

# ATDI

## SPECTRUM MANAGEMENT & ELECTRONIC WARFARE

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# Today's Agenda

1

**Introducing ATDI**

2

**Automated Battlespace  
Spectrum Management Solution**

3

**HTZ Warfare - key capabilities  
and demo videos**

A

**Annex 1 – HTZ Warfare technical capabilities**

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**Annex 2 – Key references**

# About Us

## BATTLESPACE SPECTRUM MANAGEMENT AND ELECTRONIC WARFARE NETWORK PLANNING AND MODELLING SOFTWARE SOLUTIONS

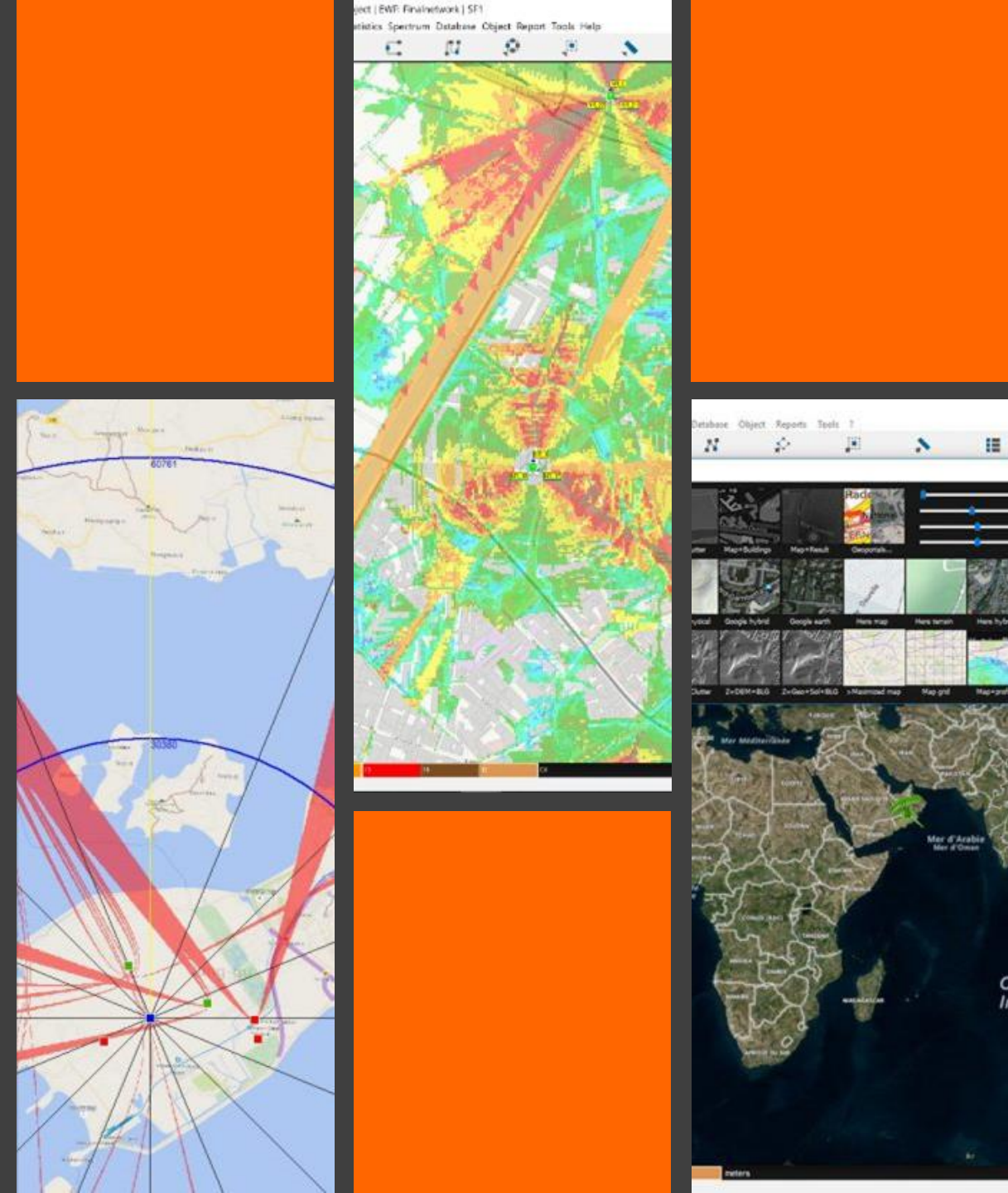
### OUR FOCUS IS TO SUCCEED AT EVERY LEVEL OF COMMAND IN ELECTROMAGNETIC SPECTRUM OPERATIONS

ATDI are global leaders in the development and implementation of automated spectrum management solutions.

For over three decades, we have backed over 2,000 civil and defence spectrum agencies, operators and vendors. Our solutions continue to evolve to meet the growing needs of the defence industry.

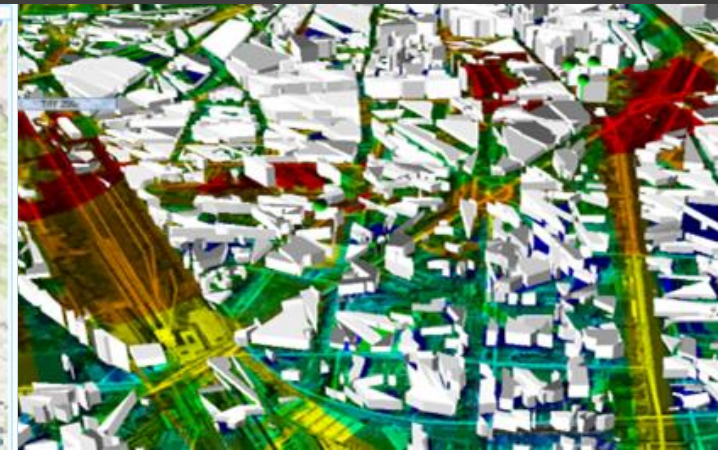
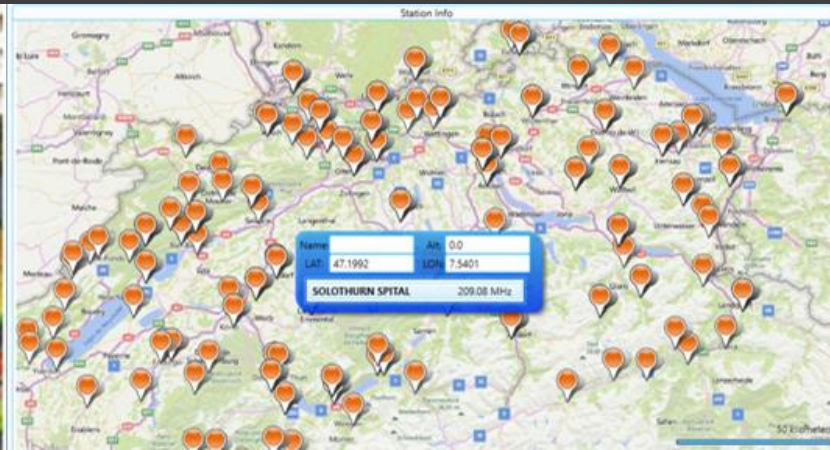
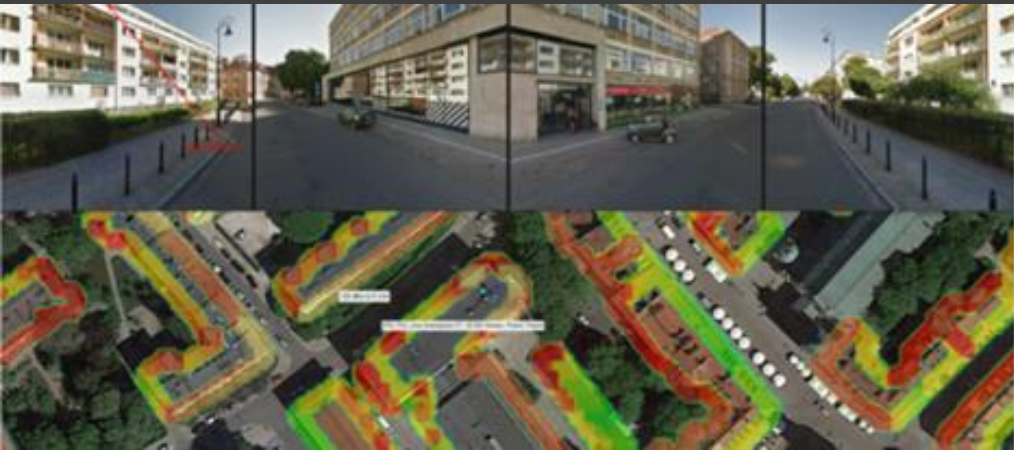
We provide a unique and global solutions for:

- **Radio planning and optimisation:** activities for all communication and transmission systems used by the Ground/Air/Sea/Space forces;
- **Frequency management (FM)**
- **Spectrum management solution (SMS):** for planning, coordinating, and managing joint use of the EMS through operational, engineering and administrative procedures;
- **Electronic Warfare (EW)** management / interception and intelligence



# Our Values & Contributions

- Dedicated R&D to ensure we stay ahead of the game
- Solutions compatible with ITU regulations. Contributions to industry organisations including ITU-R and ITU-D, NATO-STCCT, DCI and Old Crows.
- Our team has an excellent understanding of our customers needs – how – discussions/industry experience and a desire to find the best fit (solution) for the end user
- Our team – built from diverse backgrounds enables us to draw from a wealth of knowledge and understanding of the industry and its requirements
- Work in partnership with our end users to ensure both pre-production, throughout project rollout and beyond.





# Our Offices Global Footprint

- Allows us to leverage different time zones
- Provide support around the clock
- Fast response times
- Draw resources from across the group to support larger projects ensuring we offer the very best services to our end users
- Shared experiences – combining many man-years experience across the group. At every stage of the project (from project outset to going live) we aim to learn and improve our services. To do that we carry out regular internal project reviews and a group review at handover.



# Automated Battlespace Spectrum Management Solution

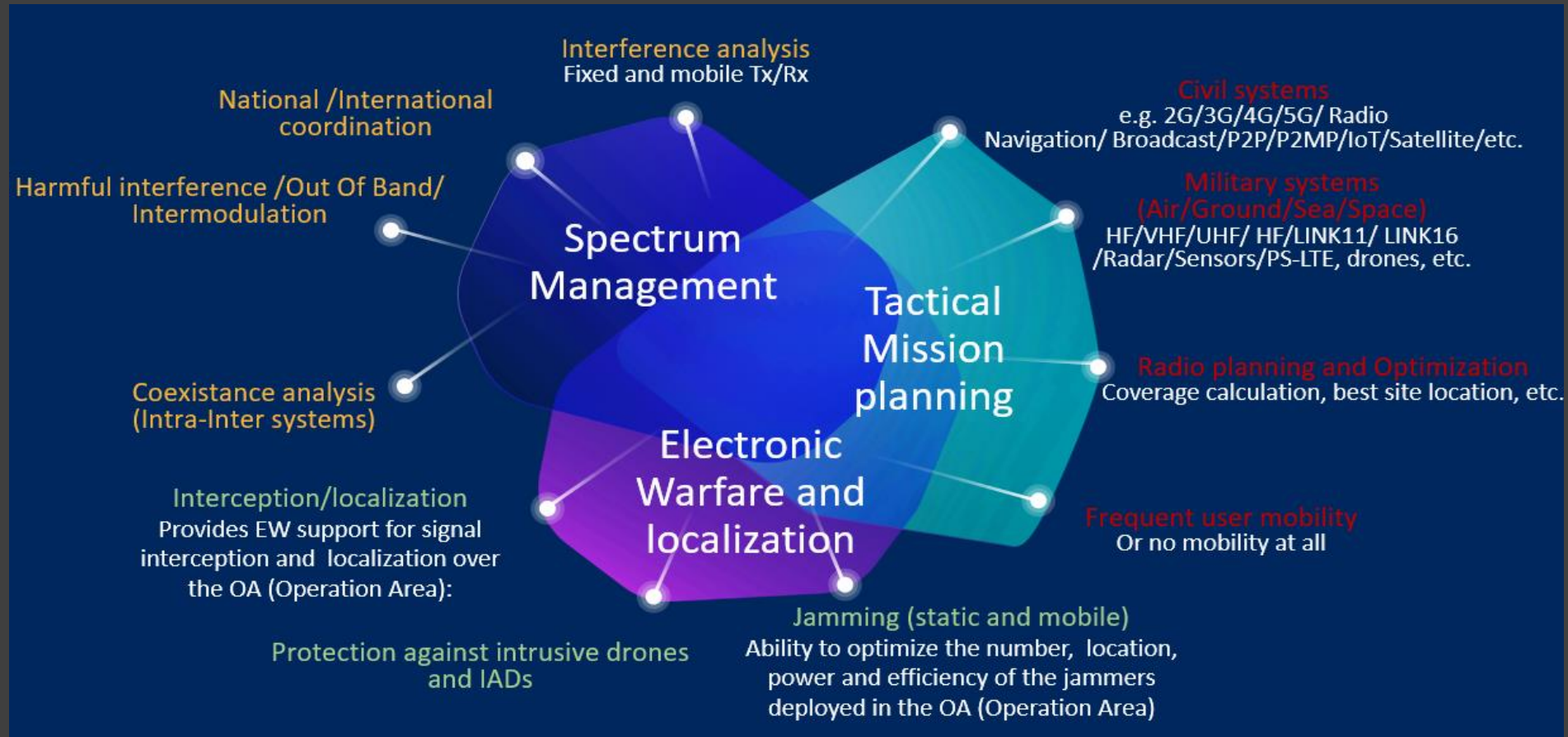
Electromagnetic Spectrum (EMS) is widely used for military operations. Competing demands for radio spectrum means it must be strictly coordinated and controlled. Battlespace spectrum management is the planning, coordination and management of EMS, to enable military systems to perform their functions without causing or suffering from harmful interference.

With over three decades of development, ATDI has developed a leading military network planning, EW modelling tool and frequency management solutions, HTZ Warfare and ICS manager.

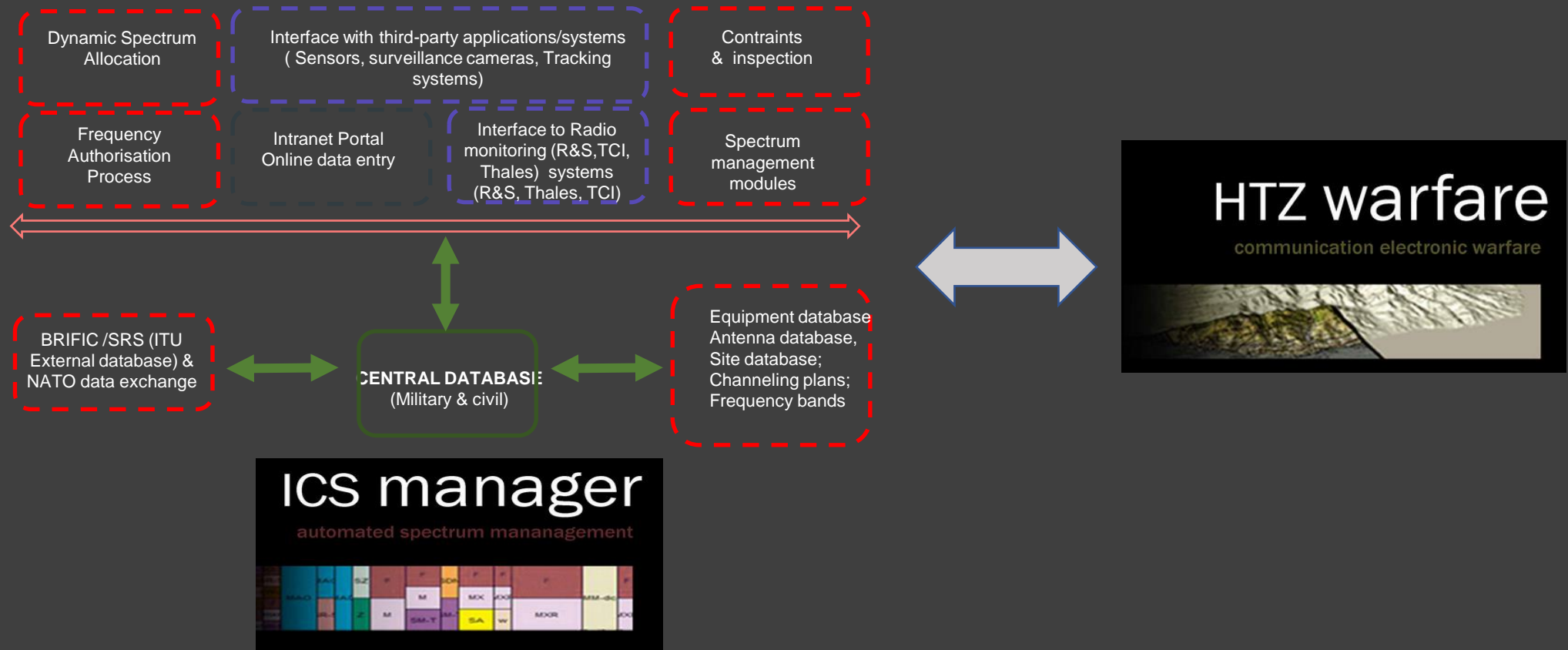
Our solutions allow defence spectrum managers to:

- **Control** the use of spectrum
- **Deconflict** electromagnetic spectrum interference
- **Joint Mission Operation** support standard mission planning data (SFAF, SMEDEF-XML, etc)
- **Tactical Mission Planning** rapid tactical mission network deployment and frequency assignment
- **Convert** private GIS dataset to secure confidential information
- **Automate** complex mission planning workflows to support field operations
- **Share and Control** database to support simultaneous data access

# Automated Battlespace Spectrum Management Solution



# Automated Battlespace Spectrum Management Solution





# HTZ Warfare

## All-in-One Multi Technology Capability

### HTZ WARFARE SUPPORTS ALL TECHNOLOGIES & FUNCTIONS FOR THE DEFENCE AND SECURITY MARKETS:

- Radio Critical Communication: VHF/UHF, HF, LINK11, LINK16, TETRA, PMR, TETRAPOL, P25, DMR, CDMA, CDMA 2000, TEDS, PR4G, PS-LTE (Public Safety), paging...
- Satellite/Earth station
- Microwave-links & Point to Multi-Points
- Radio cellular technologies: GSM, GPRS, EDGE, EDGE Evolution PMR, Trunked Radio Systems (TETRA, TETRAPOL, APCO-25, MPT 1327), GSM-R, DCS, CDMA EVDO GPRS, Wi-Fi (802.11a/b/g/ac), WiMax (802.16 a/d/e), UMTS, R99, HSDPA, HSUPA, HSPA+, DB-HSDPA, DC-HSDPA, CDMA 2000 1x, CDMA 200 EV-DO, DCS, LTE Advanced (latest 3GPP release), MBSFN-LTE, NB-IoT (3GPP), IoT/LoRA/SigFox, WiFi, Ingenu, LoWPAN, RPMA, Zigbee, Enocean, ISA 100, LTE-M, LTE-R (TDD/FDD), ZWave, Mesh network, Smart Grid, CISCO smart grid technology, 5G-NR (FDD/TDD), SCADA,
- Aeronautical & UAVs : Communications (Ground To Ground/Ground To Air), Radio Navigation (GP, markers, Loc, MLAT, DME, TACAN, NDB, Markers, GBAS RX, MLS AZ, etc.) and Surveillance systems, drones
- Radio-localisation: (DF/Sensors/MLAT, Telemetry, TDOA, RSSI, etc.)
- Jammers (Fixed frequency mode, **wide band – diffusion**, **wide band – adaptive mode**)
- Broadcast : Radio analog and digital (FM, AM, LF/MF, TDAB, etc.), TV analog and digital (DVB, DVB-T2, ISDB-T, DMR, DVB-S, DVBS2, etc.)
- Subscribers and User Equipment

### HTZ WARFARE SUPPORTS ALL TECHNOLOGIES & FUNCTIONS FOR THE DEFENCE AND SECURITY MARKETS, INCLUDING:

- **TACTICAL COMMUNICATIONS (ELINT, COMINT)**
- **UAV/UAS MISSION PLANNING**
- **MARITIME COMMUNICATIONS**
- **LMR/PMR/P25/TETRA**
- **PUBLIC SAFETY NETWORK/PPDR**
- **HF COVERAGE ANALYSIS**
- **MICROWAVE LINKS**
- **SATELLITE & EARTH SEGMENT (GSO/NON-GSO) DESIGN**
- **RADAR, INTERCEPTION, JAMMING EFFICIENCY**

# HTZ Warfare Propagation models

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' window with the following sections highlighted by numbered callouts:

- 1:** 'Free space loss' section under 'Propagation losses ='. It includes a checkbox for 'Near field calculation' and a text area for '20.LOG[ (4.PI.D) / wavelength ]' and 'ISO'.
- 2:** 'Diffraction geometry' section under '+ Min [ Diffraction, Tropo, Ducting, Reflections, Absorption ] attenuation'. It lists various models 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, No diffraction loss, Lateral diffraction (UTD), Power correction (angle), VHF correction, and More methods...
- 3:** 'Gases / Fog / Clouds / Sand' section under '+ Attenuation by atmospheric gases and rain'. It includes checkboxes for Gas ITU-R 676 (1-1000 GHz), Gas ITU-R 1820 (47-48 GHz), Vapour (7.50 g/m3), Water (0.320 g/m3), Fog ITU-R 840 (> 10 GHz), and Duststorm (<115 GHz)...
- 4:** 'Propagation methods' section. It lists various ITU and FCC models, including ITU-R 370 (30-1000 MHz), ITU-R 525/526-15, ITU-R 525/526-11, ITU-R 1546-6 (30-4000 MHz), ITU-R 1812-5 (VHF-UHF), ITU-R 452-16 (0.1-50 GHz), ITU-R 452-14 (0.1-50 GHz), ITU-R 1147-4 (150-1700 kHz), ITU-R 368-9 (10 kHz-30 MHz), ITU-R 1009-1 (LoS), ITU-R 528-3 (V/U/S/HF), ITU-R 1225 (M/T 2000), ITU-R 2001-3 (30 MHz - 50 GHz), and ITM NTIA (20 MHz-20 GHz)...
- 5:** '3GPP / COST (empirical)' section. It lists models 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:** 'Specific / External' section. It includes options for BR method (uV), Wofnar method (1-1000 MHz), CCIR - MF (550-1700 kHz), Egli (V/UHF), Ext. model (DLL), Composite output, Use Tx/Rx effective heights, Flat earth profile sent to DLL, and Reverse profile.
- 7:** 'Global parameters' section. It includes fields for Earth radius km land (8500), Earth radius km sea (8500), RMS wave height (m) (0.00), Variability (50.0 pc), Time (50 pc), and a checkbox for 'Variability (P2P unwanted signal)'.

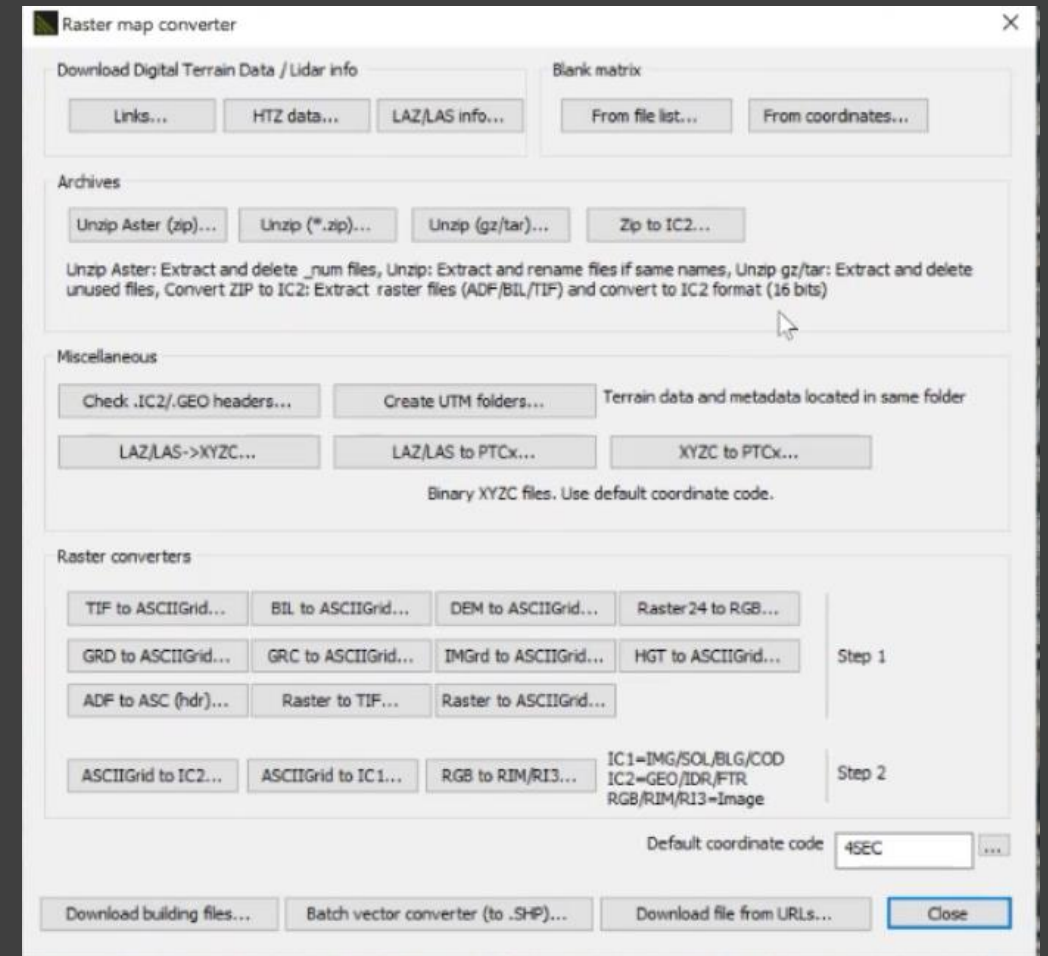
Other visible sections include 'Subpath attenuation', '3D reflections', 'Troposcattering', 'Rain / Snow', 'Slope model coefficients', '2D reflections', and 'Info'.

# HTZ Warfare

## Robust GIS Data Support

HTZ Warfare has various tools to acquire and manage digital maps including DTM, clutter, image and vector files

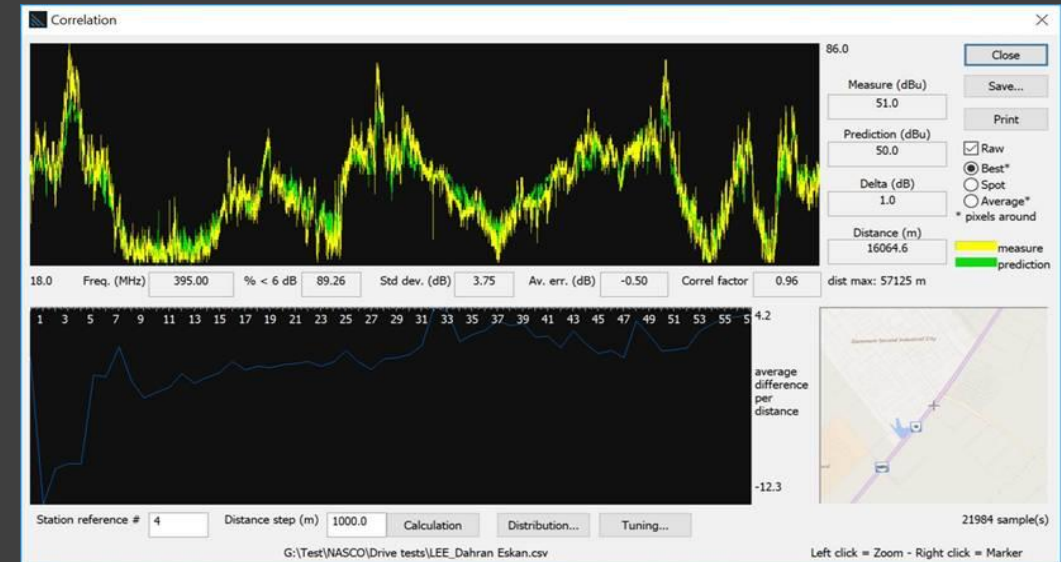
- In-built tool to access ATDI GIS database to download medium to high resolution DTM and clutter worldwide. High resolution 3D building layer is also available for some cities;
- 3<sup>rd</sup> party map image API connection like Google Maps, MS Bing Maps, Geospatial, Open Street Maps, etc.
- Private GIS data conversion using Raster Map Converter in HTZ Warfare. The tool supports generic formats to convert into HTZ formats.
- Data production and development services are also available for any specific project needs.



# HTZ Warfare Unprecedented Modelling Accuracy



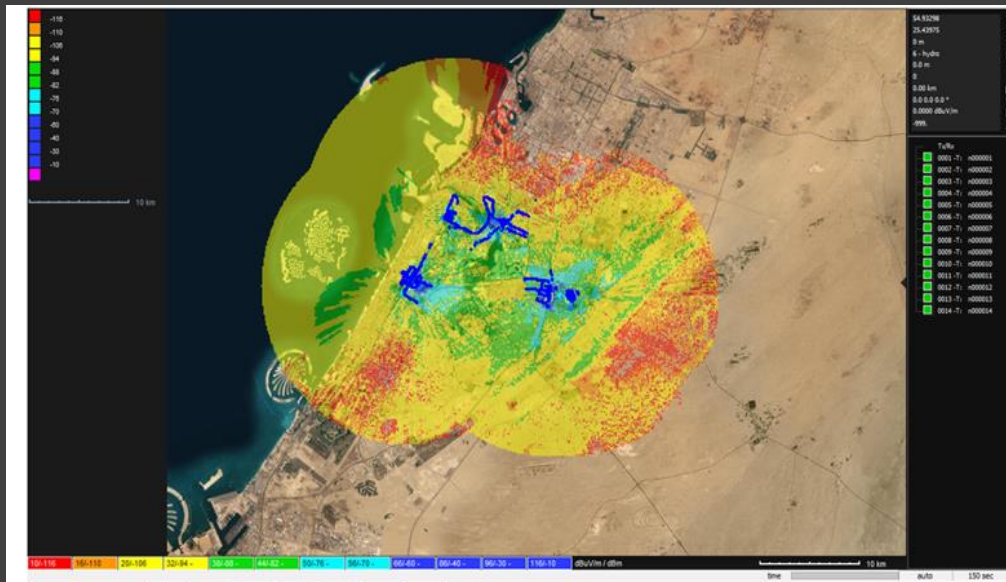
TETRA station located in Damman KSA (Azizia Palace)  
Standard Deviation Error (dB): 2.79  
Correlation Factor: 0.98  
Sample measurement: 22347



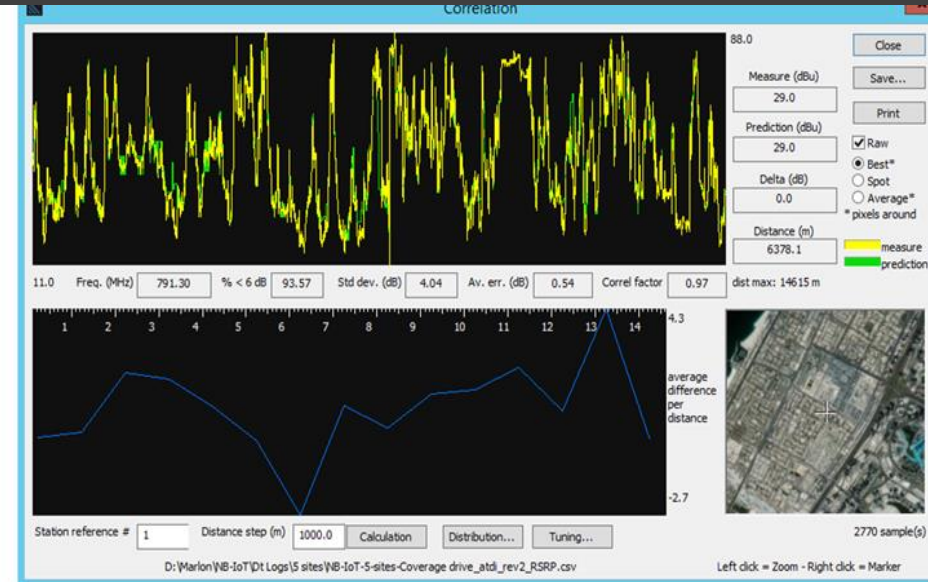
TETRA station located in Dahrhan Easkan (KSA)  
Standard Deviation Error (dB): 3.75  
Correlation Factor: 0.96  
Sample measurement: 21984



# HTZ Warfare Unprecedented Modelling Accuracy



5G-NR coverage prediction (3.5GHz) Dubai city (UAE)



NE501 RSRP coverage prediction vs. Scanner (3.5GHz) Dubai city (UAE)  
Standard Deviation Error (dB): 4.04  
Correlation Factor: 0.97  
Sample measurement: 2770

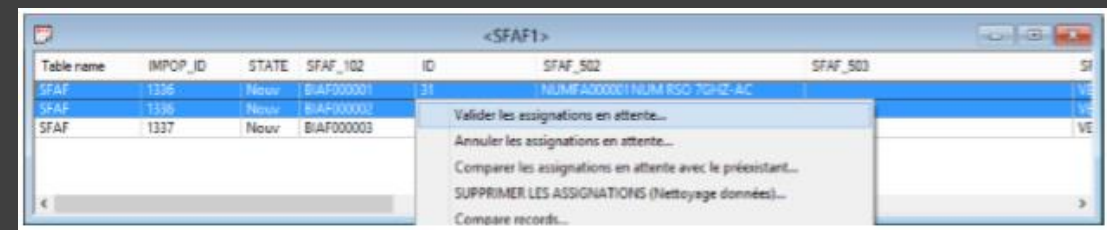
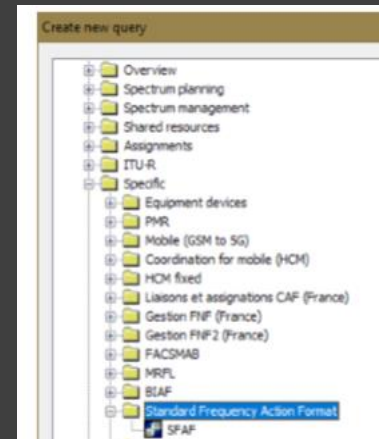
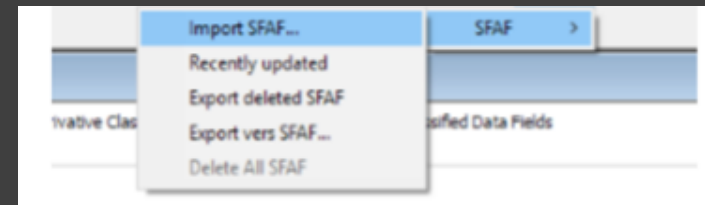


# HTZ Warfare Tactical Mission Planning

In the mission critical environment, access to online and offline operations for rapid network planning and frequency assignment is the key for the mission success. HTZ Warfare supports:

- Examines links between communication assets and assesses the performance of the link in detail. All simulations are based on proven, accurate simulation methods;
- Moves individual sites and analyses communication capabilities virtually instantly;
- Assesses the impact of communication site failures and their impact on the network, so that contingency plans can be included as part of the normal system design process;
- Identifies network capabilities for moving elements, such as convoys, through hostile territory. Suitable locations for talk-through sites can be easily identified;
- Supports the complete design of communication networks, including the ability to minimise interference, assign frequencies and generate alternative communication plans;
- Network changes to any part of a network can be analysed and viewed virtually instantaneously. This includes the ability to assess the effect of failure or enemy action on the network. This supports mitigation planning and reduces the likelihood of communication failures in the field;

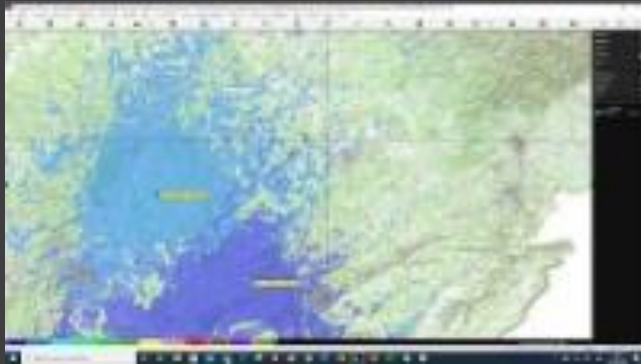
*SFAF and SMADEF-XML formats are compatible*



# HTZ Warfare Tactical Mission Planning demonstration

## Part 1: Mission Scenario and Project Set up in HTZ Warfare

<http://www.youtube.com/watch?v=mdKWJaw09GQ>



## Part 2\_Mission Network Analysis and Frequency Assignment

<http://www.youtube.com/watch?v=cHZIWm8ycSE>



## Part 3\_HTZ Warfare mission planning process summary

[http://www.youtube.com/watch?v=S7\\_2IAkoctM](http://www.youtube.com/watch?v=S7_2IAkoctM)



# HTZ Warfare

## Electronic Warfare

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Battlespace spectrum management is the planning, coordination and management of EMS, to enable military systems to perform their functions without causing or suffering from harmful interference.

Significant importance is placed on the performance of radio intercept receivers, direction finders and communications jamming equipment. Key features that determine the success of a mission is the ability to intercept or jam enemy communications. And similarly, to share information with the command structure without undue interference.

- Assess the risk of interception or jamming by known enemy electronic warfare assets;
- Electronic warfare for communications planning can be included by analysing intercept vulnerability, identifying the possible effects of enemy jamming and developing plans to overcome these factors;
- Plans for the deployment of intercept receivers, including intercept coverage assessment and gap identification, maximising the efficiency of deployed sensors or minimising the assets assigned to a given objective;
- Deploy direction finders with best site searching, DF baseline coverage assessment and communications planning between assets. The system can be integrated with DF systems, so that DF hits can be displayed directly on the planner's screen;
- Plan offensive communication jamming missions, including asset optimisation, communications planning and assessments of jamming effects on own communications systems;
- Determine the vulnerable points in known enemy communications systems and prioritise targets for attack.

# HTZ Warfare Electronic Warfare Use Case

## UAV/UAS Counter-drone network analysis

Part 1: Mission Scenario and Project Set up in HTZ Warfare

<https://www.youtube.com/watch?v=5EqnNwfG7xw&t=1s>



Part 2 Counter-drone jamming effects analysis in HTZ Warfare

<http://www.youtube.com/watch?v=M3fYDETFNv8>



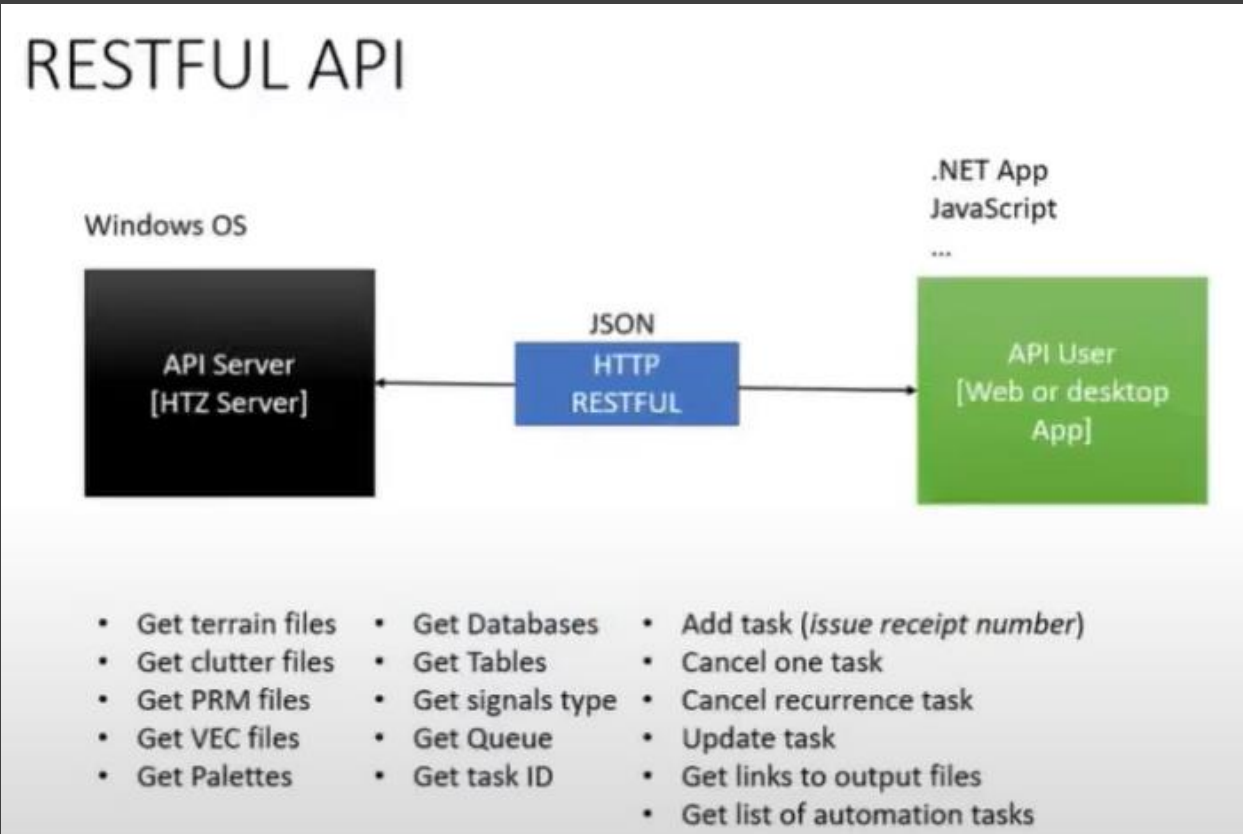
# HTZ Warfare Planning Automation

**Staying connected to Headquarters while in enemy territory is an essential part of many military missions.**

HTZ Warfare provides the ability to custom workflows to support different end-user requirements or system capabilities. This simplifies interfaces for software users who may not have a radio propagation background.

For instance, by identifying the areas with no possible communication with headquarters, routes can be chosen for ground vehicles, helicopters and planes moving at different speeds and using different types of equipment.

The entire planning and problem solving is managed in an automated fashion.





# HTZ Warfare Planning Automation use case (videos)

Part 1: MANET concept and introduction  
<http://www.youtube.com/watch?v=-NAFafSWWog>



Part 2: Project set up and simulation analysis in HTZ Warfare  
<http://www.youtube.com/watch?v=UGrBOjz83CA>



Part 3: Continue Part 2 and Automation in HTZ Warfare (starts at 8:10)  
<http://www.youtube.com/watch?v=7bg8HFhT4Sc>



# Our Services

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## Training

Customised training service online or onsite.



## Support

24/7 global technical support via phone, email and web-conference



## System Customisation

Business analysis, system design, architecture, customisation, integration, and configuration.



## Spectrum consulting

Provide professional consulting services in spectrum engineering and management to solve any spectrum issues.



## Cartographic data

Medium to High resolution DTM and Clutter library.  
Cloud base digital map image streaming and cache support.



## System Deployment & Maintenance

Support on Go-Live, Testing, and bug fixing.  
On-going maintenance support with software updates.

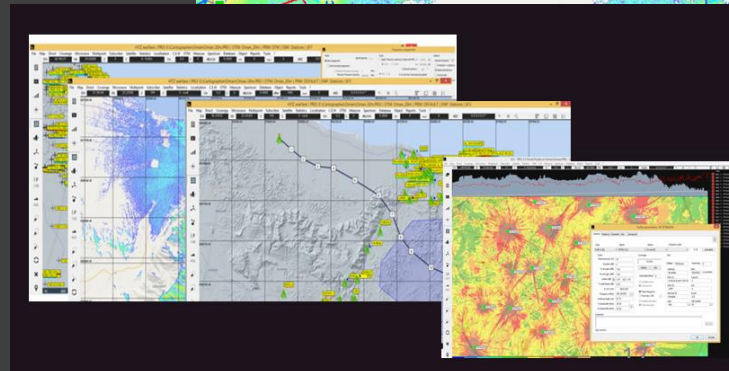
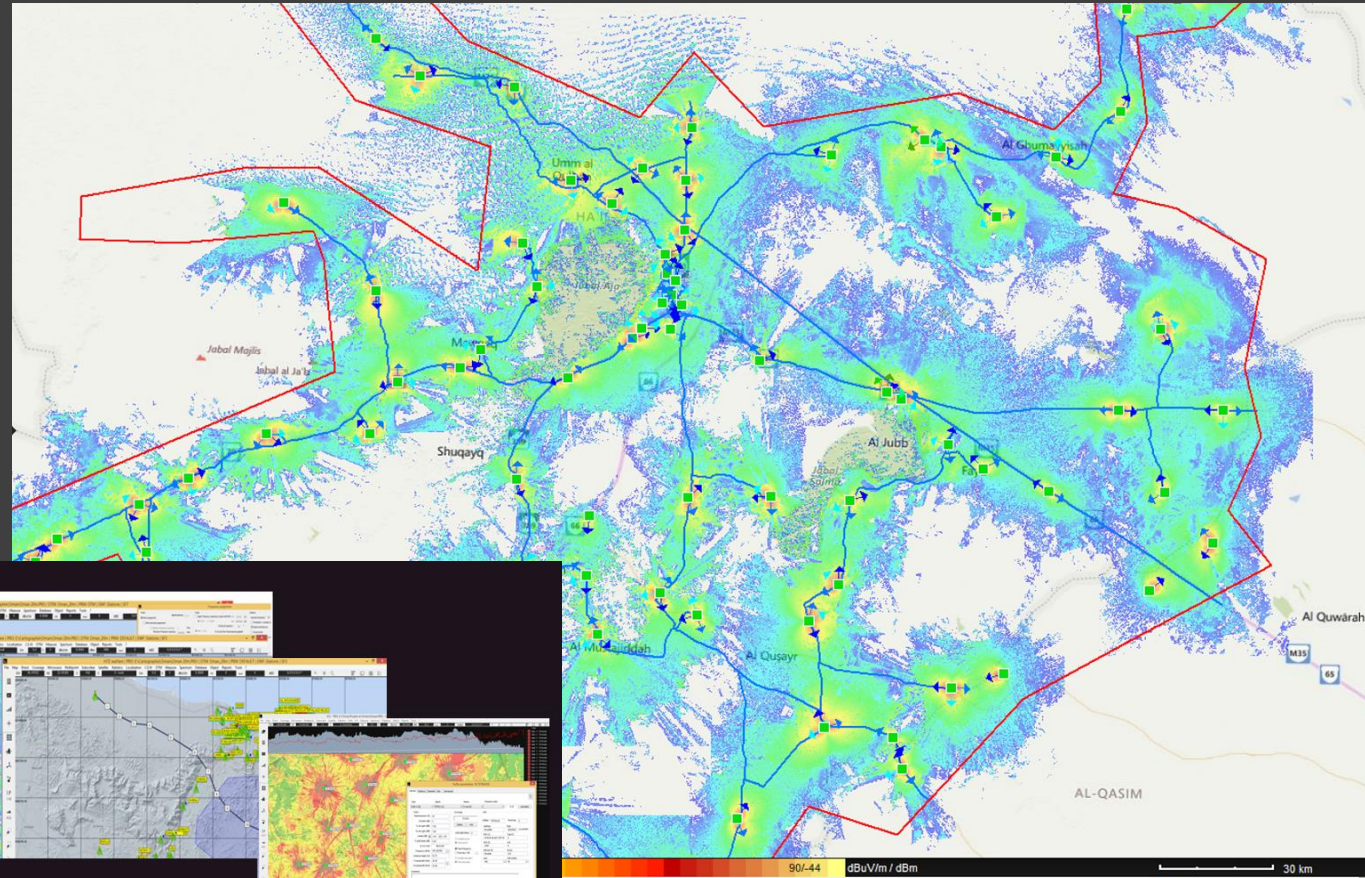
# Annex

Technical Analysis Capabilities in HTZ Warfare

# HTZ Warfare Critical Comms Network Planning

**TETRA, P25, DMR, CDMA, CDMA 2000, TEDS, TETRAPOL, PS-LTE, VHF/UHF**

- DL/UL Coverage planning (outdoor, indoor, in car)
- DL/UL link budget calculator
- Automatic best site selection candidates according to coverage objective
- Automatic site planning
- Automatic site optimization (azimuth, power, tilt, antenna model...)
- Interference calculations
- Automatic Frequency assignment
- Traffic & mobility profile editor (UE)
- Capacity planning (Erlang, data)
- Automated handover, neighbor list planning
- Monte Carlo simulations





# HTZ Warfare Critical Comms Network Planning

## Ground to Ground Communications



VHF AM radio base station JOTRON (TR-7550)

- Portable Radios (ICOM)
- Mobile Radios (ICOM)



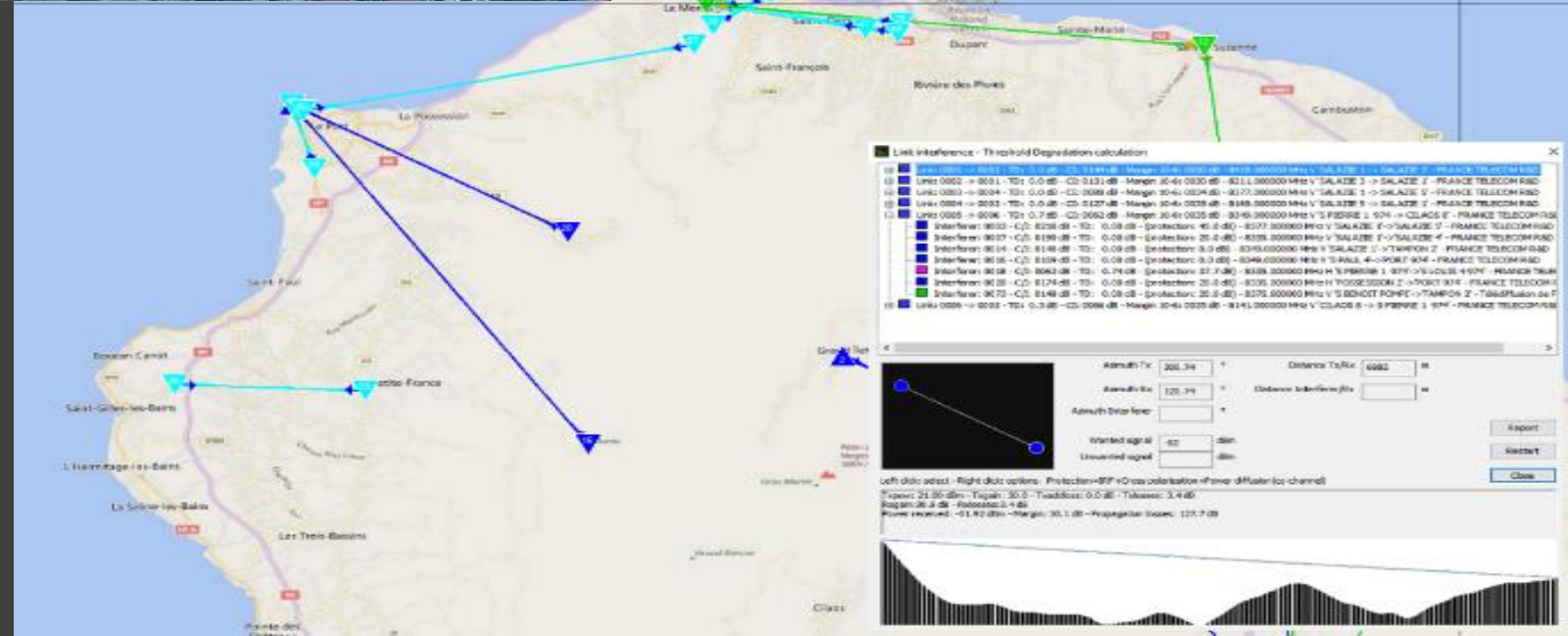
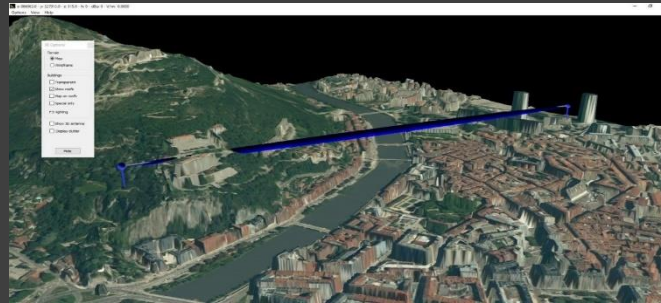
ITEM	CH FREQ. (MHZ)	USE
1	CH 1: 133.500	Ground to Ground communication
2	CH 2: 121.700	Operation room to Tower communication
3	CH 3: 118.100	Monitor in operation room from Air to Ground communication



# HTZ Warfare

## Microwave, P2MP, Backhaul, mm Wave bands

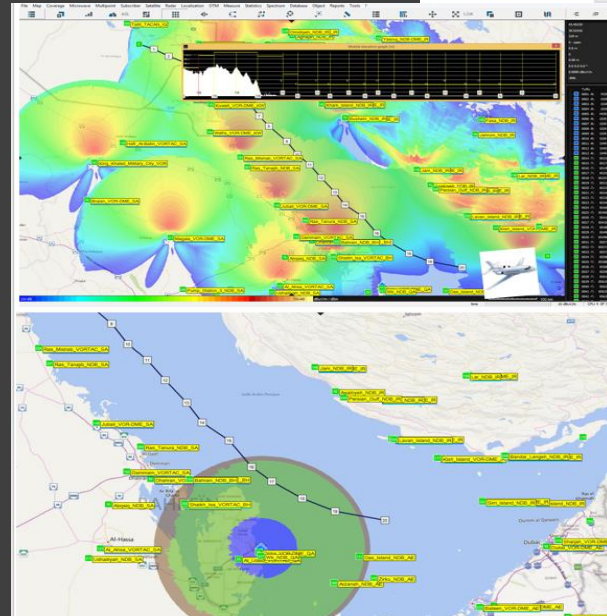
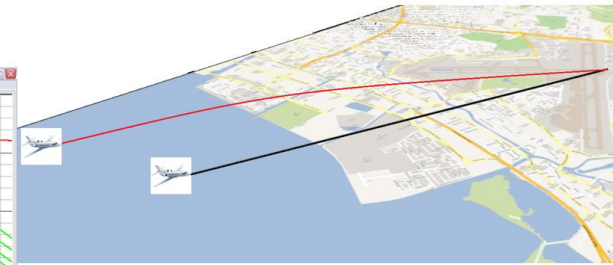
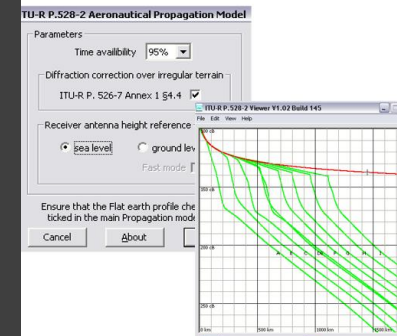
- Profile budget calculations
- Frequency and space diversity
- Multi-K factor calculations
- Climate and rain parameters
- Reliability calculations
- Automatic antenna orientation
- Link optimization
- Automated frequency planning
- Interference calculations
- Quality objectives calculations (ITU-R F. 1703 and ITU-T G.827)
- MIMO Antenna systems
- M2M, D2D, SCADA, CDMA 450, MMDS, WiMAX, LMDS, etc.



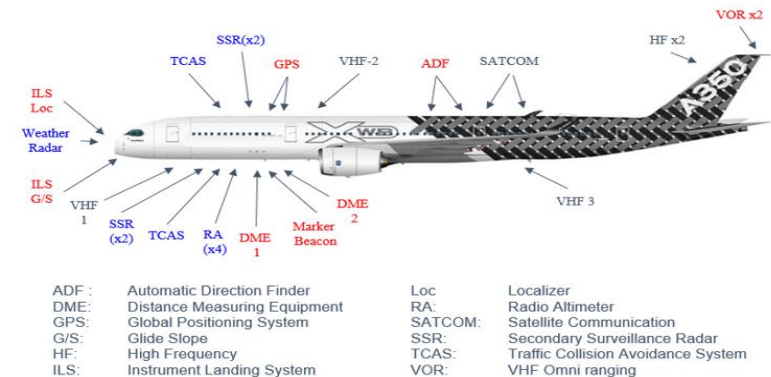
# HTZ Warfare Aeronautical Services

- Aeronautical Communication Systems (VHF/UHF Ground To Air, Air to Ground, Broadband LTE A2G (Air To Ground),
- Radio navigation systems: GP, markers, Loc, MLAT, DME, TACAN, NDB, Markers, GBAS RX, MLS AZ, etc.
- Surveillance system: Radar (PSR, SSR, etc.) including coverage, interference and coexistence analysis
- Multi-lateration (Time Sum of arrival – TSOA / Time Difference of arrival (TDOA)
- Building restricted area ICAO recommendations
- Coexistence between aeronautical services and FM network (ITU-R/ SM1009)
- Coexistence between radar and LTE network (from OFCOM recommendations)
- Traffic/Interference analysis and Automatic Frequency Assignment

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



## Modeling aircrafts with all radio navigation equipments with HTZ warfare



Distance / elevation pattern

°	km/M	°	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	32.54	51	24.77	71	16.99
	10.29		16.11		21.93		27.75		33.57		39.92		32.15		24.38		16.61
	10.58		16.40		22.22		28.04		33.86		39.53		31.76		23.99		16.22
	10.87		16.69		22.51		28.33		34.15		39.15		31.37		23.60		15.83
	11.16		16.98		22.80	-25	28.62	-5	34.44	15	38.76		30.98		23.21		15.44
	11.46		17.28		23.10		28.92		34.74		38.37		30.60		22.82		15.05
	11.75		17.57		23.39		29.21		35.03		37.98		30.21		22.44		14.66
	12.04		17.86		23.68		29.50		35.32		37.59		29.82		22.05		14.27
	12.33		18.15		23.97		29.79		35.61		37.20		29.43		21.66		13.89
-80	12.62	-60	18.44	-40	24.26	-20	30.08	0	35.90	20	36.81	40	29.04	60	21.27	80	13.50
	12.91		18.73		24.55		30.37		35.80		36.43		28.65		20.88		13.11
	13.20		19.02		24.84		30.66		70.30		36.04		28.26		20.49		12.72
	13.49		19.31		25.13		30.95		79.60		35.65		27.88		20.10		12.33
	13.78		19.60		25.42		31.24		76.00		35.26		27.49		19.72		11.94
	14.07		19.89		25.71	-15	31.53	5	61.00	25	34.87		27.10		19.33		11.55
	14.37		20.19		26.01		31.83		50.50		34.48		26.71		18.94		11.17
	14.66		20.48		26.30		32.12		50.80		34.09		26.32		18.55		10.78
	14.95		20.77		26.59		32.41		49.20		33.71		25.93		18.16		10.39
	15.24		21.06		26.88		32.70		41.60		33.32		25.54		17.77	89	10.00
70	15.53	50	21.35	30	27.17	10	33.00	10	33.00	30	33.00	50	25.16	70	17.38		

converted diagram preview

dB

rotary ☐

☐ km  
☒ statute mile  
☐ international nautical mile  
☐ geographical nautical mile

R/R0: 367.90 miles

reset interpolate

Close Cancel

Radar constraints

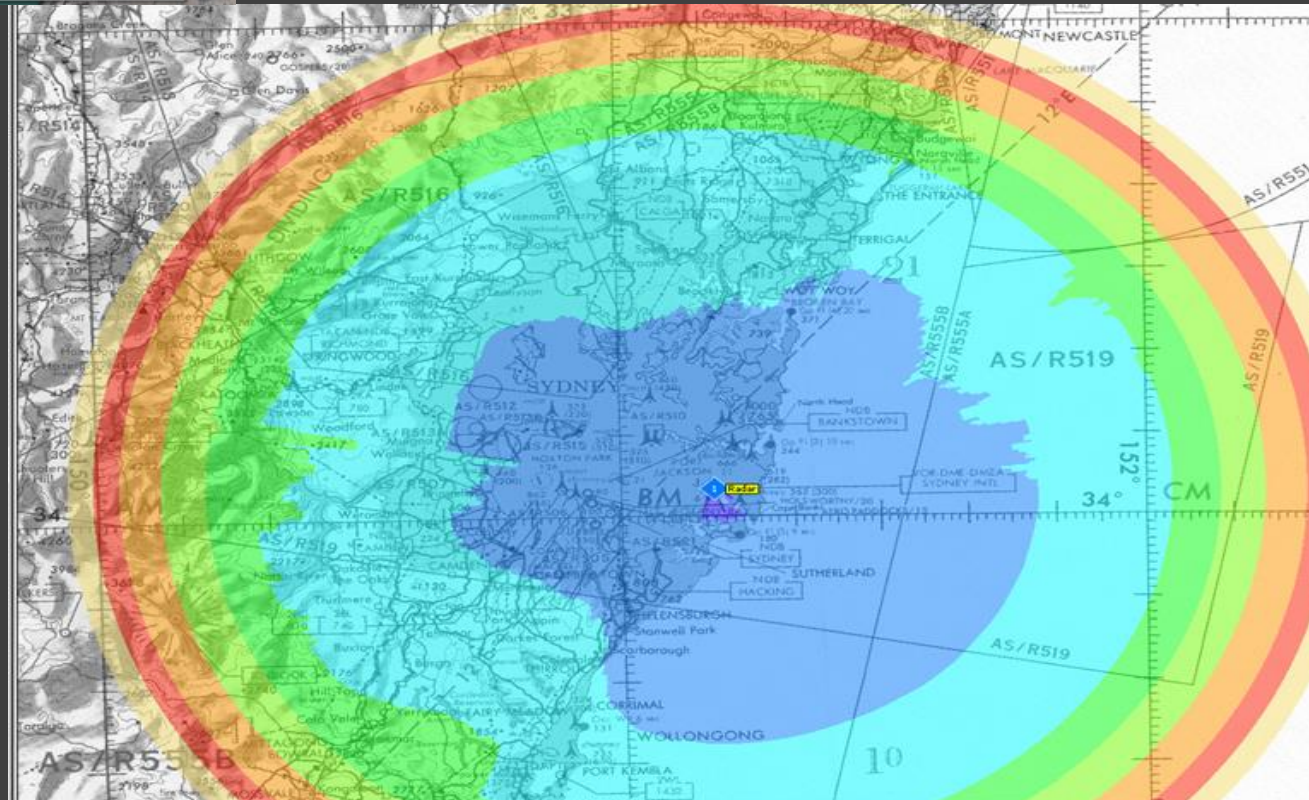
The graph plots a vertical axis from 0 to 50 against a horizontal axis labeled 'RADAR HORIZON' from 0 to 180. A solid curve starts at (0,0) and rises to a peak of approximately 45 at a radar horizon of 150, before dipping slightly. A dashed line starts at (0,50) and slopes downward. The region between the solid curve and the dashed line is filled with a stippled pattern.



# HTZ Warfare

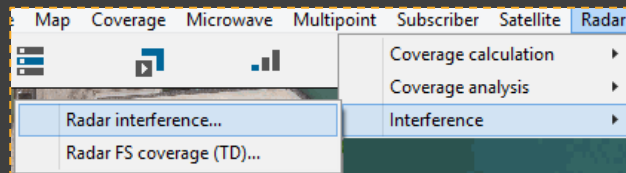
## Radar Minimum Detection Height

Point	Subscriber	Satellite	Radar	Localization	OTM	Measure	Statistics	Spectrum
			Coverage calculation			Radar coverage...		
			Coverage analysis			Radar FS coverage...		
			Interference			Radar coverage (min detection)...		



Label	
Target detected	Blue
150 feet ASL min	Cyan
300 feet ASL min	Light Blue
450 feet ASL min	Green
600 feet ASL min	Light Green
750 feet ASL min	Yellow-Green
900 feet ASL min	Yellow
1050 feet ASL min	Orange
1200 feet ASL min	Red
1350 feet ASL min	Dark Red

# HTZ Warfare Radar Interference Analysis

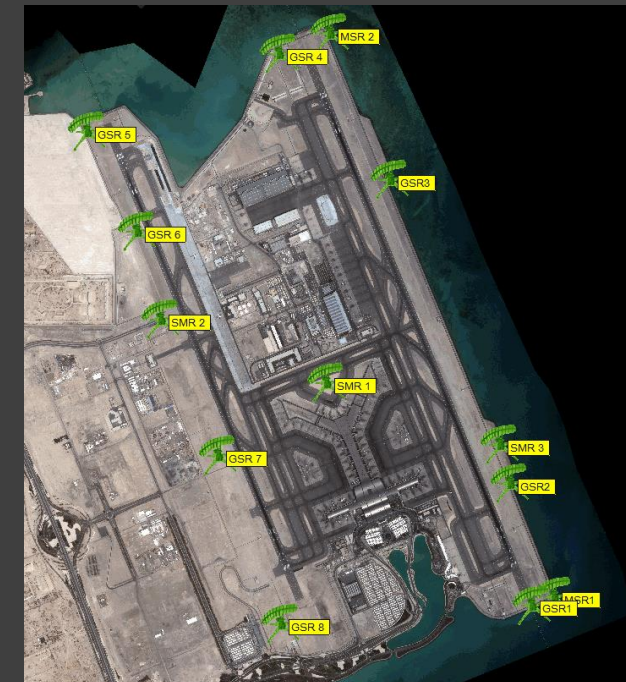
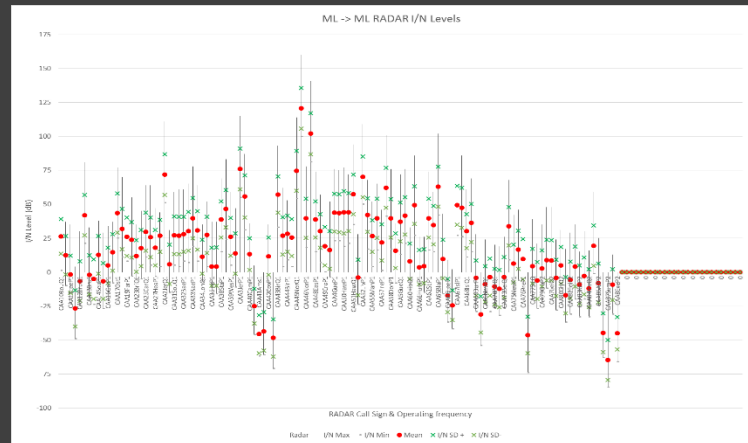


This functions rotates the radar horizontal antenna pattern in 1-degree intervals and calculates the I/N and Threshold degradation. The radar coverage is then calculated using the threshold degradation and then calculates the radar coverage for the given probability of detection and radar cross section.

The 'Radar interference' dialog box contains the following settings:

- Target height (m): 2000.00
- Visibility rule (> n mrad) (-9999=normal): -9999
- Unwanted = activated (selected)
- Unwanted = de-activated and activated
- Unwanted = de-activated
- Collision probability (Unwanted aperture): ☒
- Percentage of time - wanted: 50
- Percentage of time - unwanted: 10

Buttons: OK, Cancel, Station list..., IRF...





# HTZ Warfare

## Radar Coexistence; Radar Vs Windfarm

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

Wind turbine parameters: 45 WT000001

General Pattern Envelop Site

Type Status

Wind turbine (12) 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) 11200.00000 (rcs)

Info

Callsign WT000001

Address WT000001 Date 20161205

Info (1) Type ID

Info (2) Link

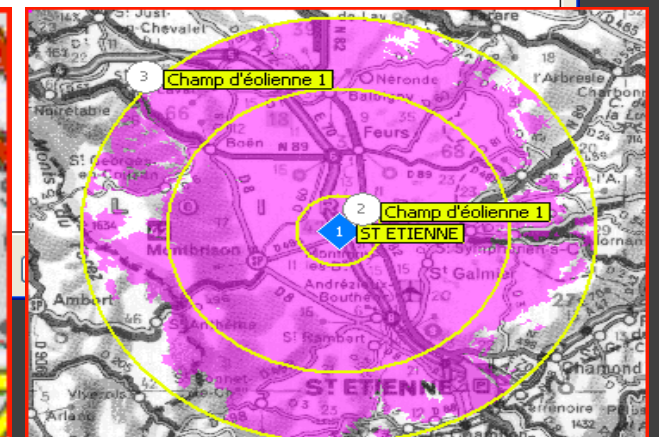
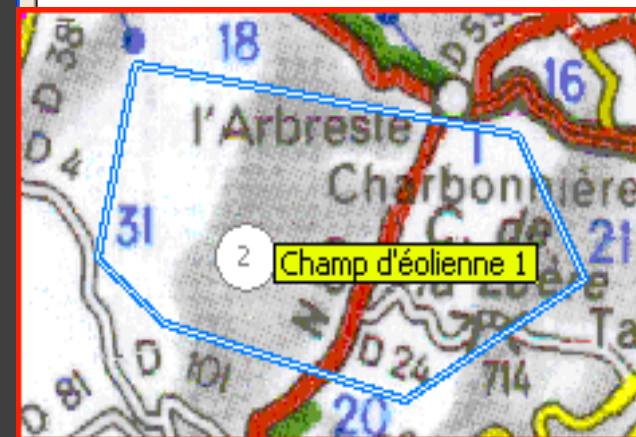
Network ID Group

User WZ Call number 0

Report

Wind turbine - Radar constraints

Radar type	Wind turbine #	Callsign	Height	Agreement	Max Height
ZIT	2	Eolienne 1	150.00	NOK	0
ZIT	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



# HTZ Warfare

## Multi-lateration- 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

Delete info

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 yyymmmdd

Info (1): TXRX Type ID: C

Info (2): Link:

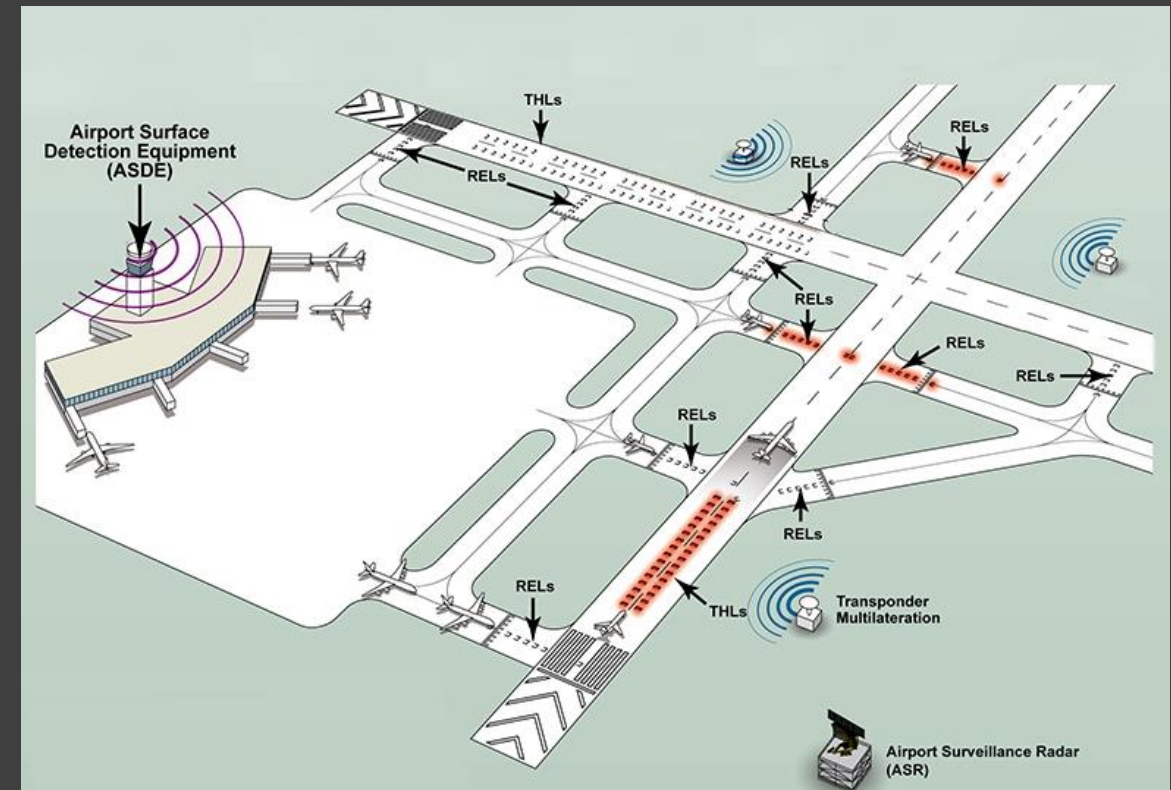
Network ID: Group:

User: Call number: 0

Comment:  
Demo MLAT Interrogator parameters

SQL record 0

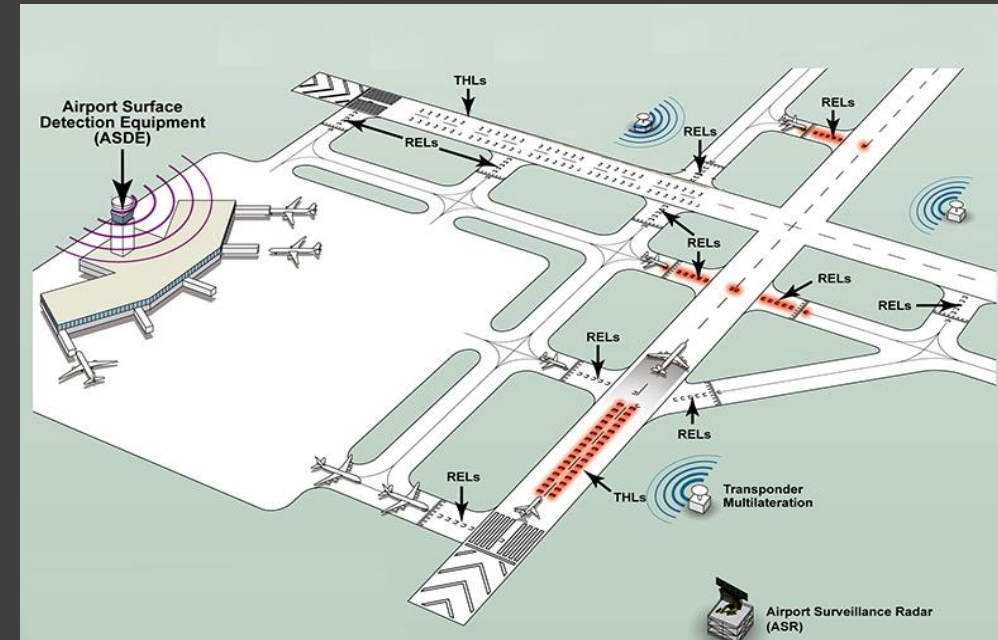
OK Cancel



# HTZ Warfare

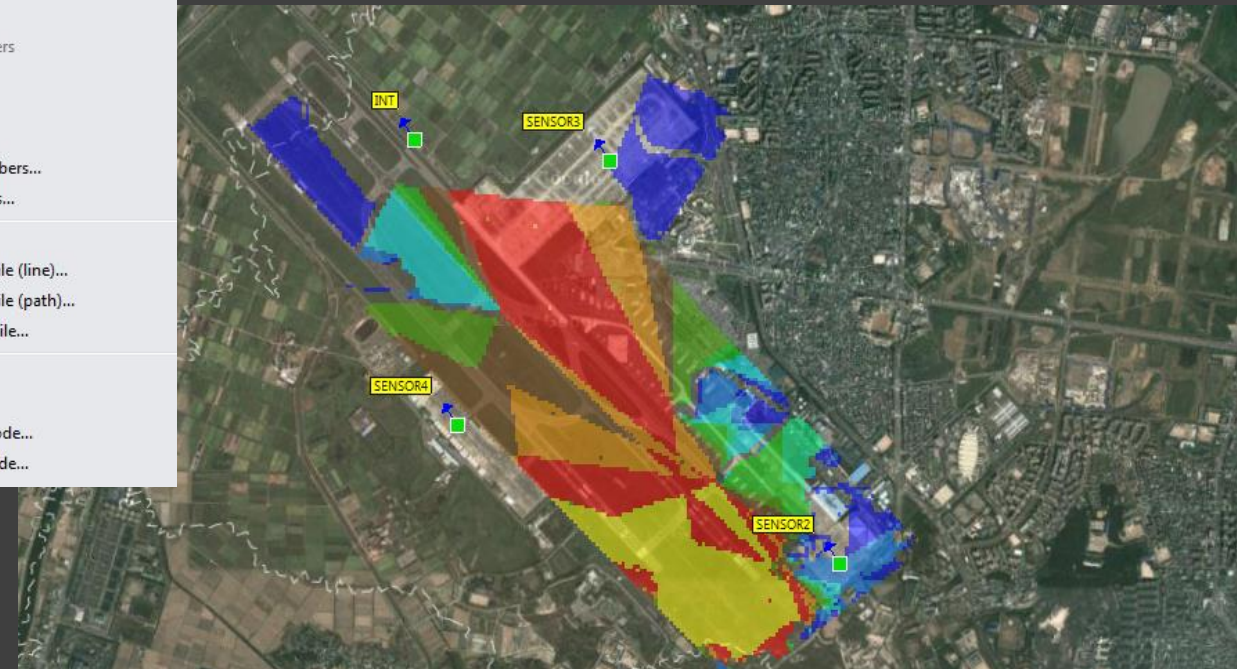
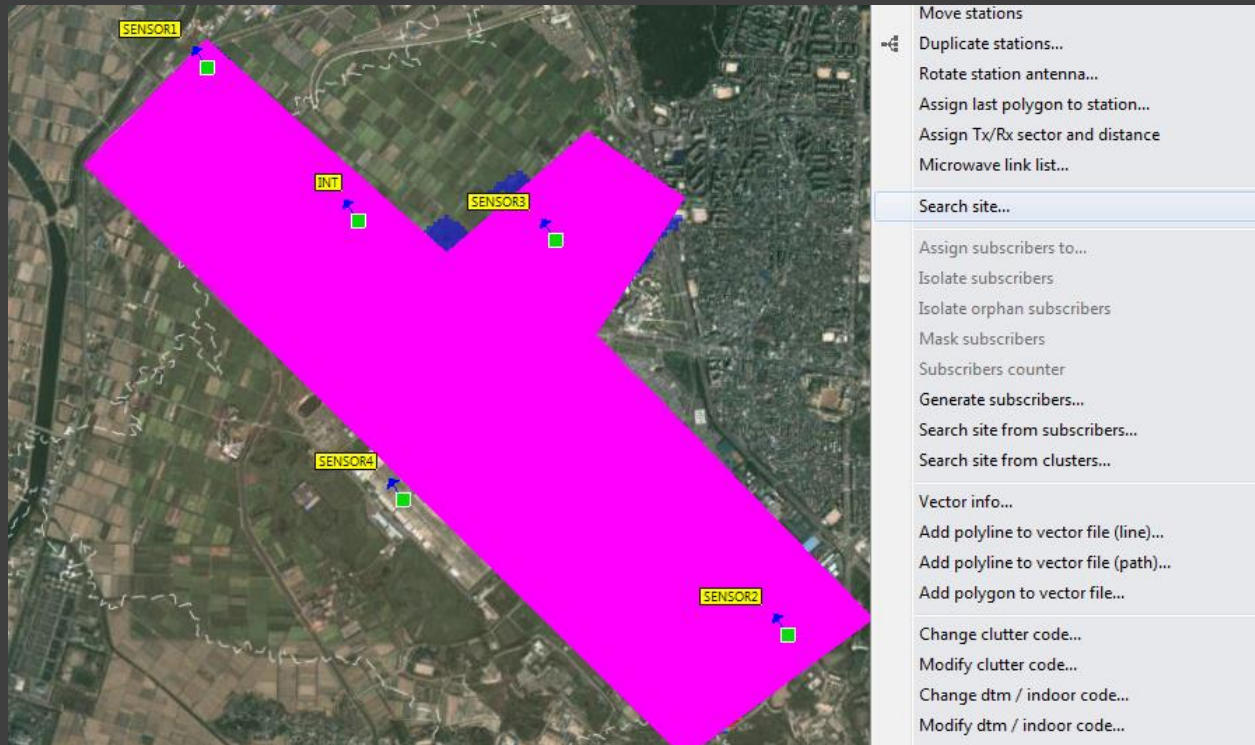
## Multi-lateration- Airport surface

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





# HTZ Warfare Multi-lateration- Airport surface



# HTZ Warfare Broadband LTE A2G

## 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 4 / 2

TDD

DL-to-UL configuration

DL-to-UL config 1

Special subframe format type

Subframe Format 7

Regural DL/UL subframes 4

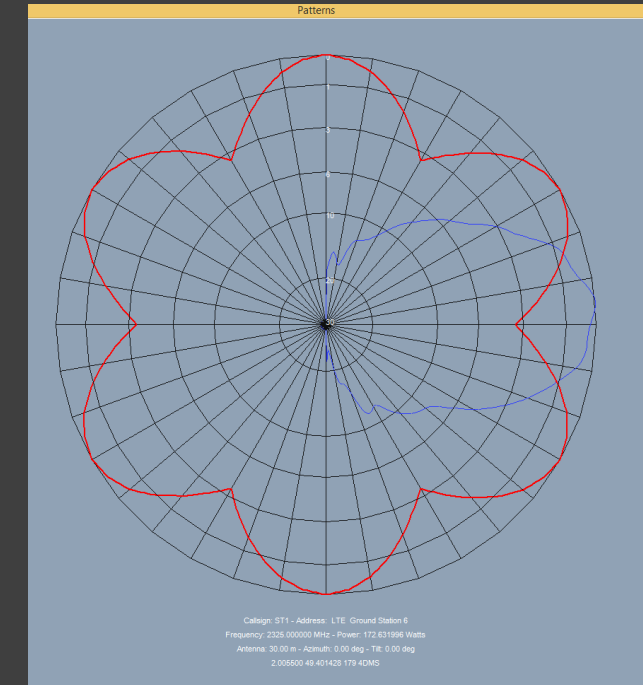
Special subframes 2

DL/UL ratio 54,29

Bandwidth (kHz) 5000,00

PDCCH symbol(s) 1

Max power (W) 30.000000



Antenna patterns (H/V)



# HTZ Warfare Broadband LTE A2G

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

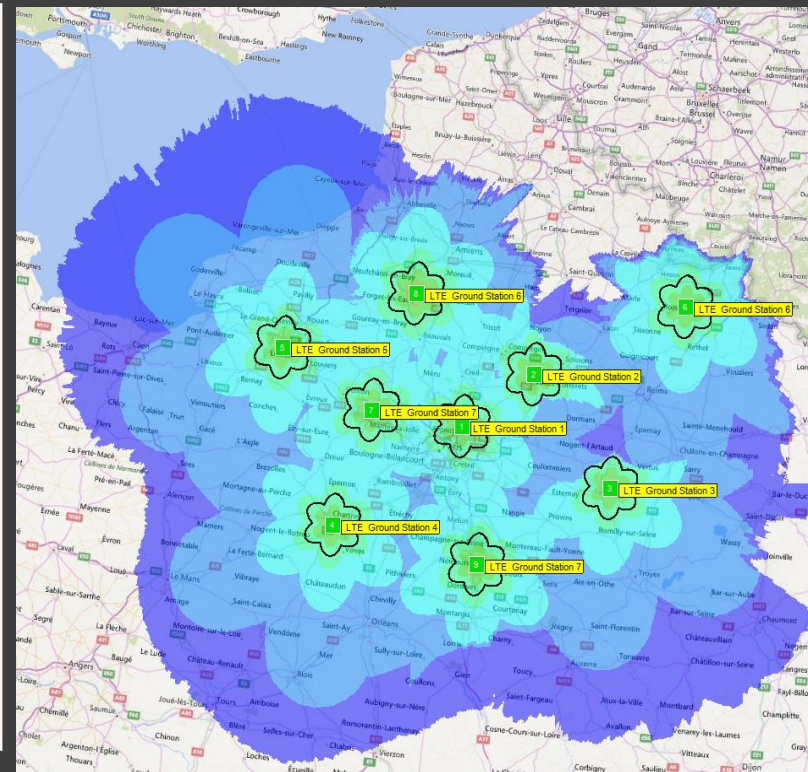


Fig 1: RSRP coverage (Aircraft altitude: 8000 ft)

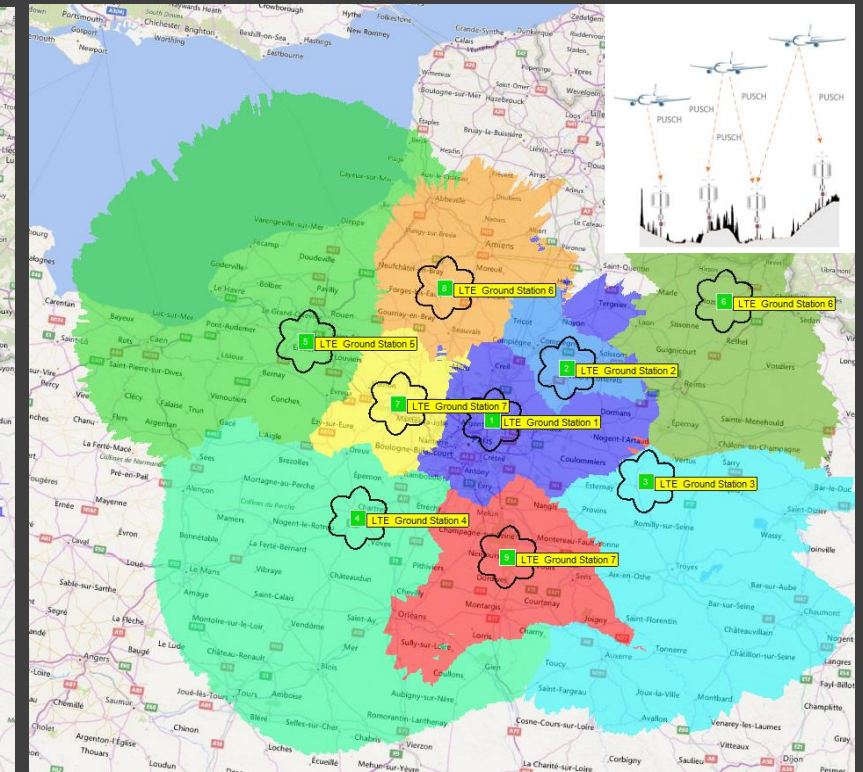


Fig 2: Best server RSRP map (Aircraft altitude: 8000 ft)

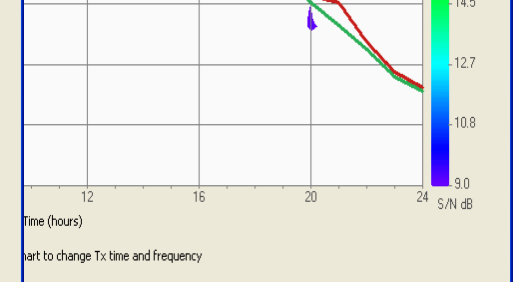
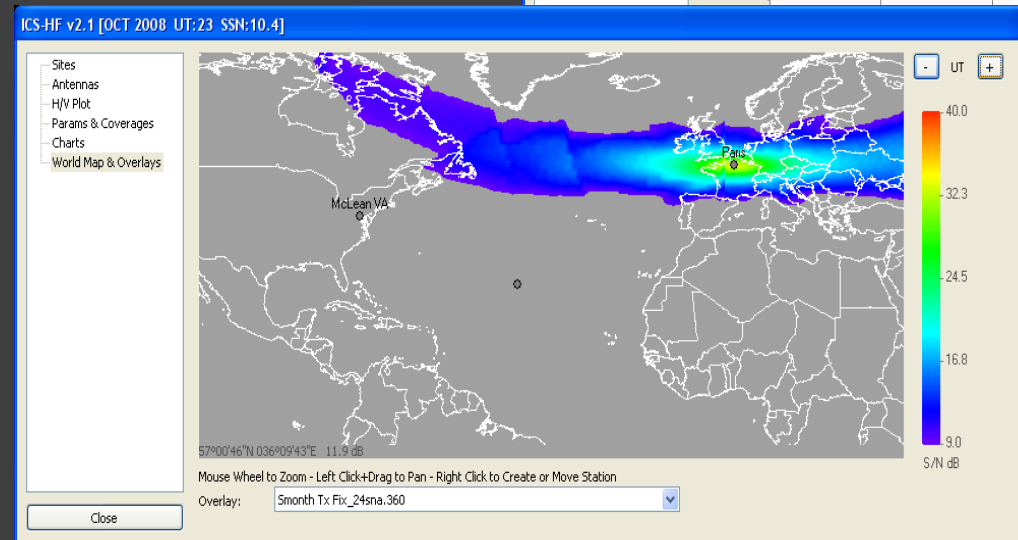
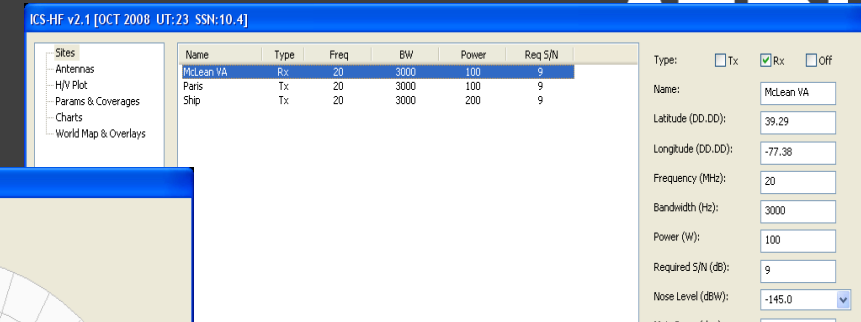
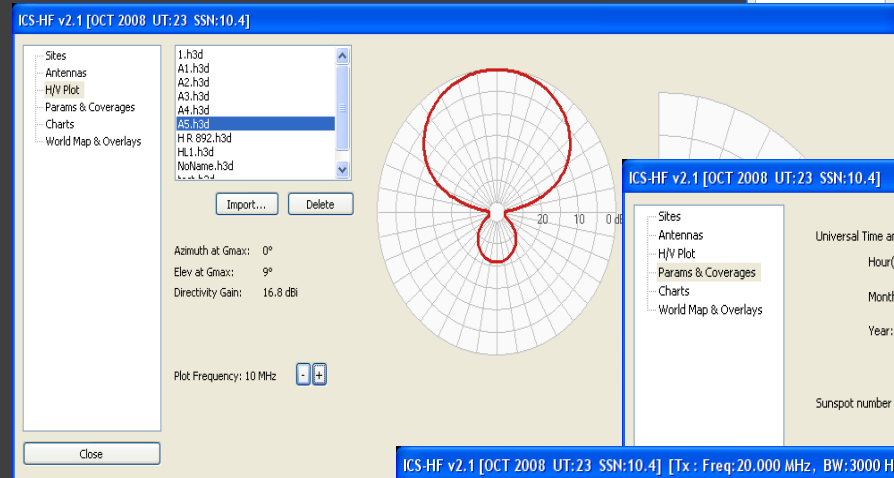
# HTZ Warfare HF Planning

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

## CHART ANALYSIS

MUF (Maximum Usable Frequency)

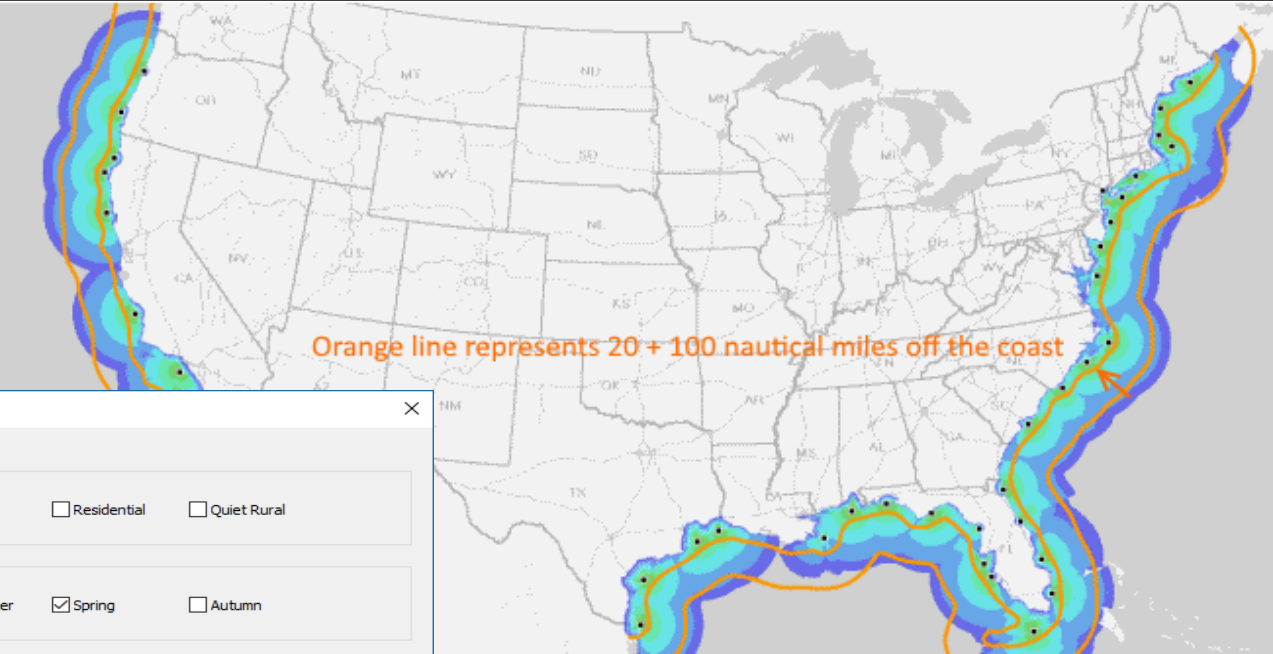
FOT (Frequency of Optimal Transmission)



# HTZ Warfare

## HF Planning – Maritime Groundwave

In order to properly model the radio wave propagation of MF signals, HTZ warfare integrates the latest ITU recommendations specific to MF Groundwave propagation: ITU-R P.368-9 and ITU-R M.1467-1. Calculation feature used to generate the field strength received predictions for each pixel on the map is based on the integration of ITU-R P.368-9 into HTZ's propagation engine.



NOISEDAT Calculator

Freq (MHz):

0.518

Bandwidth (Hz):

500

S/N (dB):

8

Dt+(dB) (0->90%  
3->95%):

0

Emrp (W):

1000

Latitude (dd.ddd):

45.700457

Longitude (dd.ddd):

2.191760

Rx Environment

☐ Business
☒ Rural
☐ Residential
☐ Quiet Rural

Season

☐ Winter
☐ Summer
☒ Spring
☐ Autumn

TIME	FA	THRESH	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL
0000-0400	92.6	-46.4	80.4	58.6	75.1	82.0	9.5	10.1	2.2
0400-0800	84.3	-54.7	60.9	58.6	75.1	70.2	10.6	13.8	11.1
0800-1200	85.4	-53.6	47.4	58.6	75.1	75.2	5.9	9.7	1.5
1200-1600	81.7	-57.3	55.8	58.6	75.1	65.4	8.3	16.1	22.9
1600-2000	88.5	-50.5	69.0	58.6	75.1	69.5	15.4	18.7	18.0
2000-2400	92.2	-46.8	80.2	58.6	75.1	82.1	8.8	9.7	2.4

A2

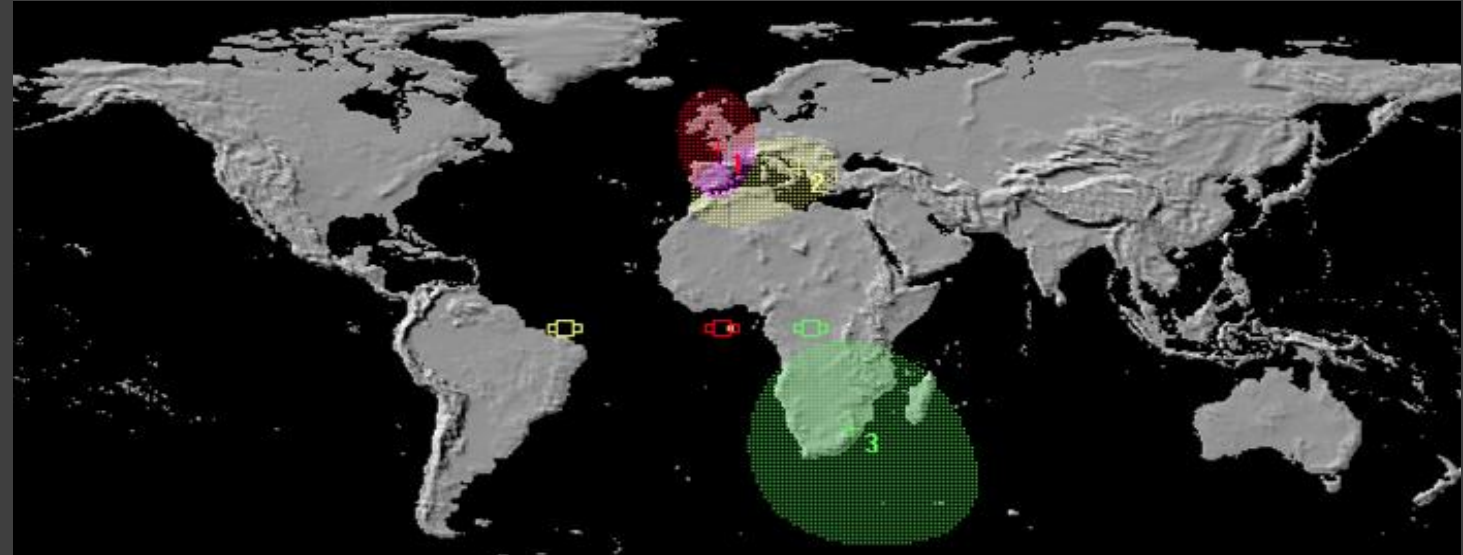
Calculate

Close



# HTZ Warfare Satellites

- 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 parameters**

Call-sign: SAT 3    Color: [Black]    Type: NGS0    description: Satellite 3

Info Press CTRL+Enter to change line

**Altitude**

Longitude \* 19.0000  
Latitude \* 0.0000  
StationKeepingError \* 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

[Euler -> coordinates] [Coordinates -> Euler]

**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  
☒ Circular pattern    ☐ Elliptical    ☐ Other  
Pattern type [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 polarisation (rotation yaw) \* 0.0000

**Circular orbit**

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

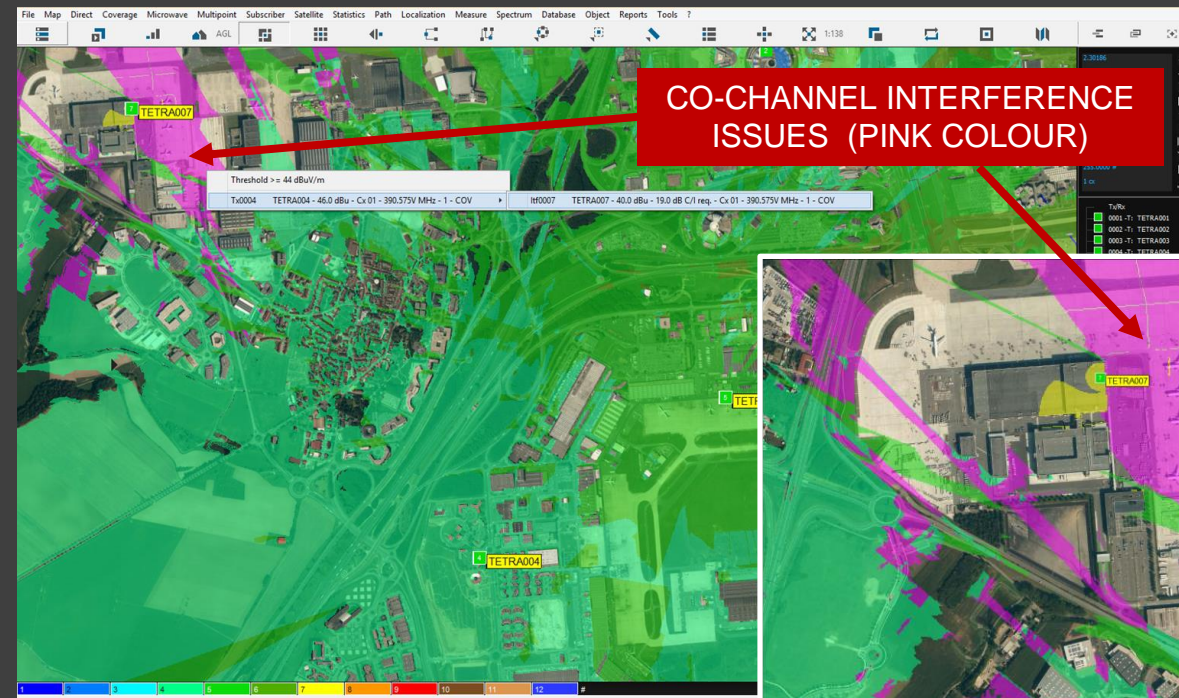
Model atten -1 = R.618 (dB) -1.0    Nb subscribers 0    BW occupancy MHz 0.00000    Loss dB 0.0    [OK] [Cancel]

\*none = not selectable



# HTZ Warfare Interference Analysis

- Provides all capacities for frequency interference analyses (co-, interstitial and adjacent channel interference) based on propagation conditions and the scenario of existing stations.
- Procedures are implemented for all services and consider the special behavior of different service types with regards to bandwidth, spectral distribution or filter curve of the receiver. Interference analysis can be performed using a general analysis function delivering a fast result.
- Comprehensive report that summarizes all technical and operational details of the performed interference analysis can be generated. This includes for example the operational characteristics of the transmitters/receivers, their locations, the utilized propagation model, etc. All identified interference cases are presented on the produced interference reports. In addition, all interference cases may also be visualized graphically on the GIS.



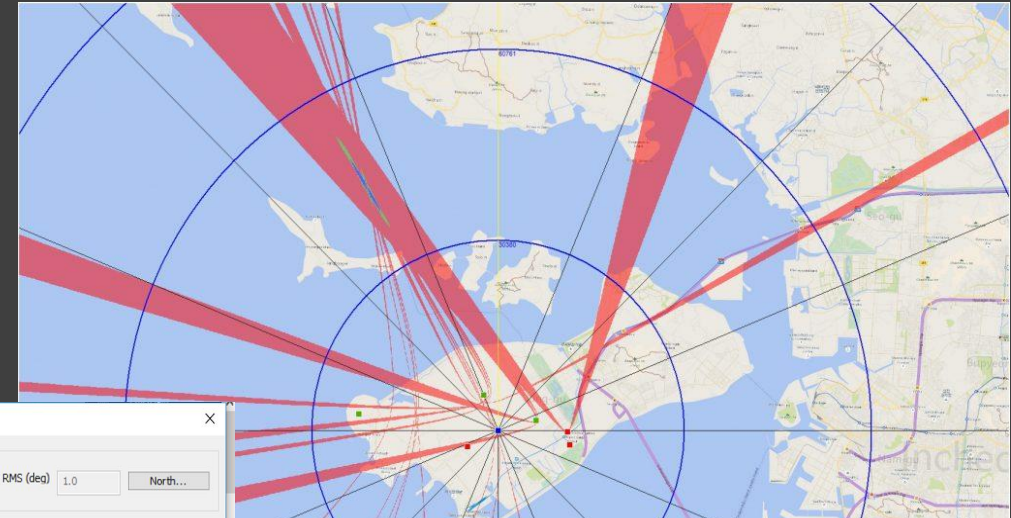


# HTZ Warfare

## Hybrid Localisation from Measurement

This function is drawing a map of the possible locations of the reference station that has been measured (Target transmitter). It will localize the “target transmitter”, based on the measurement file imported, containing for each coordinate point, either:

- Field strength received (RSSI) measured, or
- Angle of arrival (AOA) of the signal received, or
- Angle of arrival (AOA) of the signal received and Field strength received (RSSI) measured,
- Field strength received (RSSI) measured and measurement azimuth



Hybrid localization from measurements

Measurement file name:

Preview:

Generic format: X[separator]Y[separator]FS[separator]AOA (deg)<CR>

Measurement file settings

Separator:  ☐ X and Y are inverted

Coordinate code:

Number of values:

☐ Move measurements on vector line

☐ Use vector polygon(s) as mask

☐ Set clutter to 0 on measurement point

☐ Add measurement to vector layer

Processing

☐ RSSI only

☐ AOA only

☐ AOA + RSSI / AOA or RSSI

☐ Homing (Direction + RSSI)

Tolerance margin (max - n) (dB):

Distance discrimination (meas. pts) (m):

Clutter filter (target transmitter location)

<input checked="" type="checkbox"/> open	<input checked="" type="checkbox"/> rail
<input checked="" type="checkbox"/> village	<input checked="" type="checkbox"/> road
<input checked="" type="checkbox"/> suburban	<input checked="" type="checkbox"/> airport
<input checked="" type="checkbox"/> urban	<input checked="" type="checkbox"/> tunnel
<input checked="" type="checkbox"/> dense urban	<input checked="" type="checkbox"/> open rural
<input checked="" type="checkbox"/> forest	<input checked="" type="checkbox"/> b-plaster
<input checked="" type="checkbox"/> hydro	<input checked="" type="checkbox"/> b-brick
<input checked="" type="checkbox"/> high urban	<input checked="" type="checkbox"/> b-glass
<input checked="" type="checkbox"/> park/wood	<input checked="" type="checkbox"/> b-wood
<input checked="" type="checkbox"/> roof - building	<input checked="" type="checkbox"/> route

Bearing measurement

RMS (deg):

RSSI measurement

Conversion to dBu (+dB):

Min range (measurement):

Max range (measurement):

Tolerance (measure - prediction) (dB):

Threshold (dBu/m):

Meas. Rx antenna (m):  ☒ AGL ☐ ASL

LOS calculation only ☐

Measurement file cases:

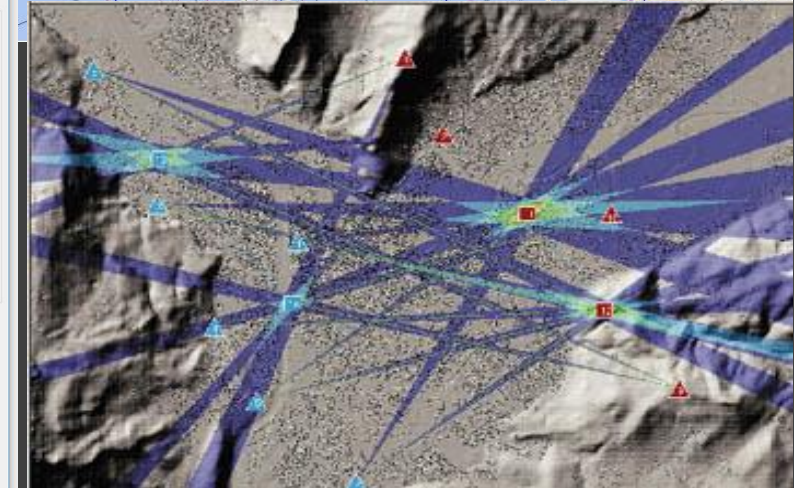
If FS, RSSI localization will be performed

If AOA and FS, RSSI localization sector limited (AOA+RMS)

If AOA only, DF localization (AOA+RMS)

If Homing, AOA = measurement azimuth+RMS

☒ Add localized point(s) on the map



# Annex

References

# References

## Military, Defence administrations

**APCO AFC**

**US Army Spectrum Management Office**

**JSC**, Joint Spectrum Center

**FAA**, Federal Aviation Administration

**DOE**, Dept. of Energy HQ Spectrum Management Office  
Bonneville Power Authority

Western Area Power Authority

National Nuclear Security Administration

**DOI**, Dept. of Interior Wireless Management Office

**FCC**, Federal Communications Commission

**USAF**, United States Air Force

**NASA**, National Aeronautical Space Administration



National Security Agency

**DHS**, Dept. of Homeland Security Wireless Management

US Coast Guard HQ/LANT/PAC

US Customs and Border Patrol

Immigration and Customs Enforcement

**DOJ**, Dept. of Justice Wireless Management Office

FBI, DEA

**INEL**, Idaho National Engineering Laboratory

**SPAWAR**, Space and Naval Warfare Systems Command

**NTIA**, National Telecommunications Information Administration

# References

## Military, Defence administrations

### France:

French National Air Operation center / CNOA (centre national des opérations aériennes française)  
 Signal Corps / CNGF (Centre nationale des Gestions des Fréquences)  
 DGA MI (Direction Générale de l'armement)  
 STAT (Section Technique de l'Armée de Terre)  
 DCI (Défense Conseil International)

### Europe:

NARFA (National Allied Radio Frequency Agency) – Norway  
 DSTL - Defense Science and Technology Laboratory (UK)  
 Royal Air Force Henlow (UK)  
 HMGCC – Her Majesty's Government Communications Centre (UK)  
 Ministry of Defense (Belarus, Kazakhstan, Serbia, Poland, Romania, etc)  
 RUAG Electronics (Switzerland)  
 Armasuisse (Switzerland);  
 FUB (frequency management department/Frequenzmanagement, Switzerland)  
 Finnish Army;  
 British Army;  
 Portuguese Air Force;  
 Norwegian Navy;  
 Forsvarets forskningsinstitutt (FFI);

### MENA:

UAE Air Force (Abu Dhabi)  
 UAE Electronic warfare (Abu Dhabi)  
 Border Guards of KSA  
 Direction Centrale des Transmissions et de Guerre Electronique (Algérie)  
 QESC (Qatari Electronic Signal Corps)  
 Minister of Defense (Bahrein) - BHQ (Bahrein Headquarter)  
 Minister of defense of Morocco (Royal Marine)  
 Ministry of Defense (Oman, Egypt);  
 Egyptian Air Force (EAF)  
 PSDARC (KSA)

### Asia Pacific:

Minister of defense of Bangladesh  
 Minister of defense of China  
 Korean Army Signal School (South Korea)  
 Agency of Defence Development (South Korea)  
 Joint Chiefs of Staff (South Korea)  
 DSO & DSTG (Australia)  
 DSTA (Singapore)  
 PLPE (Malaysia)  
 Land Engineering Agency, ADF (Australia)  
 Indian Air force Army;  
 DLRL (India);  
 Taiwanese Army, Thai Army;...

# References Vendors

---

NOKIA Portugal

Motorola solution (UK, Poland, Norway, Oman, Duba, Pakistan,...)

Thales

Airbus (Germany, Romania, France, Qatar...)

Teltronic (Spain)

Ericsson (France)

KAPSCH (France, Austria, Bulgaria)

Marconi (UK)

Philips (Netherlands)

Raytheon (US)

Sepura (Malaysia)

SELEX (Finmeccanica, Italy)

Boeing (USA)

Rhode and Schwartz (Germany)

Lockheed Martin (USA, UK)

Hytera (Austria, Germany)

Etc...





# Thank you!

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**End of Document**