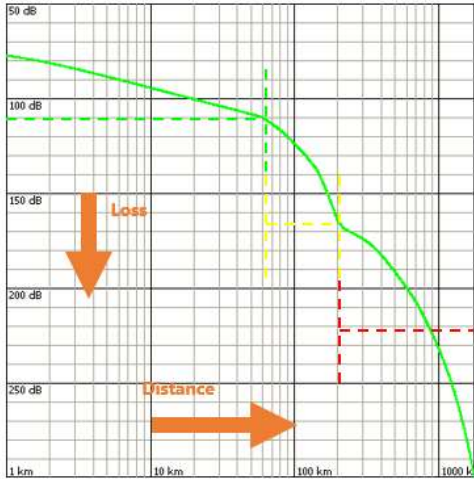
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3.2 - AERONAUTICAL MODEL (2/3)

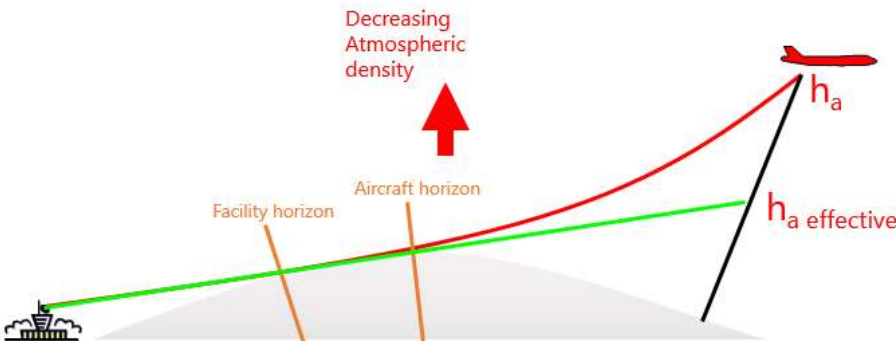


Propagation regions:

Line of sight (LOS)

Diffraction

Tropospheric



Effective height geometry

- Atmospheric density decreases with height
- Other models simplistic using a K effective
- Ray tracing using exponential height density

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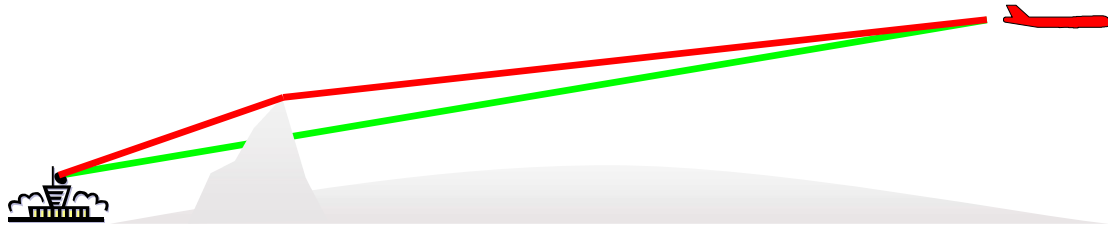
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3.2 - AERONAUTICAL MODEL (3/3)

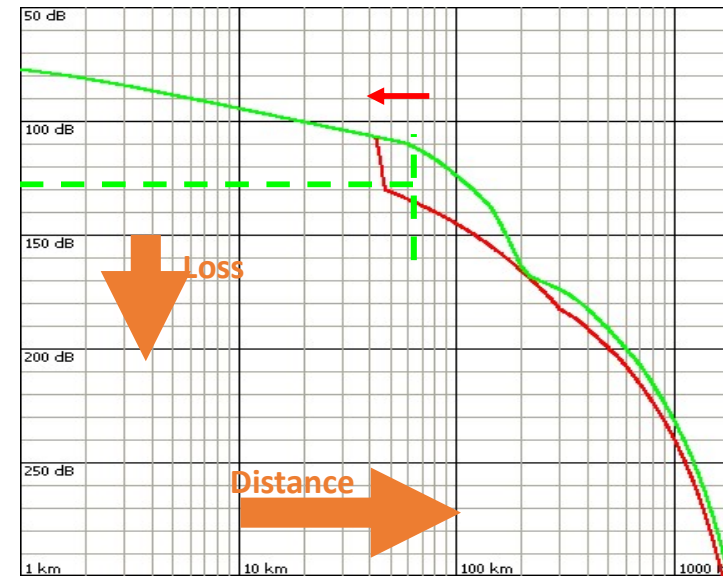


Based upon ITU-R F-77

- The main engine

Constrained to ITU-R P. 528-2

- Continuous curve set
- Frequencies: 100MHz – 20GHz
- Heights: 0 – >100,000ft
- Availability: 5 / 50 / 95% time



Terrain Obstacle Horizon Limiting

- Limits LOS region
- Less relevant in mid paths when in troposcatter

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3.3 - Aeronautical Communication Systems



- TETRA/VHF/UHF
- HF
- Satellite systems
- LF/MF
- Microwave links
- Broadband LTE A2G (Air To Ground)
- HAPS (High Altitude Station Platform)



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3.3 - GROUND TO GROUND COMS

BASE STATION CONFIGURATION

- PMR
- TETRA
- Land mobile

Communication channels

General parameters

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3.3 - ANTENNA SETTING

BASE STATION CONFIGURATION

Antenna diagrams (Horizontal & Vertical)

General Patterns Channels Site Advanced

2D antenna H+V (1 polarization) ...

734957X1 734957X1 Zoom

Horizontal pattern -90 Vertical pattern +90

Tx pol V H C M
 Rx pol V H C M
 X polar. disc. (dB) 0

Antenna database none

Diameter or size (m) 0.0 Aperture (°) 0.00

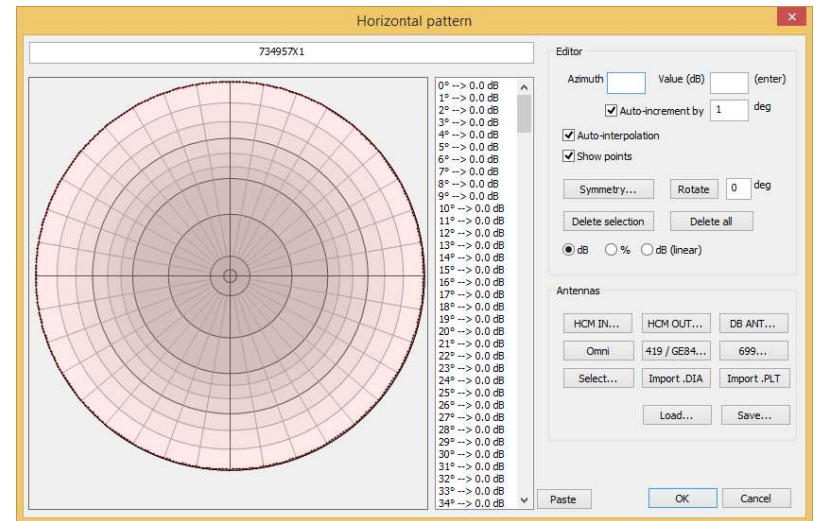
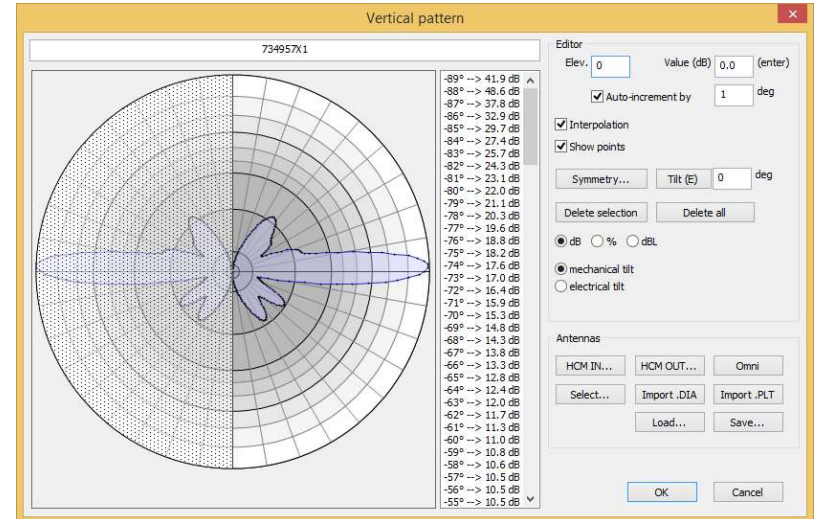
Crossover distance between near and far fields (m) 0.0

Azimuth (0-359°) 0.00 Sat..
 Tilt (-90 +90°) 0.000

Tx ant gain (dBi) 7.50
 Rx ant gain (dBi) 7.50

Standard antenna
 SU-MIMO SD
 SU-MIMO SM
 MU-MIMO
 SIMO
 AAS

No. arrays T/R 0 / 0 ...



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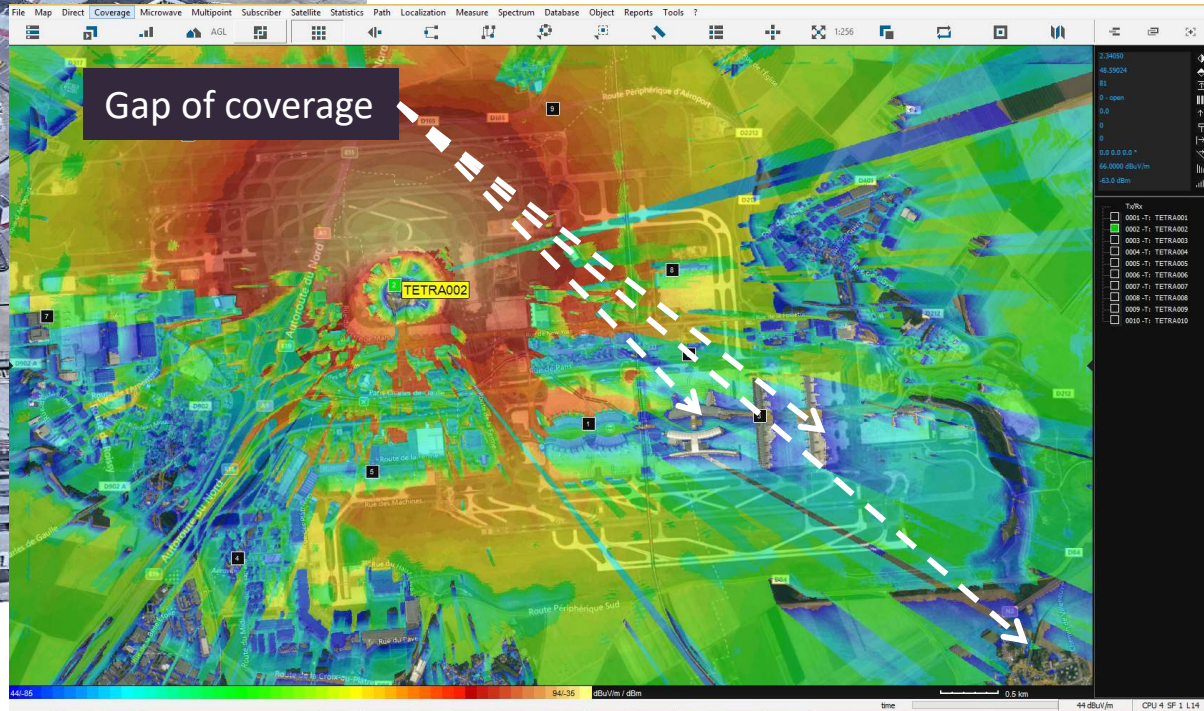


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3.3 - Reception foot print prediction

TETRA site location
EIRP: 26W
Antenna Height: 10m



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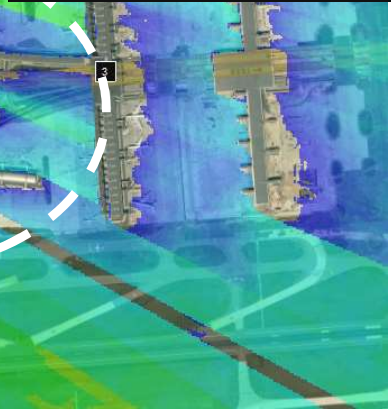
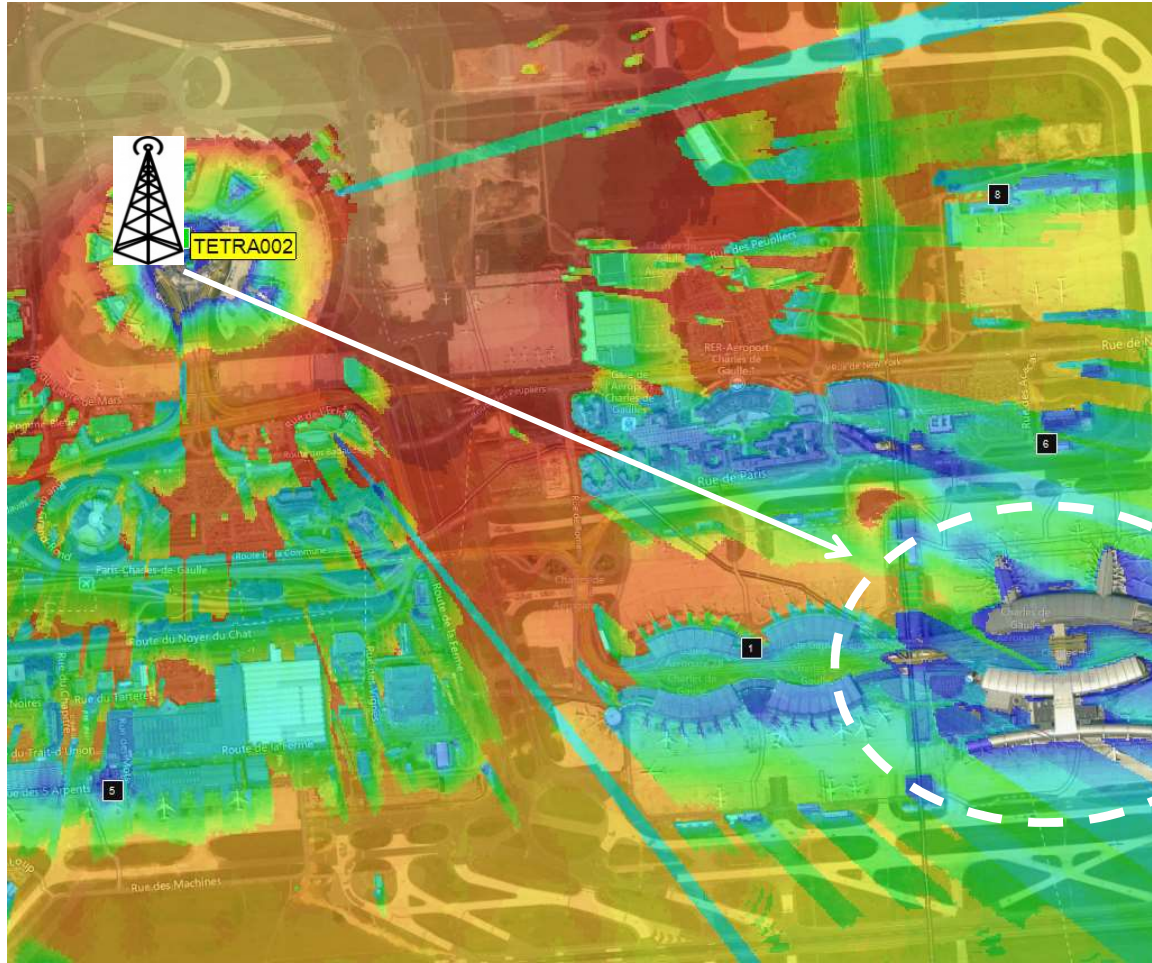
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3.3 – Coverage prediction



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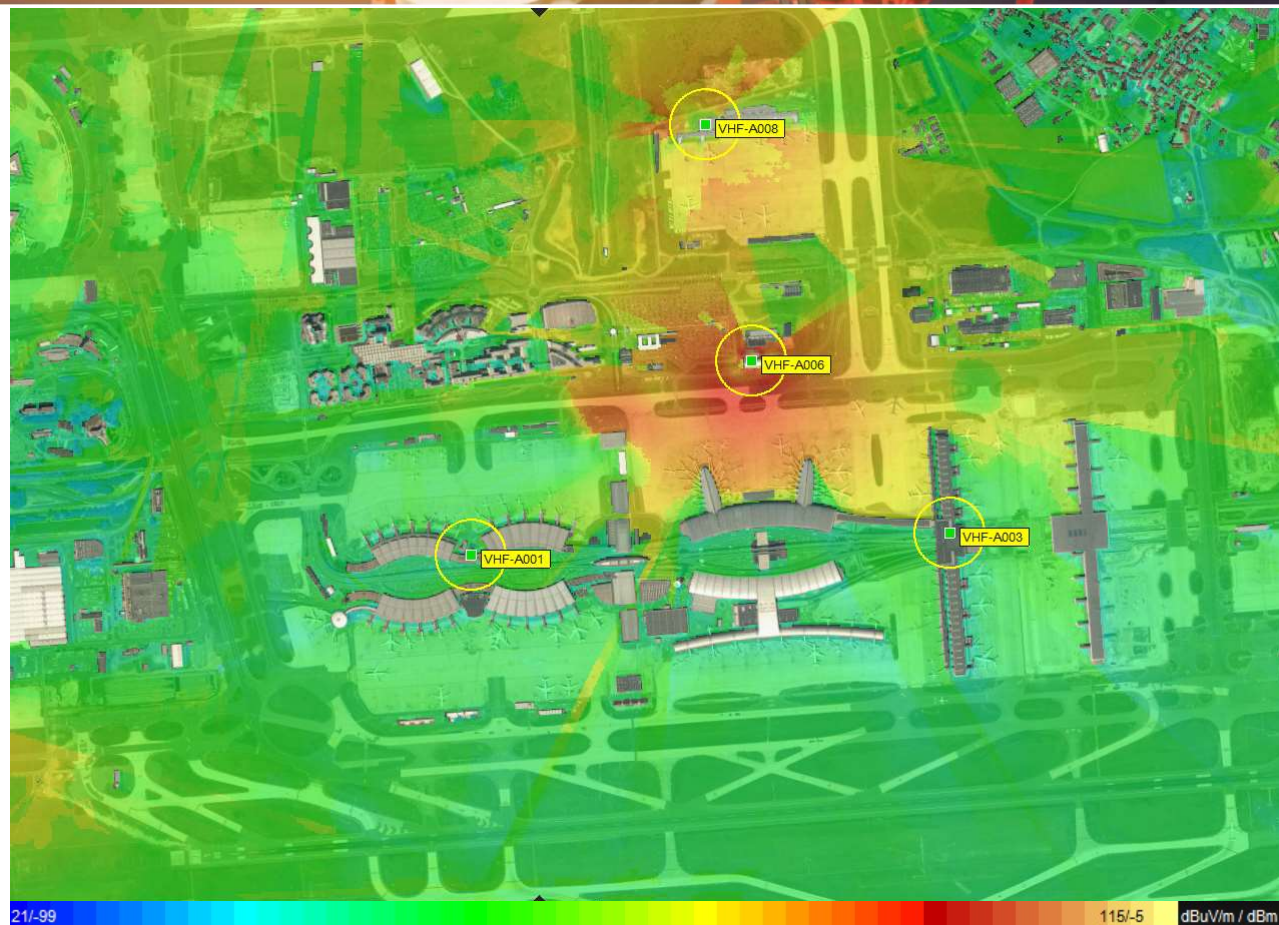


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3.3 VHF GROUND TO GROUND (AM- Voice) COVERAGE SIMULATION

- Site locations : CDG Airport (Paris)
- Receiver antenna height : 1.5m
- Tx power:
- Rx Sensitivity: $20\text{dB}\mu\text{V/m}$



VHF outdoor coverage (CDG airport)

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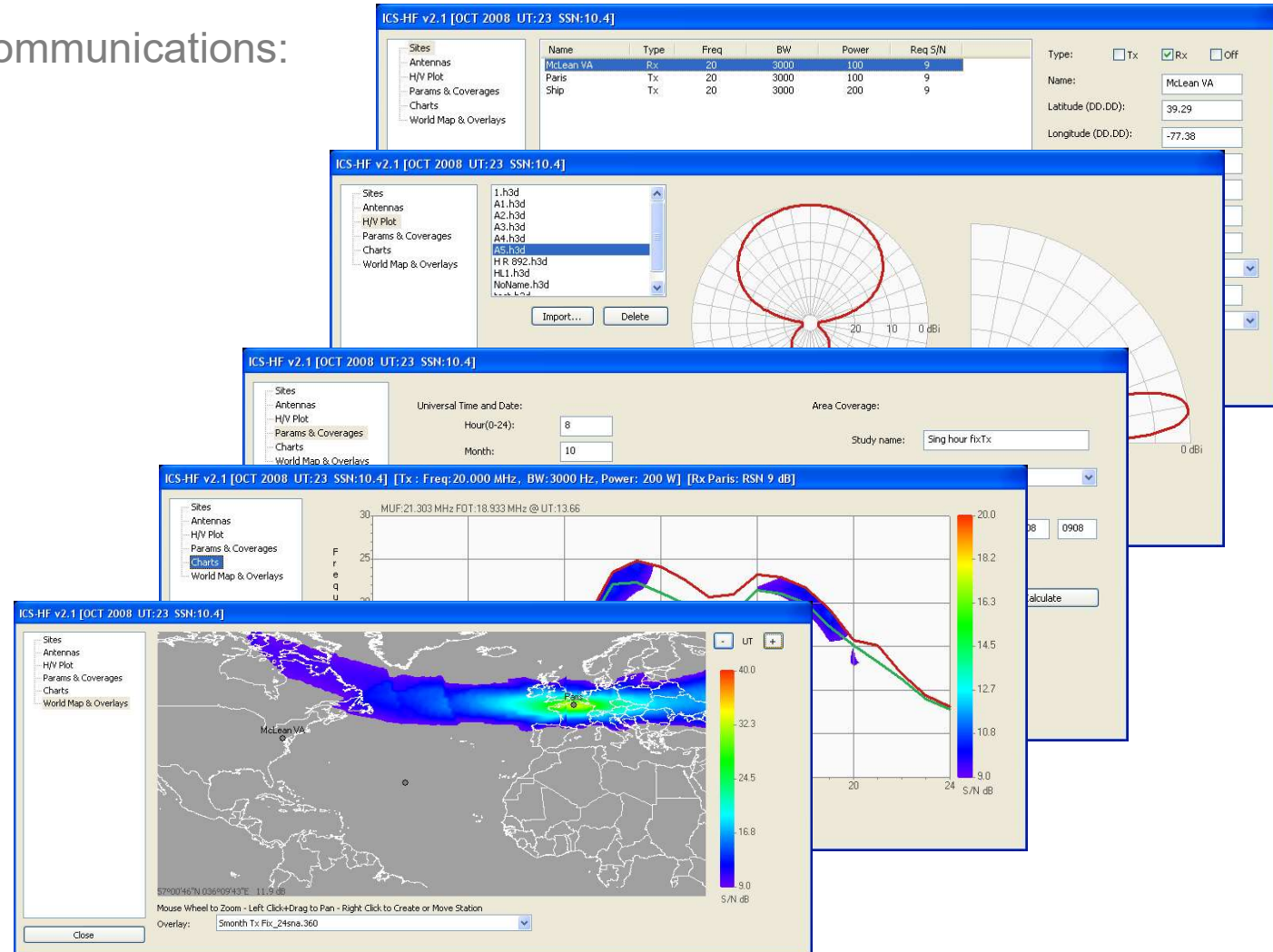
3.3 HF Module

HF planning features in HTZ communications:

MODE	OPTIONS
COMMUNICATION STATISTICS	IN DOWNLINK
	IN UPLINK
	IN NIGHT TIME
	IN DAY TIME

MODE	Equipments
SINGLE HOUR COVERAGE	FIXED TRANSMITTER
	MOBILE TRANSMITTER
SINGLE MONTH 24h COVERAGE	FIXED TRANSMITTER
	MOBILE TRANSMITTER

CHART ANALYSIS
MUF (Maximum Usable Frequency)
FOT (Frequency of Optimal Transmission)



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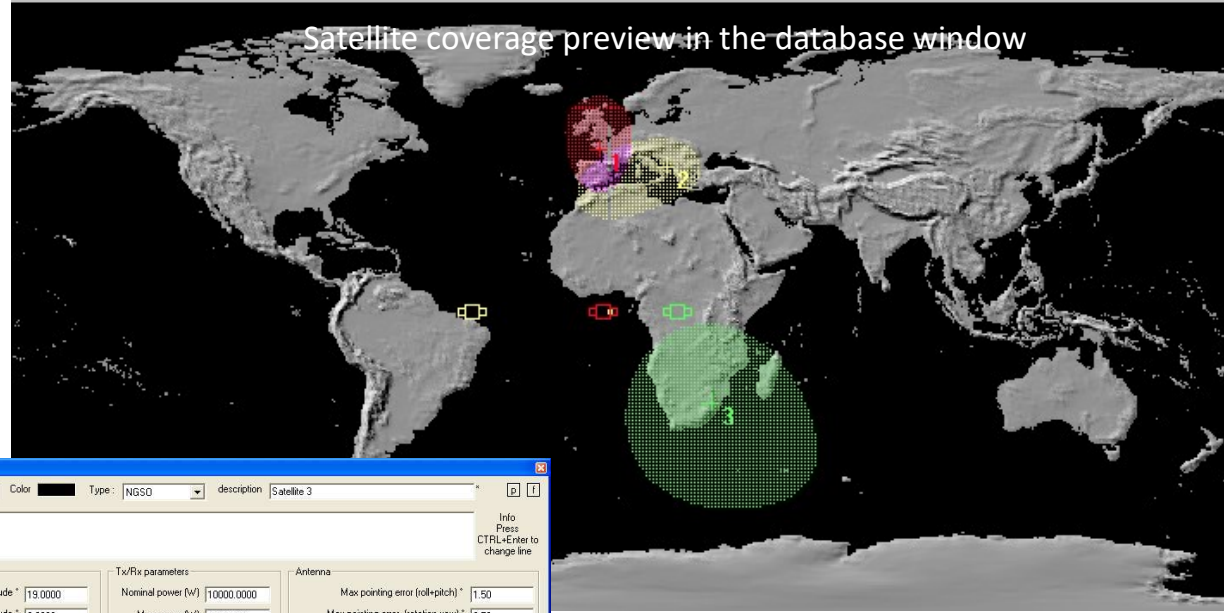


3.3 Satellite

Features :

- GSO/non-GSO satellite coverage planning and link budget (EIRP, G/T, C/N)
- Wide-beam and HTS beam planning across all satellite frequency bands
- Automated frequency planning
- GSO vs GSO and GSO vs non-GSO interference analysis ($\Delta T/T$, C/I, PFD and EPFD masks)
- Satellite vs terrestrial co-existence analysis /Earth station coordination (ITU APP 7)
- DTH network planning /VSAT network planning and optimization
- Covers all satellite services: FSS, BSS, MSS, Earth-exploration, meteorological and more

Satellite coverage preview in the database window



Satellite parameters

Call-sign: [SAT 3] Color: [] Type: [NGSO] description: [Satellite 3]

Info Press CTRL-Enter to change line

Altitude

Longitude: [18.0000] Latitude: [0.0000] Station/keepingError: [1.00] distance to earth centre km: [42164]

Boresight coord: [Earth boresight coord...]

Boresight longitude: [19.0000] Boresight latitude: [48.0000] Boresight/earth centre (dist): [6378] Boresight orientation: [0.0000] Boresight Euler angle phi: [0.0000] Boresight Euler angle theta: [0.0000] Boresight Euler angle psi: [0.0000]

Tx/Rx parameters

Nominal power (W): [10000.0000] Max power (W): [10000.00] Tx gain (dB): [0.00] Rx gain (dB): [0.00] Tx losses (dB): [0.00] Rx losses (dB): [0.00] ISO: []

Tx frequency (GHz): [11.00000] Tx bandwidth (MHz): [40.00000] Rx frequency (GHz): [1.50000] Rx bandwidth (MHz): [500.00000] Rx antenna noise K: [2.00] G/T (dB/K): [3.01]

Antenna

Max pointing error (roll/pitch): [1.50] Max pointing error (rotation yaw): [0.50]

Pattern type: [Circular pattern] [Elliptical] [Other] rec: 672-4, LN=-20 dB (side lobe level)

1/2 power beamwidth 3 dB: [2.0000] 1/2 power beamwidth 3 dB (major axis): [2.0000] 1/2 power beamwidth 3 dB (minor axis): [1.0000] Add 2 x Pointing Error to beamwidth: [] No error: []

Polarization: [] Clockwise: [] Polar axial ratio (Emin/Emax 1=circular): [1.00] Angle of polarization (rotation yaw): [0.0000]

Circular orbit

Inclination (+/-180): [20.0] Anomaly at TO (0 to 360): [1.0] Relative time T-T0 (sec): [20000]

Model atten -1 = R.618 (dB): [1.0] Nb subscribers: [0] BV occupancy MHz: [0.00000] Loss dB: [0.0] [OK] [Cancel]

*none = not selectable



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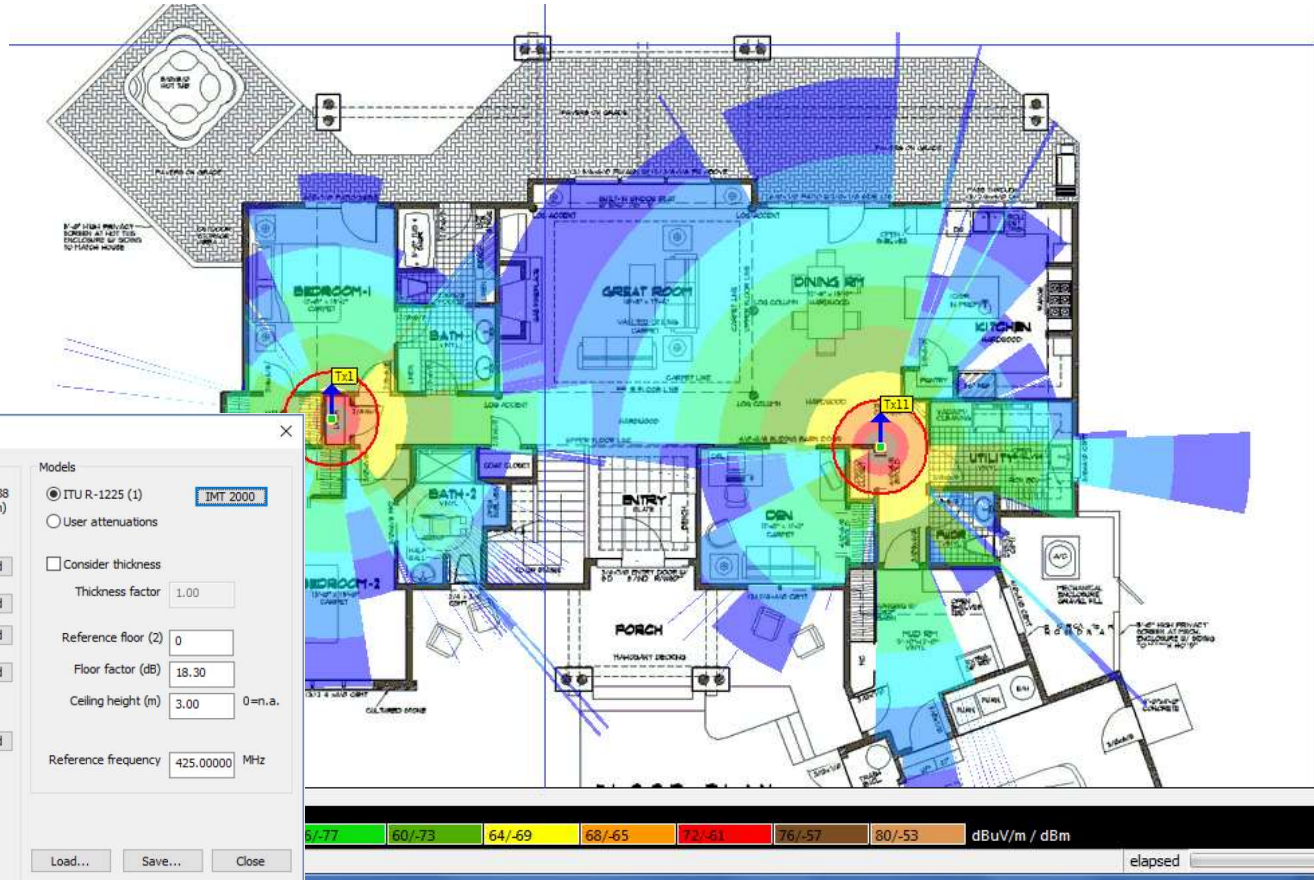


3.3 Indoor coverage

Indoor network deployment functions for 2G/3G/4G/Wi-Fi/TETRA systems :

Building data can manually extracted using ATDI tools from a **basic digitized floor plan**.

Based upon the material (wall in concrete, separation in brick on the same floor....) standards and manual attenuations can be applied , as well attenuation when a ceiling/floor is crossed.



Indoor parameters

code	material	atten (dB)	w	R, 1238 (dB/m)
0	No effect	0 dB		
1	Concrete	6.90	Wall	upd
2	Brick	6.90	Wall	upd
3	Plaster	3.40	Light wall	upd
4	Glass	3.40	Light wall	upd
5	Metal	3.40	Light wall	
6	Wood	3.40	Light wall	upd
7	Furniture wood	0.00	Furniture	
8	Furniture metal	0.00	Furniture	
9	Other	0.00	Other	
10	Non-penetrable material			

Models

ITU R-1225 (1) IMT 2000

User attenuations

Consider thickness

Thickness factor:

Reference floor (2):

Floor factor (dB):

Ceiling height (m): 0=m.a.

Reference frequency: MHz

Load... Save... Close

(1) number of penetrated walls of type w * constant loss (atten dB)
 (2) use for coverage analysis and coverage interference

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3.3 Radio planning and Optimization features

TETRA/VHF/UHF
GSM/UMTS-HSDPA/LTE (Release.13)/WiMAX

Coverage calculation and analysis

- DL/UL automatic link budget calculator
- Composite coverage
- Best server, second best server, overlapping
- ...

Automatic Optimization module

- Automatic search site location
- Automatic antenna parameter optimization (height, azimuth, tilt, model...)

Traffic & capacity analysis

- Traffic congestion analysis
- Traffic dimensioning (pilot and traffic channels)
- Traffic map plot

Interference:

- Interference analysis
- Automatic Frequency Assignment

KPIs

- Link budget analysis
- LTE: RSRP,RSRQ,SNIR
- UMTS: RSCP, Ec/IO,Eb/NO, Ec/Nt
- GSM: RSSI, C/I,
- ...

Handover and neighbor list analysis

- Handover map (Intra-Inter system)
- Neighbor list calculation
- BSIC, PCI allocations
- ...

Monte Carlo Module

- Interference analysis
- Capacity
- Throughput
-

Microwave link

MW link features

- Profile budget calculations
- Frequency and space diversity
- Multi-K factor calculations
- Climate and rain parameters
- Reliability calculations
- Automatic antenna orientation
- Link optimization
- Automated frequency planning
- Interference calculations
- Quality objectives calculations (ITU-R F. 1703 and ITU-T G.827

Radio navigation Satellite

Global flight tracking for Civil Aviation Resolution 185 (Busan, 2014)

- Coexistence with other radio systems
- Interference/loss of tracking

Wireless Avionics Intra-Communications (WAIC) – WRC 2015

- Parameters and Operational objectives for WAIC systems: Are systems in use when cabin doors are open?
- Fuselage attenuation and other surface attenuation above and below 15.7GHz.

Interference into Earth station

- Earth station vs. microwave
- Earth station vs. satellite

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3.3 LF-MF coverage

ITU-R 1147-4

Year: 1975, Month: 1, Day: 15, Hour: 0, Minute: 0

Smoothed Sunspot Number: 50

Percentage of time: 50

Apply default antenna pattern

Buttons: Close, SSN info...

Parameters for the propagation of sky-wave (LF & MF) at night time

Mode to be used:

- Slow mode (valid with any configuration)
- Fast mode (valid with ICS Telecom and HTZ Warfare, for certain configurations only)

Model:

- Rec. ITU-R P.435-7
- Rec. ITU-R P.1147-2
- LF (3 kHz to 300 kHz)
- MF (300 kHz to 3 MHz)
- Reflection on E layer only
- Reflection on E or F layers
- Apply default vertical pattern (Fig.1)

Smoothed sunspot numbers

Month	Year	SSN
10	1752	44
11	1752	42
12	1752	41
1	1753	38
2	1753	36
3	1753	37
4	1753	36
5	1753	34
6	1753	32
7	1753	29

Buttons: Database..., New..., Change..., Delete

Sea gain:

- None
- Automatic - Sea if:
 - Altitude = 0 m - Check Flat earth profile (> dll)
 - and or
 - Clutter = 6
- Manual

Manual parameters:

s1 (Tx)	0.00	s1 (Rx)	0.00
s2 (Tx)	0.00	s2 (Rx)	0.00
alpha (Tx)	1.00	alpha (Rx)	1.00

Buttons: Cancel, Default values

ITU-R P.368-9

Parameters:

Refractivity of the troposphere at the surface of the earth (N-units): 315.00

Scale height of the troposphere (km): 7.350

Add Skywave (ITU-R 1147)...

Buttons: Parameters...

Conductivity indices

Index	Conductivity(mS/m)	Permittivity
0	5000.00	70
1	4000.00	69
2	200.00	51
3	100.00	47
4	79.00	46
5	65.00	45
6	55.00	44
7	50.00	43

Buttons: Load conductivity file..., Load permittivity file..., Update the permittivities from the conductivities, Default values, Close

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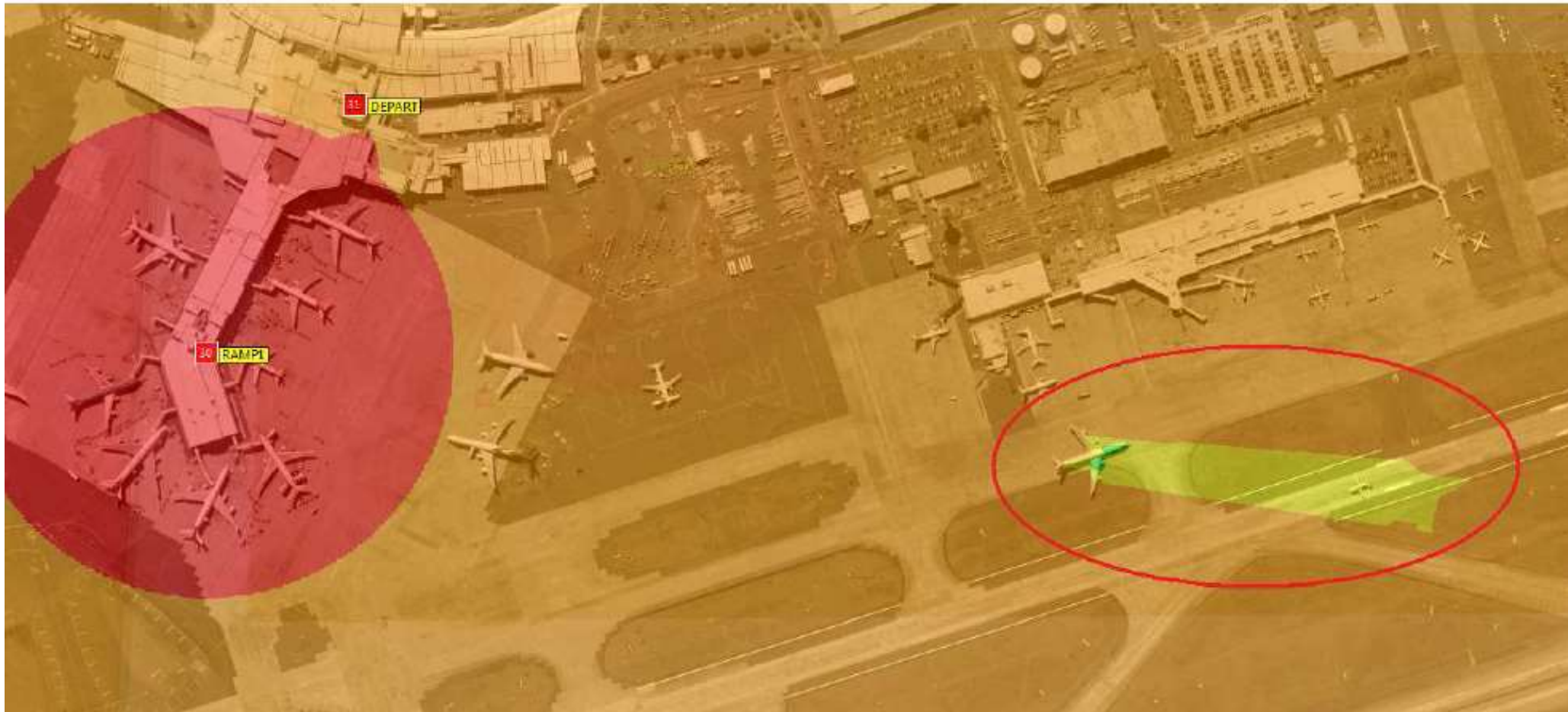
lte



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3.3 AIRPORT OBSTRUCTION



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3.3 - IMPACT DUE TO NEW BUILDINGS

Tx/Rx parameters: 1 VHF1

General | Patterns | Channels | Site | Advanced

Type	Signal	Status	Frequency plan
Tx/Rx A (0)	Generic (2)	Unknown (0)	# 1

activated

Tx/Rx

Nominal power (W)

Dynamic (dB)

Tx ant gain (dBi)

Rx ant gain (dBi)

Losses (dB) tx rx

Tx add losses (dB)

E.I.R.P (W)

Frequency (MHz)

Antenna height (m)

Tx bandwidth (kHz)

Rx bandwidth (kHz)

Coverage

ITU525

Delete info

OOB (dBW/MHz)

Variable power

Fixed power

Fixed frequency

Freq Hop / WB

Variable elevation

Fixed elevation

Info

Callsign Parenting

Address Date

Info (1) Type ID

Info (2) Link

Network ID Group

User Call number

Comment:

SQL record 0

OK Annuler

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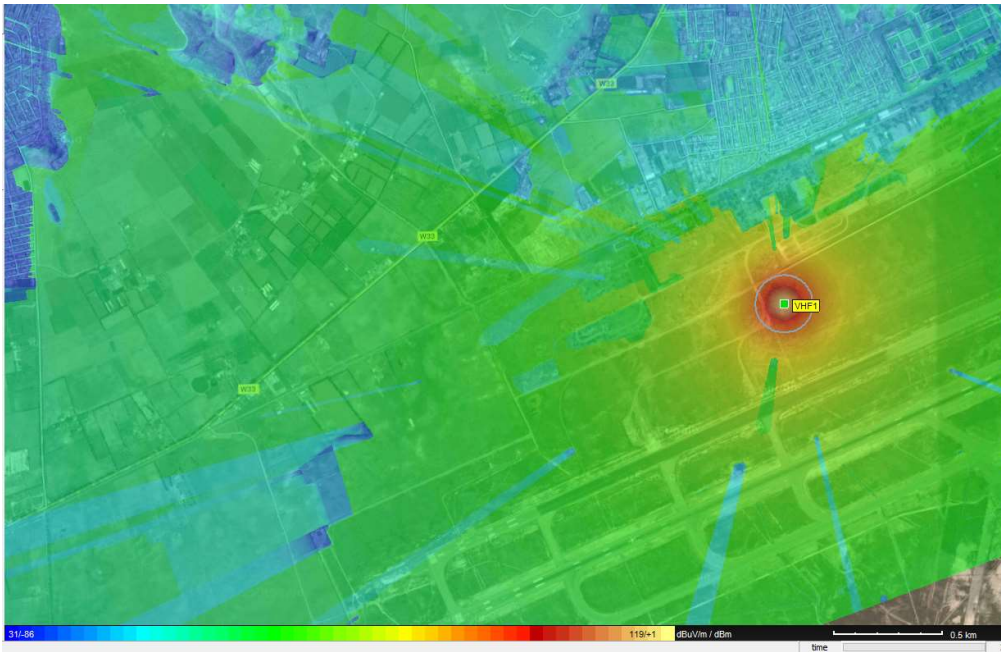
lte



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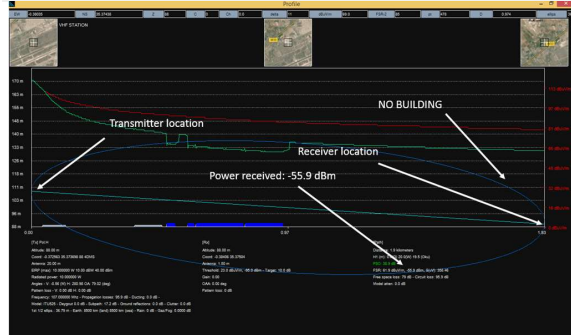
3.3 - Obstacles evaluation



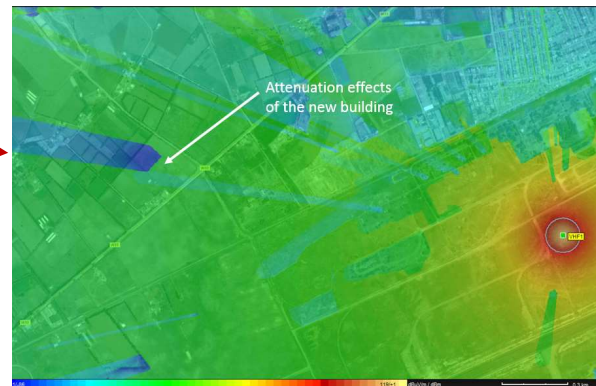
Manual creation of a new building (*)

- De-activate stations
- Activate stations
- Isolate stations
- Delete stations
- Move stations
- Duplicate stations...
- Rotate station antenna...
- Assign last polygon to station...
- New allotment...
- Assign Tx/Rx sector and distance
- Coverage calculation...
- Microwave link list...
- Subscribers
- Search site...
- Multilateration
- Vectors
- Raster operation
 - Spectrum...
 - Isolate result
 - Delete result
 - Percentage covered
 - Population covered
 - Area covered (surface and population)
 - Station database...
 - MW database...
 - SQL...
 - Popup menu setup...
- New clutter code...
- Modify clutter code...
- New dtm / indoor code...
- Modify dtm / indoor code...
- New building...
- Modify building...
- New result code...
- Clutter info

(**) New buildings can be also directly imported and created via vector file formats (SHP, KML, CSV, Autocade, etc.)



Signal attenuation due to new building



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3.3 – VHF Coverage (Abha Airport in KSA)



ITEM	CH FREQ. (MHZ)	USE
1	CH 1: 133.500	Ground to Ground communication
2	CH 2: 121.700	Operation room to Tower communication
3	CH 3: 118.100	Monitor in operation room from Air to Ground communication



- VHF AM radio base station JOTRON (TR-7550)**
- Portable Radios (ICOM)
 - Mobile Radios (ICOM)



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3.3 – VHF Coverage

Tx/Rx parameters: 1 VHF STATION

General Patterns Channels Site Advanced

Type (0) Signal (2) Modulation (1) INFO / TS-RUP

Tx/Rx A (0) Generic (2) AM compr, normal (1) activated

Tx/Rx
 Nominal power (W) 10
 Dynamic (dB) 0
 Tx ant gain (dB) 0.00
 Rx ant gain (dB) 0.00
 Losses (dB) tx 0.00 rx 0.00
 Tx add losses (dB) 0.00
 E.I.R.P (W) 10
 Frequency (MHz) 133.500000
 Antenna height (m) 10.00
 Tx bandwidth (kHz) 12.50
 Rx bandwidth (kHz) 12.50

Coverage
 Freqn.
 Delete info
 OOB (dBW/MHz) 0
 Variable power
 Fixed power
 Fixed frequency
 Freq Hop / WB
 Variable elevation
 Fixed elevation

Info
 Collision VHF STATION Parenting 0
 Address EQUIPMENT ROOM Date 20180505
 Info (1) Type ID C
 Info (2) JOTRON 7000 series Link
 Network ID GACA Group
 User Call number 0

Comment:
 Channel separation: 25 kHz or 8.33 kHz (12.5 kHz optional)

SQL record 0

General Patterns Channels Site Advanced

Transmitting

no.	ch	Loss (dB)
133.500000	0	0
121.700000	0	0
118.300000	0	0
0.000000	0	0
0.000000	0	0

Site coordinates

EW +0.8444479 North
 NG 18.23370595 East

Altitude (m) 0
 Obtain altitude Altitude in force

Coordinate code 4000

Coordinate conversion

Round altitude (m) 2027 CUT disk
 Offset (m) 0.00 m

Update Cancel

Site base...
 Add in location file

General Patterns Channels Site Advanced

3D antenna (1) (Lobesector)

Park Air oppo ante Park Air 07 MHz, 120 200m

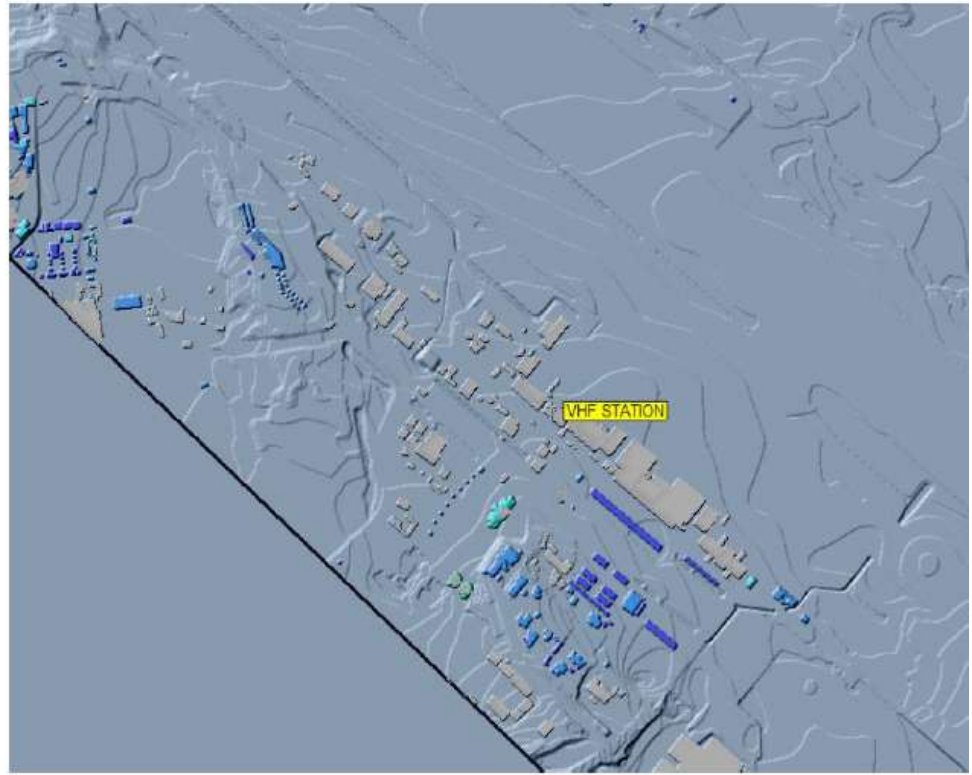
Horizontal pattern -90 vertical pattern +90

Tx pol (dB) C M
 Rx pol (dB) C M
 X polar -dec (dB) 0

Antenna details

Antenn (D-1097) 0.00
 TH (-60 +80) 0.00
 Tx ant gain (dB) 0.00
 Rx ant gain (dB) 0.00

Standard antenna
 SU-4000 3D
 SU-4000 3M
 MU-4000



Building layer view of the Abha' airport

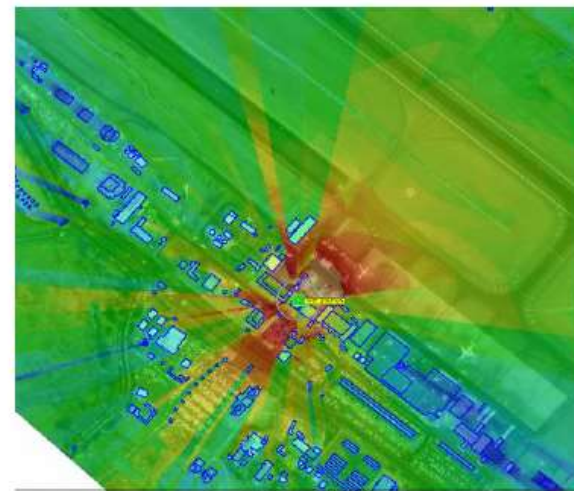
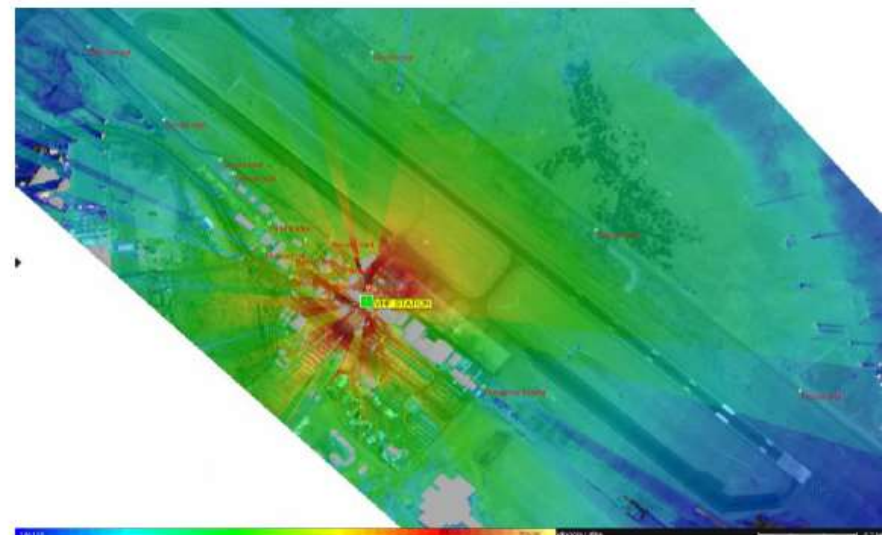
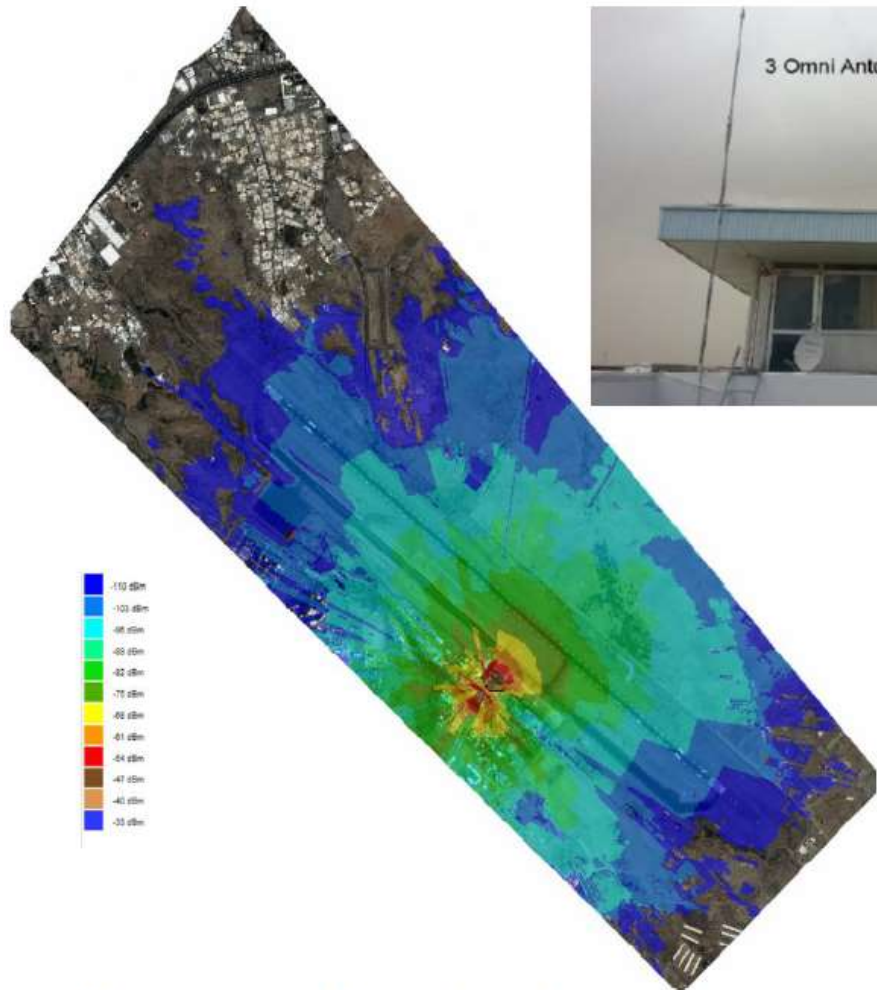
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3.3 – VHF Coverage



RSSI coverage plot with -100dBm as minimum coverage threshold

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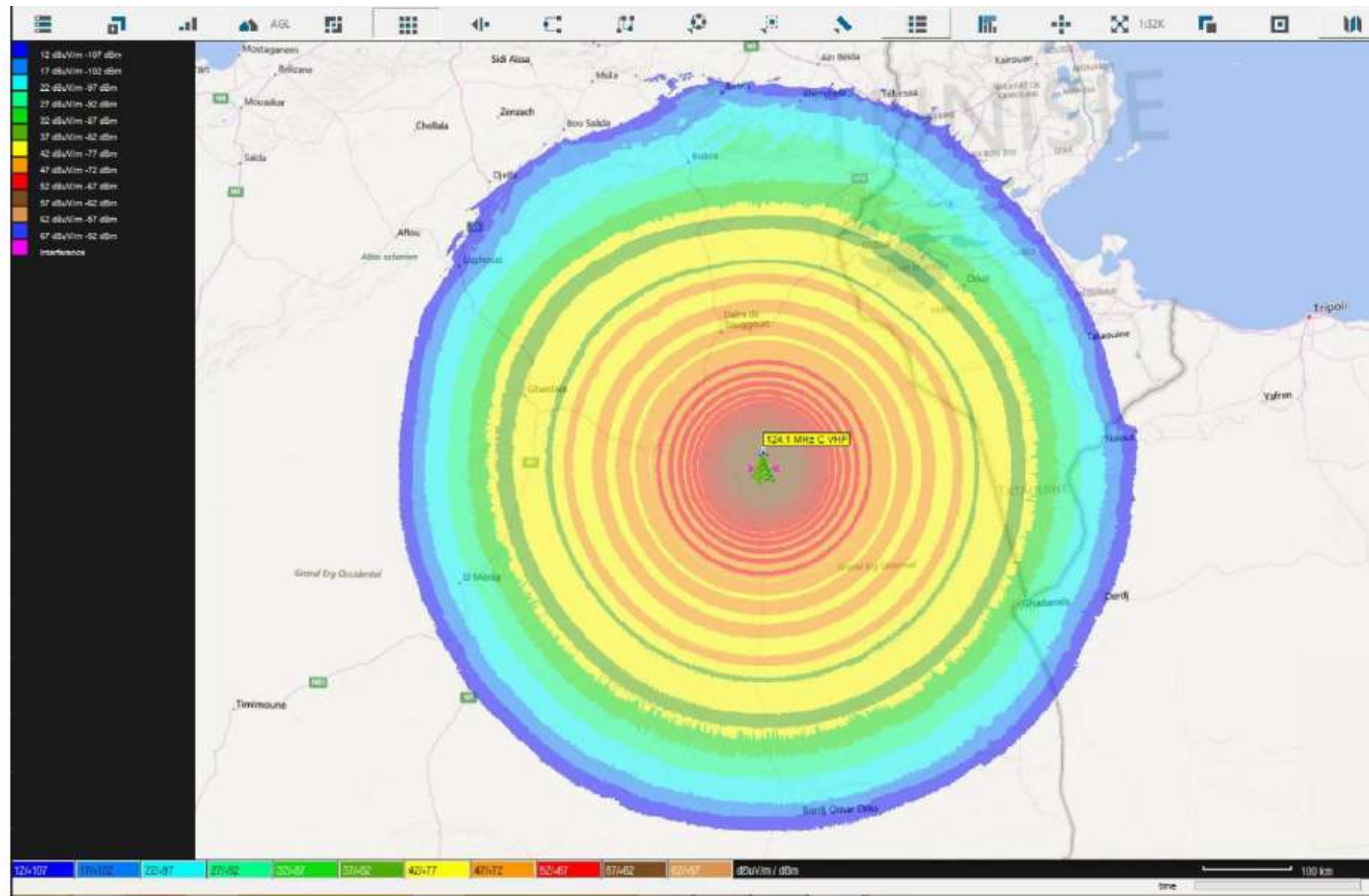
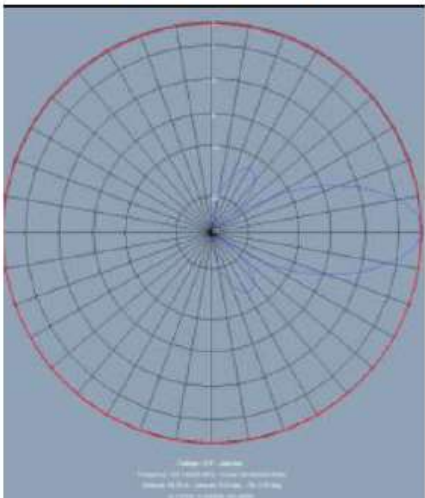


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3.3 – VHF Ground To Air simulation (Hassi Messaoud – Algeria)

- Site location : Hassi Messaoud, Ouargla (Algeria)
- AGL Height (Aircraft receiver): 30 000 ft.
- Nominal power: 50W
- Rx Sensitivity: -107dBm
- Freq: 124,1 MHz
- Omni antenna: K-717265_0127MHz_Vpol



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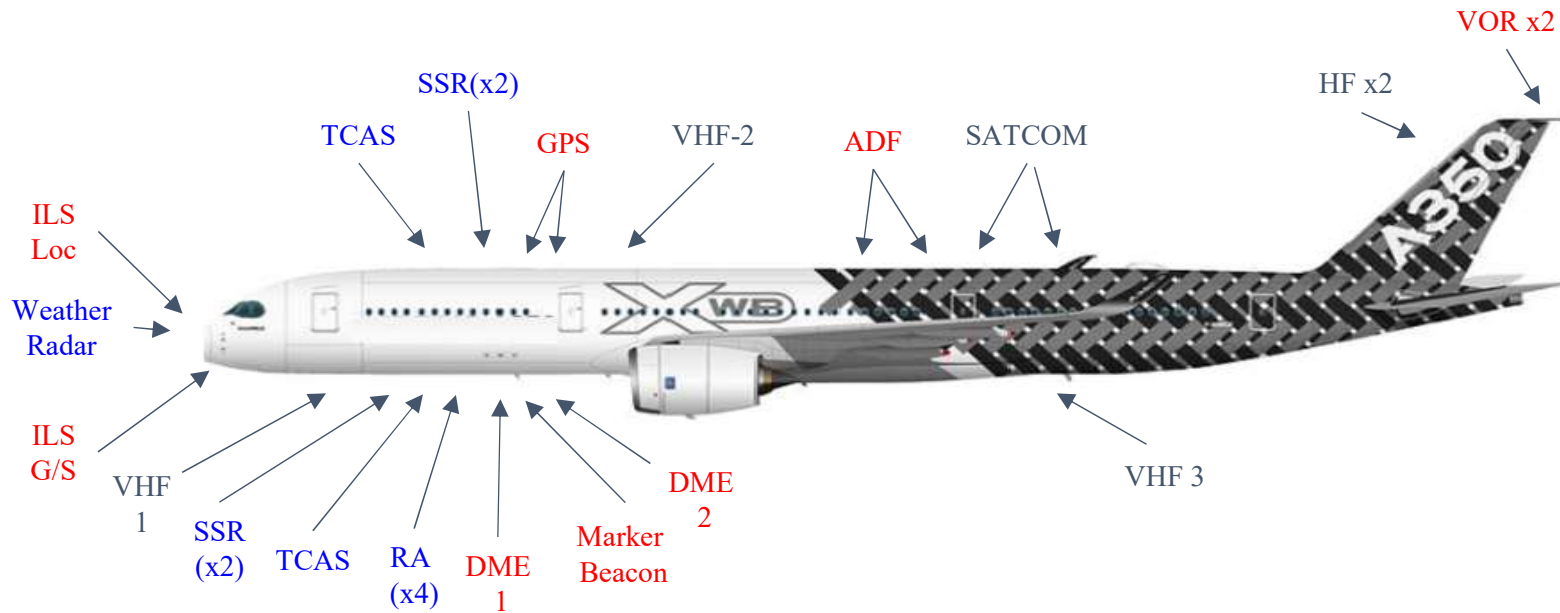


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3.3 - AIRCRAFT TRANSMITTERS

Modeling aircrafts transmitters/receivers systems with HTZ communications...



ADF : Automatic Direction Finder
 DME: Distance Measuring Equipment
 GPS: Global Positioning System
 G/S: Glide Slope
 HF: High Frequency
 ILS: Instrument Landing System

Loc : Localizer
 RA: Radio Altimeter
 SATCOM: Satellite Communication
 SSR: Secondary Surveillance Radar
 TCAS: Traffic Collision Avoidance System
 VOR: VHF Omni ranging

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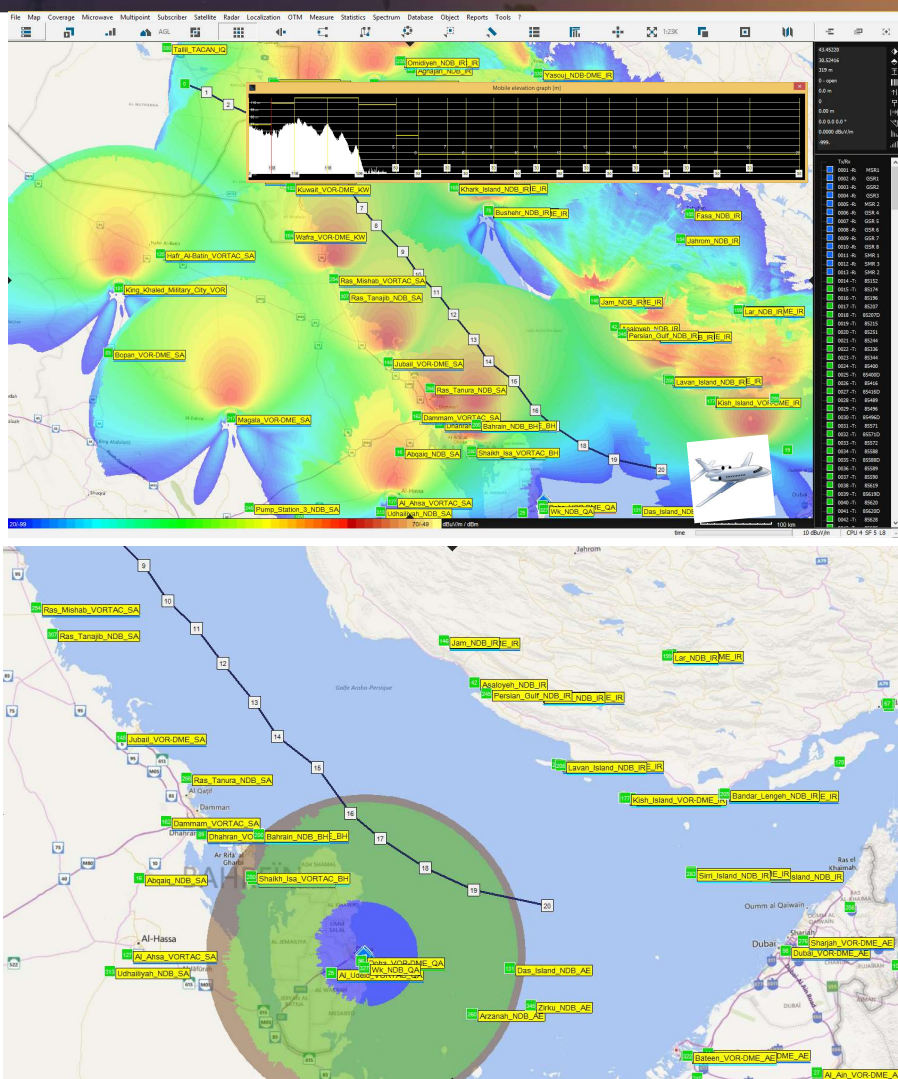
lte



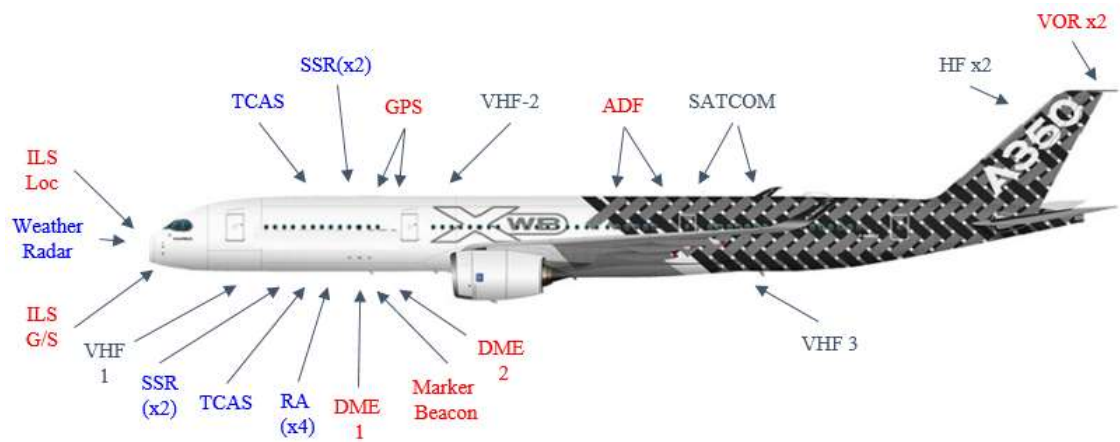
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3.3 AIRCRAFT TRANSMITTERS MODELLING



Modeling aircrafts with all radio navigation equipments with HTZ communications...



- | | | | |
|-------|------------------------------|---------|------------------------------------|
| ADF : | Automatic Direction Finder | Loc | Localizer |
| DME: | Distance Measuring Equipment | RA: | Radio Altimeter |
| GPS: | Global Positioning System | SATCOM: | Satellite Communication |
| G/S: | Glide Slope | SSR: | Secondary Surveillance Radar |
| HF: | High Frequency | TCAS: | Traffic Collision Avoidance System |
| ILS: | Instrument Landing System | VOR: | VHF Omni ranging |

3.3 - Aeronautical Communication Systems

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3.3 – Broadband LTE A2G (use case)

- LTE configuration:**
- Freq: 2325 MHz
 - Bandwidth: 5MHz
 - TDD mode (config 1/ Subframe format 7)
 - MIMO 4x2 system
- Throughput Target:**
- DL/UL : 2Mbps
 - Coverage probability: 87,5%
- Aircraft Altitude: 8000 ft.**

Output

#RE/PRB/subframe	16
Number of OFDM symbols per subframe	14
Total Number of PRBs per TTI	25
Reference signal	13.095
Primary synchronization signal (PSS)	0.000
Secondary synchronization signal (SSS)	0.632
PBCH / PRACH	1.210
PDCCH (incl. PCFICH, PHICH) / PUCCH	6.578
PDSCH	78.484

Input

FDD TDD

Cyclic prefix

Normal Extended

Antenna configuration

No. arrays T/R /

TDD

DL-to-UL configuration

DL-to-UL config 1

Special subframe format type

Subframe Format 7

Regural DL/UL subframes

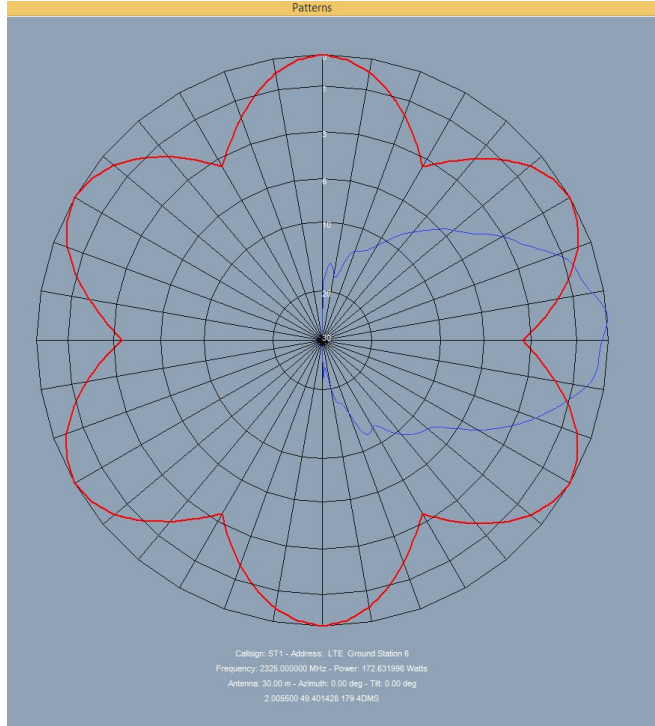
Special subframes

DL/UL ratio

Bandwidth (kHz)

PDCCH symbol(s)

Max power (W)



Antenna patterns (H/V)

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3.3 – Broadband LTE A2G (use case)

E-Node B parameters:

Type	Signal
Tx/Rx A (0)	LTE TDD (57)
Tx/Rx	
Nominal power (W)	30
Dynamic (dB)	0
Tx ant gain (dBi)	9.60
Rx ant gain (dBi)	9.60
Losses (dB)	tx 0.50 rx 0.50
Tx add losses (dB)	1.50
E.I.R.P (W)	172.632
Frequency (MHz)	2325.000000
Antenna height (m)	30.00
Tx bandwidth (kHz)	5000.00
Rx bandwidth (kHz)	5000.00

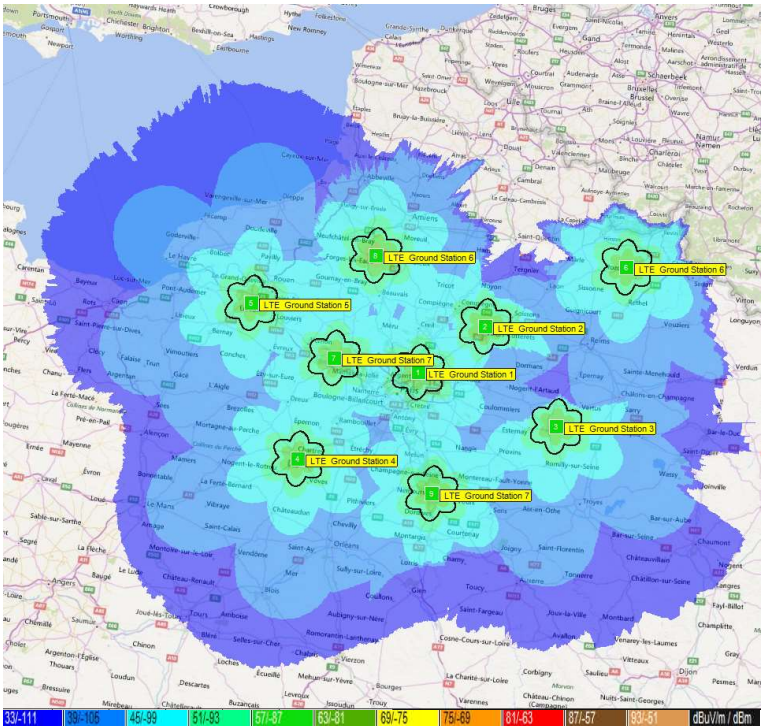


Fig 1: RSRP coverage (Aircraft altitude: 8000 ft)

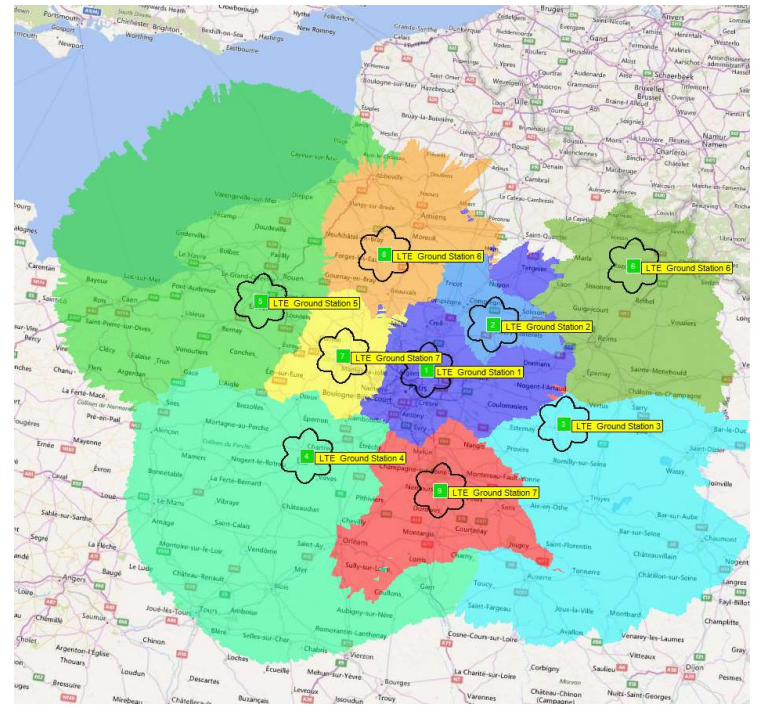


Fig 2: Best server RSRP map (Aircraft altitude: 8000 ft)

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3.3 – Broadband LTE A2G (use case)

E-Node B parameters:

Type	Signal
Tx/Rx A (0)	LTE TDD (57)
Tx/Rx	
Nominal power (W)	30
Dynamic (dB)	0
Tx ant gain (dBi)	9.60
Rx ant gain (dBi)	9.60
Losses (dB)	tx 0.50 rx 0.50
Tx add losses (dB)	1.50
E.I.R.P (W)	172.632
Frequency (MHz)	2325.000000
Antenna height (m)	30.00
Tx bandwidth (kHz)	5000.00
Rx bandwidth (kHz)	5000.00

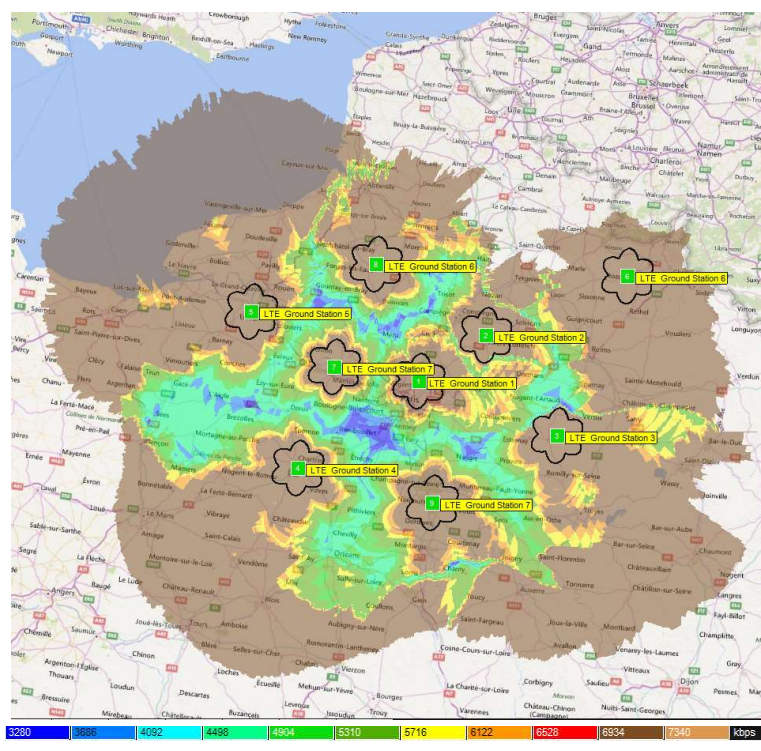


Fig 3: DL throughput map (Aircraft altitude: 8000 ft)

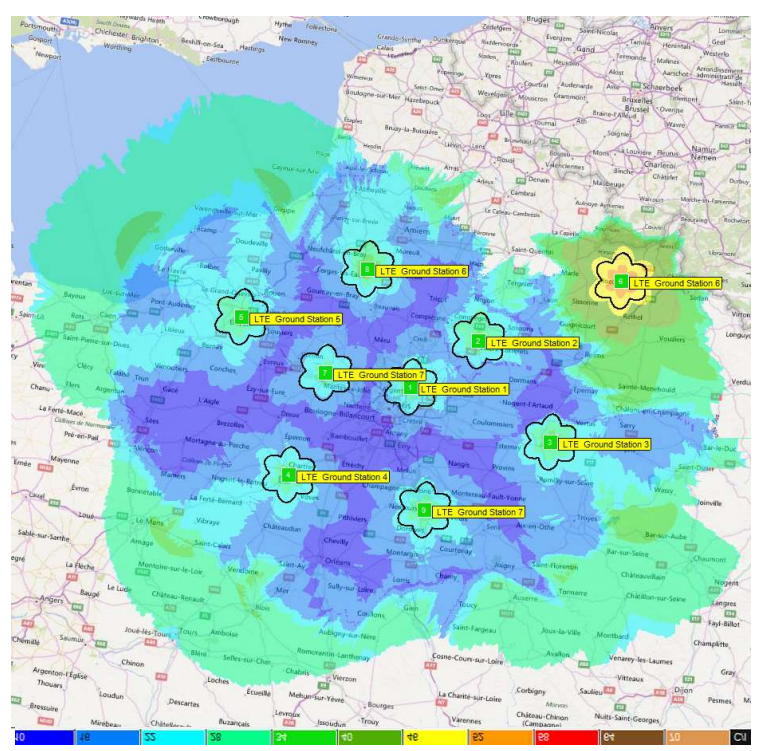


Fig 4: SNIR map (Aircraft altitude: 8000 ft)

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3.3 – Broadband LTE A2G (use case)

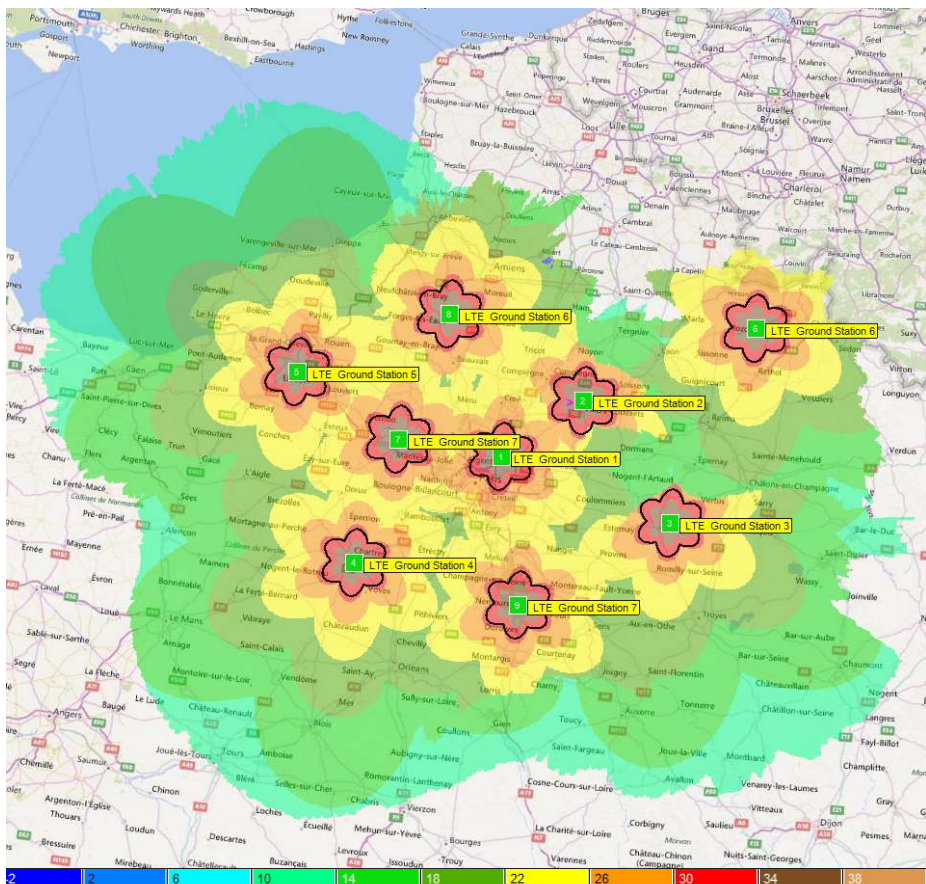
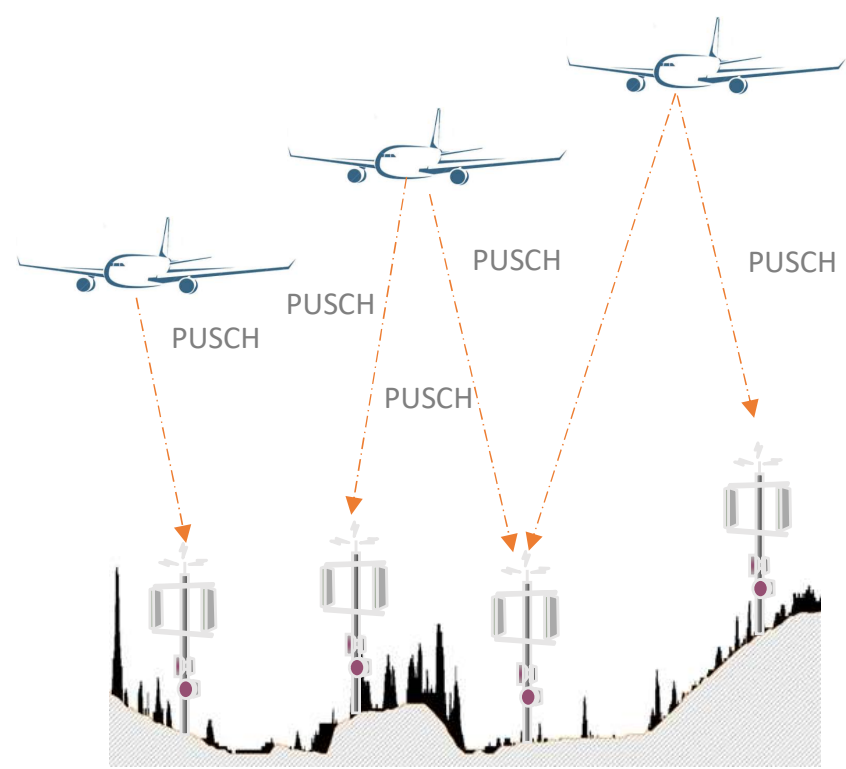


Fig 5: UL SNIR map (Aircraft altitude: 8000 ft)



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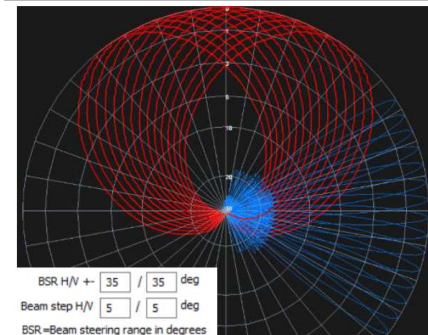


3.3 – 5G Network configuration

- Standalone (SA) and non-standalone (NSA) deployments ;
- All 5G-NR numerologies : 15,30, 60, 120, 240, 480 KHz;
- All 5G-NR Frequency bands (both below and above 6 GHz and bandwidths;
- Configuration of PDSCH, PSS, PBCH channels ...;
- Multipoint antenna system /Massive MIMO: SU-MIMO, MU-MIMO, and transmit/receive diversity;
- 2D/3D Dynamic beamforming (vertical and horizontal beams);
- DL/UL max throughput according to gNB configuration ;
- TDD/FDD/SUL, SDL duplex configuration;
- General technical parameters (feeder types, losses, power, antenna height, azimuths, ...);
- PCI (Physical Cell ID)/ PHY_GRP_ID;
- HO margins;
- DL/UL load Traffic Factor;



NR adaptive (SMART) - Beamforming



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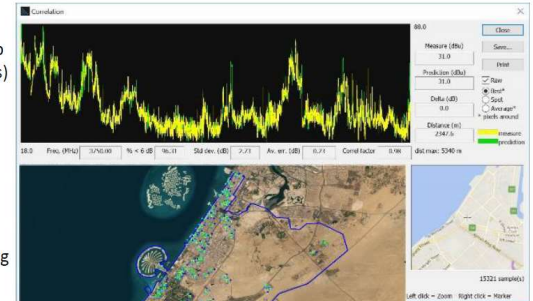


3.3 – 5G Network simulation and analysis

- Link budget calculator taking into account % reliability to achieve at the cell edge
- BRSRP plot , Probability of getting a given BRSRP value over a defined threshold, BRSRP overlapping, simultaneous BRSRP servers, 1st, 2nd and 3rd BRSRP server
- BRSRQ, best sever BRSRQ, BRSRQ with simultaneous servers, BRSRQ (normal std distribution)
- RSSI plot, best RSSI , overlapping, number of signal at a given pixel...
- Composite SNIR (PDSCH), best server SNIR, SNIR PBCH, SNIR PDCCH
- Uplink SNIR coverage map (Monte-Carlo and Noise rise methods)
- Simultaneous display and analysis of network layers
- Link connections between 5G-NR UE's and gNB
- 5G traffic analysis, CQI
- 5G NR throughput plots according to Shannon method
- Automatic PCI (Physical Cell ID) planning, Automatic PRACH RSI planning
- Neighbor list (manual /automatic)
- Inter technology Handover calculation
- Automatic cell planning
- Automatic optimization of network coverage and capacity
- Automatic parameters optimization (height, azimuth & tilt)
- Automatic best site selection according to coverage and traffic targets
- Automated frequency planning, refarming frequency bands and inter-system coexistence
- Monte Carlos simulator

Sample correlation studies using HTZ Communications

- 5G 3.5 GHz in Emirates
- 3D 10m resolution map (Including Building heights)
- Model
 - Deygout94 +
 - Fine sp
- Correlation results
 - **2.73 dB STD**
 - 0.98dB AVG Error
- Total samples: 15 321
- Dynamic Beamforming
64 arrays



ADVANCED SOLUTIONS IN RADIOCOMMUNICATIONS

ATDI



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3.4 - RADIO NAVIGATION SYSTEMS



- Doppler VOR
- Instrument Landing System (ILS)
- Coordination with FM systems (SM 1009 recommendation)

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3.4 - DOPPLER VOR

Tx/Rx parameters: 1 VOR

General | Patterns | Channels | Site | Advanced

Type: Tx/Rx A (0) | Signal: VOR (16) | Status: Coverage | Frequency plan: No 1 | activated

Tx/Rx

Nominal power (W): 1000
 Dynamic (dB): 0
 Tx ant gain (dBi): 7.20
 Rx ant gain (dBi): 7.20
 Losses (dB): tx 12.50 rx 12.50
 Tx add losses (dB): 0.00
 E.I.R.P (W): 295.1209
 Frequency (MHz): 108.05000
 Antenna height (m): 3.00
 Tx bandwidth (kHz): 50.00
 Rx bandwidth (kHz): 50.00

Coverage

prop52
 Delete info

Variable power
 Fixed power
 Fixed frequency
 Freqhop/wide band

Variable elevation
 Fixed elevation

Info

Callsign: VOR | Parenting: 0
 Address: | Date: 20130626 | yyyymmdd
 Info (1): | Type: C
 Info (2): | Link:
 Network ID: | Group:
 User: | Call number: 0

Comment:
 SQL record 0

Ctrl+Enter: change line

OK Cancel

Horizontal pattern -90 Vertical pattern +90

omni 3.SPV

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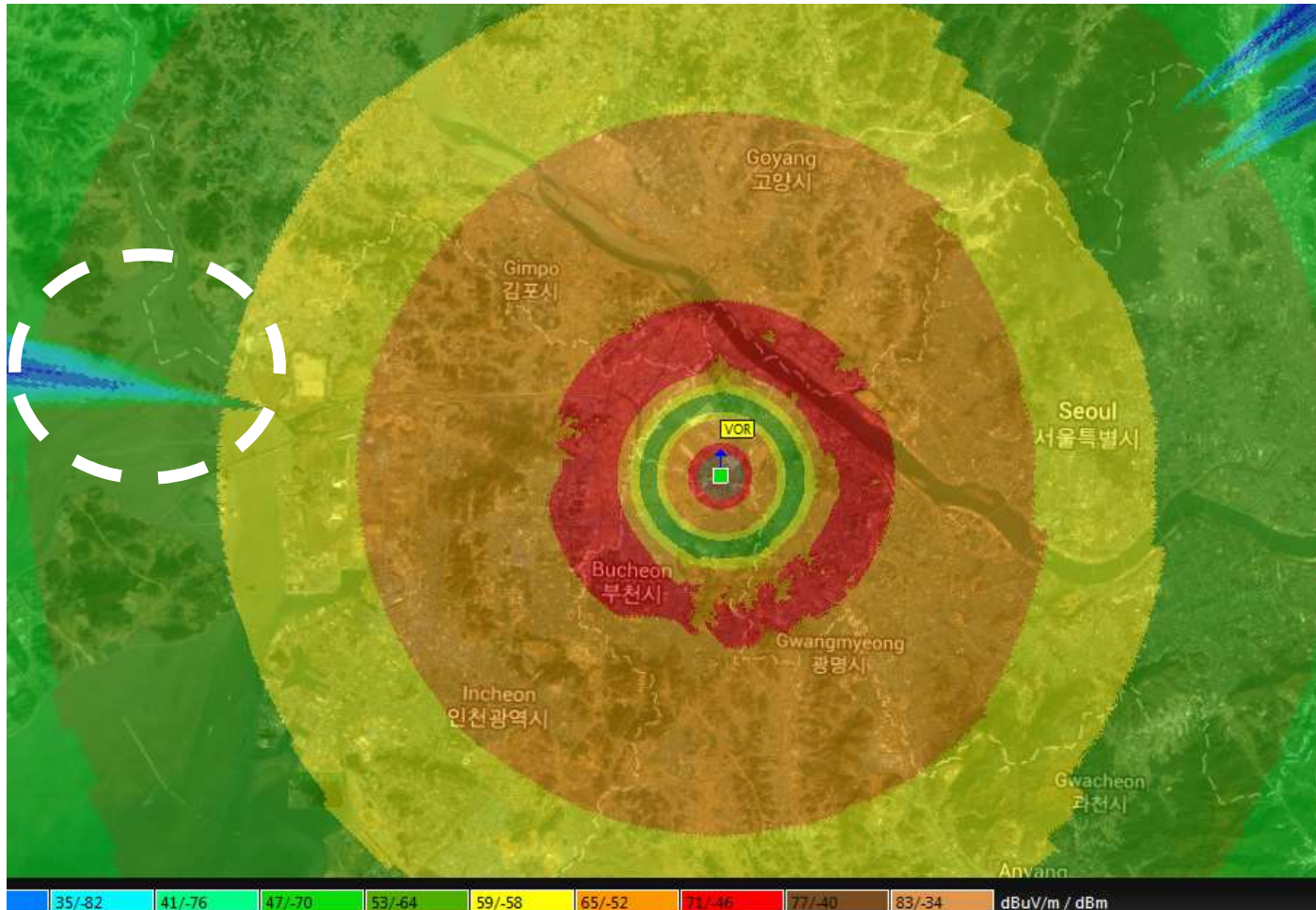
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3.4 – DOPLER VOR



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3.4 – DOPPLER VOR



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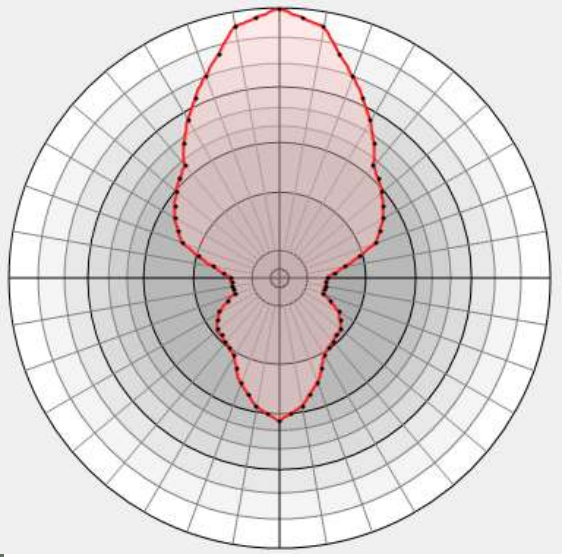
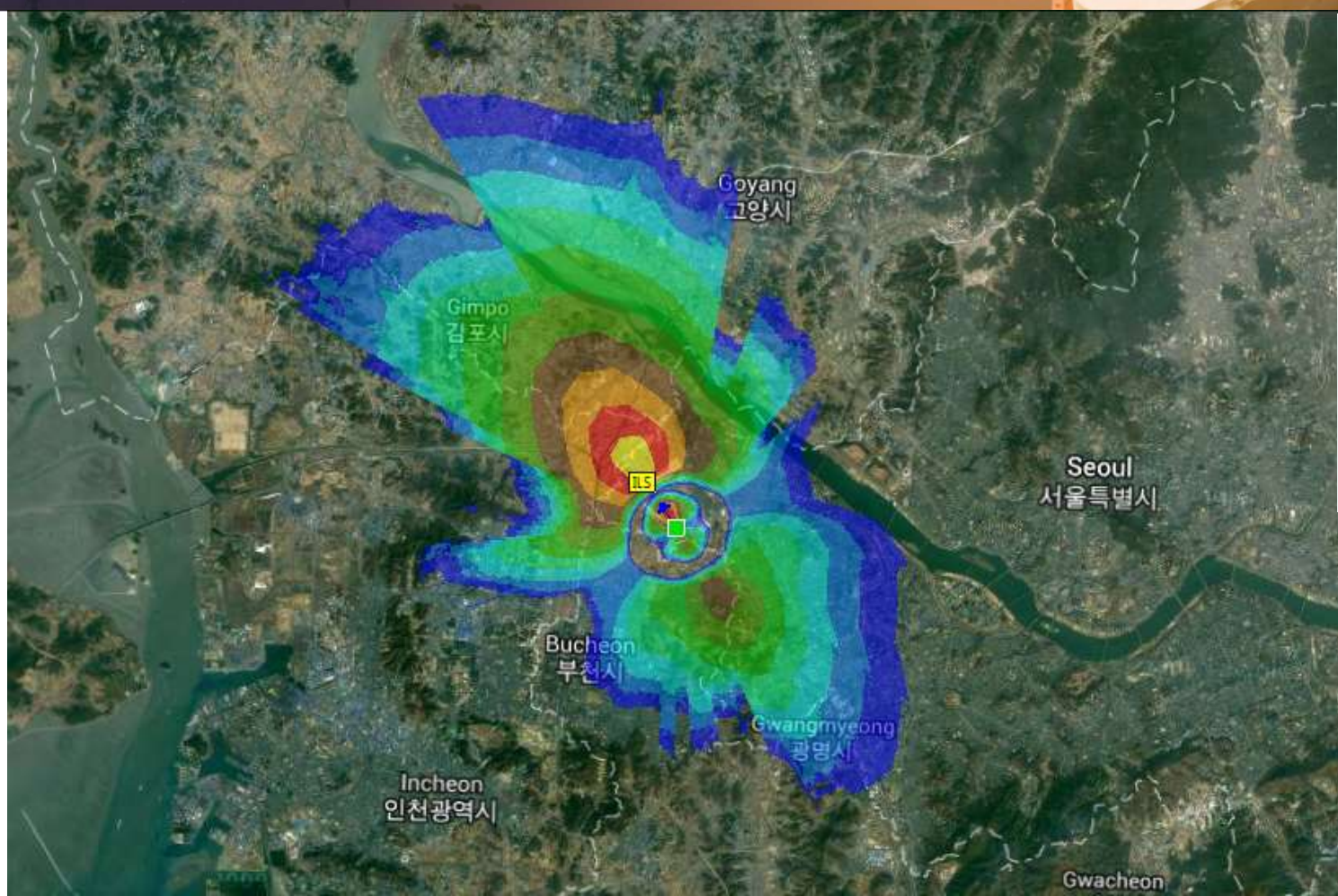
lte



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3.4. ILS



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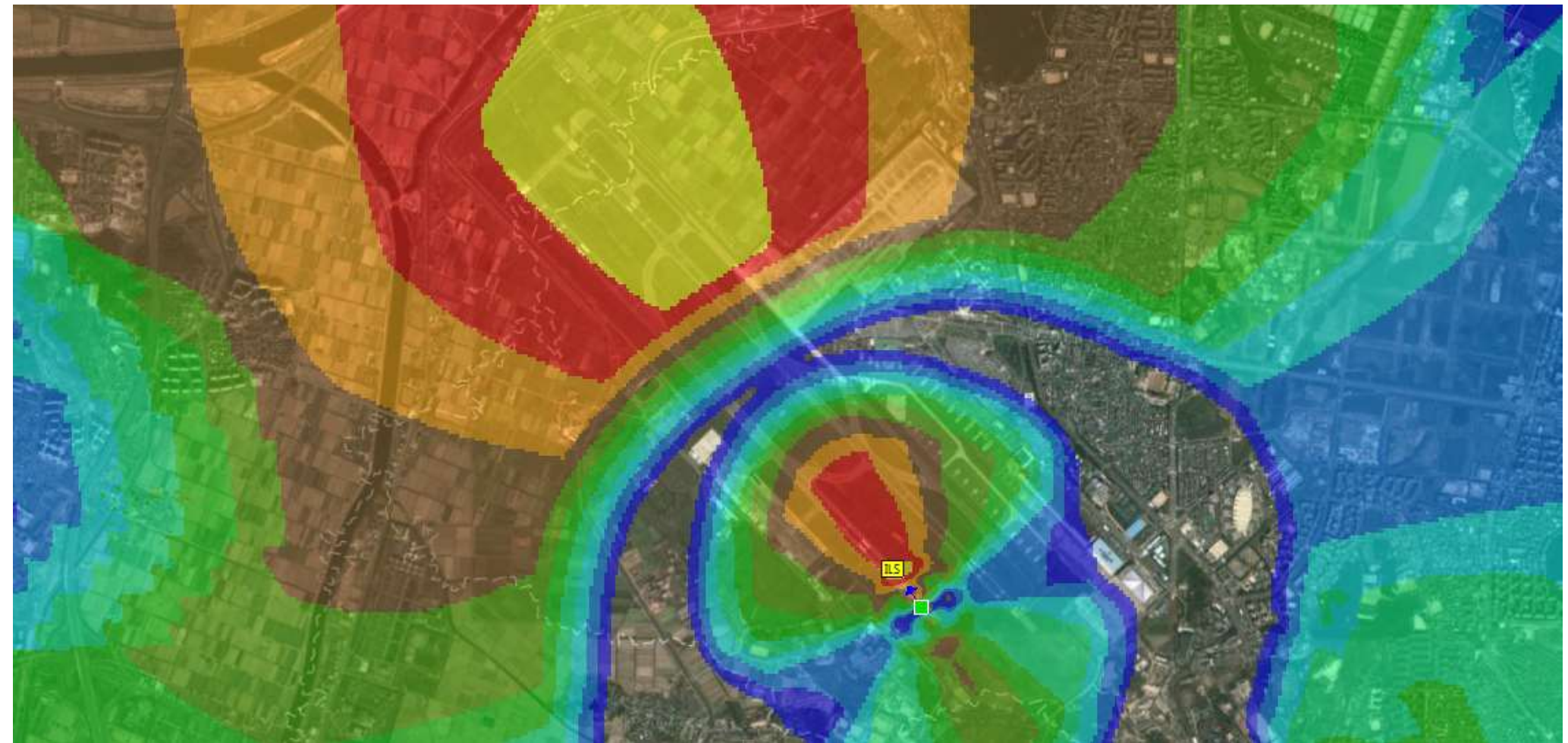
lte



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3.4. ILS



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3.4. ILS/VOR COORDINATION

Implantation of ITU SM1009

The aim of this recommendation is to check compatibility Between sound broadcasting service in 87-108 MHz and the aeronautical services in the 108-137MHz band

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3.4. ILS/VOR COORDINATION



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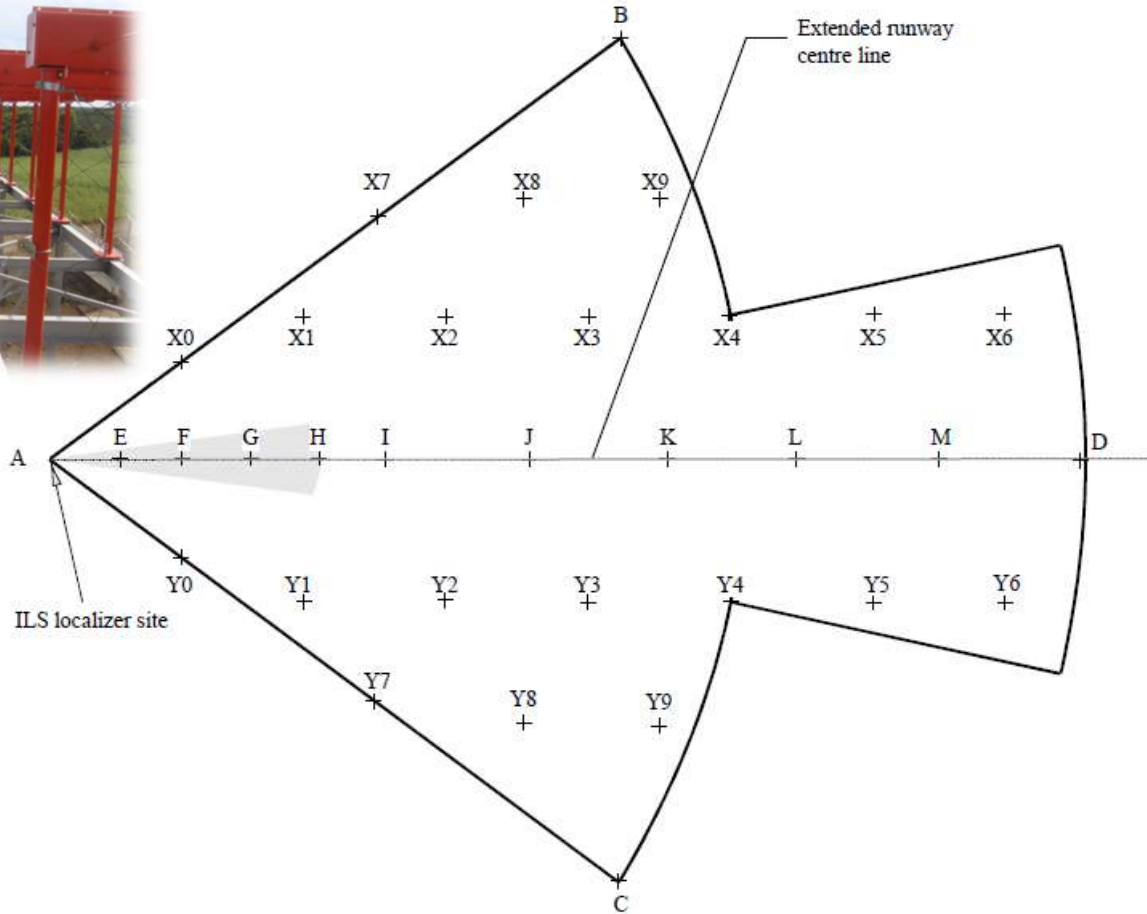
lte



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3.4. ILS/VOR COORDINATION



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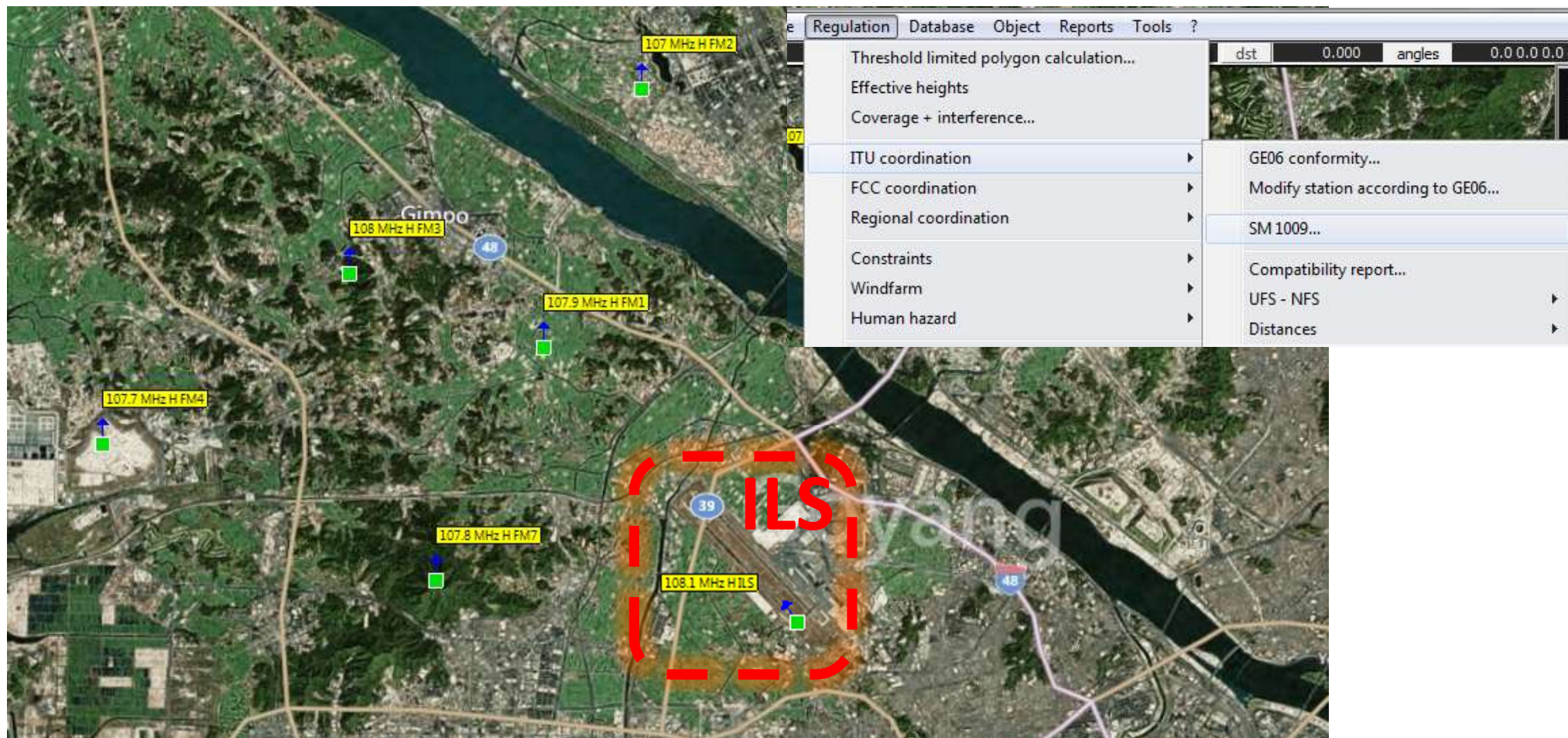
lte



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3.4 ILS/VOR AND FM COORDINATION



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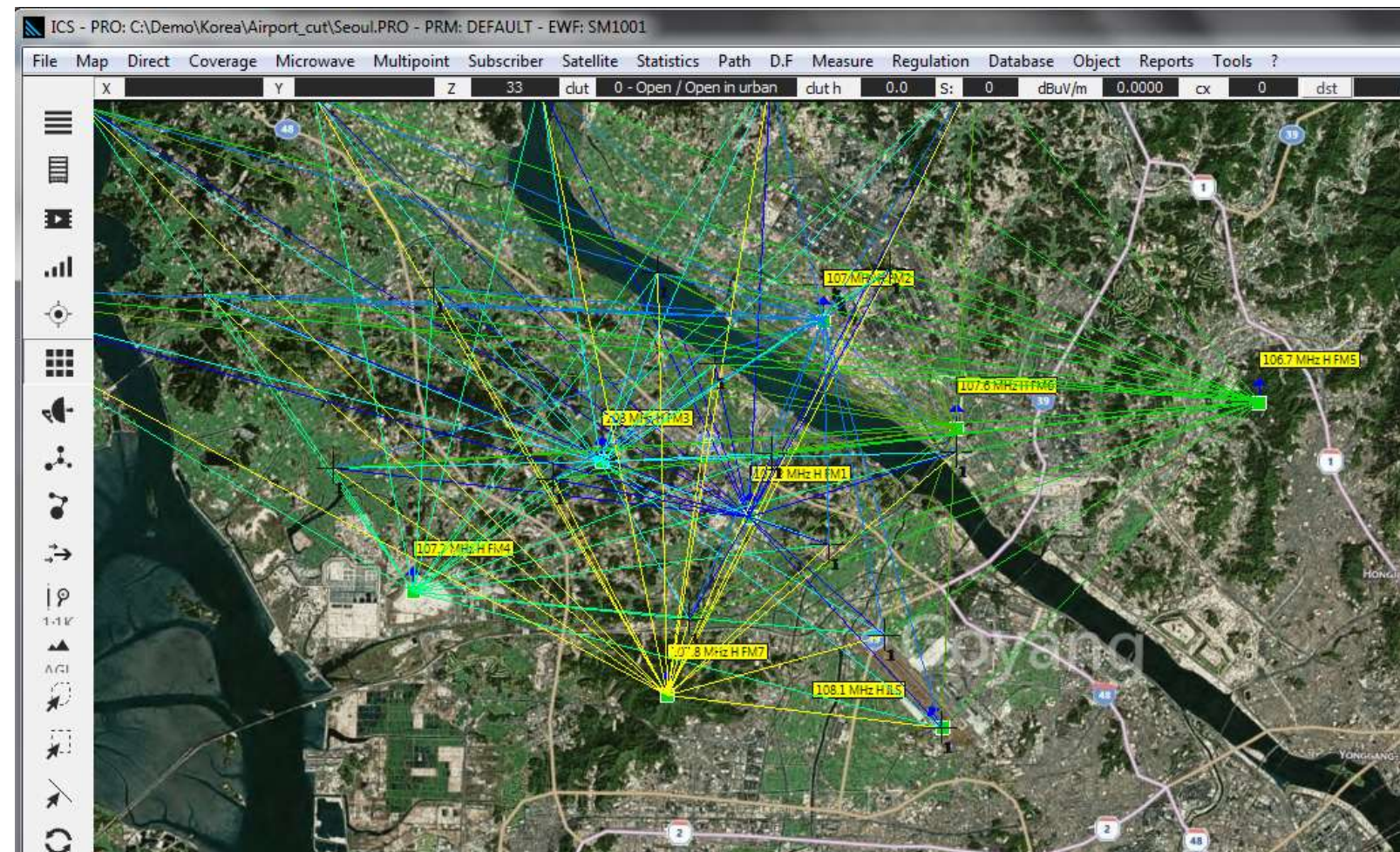
lte



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3.4 ILS/VOR AND FM COORDINATION



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3.4 ILS/VOR AND FM COORDINATION

Report listing

Record	Test point info	Wanted station #	Callsign	Wanted freq MHz	FTx 1 MHz	FTx 2 MHz	FTx 3 MHz	Fintermod MHz	Intermod product	Interference type	FS1+correct.(dBuV/m)	Co
8765	ILS y7	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	81.1	5.1
8766	ILS y7	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	81.1	5.1
8767	ILS x8	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	Interference A...	92.9	5.1
8768	ILS x8	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	Interference A...	92.9	5.1
8769	ILS x8	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	Interference B...	92.9	5.1
8770	ILS x8	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.9	5.1
8771	ILS x8	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.9	5.1
8772	ILS x8	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.9	5.1
8773	ILS x9	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	Interference A...	92.5	7.1
8774	ILS x9	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	Interference A...	92.5	7.1
8775	ILS x9	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.5	7.1
8776	ILS x9	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.5	7.1
8777	ILS x9	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.5	7.1
8778	ILS x9	1	ILS	108.10000	108.00...	107.90...	107.80...	108.10000	1A+1B-1C	No interferenc...	92.5	7.1
8779	ILS A	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-12.3	3.1
8780	ILS A	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-12.3	3.1
8781	ILS A	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-12.3	3.1
8782	ILS A	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-12.3	3.1
8783	ILS A	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-12.3	3.1
8784	ILS A	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-12.3	3.1
8785	ILS B	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-25.1	5.1
8786	ILS B	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-25.1	5.1
8787	ILS B	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-25.1	5.1
8788	ILS B	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-25.1	5.1
8789	ILS B	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-25.1	5.1
8790	ILS B	1	ILS	108.10000	108.00...	107.00...	107.90...	108.90000	1A+1B-1C	No interferenc...	-25.1	5.1

Listing... Close

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3.5 - RADARS AND MULTILATERATION SYSTEMS



- Surveillance systems (Radar)
- Multilateration (MLAT)
- Coexistence between radars and other systems

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3.5. RADAR PARAMETERS



Radar parameters: 5 RADAR

General Patterns Channels Site Advanced Radar

Type: Radar A (4) Bistatic >

Peak power (kW)	250.00000	IF bandwidth (Hz)	480000	Energy (Joule)	0.63
Antenna gain (dBi) Tx/Rx	32.00 32.00	Pulse width (us)	2.50	Effective surface (m2)	0.13
Losses (dB) Tx/Rx	0.00 0.00	Noise (dB)	6.00	N.K.T	1.636221e-20
Radiated power (W)	3.962233e+08	Detection PD	0.50	NKTB (dBm)	-111.05
Mean power (W)	0.625	RCS (m2)	2.0000 ...	R/R0 (km)	97
Antenna height (m)	12.00	PRF (Hz)	1.00		
Frequency (MHz)	9400.000000	Unambiguous range	149895.0 km	Radar limit - R/R0 (km)	97.20
Threshold (dBu)	121				

Use distance pattern for R0 computing

IF BW (Hz) = 1.2 / pulse width (sec) 1.0 / pulse width (sec) PRF = Pulse repetition frequency

< >

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3.5. RADAR PARAMETERS

Distance / elevation pattern

°	km/M	°	km/M	°	km/M	°	km/M	°	km/M	°	km/M	°	km/M	°	km/M
-89	10.00	-69	15.82	-49	21.64	-29	27.46	-9	33.28	11	40.31	31	54.32	51	69.99
	10.29		16.11		21.93		27.75		33.57		39.92		47.15		55.16
	10.58		16.40		22.22		28.04		33.86		39.53		47.16		55.22
	10.87		16.69		22.51		28.33		34.15		39.15		47.17		55.28
	11.16		16.98		22.80	-25	28.62	-5	34.44	15	38.76		47.18		55.34
	11.46		17.28		23.10		28.92		34.74		38.37		47.19		55.40
	11.75		17.57		23.39		29.21		35.03		37.98		47.20		55.46
	12.04		17.86		23.68		29.50		35.32		37.59		47.21		55.52
	12.33		18.15		23.97		29.79		35.61		37.20		47.22		55.58
80	13.62	60	19.44	40	24.26	20	30.08	0	35.90	20	36.81	40	49.04	60	61.50
	13.73		24.55		30.37		35.80		36.43		28.65		20.88		13.11
	14.02		24.84		30.66		36.00		36.04		28.26		20.49		12.72
	14.31		25.13		30.95		36.60		35.65		27.88		20.10		12.33
	14.60		25.42		31.24		37.00		35.26		27.49		19.72		11.94
	14.89		25.71	-15	31.53	5	37.00	25	34.87		27.10		19.33		11.55
	15.19		26.01		31.83		37.00		34.48		26.71		18.94		11.17
	15.48		26.30		32.12		37.00		34.09		26.32		18.55		10.78
	15.77		26.59		32.41		37.00		33.71		25.93		18.16		10.39
	16.06		26.88		32.70		37.00		33.32		25.54		17.77	89	10.00
	16.35	-30	27.17	-10	32.99	10	40.70	30	32.93	50	25.16	70	17.38		

Radar constraints

Radar type

- High/medium altitude
- Low altitude
- Others
- Landing
- User defined

Area constraints

Max radius (km)

Intermediate radius (km)

1st radius (km)

Slope (°)

First sector constraints

Begin (°)

End (°)

Distance (km)

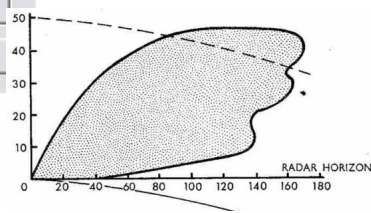
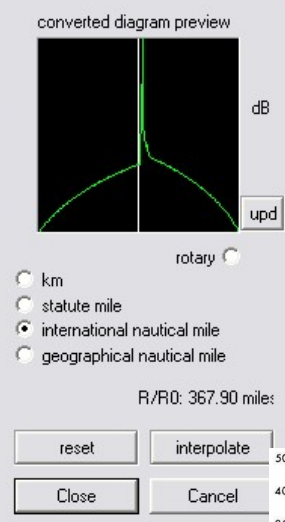
Second sector constraints

Begin (°)

End (°)

Distance (km)

OK Cancel



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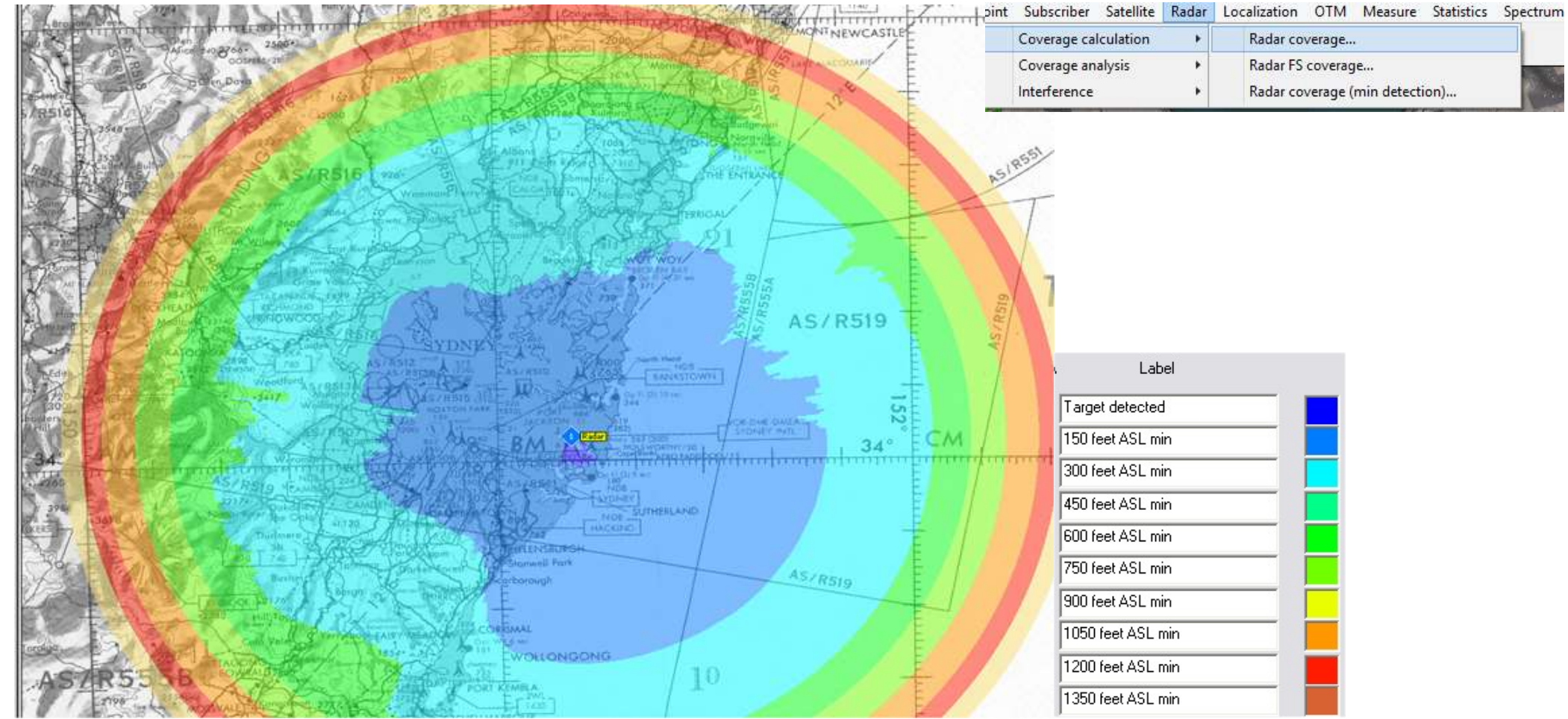
lte



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3.5. RADAR MIN DETECTION HEIGHT



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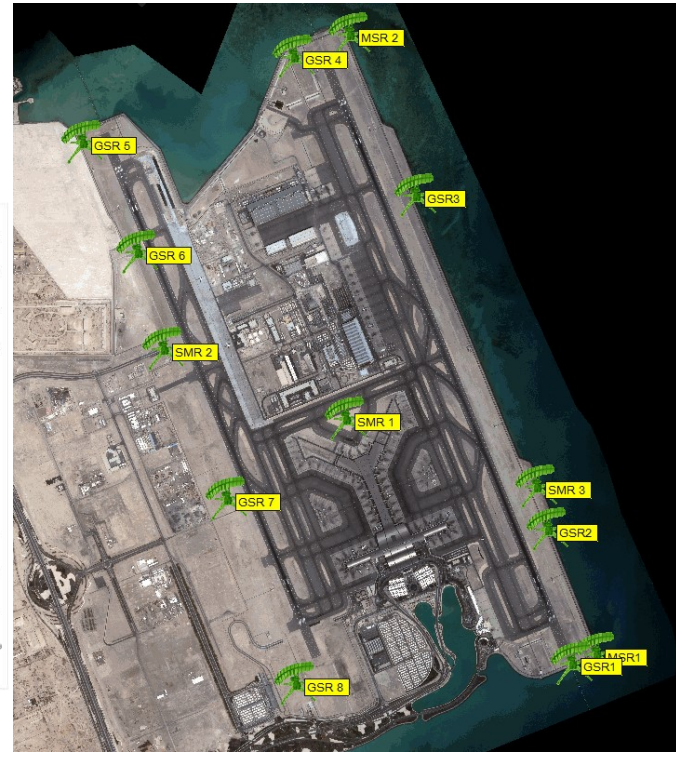
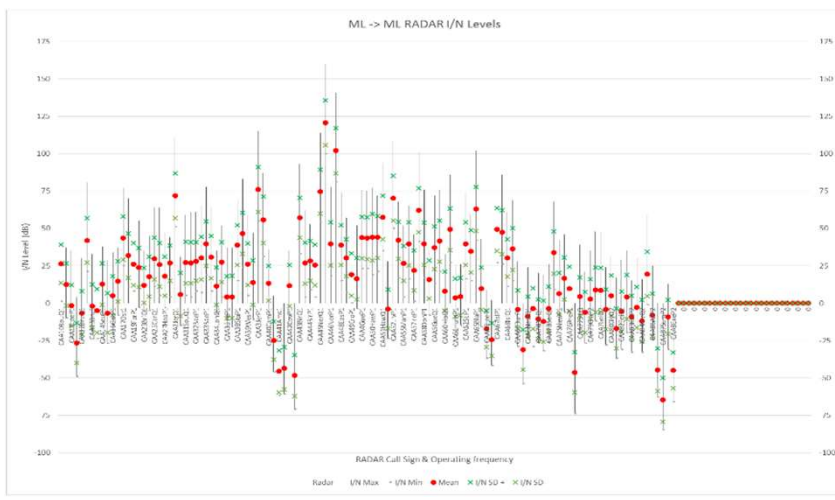
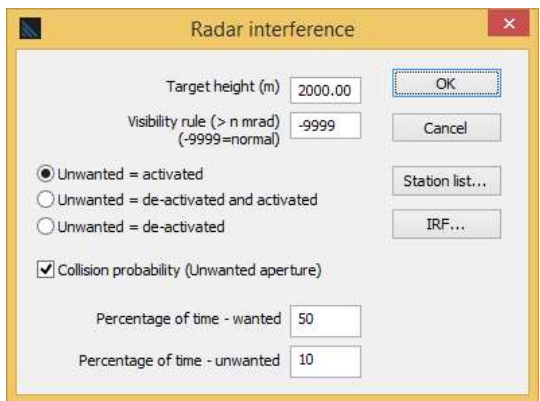
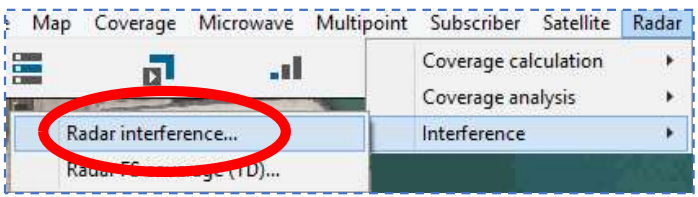
lte



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3.5 RADAR INTERFERENCE ANALYSIS



This functions rotates the radar horizontal antenna pattern in 1 degree intervals and calculates the I/N and Threshold degradation. The radar coverage is then calculated using the threshold degradation and then calculates the radar coverage for the given probability of detection and radar cross section.

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3.5 COEXISTENCE BETWEEN RADAR AND WIND FARMS

HTZ communications includes advanced features for the analysis and validation of the coexistence between radars and wind farms.

Wind turbine parameters: 45 WT000001

General Pattern Envelop Site

Type: Wind turbine (12) Status: In use (6) # 45 activated

General

Mast height (m): 80.00
Blade size (m): 50.00
Blade RCS (m2): 200000.0000
Tower RCS (m2): 300000.00
Ref. frequency (MHz): 11200.000000 (rcs)

Info

Callsign: WT000001
Address: WT000001 Date: 20161205
Info (1): Type ID
Info (2): Link
Network ID: Group
User: Call number
WZ: 0

- ITU >
 - FCC >
 - National >
 - Constraints >
 - Windfarm >
 - Human hazard >
 - ICS manager...
- Wind turbine test point reflection...
 - Wind turbine interference...
 - Wind turbine radar constraints...

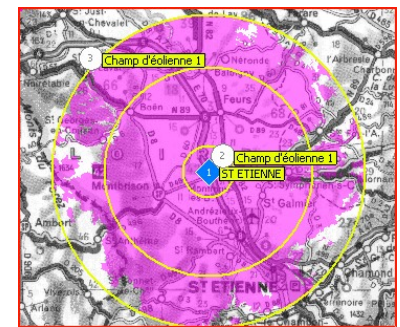
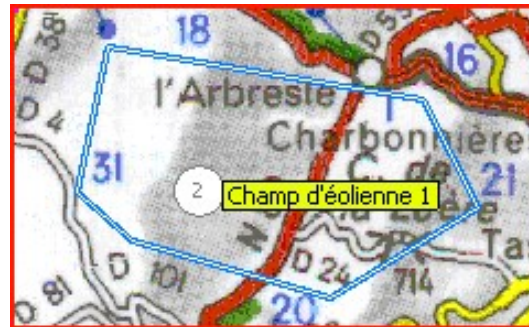
Report

Wind turbine - Radar constraints

Radar type	Wind turbine #	Callsign	Height	Agreement	Max Height
Z11	2	Eolienne 1	150.00	NOK	0
Z11	3	Eolienne 1	150.00	OK	150
Landing	2	Eolienne 1	150.00	OK	150
Landing	3	Eolienne 1	150.00	OK	150
Other	2	Eolienne 1	150.00	OK	150
Other	3	Eolienne 1	150.00	OK	150
H/L altitude	2	Eolienne 1	150.00	NOK	0
H/L altitude	3	Eolienne 1	150.00	OK	150

Printer: hp deskjet 5550 series | Print Setup... | Print | List | Quit

font size 8 font size 10 restart to enable modification



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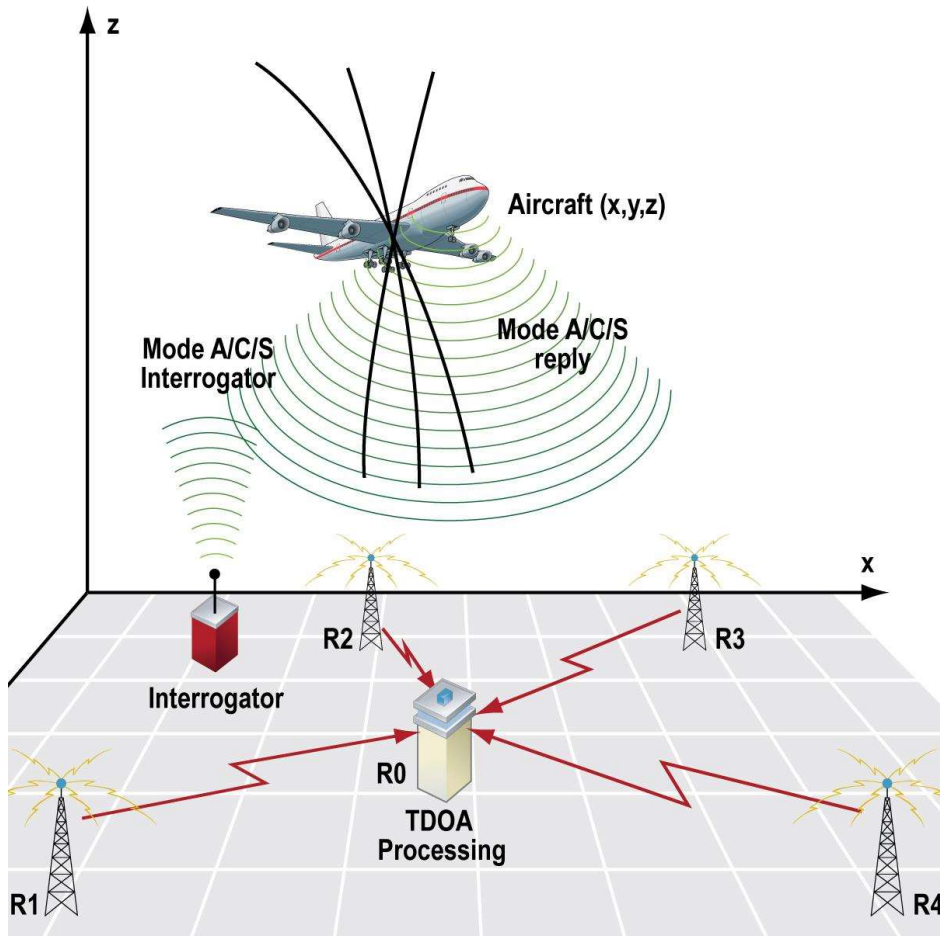
lte



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3.5. Multilateration –Sensor network



1. Interrogator ask airplane to identify itself
2. Airplane transmit signal
3. Sensors receive the signal
4. Base of ToA difference the location can be accurately evaluated

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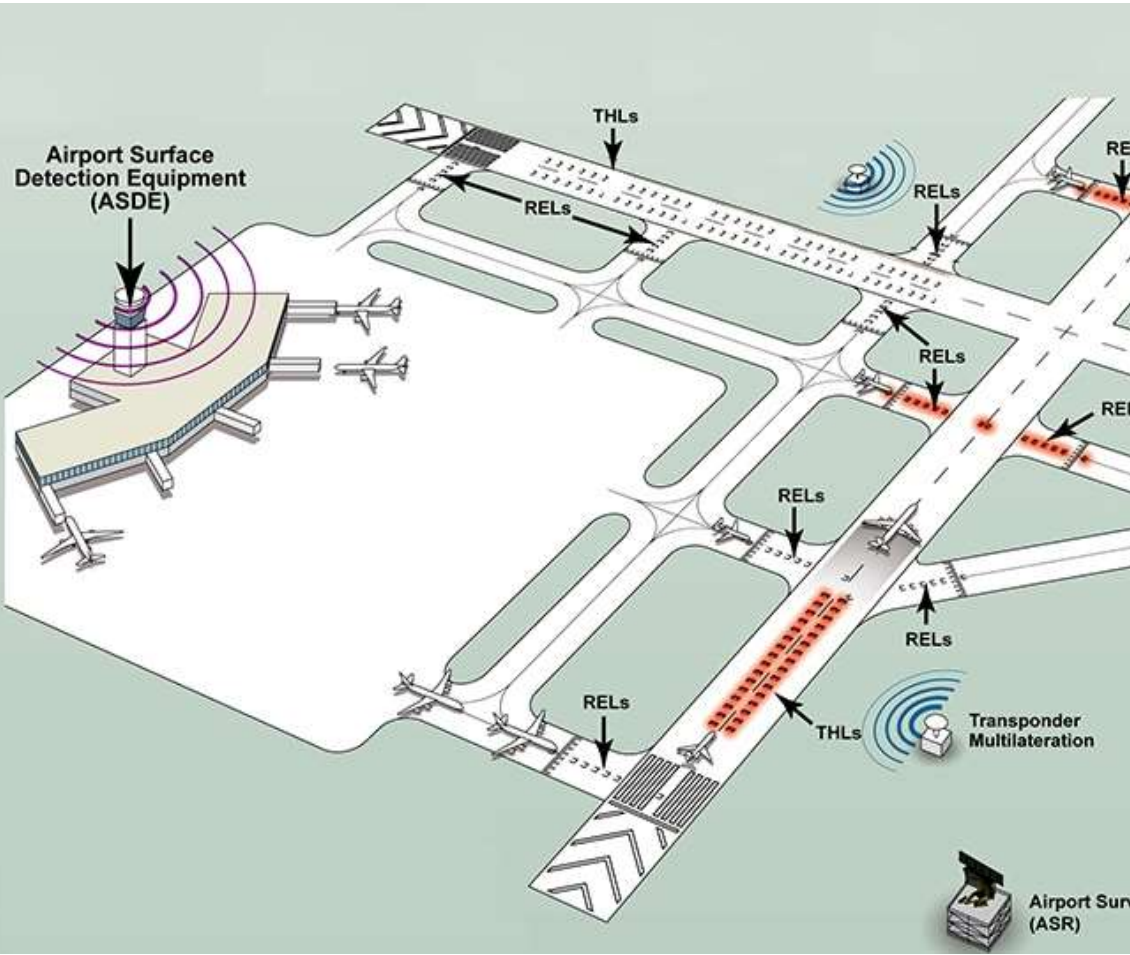
lte



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3.5. Multilateration – Airport surface



Tx/Rx parameters: 1 Interrogat

General | Patterns | Channels | Site | Advanced

Type: Tx/Rx A (0) | Signal: **MLAT interrogator (55)** | Status: Connected (5) | Frequency plan: # 1 | activated

Tx/Rx:

- Nominal power (W): **100**
- Dynamic (dB): 0
- Tx ant gain (dBi): 5.00**
- Rx ant gain (dBi): 5.00**
- Losses (dB) tx: 0.00 rx: 0.00
- Tx add losses (dB): 0.00
- E.I.R.P (W): 316.2278
- Frequency (MHz): 1030.000000 ...**
- Antenna height (m): 90.00**
- Tx bandwidth (kHz): 24000.00
- Rx bandwidth (kHz): 24000.00

Coverage: ITU525

OOB (dBW/MHz): 0

Variable power
 Fixed power

Fixed frequency
 Freq Hop / WB ...

Variable elevation
 Fixed elevation

Info:

Callsign: Interrogat | Parenting: 0

Address: Airport tower | Date: 20160208 | yyyyymmdd

Info (1): TXRX | Type ID: C

Info (2): | Link: |

Network ID: | Group: |

User: | Call number: 0

Comment: Demo MLAT Interrogator parameters

SQL record 0

OK Cancel

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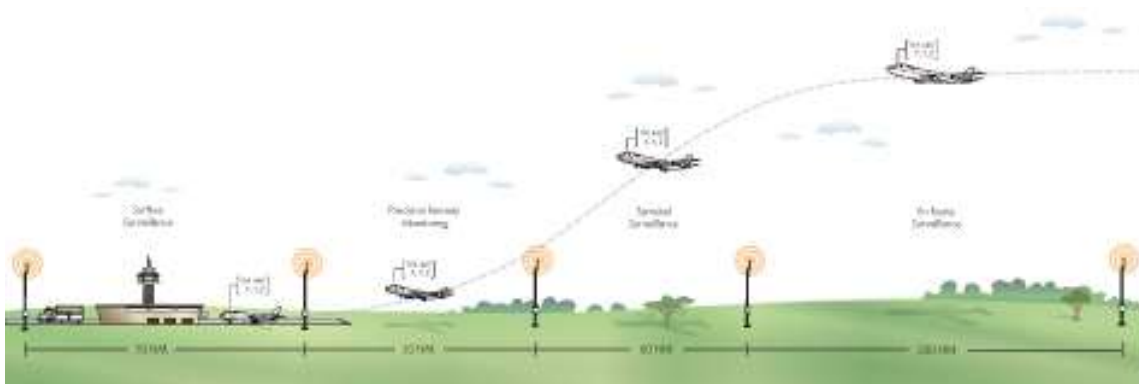
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3.5. MULTILATERATION – Air Traffic Management

HTZ communications helps in

- Planning where to put the sensors
- Planning Best spot to put the interrogator
- Evaluate the accuracy/range of the sensor network



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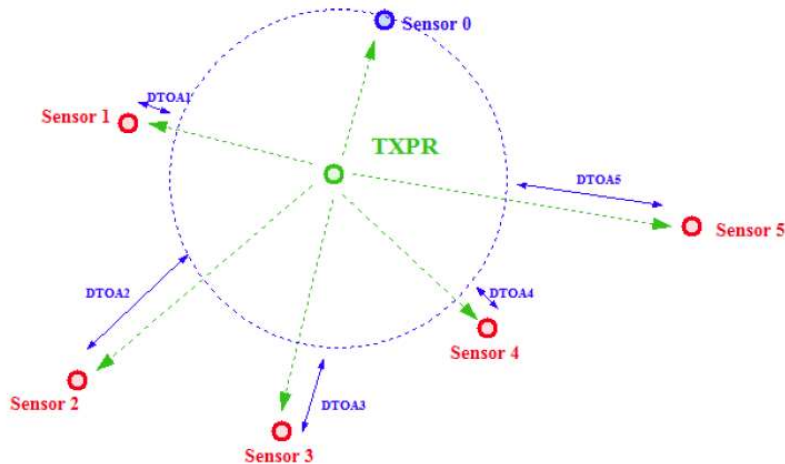
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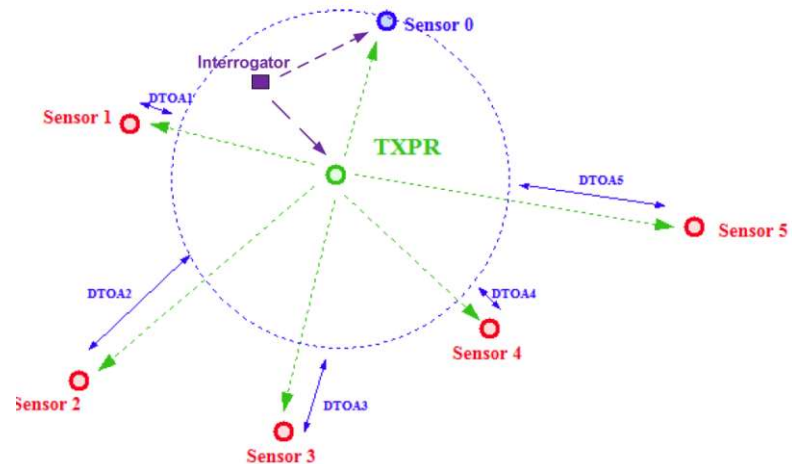
3.5. MULTILATERATION – Air Traffic Management

HTZ communications can assess the precision of a multilateration system

- Time Difference of arrival (TDOA)



- Time Sum of arrival (TSOA)



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3.5. MULTILATERATION –SENSOR LOCATIONS



- Move stations
- Duplicate stations...
- Rotate station antenna...
- Assign last polygon to station...
- Assign Tx/Rx sector and distance
- Microwave link list...
- Search site...
- Assign subscribers to...
- Isolate subscribers
- Isolate orphan subscribers
- Mask subscribers
- Subscribers counter
- Generate subscribers...
- Search site from subscribers...
- Search site from clusters...
- Vector info...
- Add polyline to vector file (line)...
- Add polyline to vector file (path)...
- Add polygon to vector file...
- Change clutter code...
- Modify clutter code...
- Change dtm / indoor code...
- Modify dtm / indoor code...

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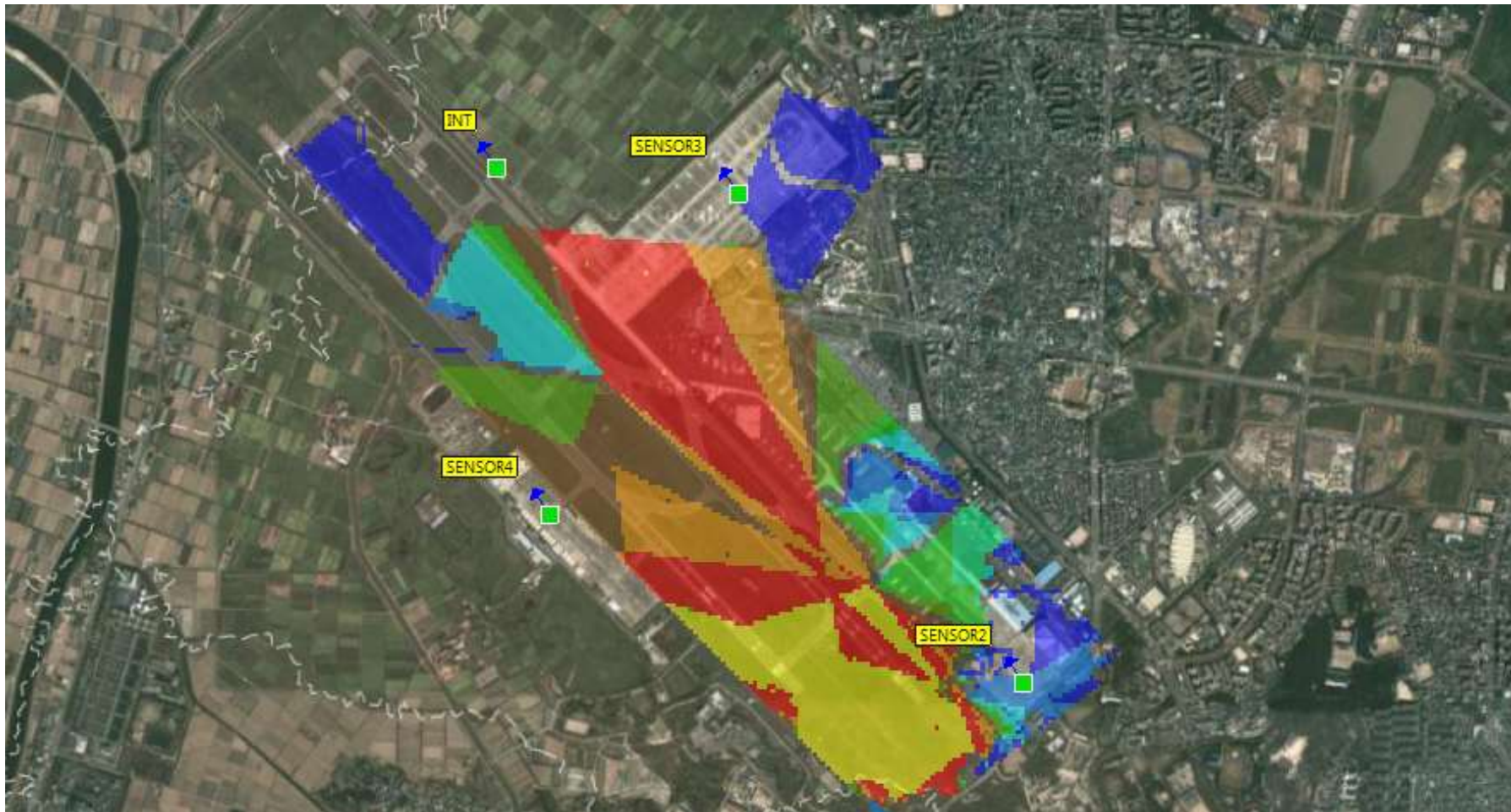
lte



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3.5. MULTILATERATION – SENSOR LOCATIONS



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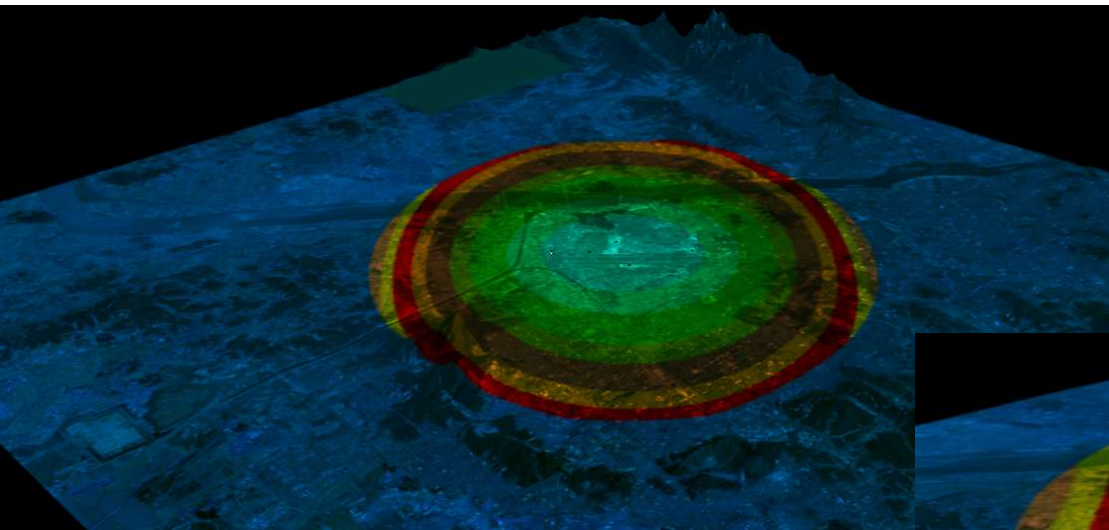
lte



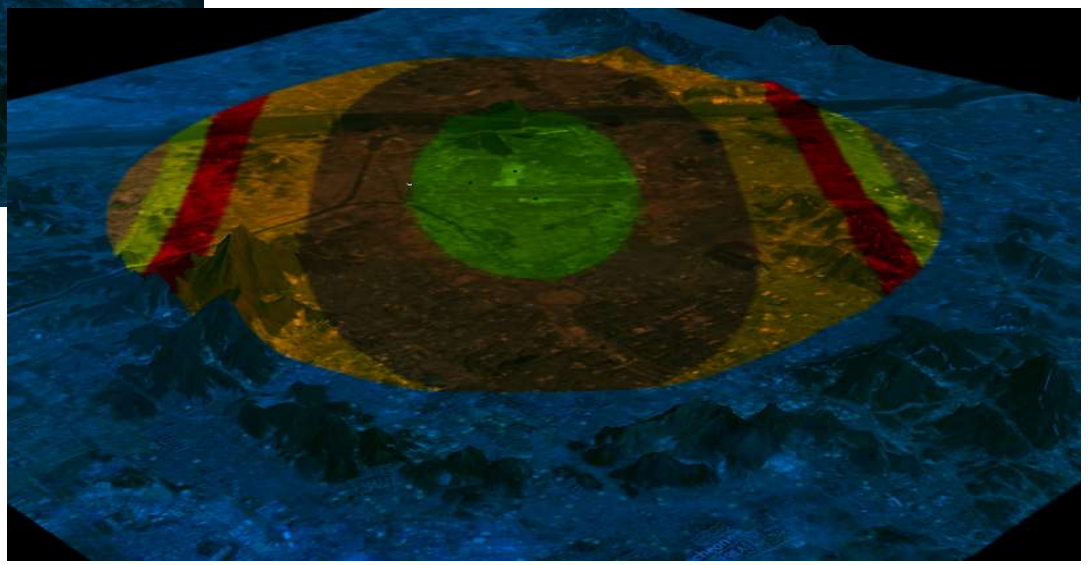
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3.5 MULTILATERATION ACCURACY MAP



MLAT ACCURACY MAP (H)



MLAT ACCURACY MAP (V)

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3.6 - HTZ communications – Harmful interference analysis

Interference & EMC

Interference calculation methods

- C/I (signal-to-interference ratio required for the receiver)
- TD (Threshold degradation)
- I/N (Interference to Noise ratio), C/N+I (Signal to Noise + Interference ratio), TIL, SNR
- IRF (Interference Rejection Factor) masks

Interference types

- Unwanted emissions: Spurious emissions and out-of-band emissions
- Intermodulation/ Harmonics
- Noise Desensitization
- Harmful interference
- DSM (Dynamic Spectrum Management)

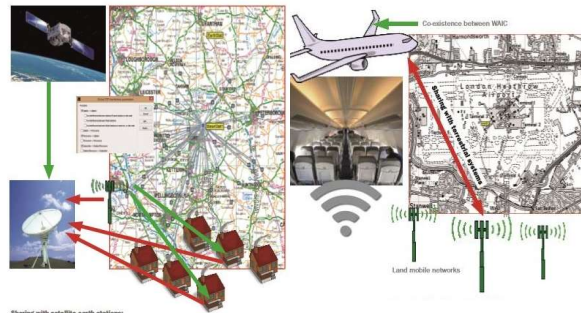
Recommendations:

- ITU-R, ICAO CEPT, ETSI, 3GPP, FCC

Interference from non-aeronautical sources

Basic functionality

- Radar vs. LTE
- Radar vs. Wind turbines
- ILS/VOR/GBAS vs FM
- VHF vs. VHF
- Jammers
- ...



International coordination

International, bi-lateral and regional coordination

- Maximum Field strength limit
- Border coordination and border agreement
- UFS, NFS, UFS delta, SFN test report
- Compatibility report
- HCM

Satellite

Global flight tracking for Civil Aviation Resolution 185 (Busan, 2014)

- Coexistence with other radio systems
- Interference/loss of tracking

Wireless Avionics Intra-Communications (WAIC) – WRC 2015

- Parameters and Operational objectives for WAIC systems: Are systems in use when cabin doors are open?
- Fuselage attenuation and other surface attenuation above and below 15.7GHz.

Interference into Earth station

- Earth station vs. microwave
- Earth station vs. satellite

EUROCAE, RTCA, ETSI, CEPT ECC

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3.7. INTERFERENCE ANALYSIS

HTZ | PRO: | DTM: D75_2m5 | PRM: TETRA | EWF: TEMP1000 | SF1

File Map Direct Coverage Microwave Multipoint Subscriber Satellite Statistics Path Localization Measure Spectrum Database Object Reports Tools ?

Threshold >= 44 dBuV/m

Tx0004 TETRA004 - 46.0 dBu - Cx 01 - 390.575V MHz - 1 - COV

If0007 TETRA007 - 40.0 dBu - 19.0 dB C/I req - Cx 01 - 590.575V MHz - 1 - COV

Multiple C/I (dB) mask - Priority 4

Compare Tx/Rx bandwidths

N=0 -19 [] Used N=8 -30 [] Used

N=1 -10 [] Used N=9 -30 [] Used

N=2 -40 [] Used N=10 -30 [] Used

N=3 -20 [] Used N=11 -30 [] Used

N=4 -30 [] Used N=12 -30 [] Used

N=5 -30 [] Used N=13 -30 [] Used

N=6 -30 [] Used N=14 -30 [] Used

N=7 -30 [] Used N=15 -30 [] Used

Pilot channel:

N=0 18 N=1 -30 N=2 -127

Use mask as filter

C/I from Tx/Rx - Priority 3

SRF from Tx/Rx C/I

C/I tables - Priority 2

[x] C/I from ITU-R 3030-413 655 1368 1009 560, FCC-D2T 69, Wiesbaden 95, 3E5E, 802.11/802.16, ETSI 101-980 301-598

Tropo Steady From T/R

Rice fading (DVB) Rayleigh fading (DVB)

FM ITU FM UK FM ITU+150

For Wiesbaden, tropo=1% and steady=50%

NFD matrix - Priority 1

[] C/I from NFD/TS-RZF Required C/I (dB) 19

XPD

Global XPD -1 dB

C/H or V: 3 dB protection except if global XPD=0

Options

Activity factor weighting [C/req+10log(activity)]

Channel weighting [C/req+10log(rb/cx-cx)/rb/cx]

More options...

Unwanted = activated

Unwanted = de-activated and activated

Unwanted = de-activated

Global interference

Global interference (+ sorting)

Max number of servers -10

Interference on best server

Wanted threshold 44

Rx antenna Height (m) 1.50

Max wanted distance calculation...

Tx bandwidth / Tx bandwidth

Load Save

OK Cancel



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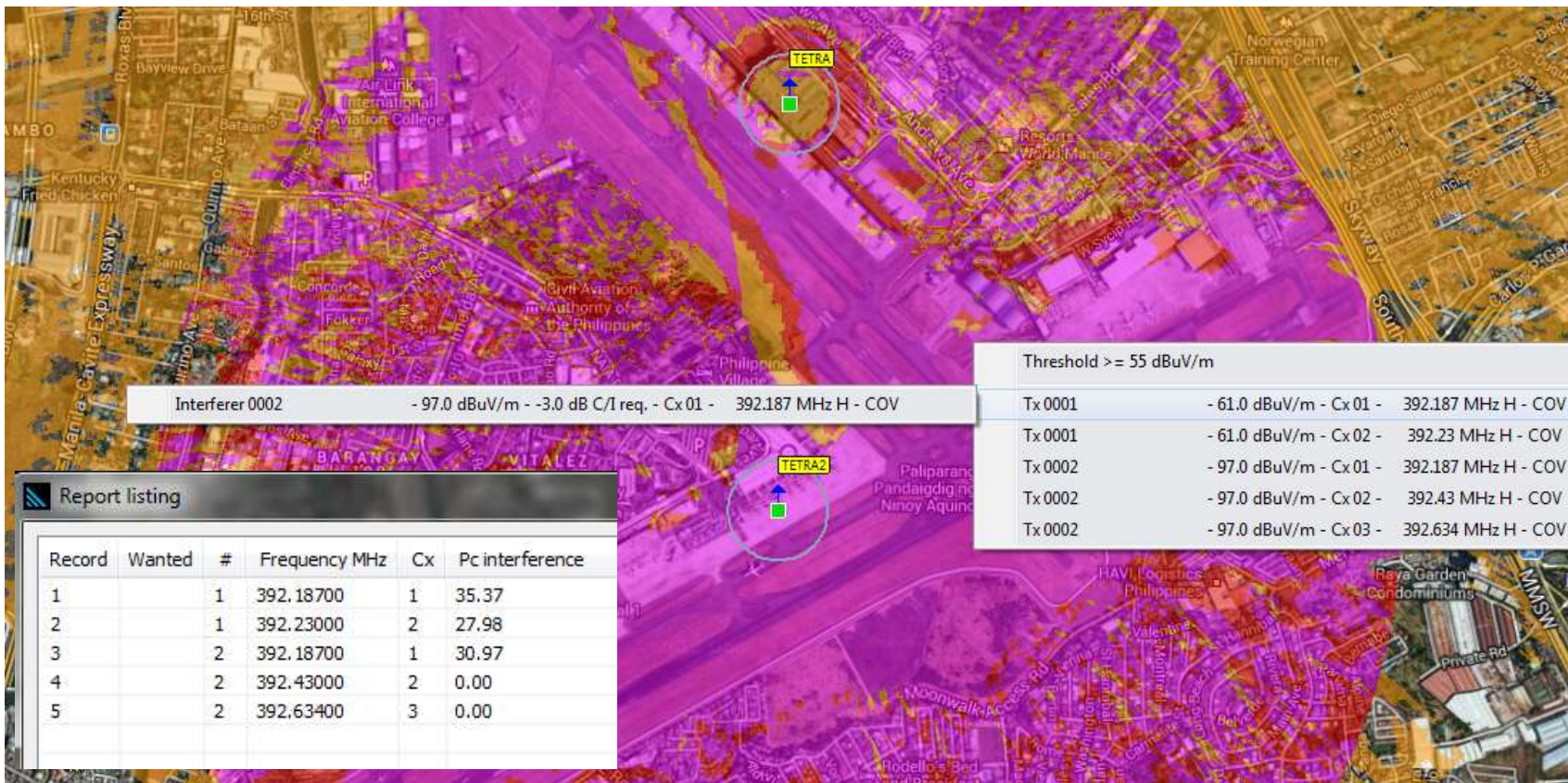
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3.7 INTERFERENCE ANALYSIS



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3.7. ICAO – Building Restricted Area

ATDI tool allows user to check compliance of an existing or new building structure in accordance with ICAO requirement within or around the airport. The ICAO recommendations test is based on European Guidance material on Managing Building restricted area, second edition published in 2009.

The compliance assessment calculations is valid for the following type of communication systems:

- DF
- VOR/DVOR
- ILS (markers, GP, Loc)
- COM
- MLAT
- TACAN
- NDB
- GBAS
- MLS
- Other

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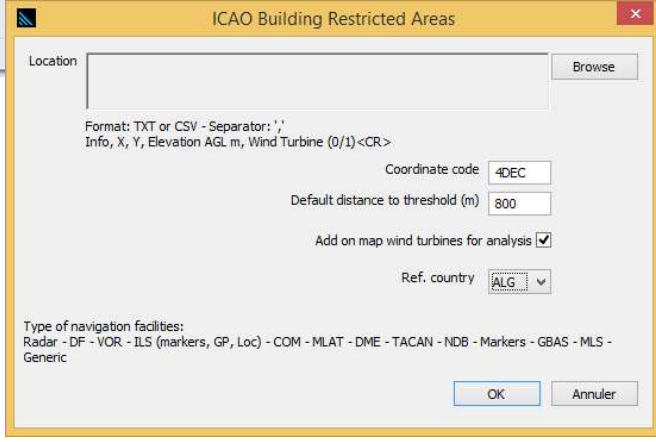
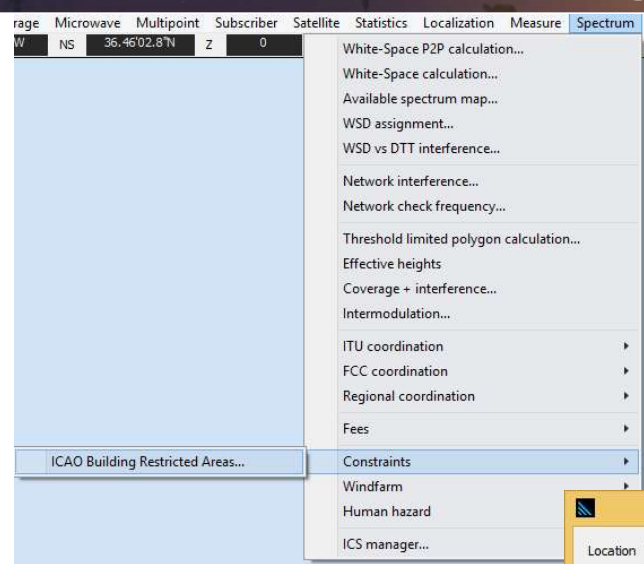
lte



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3.7. ICAO – Building Restricted Area



The ICAO building restricted area function requires area function requires a CSV File with following information of the building to be tested.

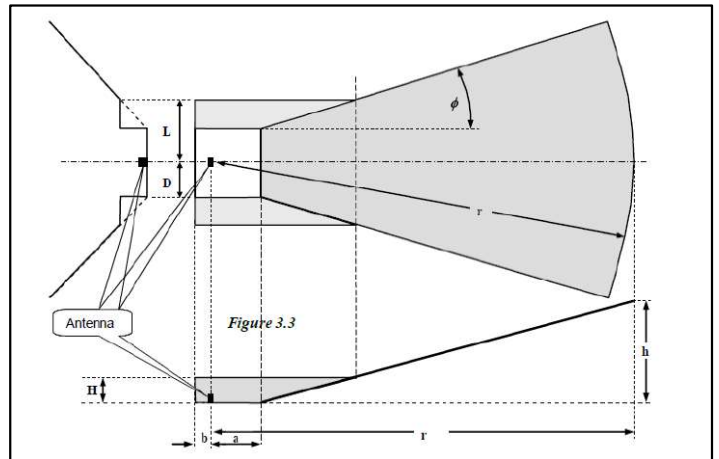


Figure: BRA shape for directional facilities (source: ICAO). The value of each dimension differs based on the technology at use.

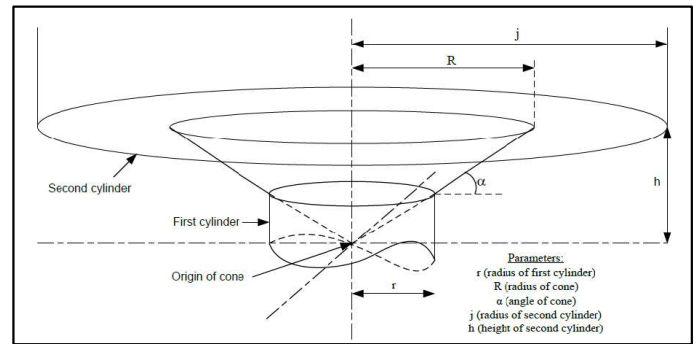


Figure: Omni-directional BRA shape 3D representation (source: ICAO)

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3.7. ICAO – Building Restricted Area

This function will be active only where there is an active station present in the project. The technology used by the station can be defined in the general tab of the station parameters.

The screenshot shows the 'Tx/Rx parameters: 1 VOR1' window with the following details:

- General Tab:**
 - Type: Tx/Rx A (0)
 - Signal: **VOR (16)** (highlighted in red)
 - Status: 0.0
 - Frequency plan: # 1
 - Activated: activated
- Parameters:**
 - Nominal power (W): none
 - Dynamic (dB):
 - Tx ant gain (dBi):
 - Rx ant gain (dBi):
 - Losses (dB): [bx]
 - Tx add losses (dB):
 - E.I.R.P (W):
 - Frequency (MHz):
 - Antenna height (m):
 - Tx bandwidth (kHz):
 - Rx bandwidth (kHz): 5
- Info Section:**
 - Callsign: VOR1
 - Parenting: 0
 - Address: [empty]
 - Date: 20160125
 - Info (1): DAB
 - Type ID: C
 - Info (2): [empty]
 - Link: [empty]
 - Network ID: [empty]
 - Group: [empty]
 - User: [empty]
 - Call number: 0
- Comment:** [empty text area]
- SQL record 0:** [empty text area]

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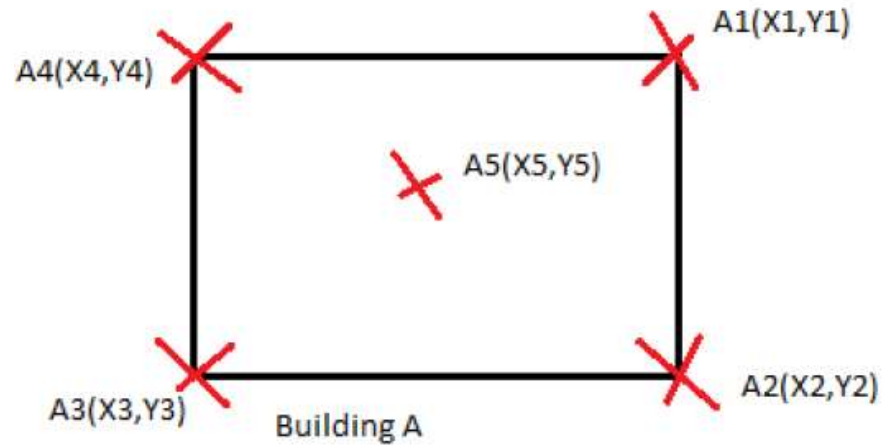
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3.7. ICAO – Building Restricted Area



CSV file format:

Info: Building identifier

X: Longitude

Y: Latitude

Elevation AGL (m) : building height above ground level

Windmill (0/1) : 1 if building is windmill, 0 otherwise

	A	B	C	D	E
1	Info	X	Y	Elevation	wind turbine
2	Building A1	276722	4149000	90	0
3	Building A2	276730	4148988	90	0
4	Building A3	276698	4148970	90	0
5	Building A4	276690	4148978	90	0
6	Building A5	276706	4148982	91	0
7	Building B1	275244	4146422	100	0
8	Building B2	275264	4146430	100	0
9	Building B3	275290	4146396	100	0
10	Building B4	275270	4146380	100	0

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3.7. ICAO – Building Restricted Area

Report listing

Record	Shape	Compliance	Info	Building X coord	Building Y coord	Elevation m ASL	TypeNav	Callsign	X	Y	Z ASL	A
1	OMNI	YES	Building A1	276722.000...	4149000.00...	98.00	VOR	VOR1	273236.000000	4149362.00...	30...	
2	DIRECTIONAL	NO	Building A1	276722.000...	4149000.00...	98.00	ILS Single Freq	ILS	273076.000000	4151290.00...	8.00	
3	OMNI	YES	Building A2	276730.000...	4148988.00...	98.00	VOR	VOR1	273236.000000	4149362.00...	30...	
4	DIRECTIONAL	NO	Building A2	276730.000...	4148988.00...	98.00	ILS Single Freq	ILS	273076.000000	4151290.00...	8.00	
5	OMNI	YES	Building A3	276698.000...	4148970.00...	98.00	VOR	VOR1	273236.000000	4149362.00...	30...	
6	DIRECTIONAL	NO	Building A3	276698.000...	4148970.00...	98.00	ILS Single Freq	ILS	273076.000000	4151290.00...	8.00	
7	OMNI	YES	Building A4	276690.000...	4148978.00...	98.00	VOR	VOR1	273236.000000	4149362.00...	30...	
8	DIRECTIONAL	NO	Building A4	276690.000...	4148978.00...	98.00	ILS Single Freq	ILS	273076.000000	4151290.00...	8.00	
9	OMNI	YES	Building A5	276706.000...	4148982.00...	99.00	VOR	VOR1	273236.000000	4149362.00...	30...	
10	DIRECTIONAL	NO	Building A5	276706.000...	4148982.00...	99.00	ILS Single Freq	ILS	273076.000000	4151290.00...	8.00	
11	OMNI	YES	Building B1	275244.000...	4146422.00...	117.00	VOR	VOR1	273236.000000	4149362.00...	30...	
12	DIRECTIONAL	NO	Building B1	275244.000...	4146422.00...	117.00	ILS Single Freq	ILS	273076.000000	4151290.00...	17...	
13	OMNI	YES	Building B2	275264.000...	4146430.00...	115.00	VOR	VOR1	273236.000000	4149362.00...	30...	
14	DIRECTIONAL	NO	Building B2	275264.000...	4146430.00...	115.00	ILS Single Freq	ILS	273076.000000	4151290.00...	15...	
15	OMNI	YES	Building B3	275290.000...	4146396.00...	115.00	VOR	VOR1	273236.000000	4149362.00...	30...	
16	DIRECTIONAL	NO	Building B3	275290.000...	4146396.00...	115.00	ILS Single Freq	ILS	273076.000000	4151290.00...	15...	
17	OMNI	YES	Building B4	275270.000...	4146380.00...	115.00	VOR	VOR1	273236.000000	4149362.00...	30...	
18	DIRECTIONAL	NO	Building B4	275270.000...	4146380.00...	115.00	ILS Single Freq	ILS	273076.000000	4151290.00...	15...	

!!!

Listing... Close

Final report generated by the "ICAO Building restricted area" function

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SWiFi



3.8. AUTOMATIC FREQUENCY ASSIGNMENT

HTZ | PRO: | DTM: D75_2m5 | PRM: TETRA | EWF: TEMP1000 | SF1

File Map Direct Coverage Microwave Multipoint Subscriber Satellite Statistics Path Localization Measure Spectrum Database Object Reports Tools ?

Network calculation
 Network analysis
 Network interference
 Network planning
 Traffic
 Handover
 Station candidates
 Station polygon
 Coverage modification
 Vectorize coverage...

Network frequency assignment...
 Network frequency usage...
 Network color code / BSIC assignment...
 Network RDS PI code assignment...
 Network TII sub code assignment...
 Physical layer cell identities...
 Root sequence index allocation...
 SC codes...
 PN codes...
 Network launch delay assignment...
 Prospective planning...
 Point planning...

2.30237
 49.00532
 108
 0 - rural
 0.0
 0
 0.0 0.0 0.0 °
 0.0000 dBuV/m
 0 cx

Tx/Rx
 0001 -T: TETRA001
 0002 -T: TETRA002
 0003 -T: TETRA003
 0004 -T: TETRA004
 0005 -T: TETRA005
 0006 -T: TETRA006
 0007 -T: TETRA007

Frequency assignment

Mode
 Band assignment signed spacing +/-
 Multi-channels assignment
 Minimum frequency spacing: 0.025 MHz
 Maximum frequency spacing: 9999999 MHz
 Band... Number of frequencies: 81
 Group assignment - multi-channels
 Keep number of channels defined per station
 Start index assignment (FH mode)
 Interference first cx vs first cx
 Group... Number of groups: 0
 List assignment
 Multi-channels assignment
 Minimum frequency spacing: 0.025 MHz
 Maximum frequency spacing: 9999999 MHz
 List... Number of frequencies: 0
 Tx plan assignment Multi-channels assignment
 Minimum frequency spacing: 0.025 MHz
 Maximum frequency spacing: 9999999 MHz
 Tx Rx Tx/Rx fixed spacing*
 Check intermodulation products <= 7
 Intermodulation distance <= 1 m
 Polarization assignment H/V Multichannels interference

Rules
 Apply frequency spacing on same site MHz: >= 0.0010 (1) <= 9999999 (2)
 Tx/Tx Tx/Rx
 if azimuth spacing < 360 °
 and or if (1)=(2) then fixed spacing applied
 Forbid same polarization on site if az. spacing < 1 °
 Forbid same Tx frequency on same site
 Site: Distance between stations <= 1 m
 Forbid same Rx frequency if distance <= 500 m
 Forbid same Tx frequency if distance <= 5000 m
 Organize Tx list - freq. isolation constraint
 Organize Tx list - sector constraint (delta=0°)
 Organize Tx list - coverage size constraint
 Assign polarization (H/V)
 Exhaustive method Assign all channels
 Monte-Carlo method Assign pilot channel
 Adaptive method Assign traffic channels
 Sequential method New Tx/Rx cx: 1

Options
 Wanted threshold 44 dB
 Threshold = wanted cover. (extd rad)
 Global interference Force 0 interference
 Virtual mode
 Unwanted coverage from FDU path...
 Resolution: 1:1 High Medium Low
 Rx ant discr
 none 419/GE OET69 User ...
 Assign selected station frequencies
 Check for error Number of pass 1
 Station Channel
 Tx freq. Rx freq. MHz
 Start Stop Delta F...

Same Freq: Activ. Tx Net ID Lkd Tx* Group
 Forbid same frequency if same neighbour
 Apply frequency spacing if inside station polygon
 Apply frequency spacing between linked stations
 Overlapping rule (frequency reuse):
 if Delta FS <= 3 dB
 Delta Freq >= 0.010000 MHz

Max distance Station list... C/I... Clutter...
 Reset_COV Load... Save... Close

Reset COV files before Start if new station order or new coverage
 (*) signed duplex only used if fixed spacing
 Max interference distance x 2 applied
 Adaptive and Monte-Carlo methods require several passes

35 80 87 74 81 88 95 102 109 116 123

time 500 m 44 dBuV/m CPU 4 SF 1 L15

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Thank you!

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