

Company Overview and Visualyse Products

Presented by:

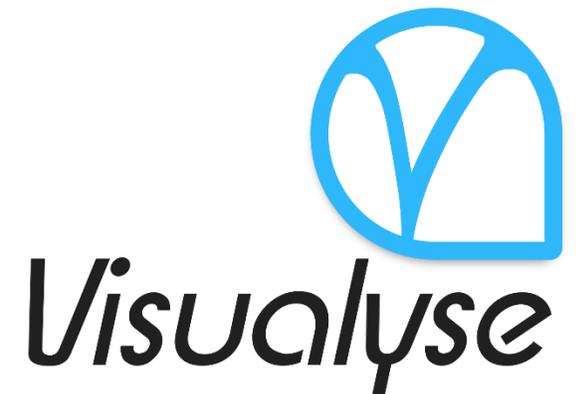
John Pahl

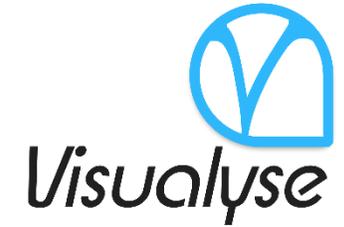
Director

johnpahl@transfinite.com



www.transfinite.com





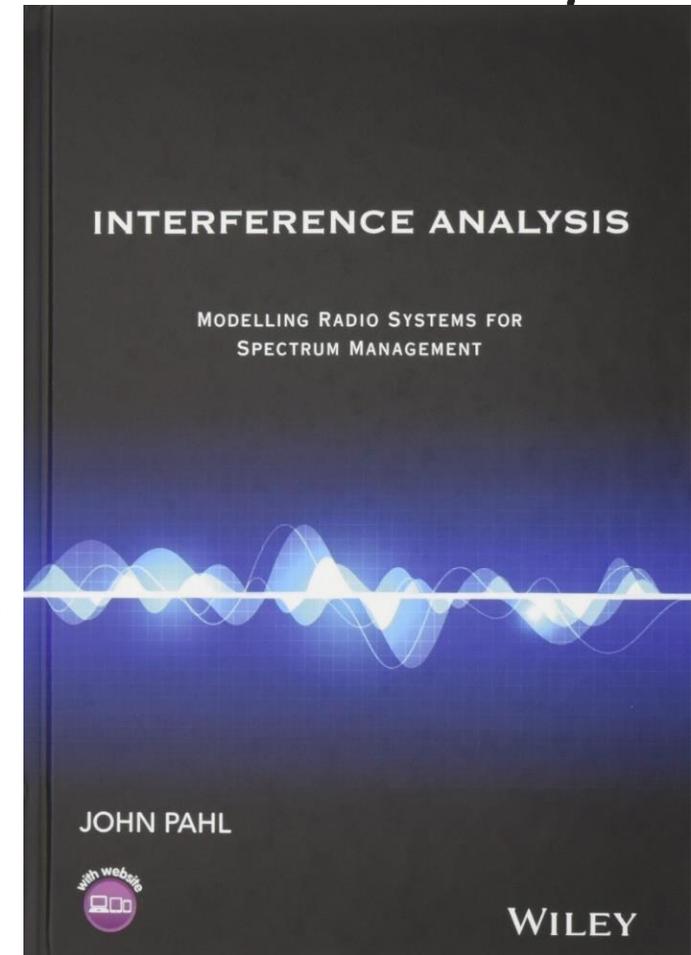
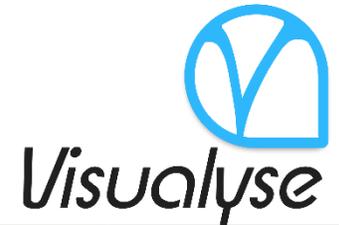
Presentation Overview

- Transfinite Systems Ltd
- Visualyse Products:
 - Visualyse Professional
 - Visualyse Interplanetary
 - Visualyse GSO
 - Visualyse Coordinate
 - Visualyse EPFD
 - PFD Mask Generation Tool
- Summary: Why Visualyse Products



Transfinite Systems Ltd

- UK based independent SME, founded in 1994
- Core focus of company:
 - *Provision of software tools and services to analyse compatibility between radiocommunications systems*
- Key Strengths:
 - Aim to be best at:
 - The tools, methodologies, and analysis techniques that are applicable to interference analysis, coordination and spectrum management
 - Combine with:
 - Wider understanding of the regulatory environment, needs of spectrum managers and spectrum users
 - Reputation and contacts built up over 25 years including UK regulator Ofcom and ITU in Geneva
 - Leading experts in field:
 - Consultants have written books and many papers



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Visualyse Product Range

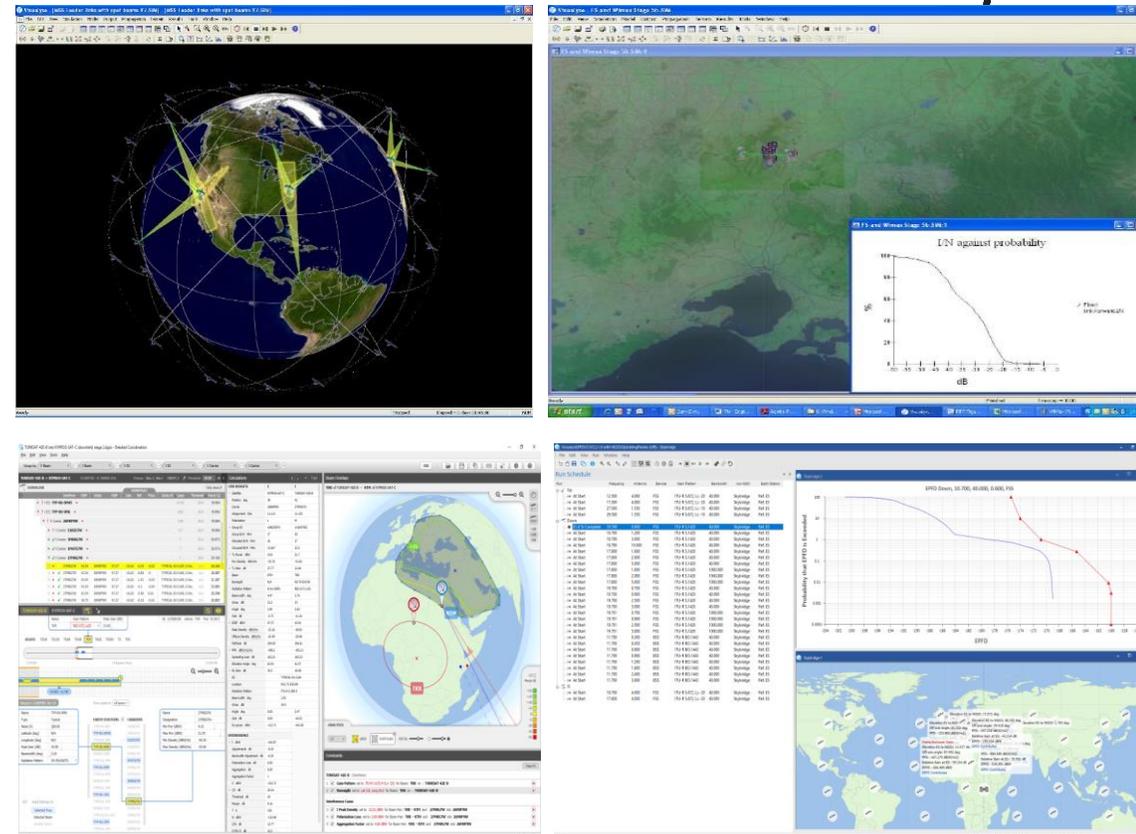
- Transfinite Systems Ltd develop and market range of Commercial Off The Shelf (COTS) software products:
 - **Visualyse Professional** – a generic study tool to undertake interference analysis between a wide range of radio services including terrestrial and satellite
 - Additional Modules: **Define Variable**, **Terrain** and **Traffic**
 - **Visualyse Interplanetary** – a version of **Visualyse Professional** with enhanced geometric framework to support analysis around the Moon, Mars and other celestial bodies
 - **Visualyse GSO** – to support coordination trigger analysis for GSO and non-GSO satellite networks and detailed coordination for GSO satellites
 - **Visualyse Coordinate** – to support the coordination of satellite ES
 - **Visualyse EPFD** – software for regulators and satellite operators to check non-GSO satellite filing meets the EPFD limits in the Radio Regulations and help non-GSO operators develop their filings
 - Extension: **PFD Mask Generation Tool**
- Full support including Training, Support, Maintenance etc.
- Global customer base for products – widely used within fora such as ITU-R
- Also undertake consultancy services and general training



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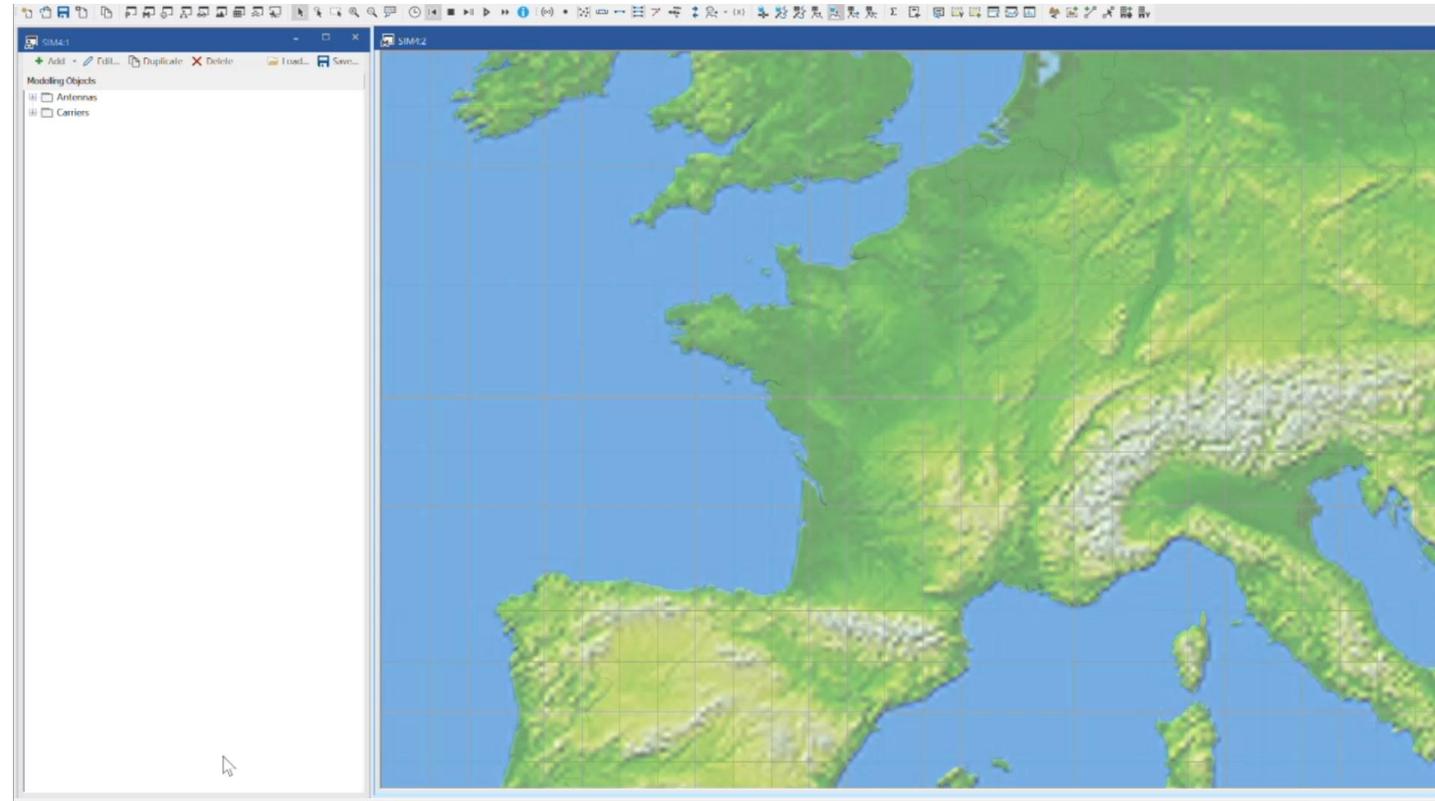
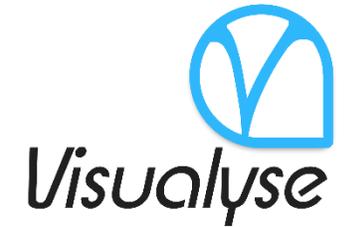


Visualyse



Visualyse Professional Overview

- Flexible **Study Tool** for Radio Communication Systems
- Model wide range of systems, civil and military:
 - **FS: P-P, P-MP, MP-MP – including WiMax, FWA etc.**
 - BS: DAB, DVB, DBV-H, Analogue etc.
 - MS: BR / PMR, 2G, 3G, 4G, 5G etc.
 - Satellite: FSS, BSS, MSS, ISLs
 - GSO, non-GSO, HEO
 - Earth, Moon, Mars etc.
 - Aeronautical & Maritime: UAVs, ESVs, ESIMs, radar etc.
 - Science: Radio Astronomy, Meteorological, remote sensing etc.
- Calculates signal strength for wanted and interfering systems:
 - C, I, C/I, C/N, C/(N+I), I/N, PFD, EPFD
 - Availability and throughput statistics
 - Co-frequency and non-co-frequency
 - Single entry and aggregate interference
- Wide range of modelling methodologies:
 - Static, Input-variation, Area, Dynamic, Monte Carlo etc.



Import from ITU's Terrestrial IFIC

PtP Fixed Links

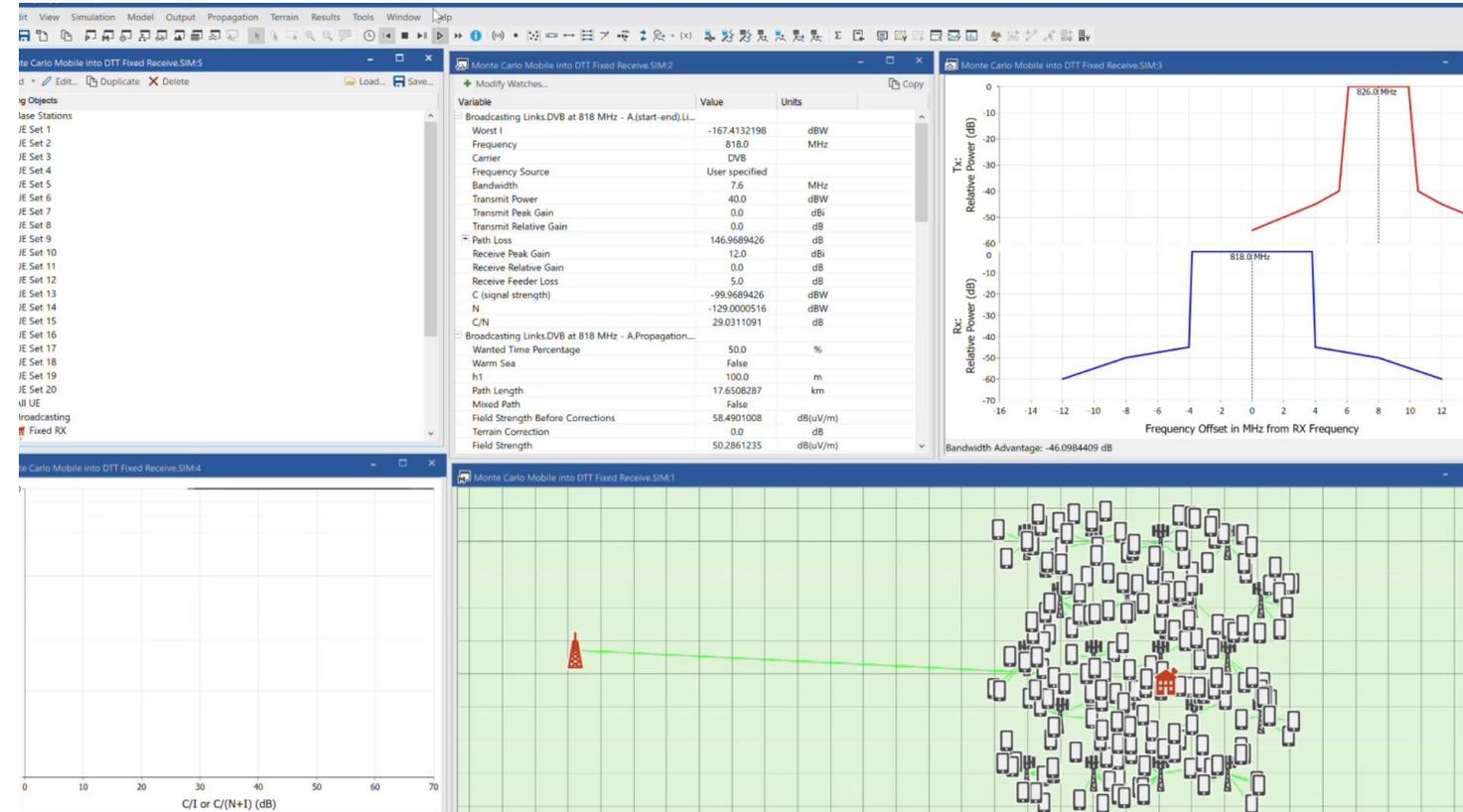
Propagation models = P.525, P.530, P.452



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Mobile into terrestrial DVB receiver

Non-co-frequency scenario with calculation of NFD

Monte Carlo modelling using Define Variable Module



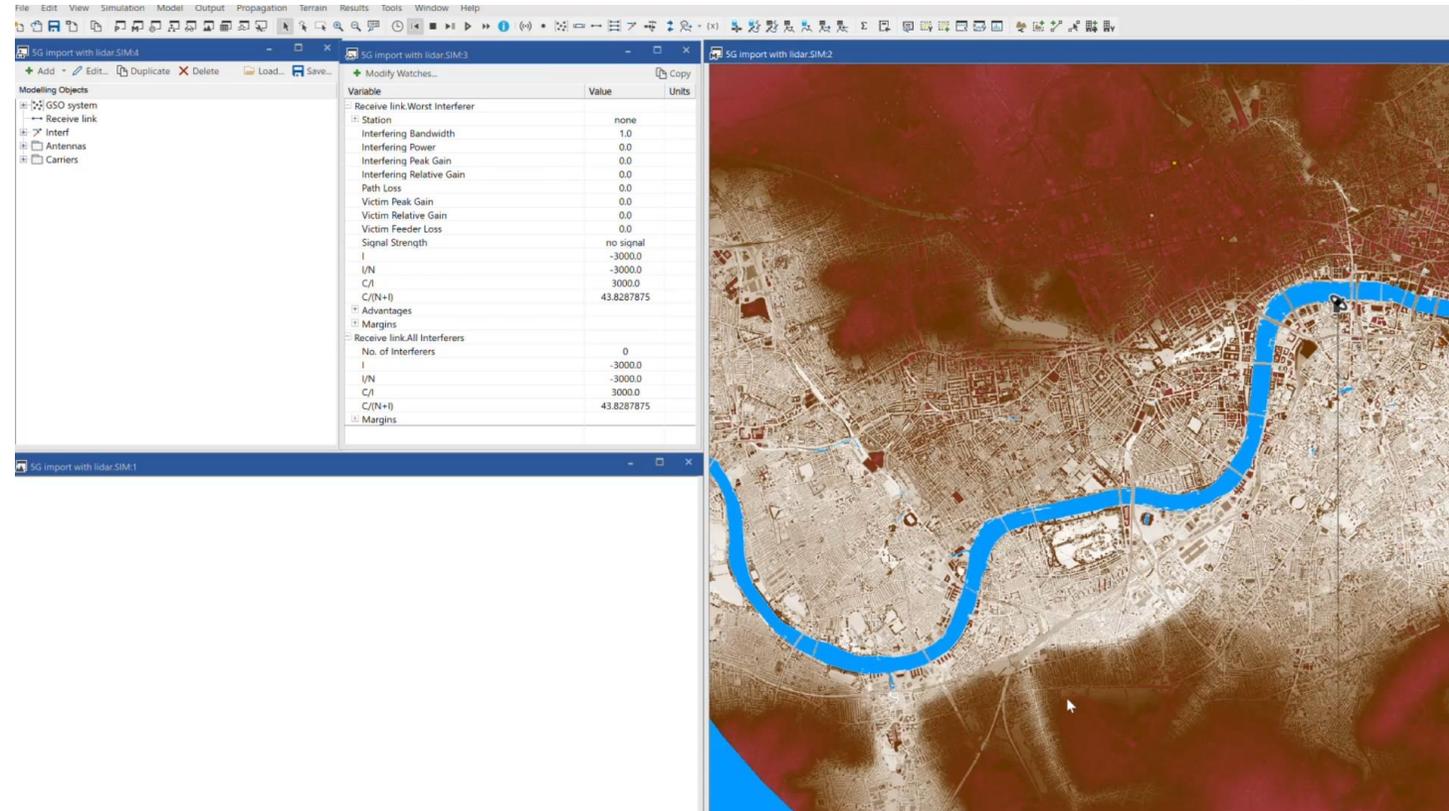
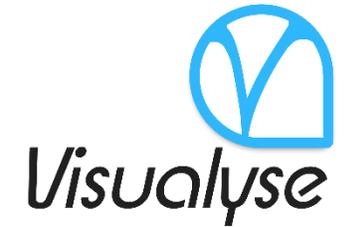
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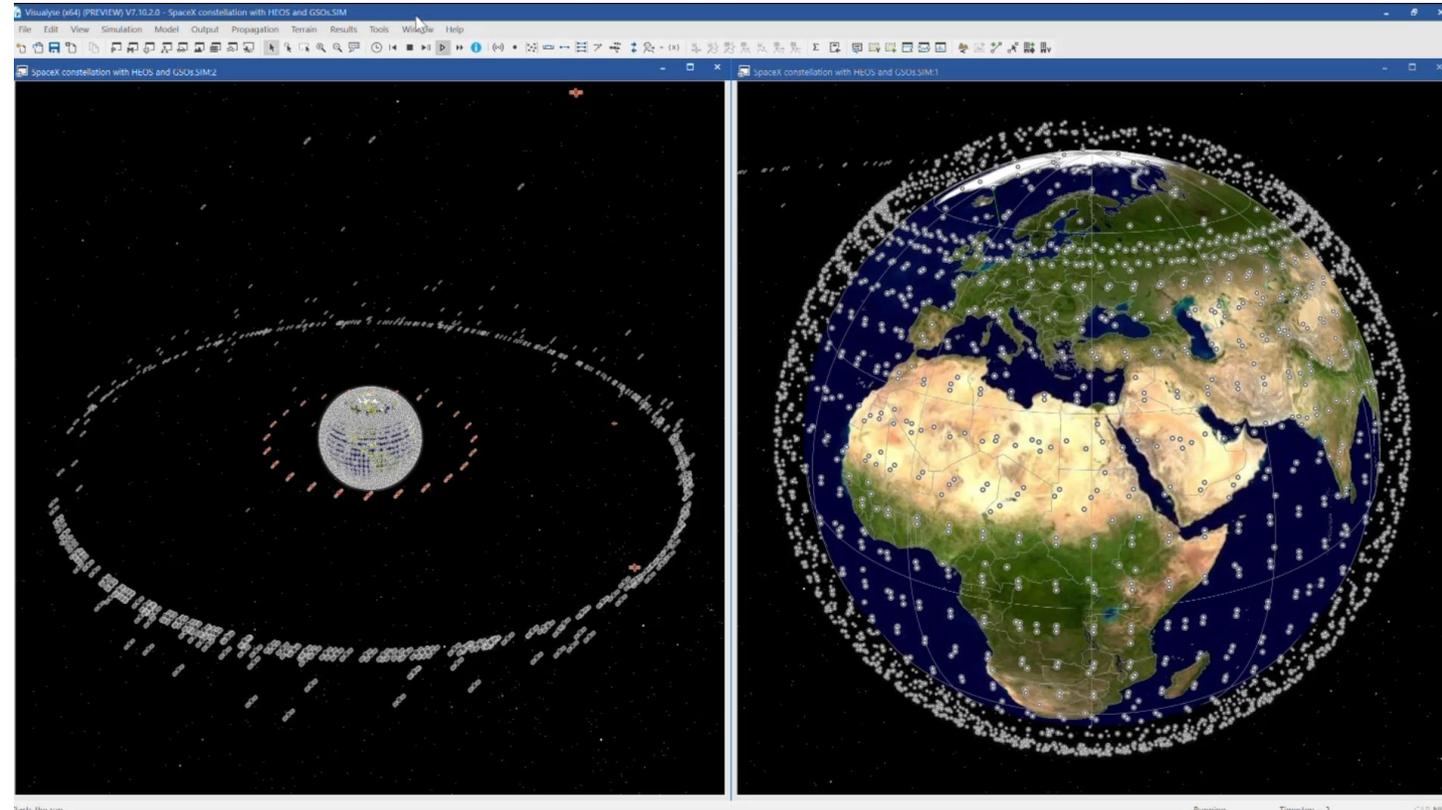
Import 5G systems using text files

Monte Carlo modelling using Define Variable Module

Lidar data used with P.2001 propagation model

Visualyse Professional Overview

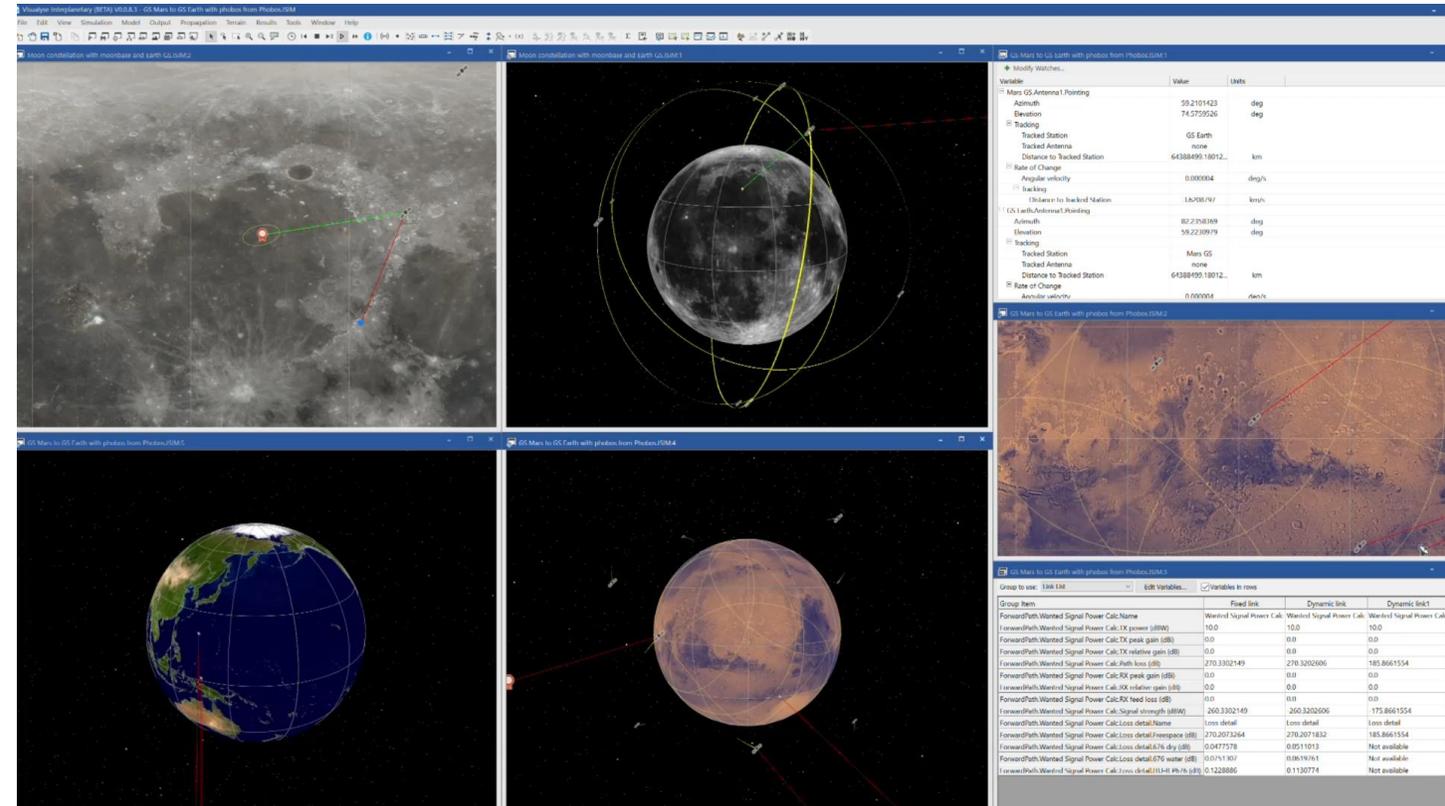
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SpaceX full constellation made from multiple sub-constellations in LEO
 O3B in MEO
 Geostationary satellites from TLE import
 HEO systems in 24 hour orbit

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Visualyse Interplanetary

Missions around the Moon and Mars communicating with Earth
Constellations around Moon communicating with Lunar surface

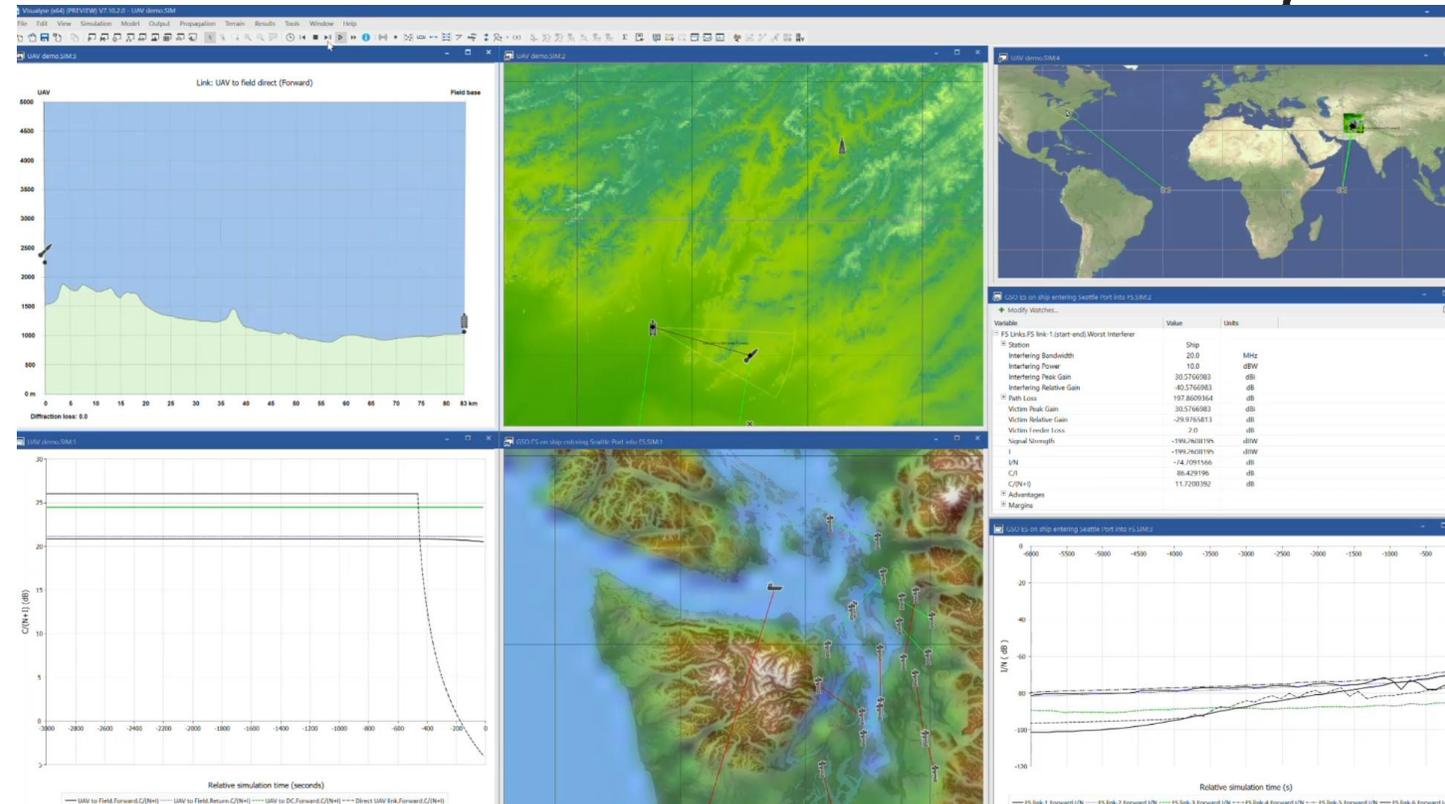




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UAV on flight path with ground and satellite links

Earth station on vessel entering port interfering with fixed links

Waypoints set using Define Variable



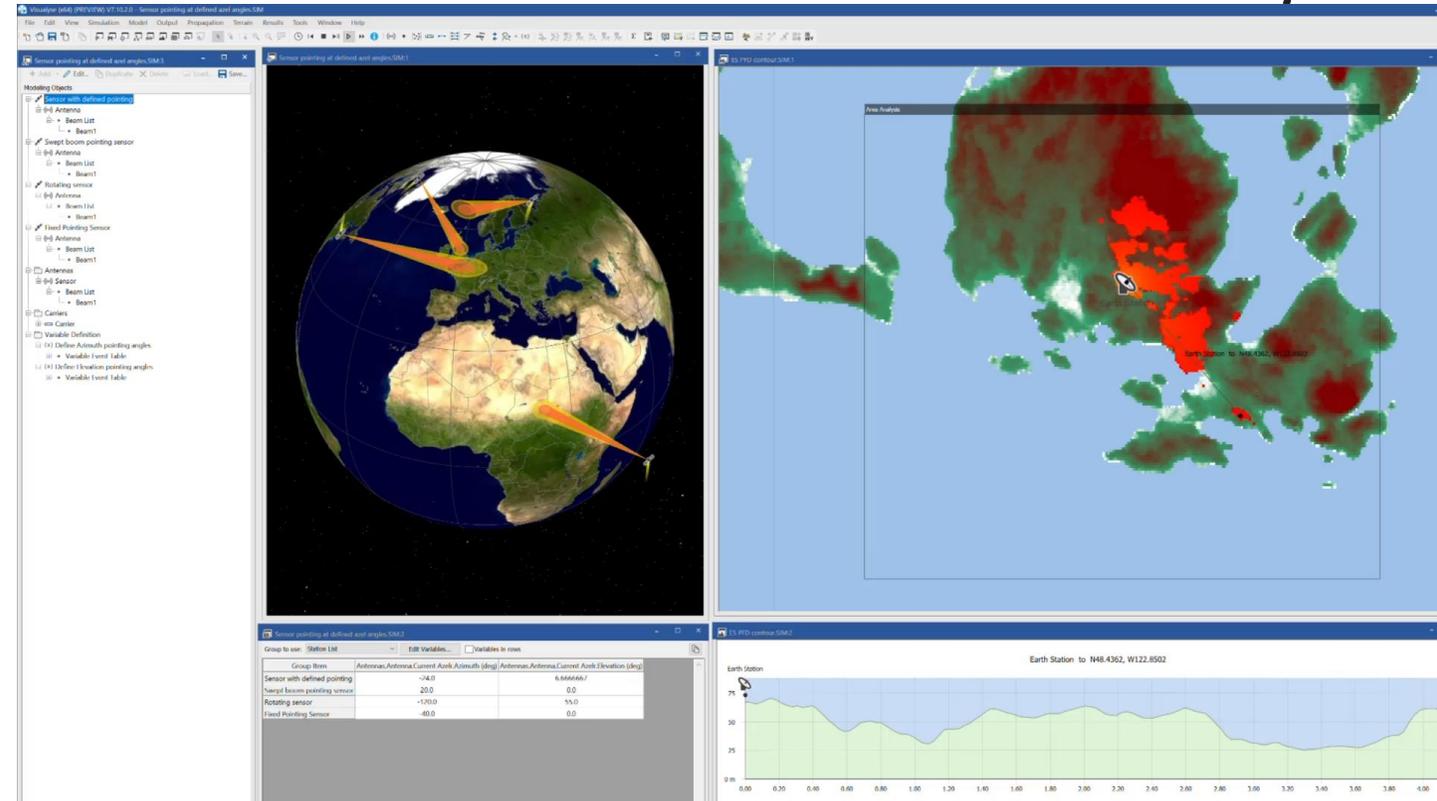
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EESS sensor with pointing using Define Variable
Area Analysis calculating protection zone around a sensitive site



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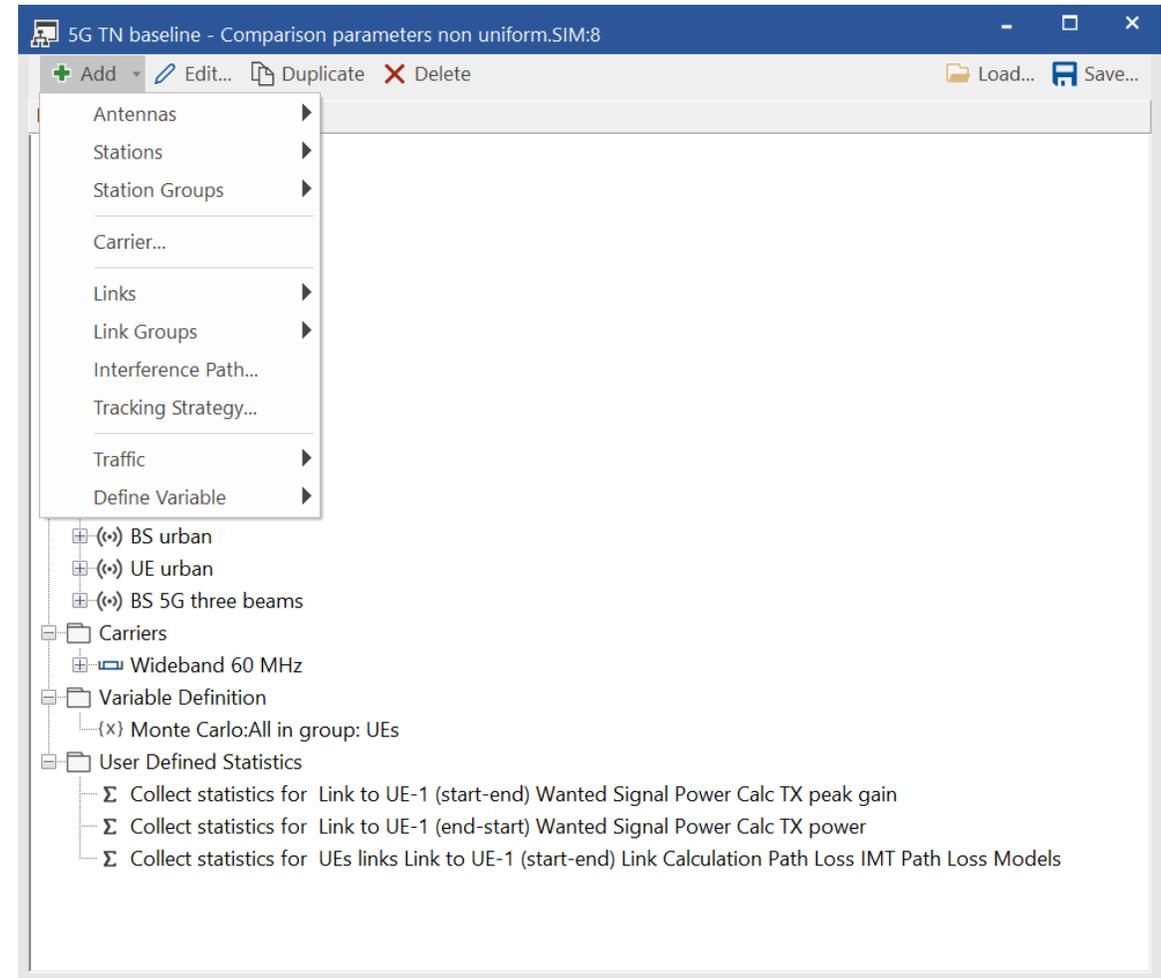
How it Works



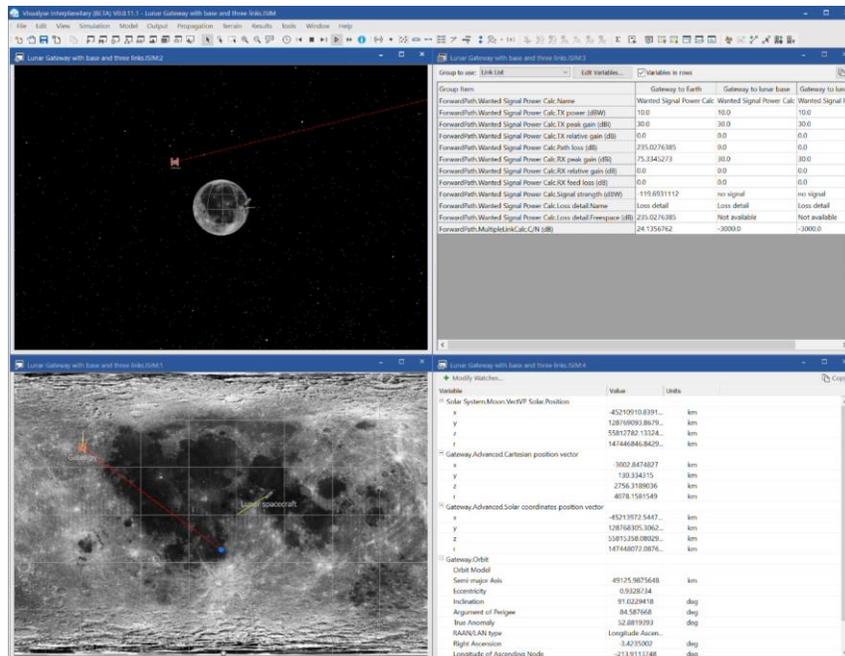
- Powerful object model:
 - Antenna Types
 - Stations
 - Carriers
 - Propagation environments
 - Tracking strategies
 - Links
 - Interference Paths
 - Traffic
 - Define Variable
- Libraries of core algorithms:
 - Station dynamics
 - Antenna pointing methods
 - Propagation models
 - Gain patterns
 - Station selection rules
 - Etc.



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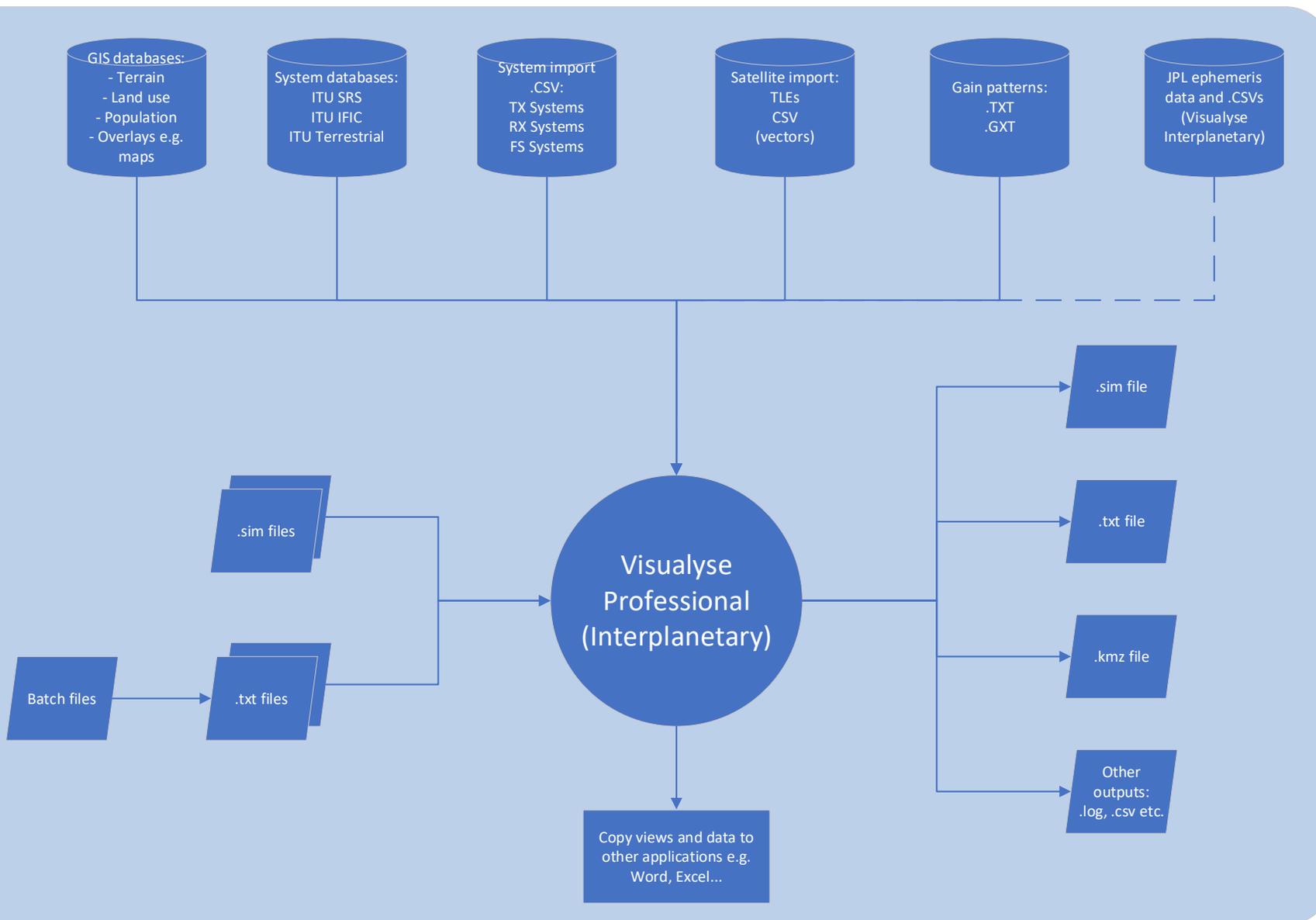


Visualyse Professional Versions



Version:	Visualyse Professional	Visualyse Interplanetary
Earth model:	Spherical	Ellipsoidal
Includes nutation etc.:	No	Yes
Coordinate system:	Earth Centred Inertial (ECI)	J2000.0 vectors
Celestial bodies:	Earth only	Solar system
Includes Doppler:	No	Yes
Orbit models:	Point mass, point mass plus J2	Point mass, point mass plus J2, SGP4/SDP4, vector import
Point at astronomical object:	No	Yes
Julian dates and dynamic time:	No	Yes

Interfaces: Files and Databases



Visualyse Professional Libraries and Update Process



- The industry is always changing
- We intend to remain the leading tool for radiocommunication studies
- We keep track of work within industry bodies and international regulatory organisations (ITU, CEPT, 3GPP etc.)
- Frequently update propagation models and gain patterns
- Additional features included as part of continual update process
- Covered by the Visualyse Annual Maintenance and Support(AMS) contract



Propagation Model Selection

Propagation Models

<input type="checkbox"/> ITU-R Rec. P.525	basic transmission loss in free space
<input checked="" type="checkbox"/> ITU-R Rec. P.452	propagation model for terrestrial interference analysis
<input type="checkbox"/> ITU-R Rec. P.526	propagation loss due to diffraction over terrain
<input type="checkbox"/> ITU-R Rec. P.528	propagation for aeronautical mobile in VHF/UHF/SHF bands
<input type="checkbox"/> ITU-R Rec. P.530	multipath model used in design of terrestrial links
<input type="checkbox"/> ITU-R Rec. P.1546	propagation model for terrestrial services
<input type="checkbox"/> ITU-R Rec. P.1791	propagation model for ultra-wideband applications
<input type="checkbox"/> ITU-R Rec. P.1812	propagation model for point-to-area services in VHF/UHF bands
<input type="checkbox"/> ITU-R Rec. P.2001	general purpose terrestrial propagation model (20 MHz-50 GHz)
<input type="checkbox"/> ITU-R Rec. P.2108	prediction of Clutter Loss (30 MHz - 100 GHz)
<input type="checkbox"/> ITU-R Rec. P.2109	prediction of Building Entry Loss (80 MHz - 100 GHz)
<input type="checkbox"/> Longley-Rice	propagation model for point-to-point services (20 MHz-40 GHz)
<input type="checkbox"/> ITU App. S7 Mode 1	(WRC 95) great circle path loss
<input type="checkbox"/> ITU App. S7 Mode 2	(WRC 95) rain scatter loss
<input type="checkbox"/> ITU App. S7 1&2	(WRC 95) great circle and rainscatter loss
<input type="checkbox"/> Egli	for terrestrial mobile at 900MHz
<input type="checkbox"/> Hata/COST 231	for terrestrial mobile up to 2GHz
<input type="checkbox"/> Lee	for point to area model applicable at 900MHz
<input type="checkbox"/> TIA Bulletin 10F	used in fixed service coordination
<input type="checkbox"/> Extra Losses	fixed or path dependent losses
<input type="checkbox"/> IMT Path Loss Models	ABG, CI/CIF, 3GPP TR 38.900/38.901, WINNER II/+, M.2135

Rain Models

<input type="checkbox"/> ITU-R Rec. P.530	rain model used in design of terrestrial links
<input type="checkbox"/> ITU-R Rec. P.618	rain model used in the design of satellite links
<input type="checkbox"/> Crane Rain Model	rain attenuation model

Atmospheric Losses

<input type="checkbox"/> ITU-R Rec. SF.1395	loss due to atmospheric gas for FSS into FS
<input type="checkbox"/> ITU-R Rec. P.676	loss due to atmospheric gas for terrestrial and slant paths
<input type="checkbox"/> ITU-R Rec. P.840	attenuation due to clouds and fog
<input type="checkbox"/> Dry Air	attenuation through a dry atmosphere
<input type="checkbox"/> Water	attenuation due to water vapour

OK Cancel

Antenna Type Properties

5G BS gain pattern

Circular Elliptical Shaped Contour

Roll-off: ITU-R M.2101 Change

Roll-off parameters: <Determined by the pattern> Params

Beamwidth: deg

Peak gain: 23.06175 dBi

Gain floor: dB

Electronically steerable

Advanced...

Slice angle: 0.0 deg

Peak = 23.1

Polar Cartesian

Beamwidth is half-power beamwidth

OK Cancel

Edit ITU-R M.2101 Parameters

Element gain: 5.0 dBi

	Horizontal	Vertical
Number of elements:	<input type="text" value="8"/>	<input type="text" value="8"/>
D to Lambda:	<input type="text" value="0.5"/>	<input type="text" value="0.5"/>
Beamwidth:	<input type="text" value="65.0"/>	<input type="text" value="65.0"/>
Front to back:	<input type="text" value="30.0"/>	<input type="text" value="30.0"/>
	-180 <= Az <= 180	-90 <= El <= +90
Maximum scan angle:	<input type="text" value="60.0"/>	<input type="text" value="60.0"/>
Minimum scan angle:	<input type="text" value="-60.0"/>	<input type="text" value="-60.0"/>

Extended pattern: Subarray

Number of elements:

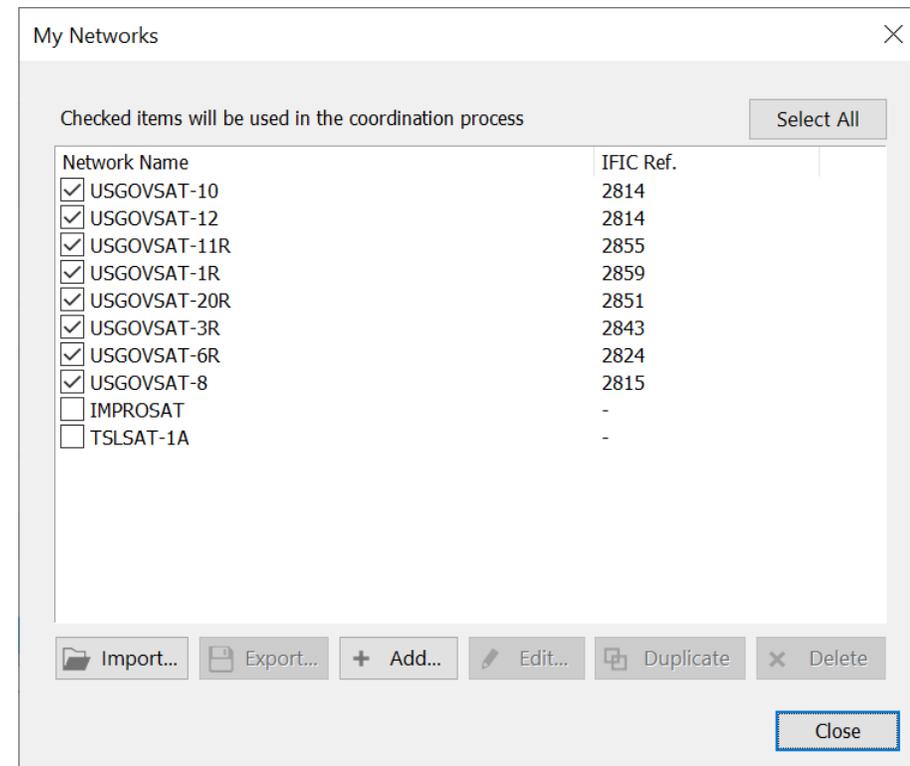
D to Lambda:

Downtilt: deg

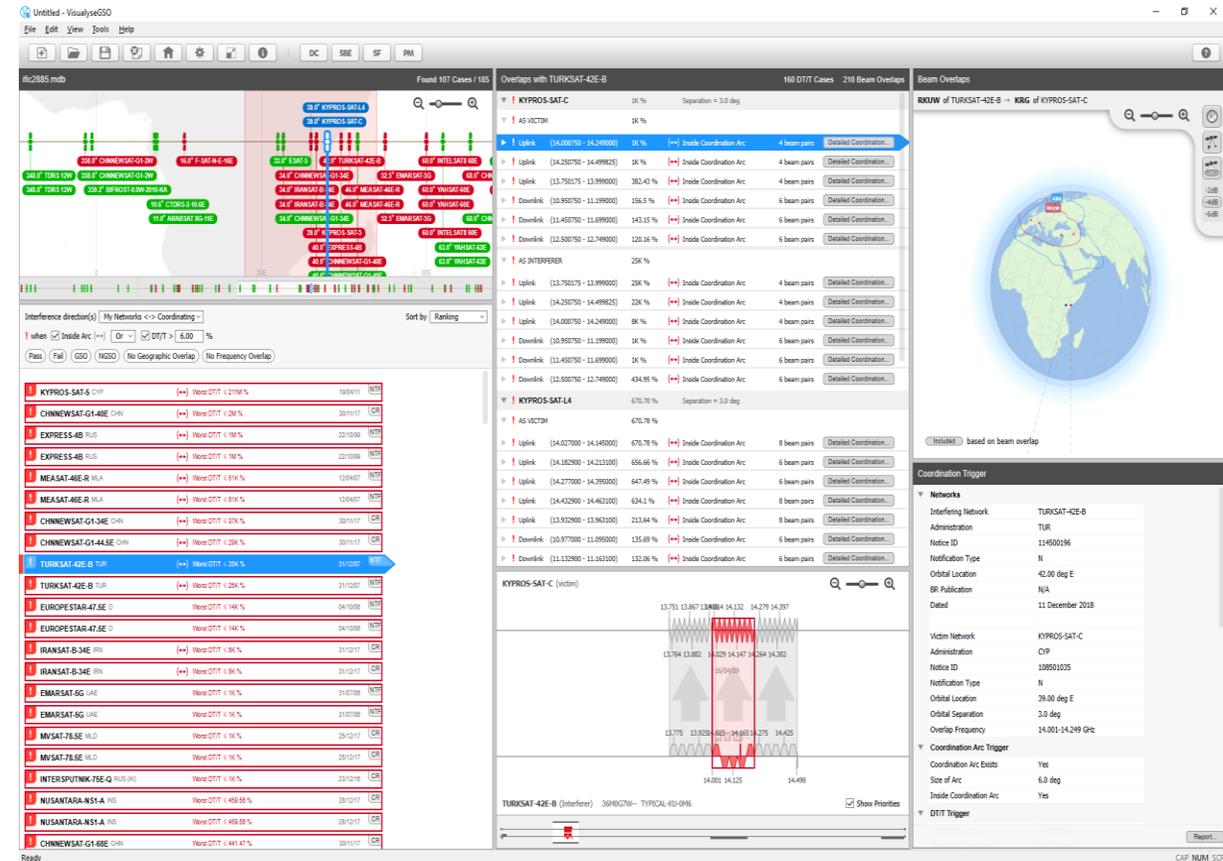
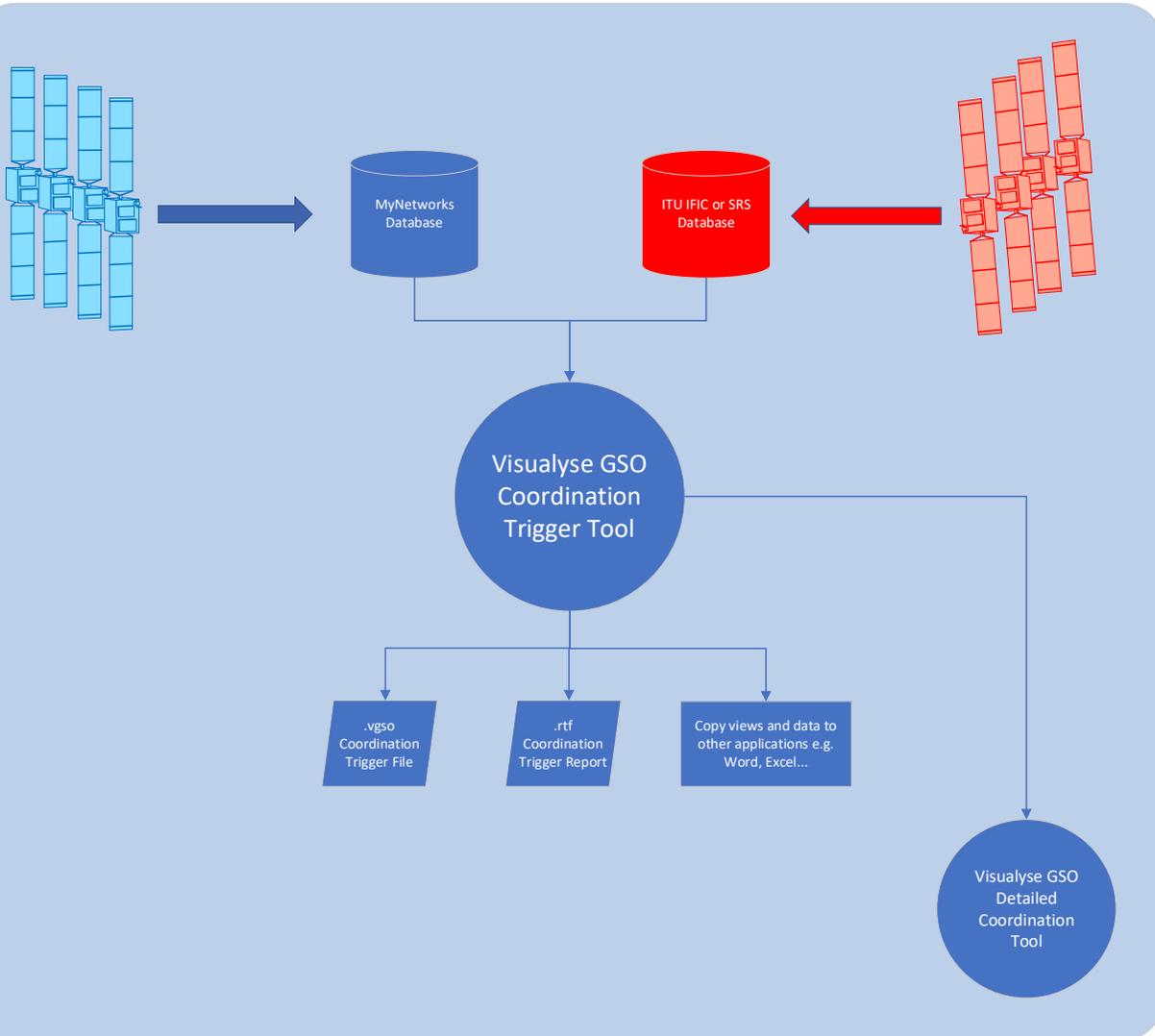
OK

Visualyse GSO

- Designed to support coordination of GSO and non-GSO satellite networks
- Key attributes
 - Ability to define My Networks
 - **Both GSO networks and non-GSO systems**
 - Import from SRS/IFIC or create New
 - Ability to check My Networks (both GSO and non-GSO) against ITU BR IFIC:
 - Coordination Arc
 - DT/T
 - Frequency overlap
 - Ability to undertake detailed coordination analysis for GSO-GSO scenarios
 - Ability to generate reports to support the process
- Additional tools including:
 - Priority Map
 - Slot Finder



Visualyse GSO Coordination Trigger



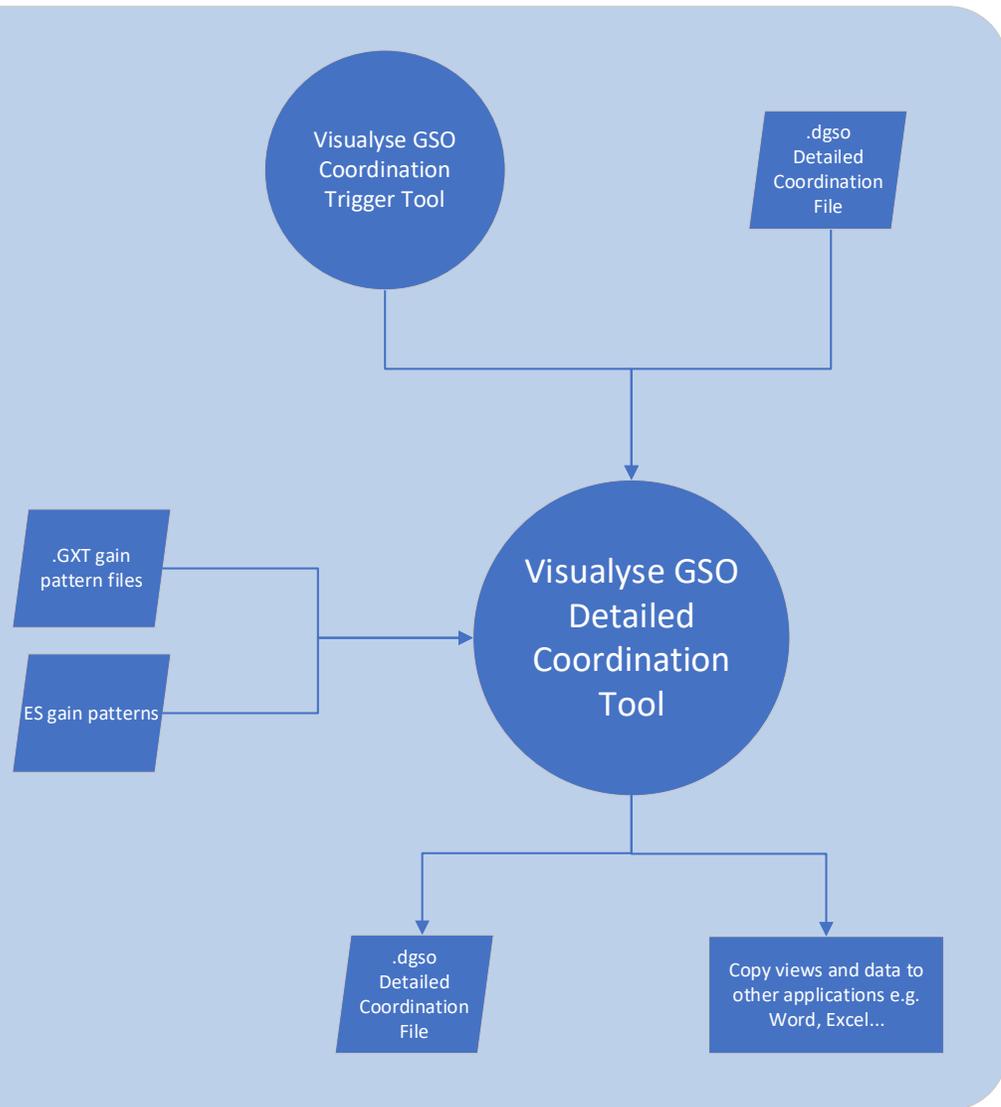
Designed for **both GSO and non-GSO** coordination trigger analysis

Visualyse GSO Coordination Trigger Views:

- GSO arc satellite map
- Network list
- Overlaps
- Overlaps diagram
- 3D view and beam overlaps
- Coordination trigger and calculations

Visualyse GSO

Detailed Coordination



The screenshot displays the Visualyse GSO Detailed Coordination Tool interface. The main window is titled "TURKSAT-42E-B into KYPROS-SAT-C (downlink) stage 2.dgso - Detailed Coordination". The interface is divided into several panels:

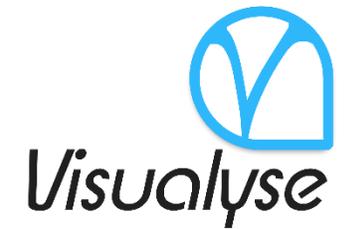
- Interferer Table:** Lists various interferers with columns for ERP, Victim, ERP, Gain, BW, Ploss, Victim ES, Cases, Threshold, and Worst Q1. Interferers include TYP-KU-0M45, TYP-KU-0M6, and several 26M0F9W and 27M0G7W carriers.
- Beam Budgets Table:** Shows parameters for the satellite (TURKSAT-42E-B) and carrier (KYPROS-SAT-C), including Position, Carrier, Assignment, Polarisation, Group ID, Group BW, Allocated B/W, Occupied B/W, Tx Power, Pwr Density, Tx Gain, Beam, Bore-sight, Radiation Pattern, Beamwidth, Gmax, Angle, Grel, ERP, Peak Density, Off-axis Density, Pathloss, PFD, Spreading Loss, Elevation Angle, and Rx Gain.
- Earth Stations Table:** Lists earth stations under "CARRIERS" with columns for Name, Type, Noise, Latitude, Longitude, Peak Gain, Beamwidth, and Radiation Pattern. Stations include TYP-KU-0M5, TYP-KU-0M6, TYP-KU-0M9, TYP-KU-1M2, TYP-KU-2M4, and TYP-KU-2M4.
- Beam Overlaps Map:** A globe showing the coverage areas of the satellite (TKR) and earth stations (TKM). The map includes a legend for peak density and a "CONTOURS" control.
- ANALYSIS Panel:** Displays constraints and interference cases. Constraints include Gain Pattern, Bore-sight, and C-ERP. Interference cases include Peak Density, Polarisation Loss, and Aggregation Factor for various beam pairs.

Designed for GSO to GSO satellite coordination

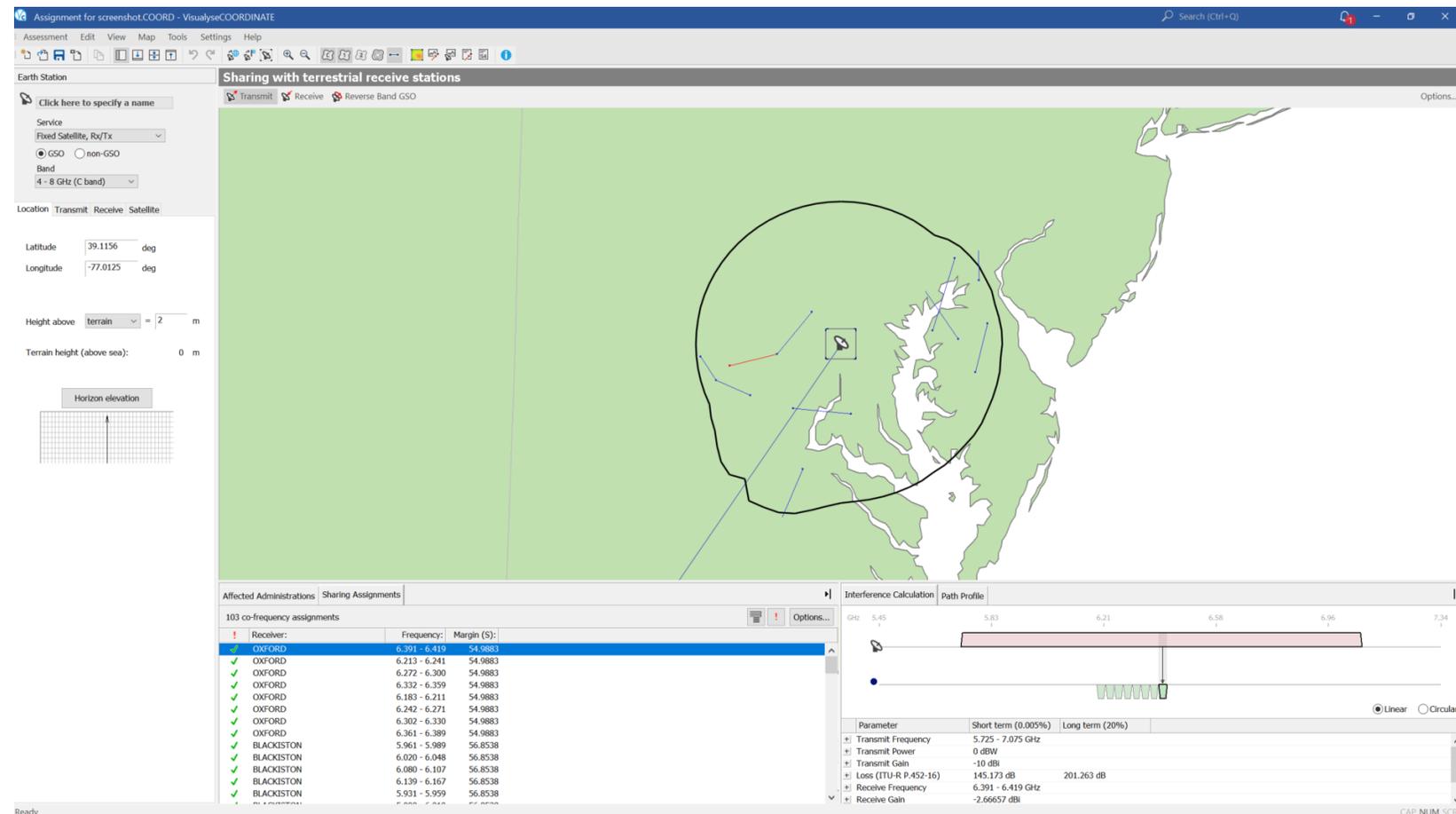
Visualyse GSO Detailed Coordination Views:

- Interference cases
- Network editor
- Calculations
- Beam overlaps
- Constraints

Visualyse Coordinate



- Visualyse Coordinate supports the coordination of satellite ES with terrestrial services
 - Both GSO and non-GSO ES
- Implements algorithm in Appendix 7 to generate contours
 - Mode 1 and Mode 2
- Can undertake detailed interference analysis with those assignments inside the contour
- Can interface to databases:
 - Terrain / surface data
 - FS assignments
 - ES assignments
- Site Analysis tool to identify preferred location for new ES or gateway





Visualyse

Visualyse EPFD

- Visualyse EPFD uses the algorithm in Recommendation ITU-R S.1503-2 to determine if non-GSO FSS networks meet the EPFD thresholds in Article 22 of the Radio Regulations
 - EPFD = Equivalent Power Flux Density
- Visualyse EPFD is a commercialised version of a tool developed for the ITU
- Visualyse EPFD has an interactive user interface that:
 - Shows the runs generated
 - Shows the status of each run
 - Shows the worst case geometry (WCG) calculated
 - Allows different geometries of GSO satellite and Earth Station to be selected
 - Shows the location of each non-GSO satellite and Earth Station
 - Shows the calculation components that make up the aggregate EPFD
 - Includes additional optimisation and performance options
 - Includes ability to undertake Resolution 770 analysis to check Q/V band systems against the 22.5L limits agreed at WRC-19
- Additional tool to support the generation of satellite PFD mask:
 - PFD Mask Generation Tool



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Visualyse EPFD Users and Requirements



Different User Communities have different requirements

Non-GSO Operator:

- Need to generate PFD Masks
- Need to ensure system and its filings will meet the EPFD limits
- Need to optimise system design including PFD Masks
- Need to check other geometries

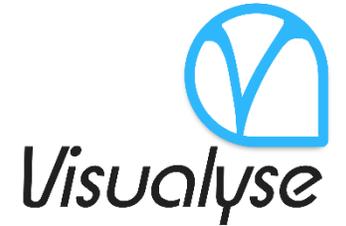
GSO Operator:

- Want to check their geometry will be protected (not just the worst-case geometry)
- Check assumptions behind non-GSO filing
- Check sensitivity to non-GSO system parameters

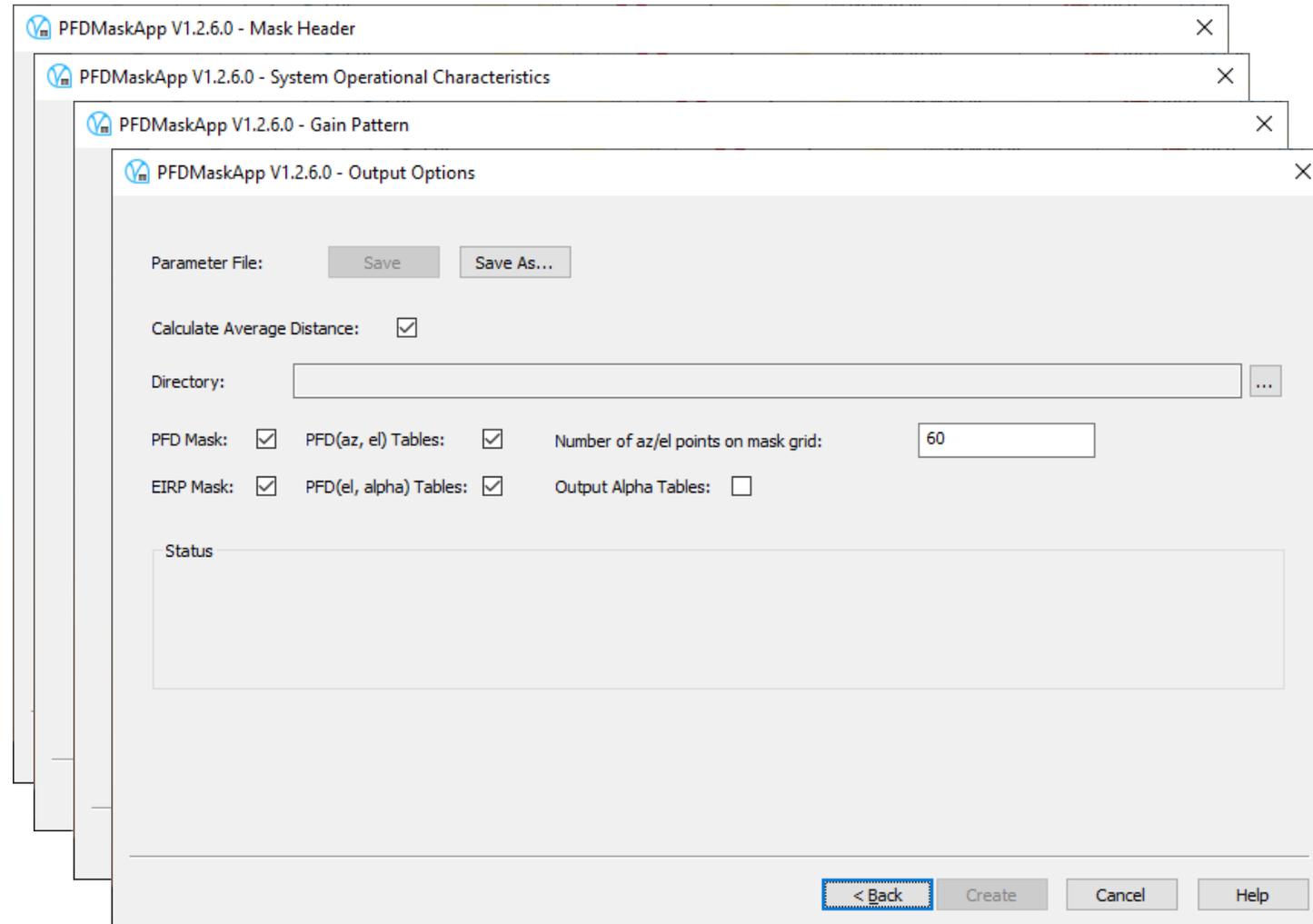
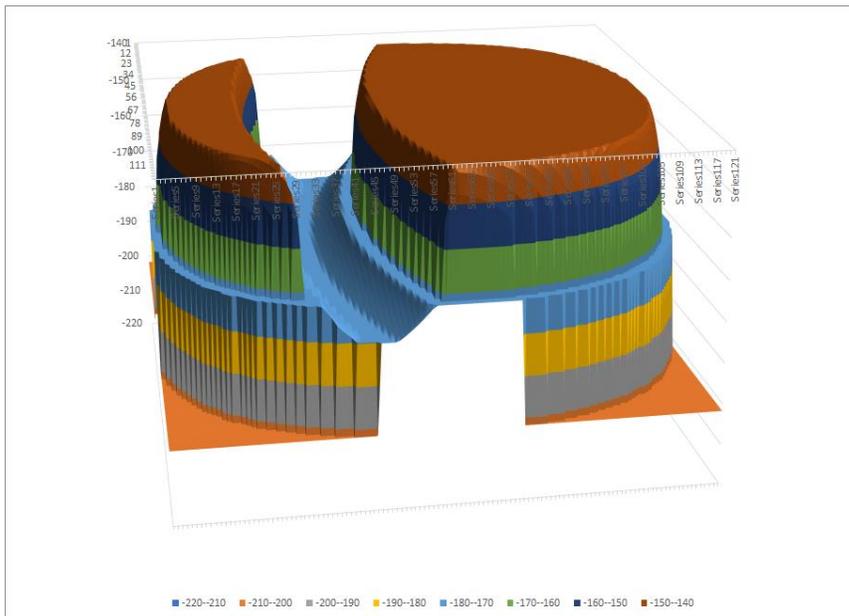
Regulators:

- Might want to do their own checks on individual systems
- Might want to check aggregate EPFD limits against Resolution 76 limits
- Might want to do their own checks on Q/V band systems under Resolution 770

PFD Mask Generation Tool



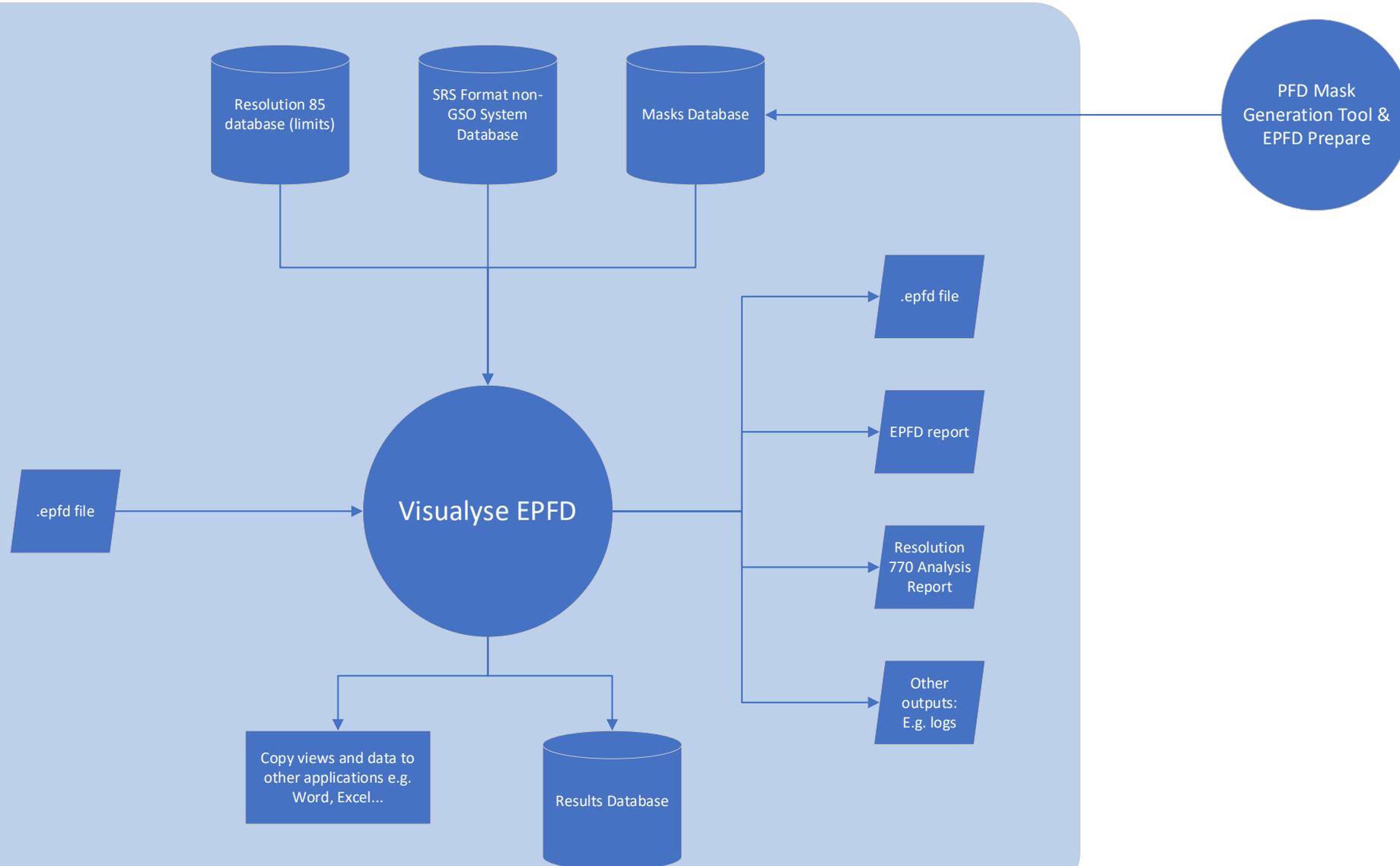
- Generates the PFD masks required for EPFD(down) analysis
- Can model systems using:
 - Steerable spot beams
 - Single fixed pointing beam
- Outputs:
 - PFD(az, el) mask in ITU's XML format
 - Visualisation files of PFD(az, el) by latitude
 - Density and distance fields required for EPFD(up) analysis



Visualyse EPFD Interfaces



Visualyse



Visualyse EPFD Analysis



New Run Definition

SRS Database: Presentations\Vis EPFD Demo inputs\OneWeb_Ka_SRS_Updated_LES.mdb ...

Masks Database: ct Presentations\Vis EPFD Demo inputs\OneWeb_Ka_Masks_reentered.mdb ...

Results Database: AppData\Roaming\Transfinite Systems\VisualyseEPFDV3\EPFDResults.mdb ...

Run Type: Art. 22 Select Non-GSO Operating Parameters XML File ...

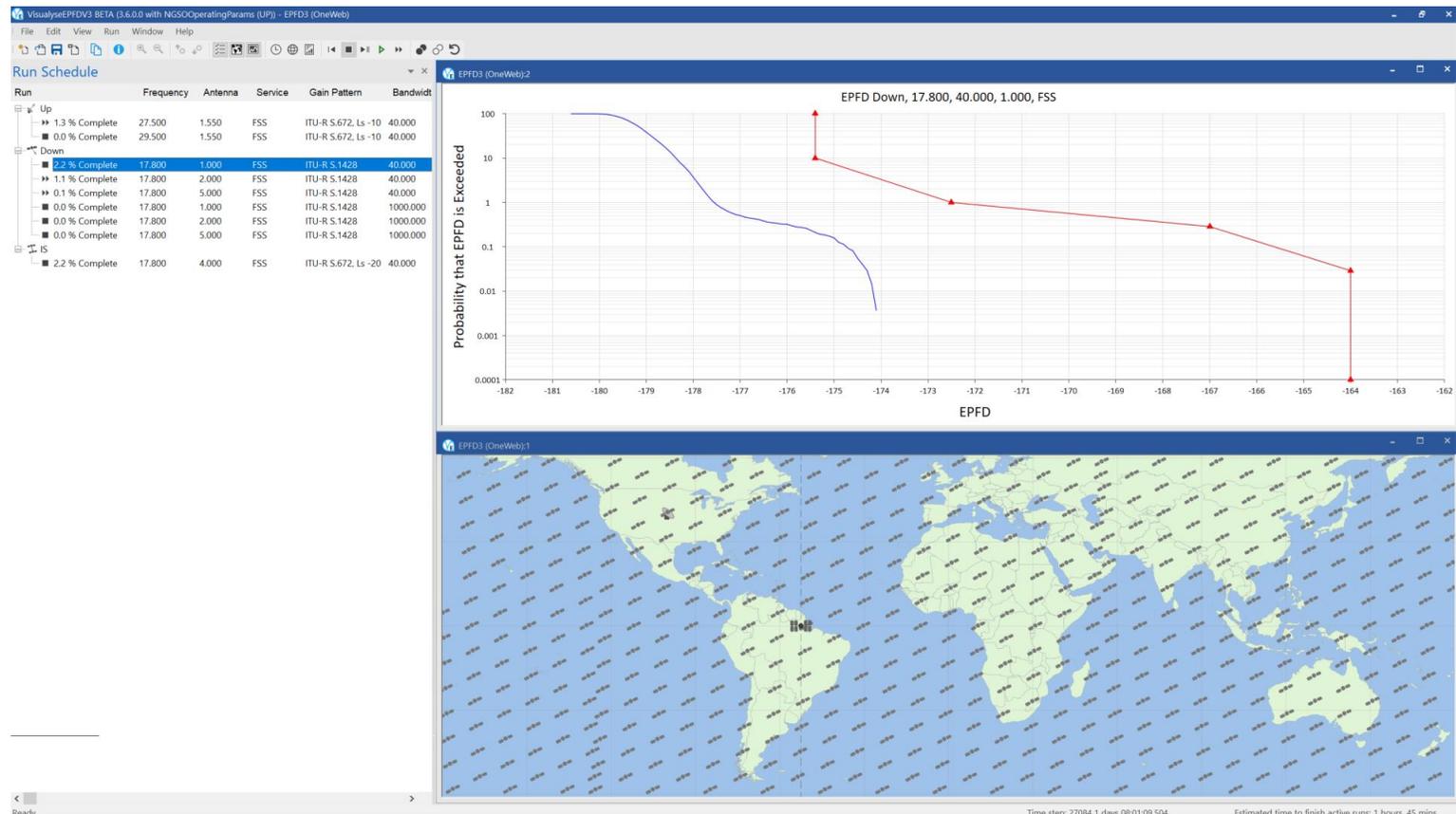
Non-GSO System: EPFD3 (OneWeb) ntc_id: 101

Timestep Calculation: TS 2

Worst Case Geometry: Settings...

Use Analytical Alpha

Start Close

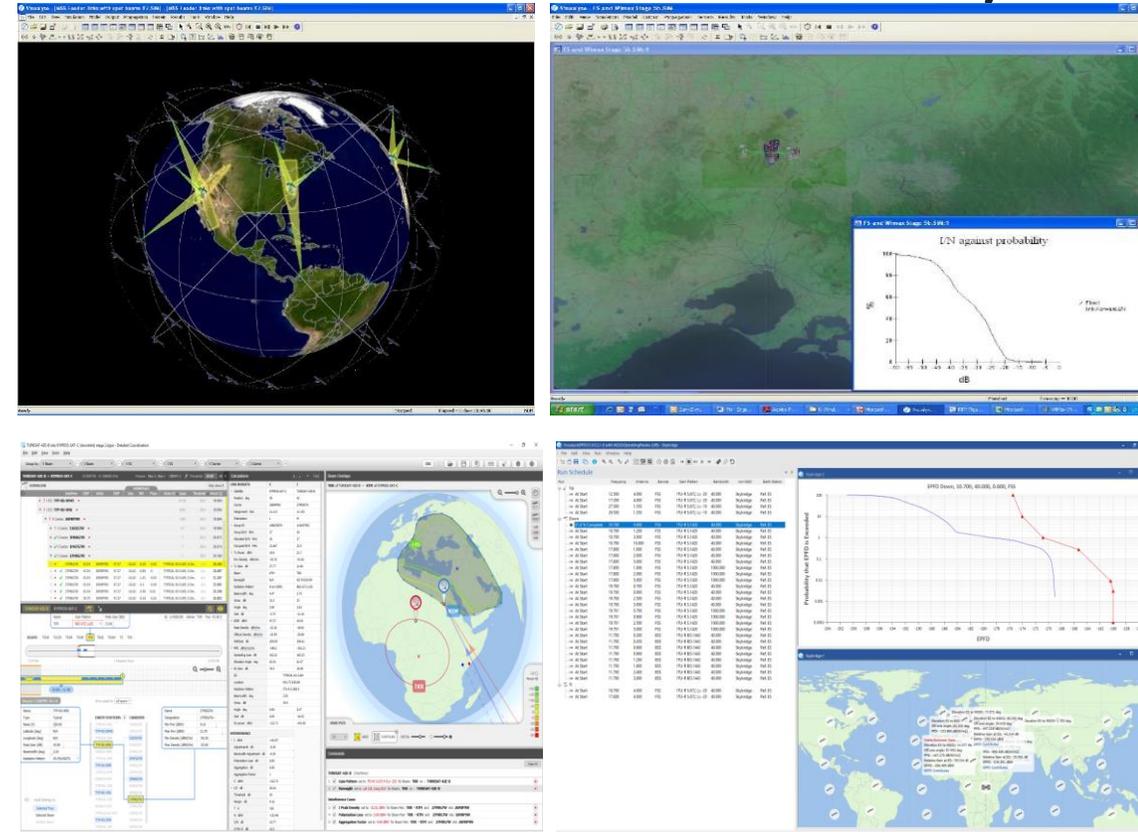




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Thank you!

- Demonstration software available from our web site
- Happy to provide slides
- Further information available on request

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