Company Overview and Visualyse Products

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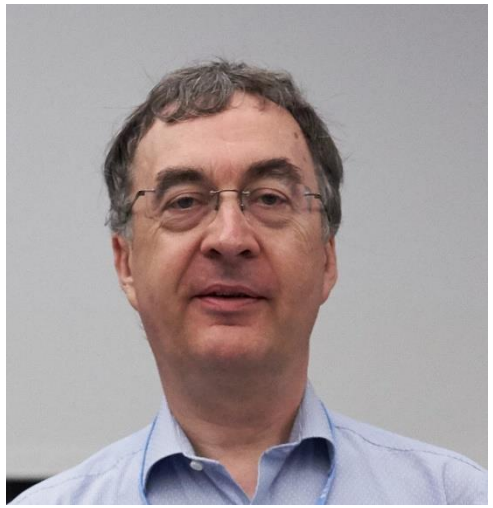


www.transfinite.com

Visualyse

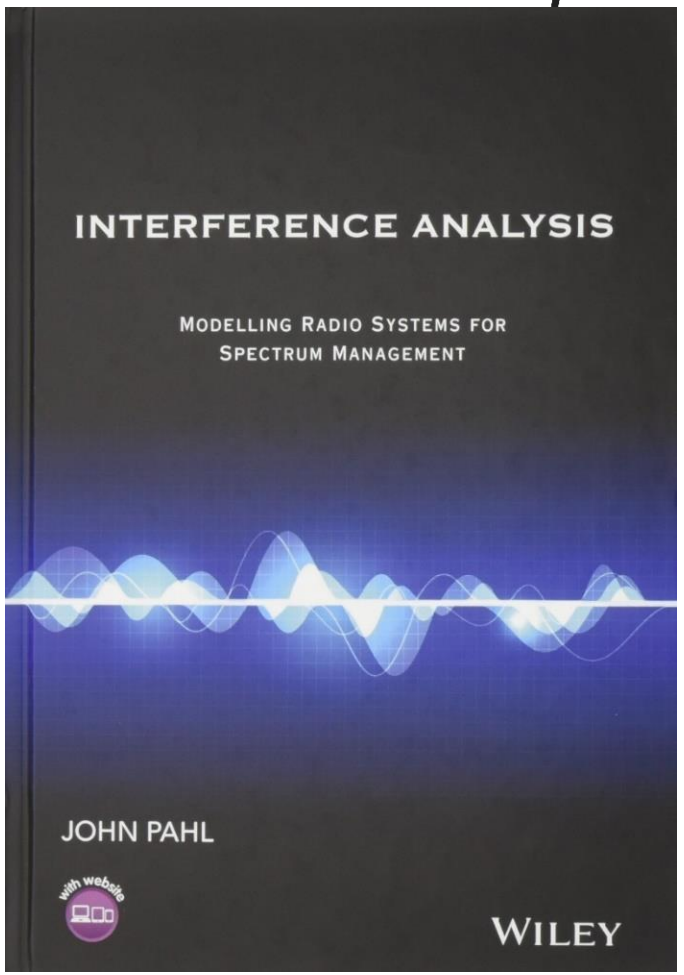
Presentation Overview

- 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

Visualyse



TRANSFINITE SYSTEMS

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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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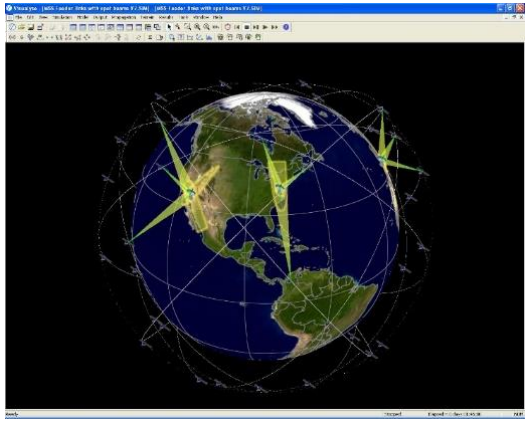
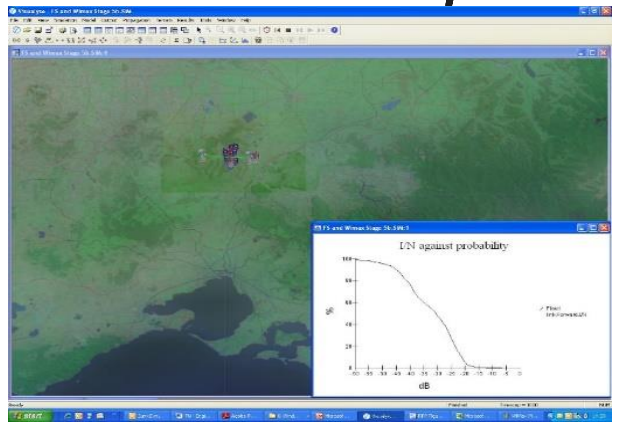
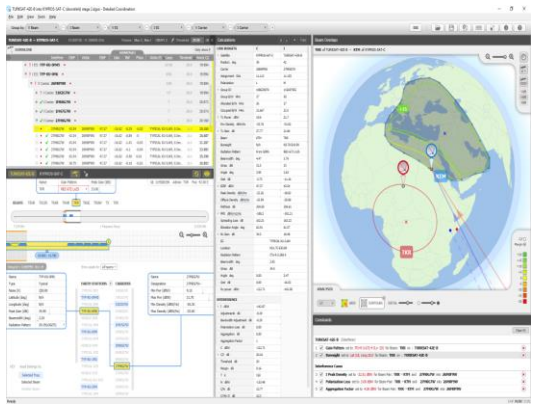
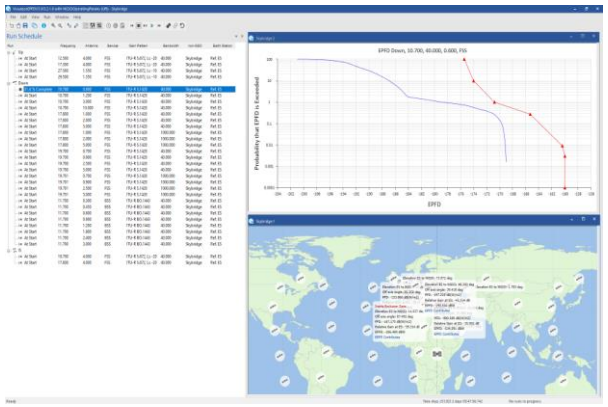




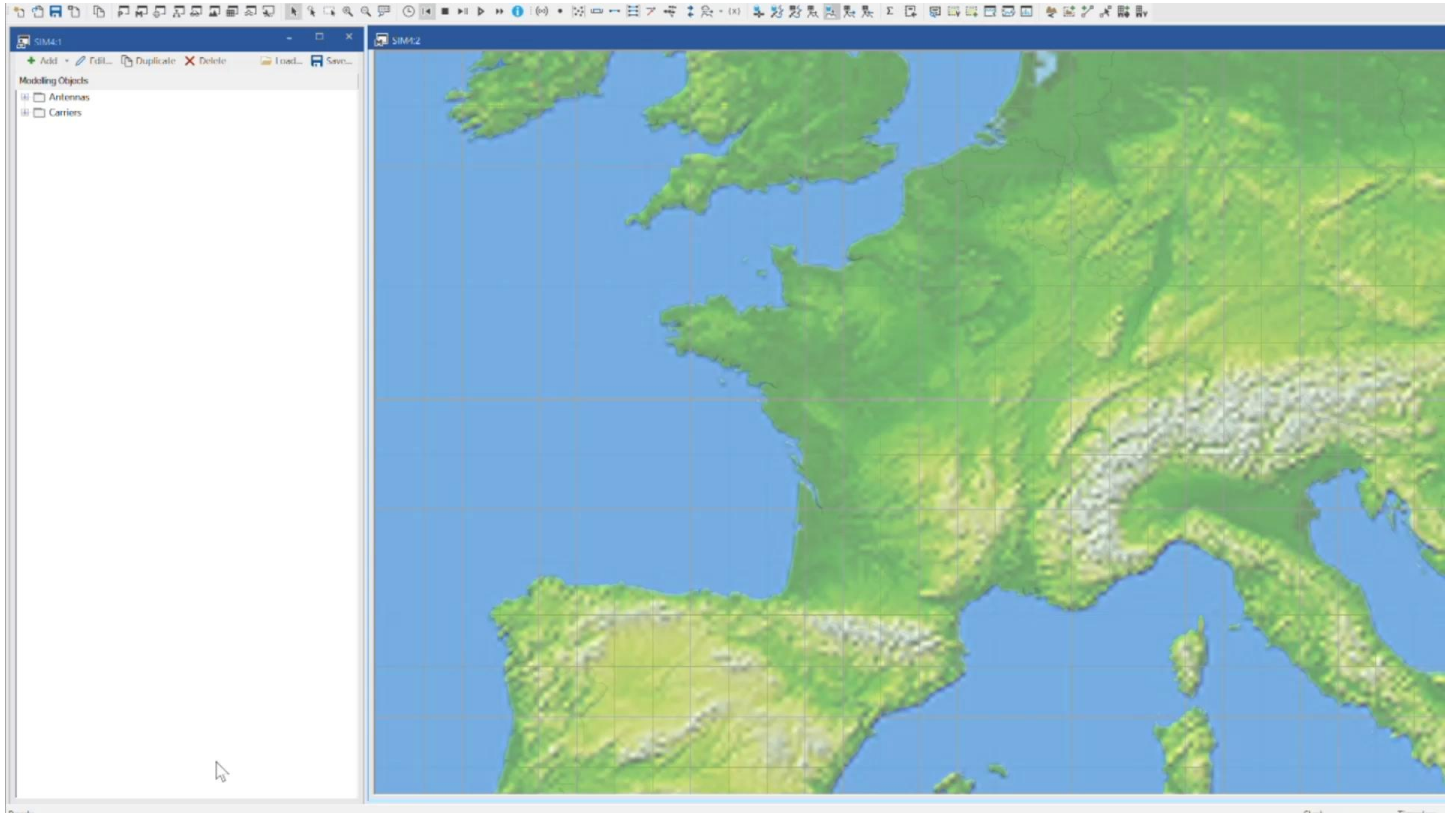




TRANSFINITE SYSTEMS

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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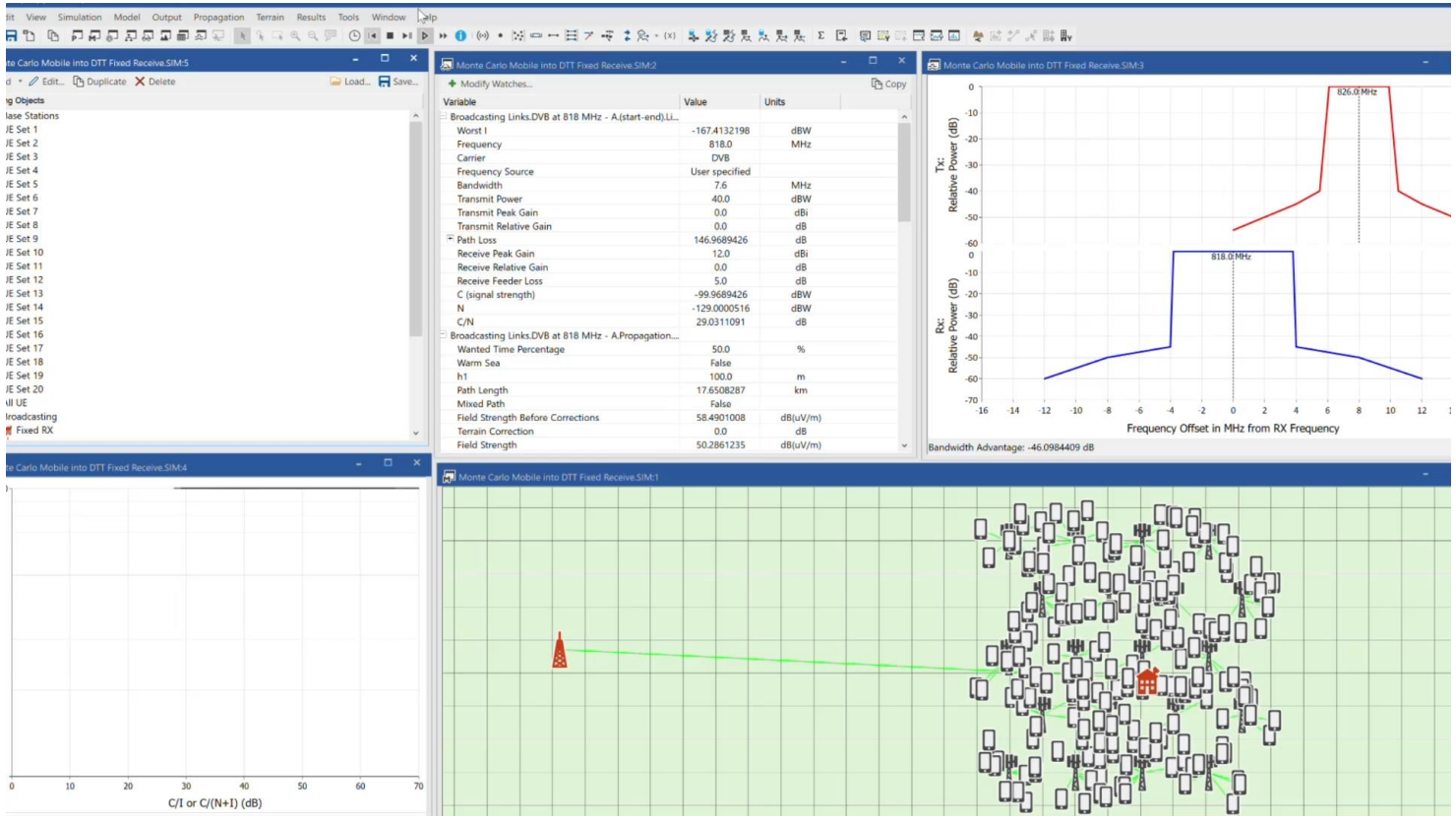

Mobile into terrestrial DVB receiver

Non-co-frequency scenario with calculation of NFD

Monte Carlo modelling using Define Variable Module

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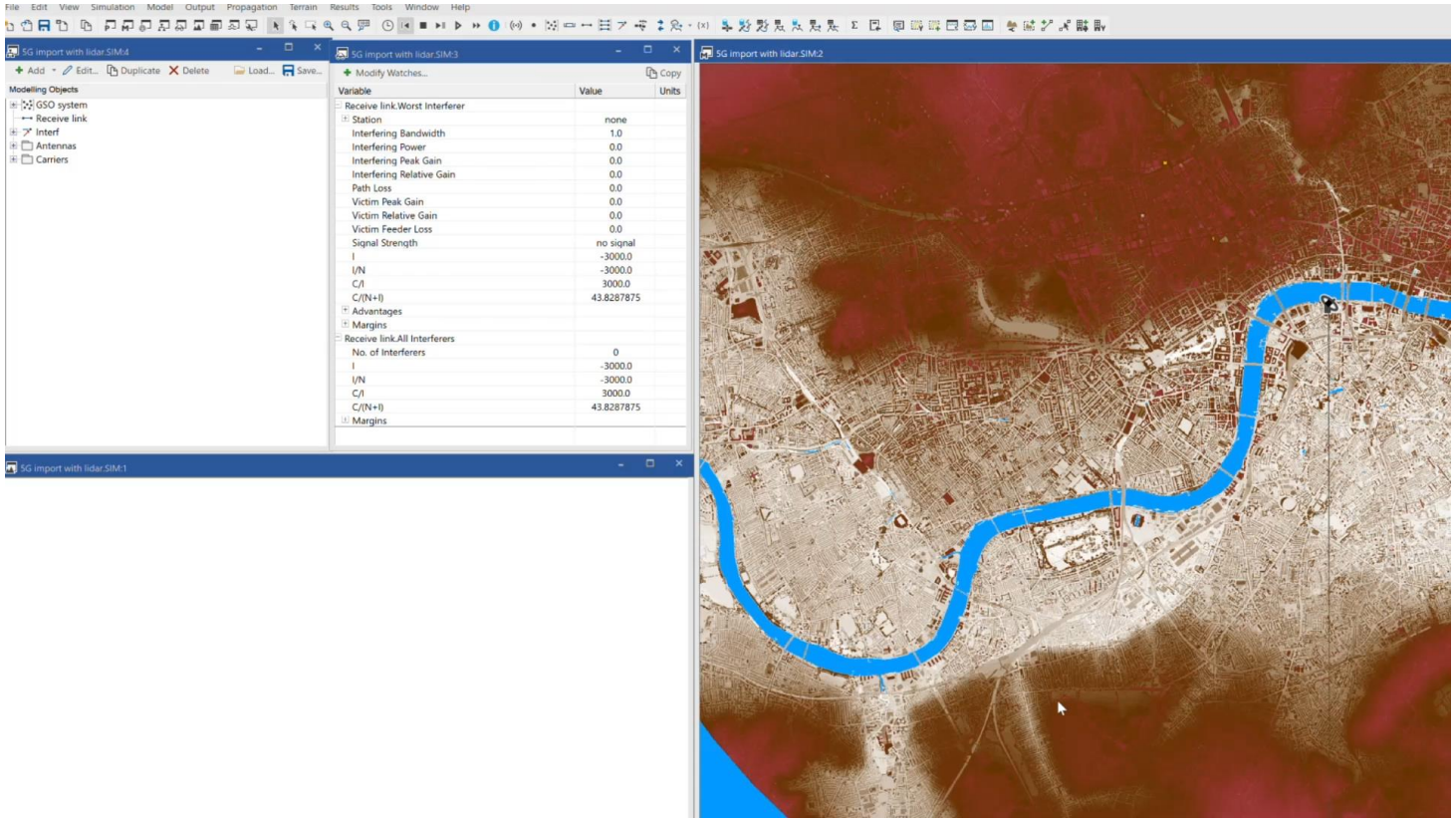

Import 5G systems using text files

Monte Carlo modelling using Define Variable Module

Lidar data used with P.2001 propagation model

TRANSFINITE SYSTEMS

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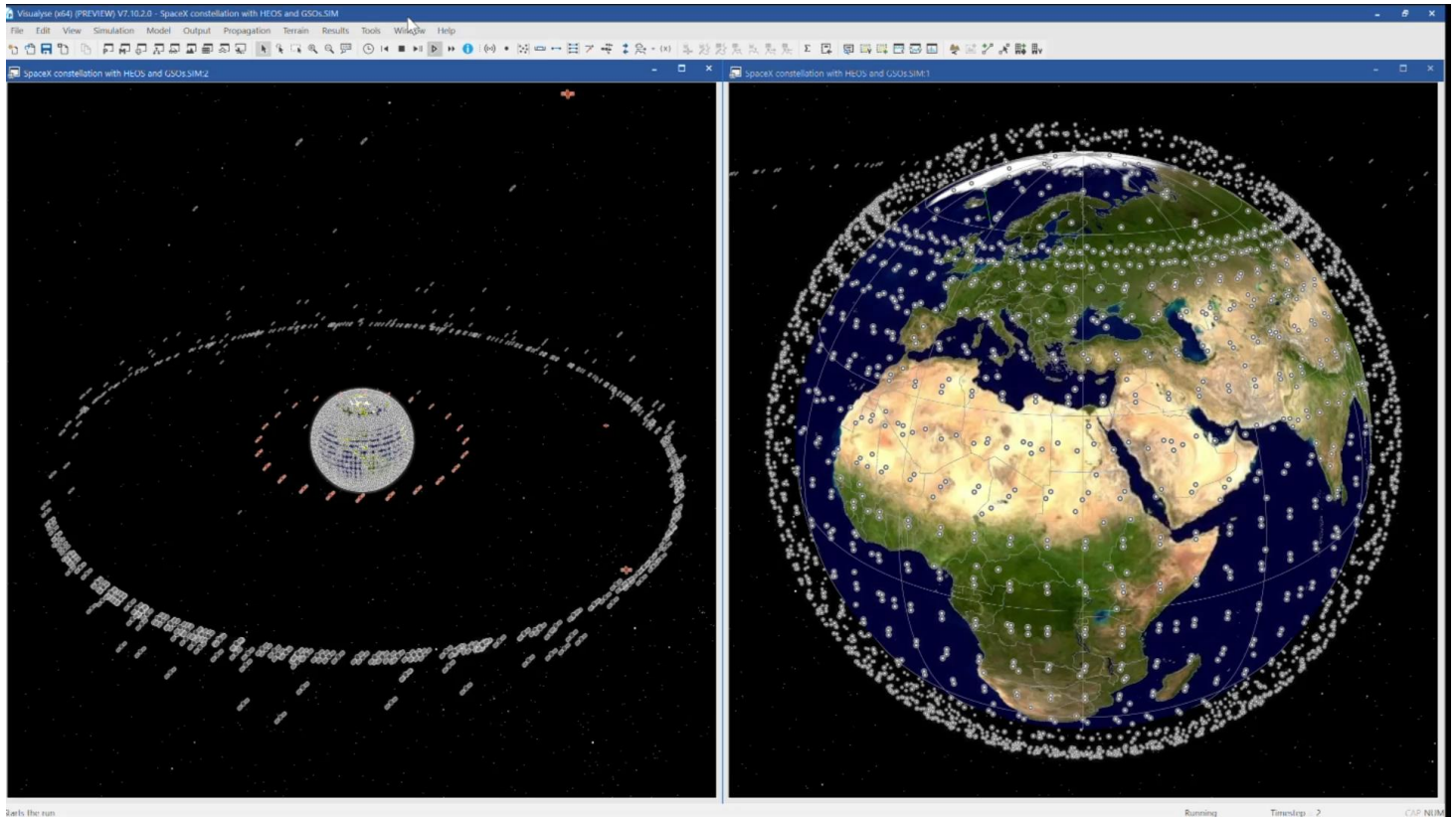

SpaceX full constellation made from multiple sub-constellations in LEO
O3B in MEO
Geostationary satellites from TLE import
HEO systems in 24 hour orbit

TRANSFINITE SYSTEMS

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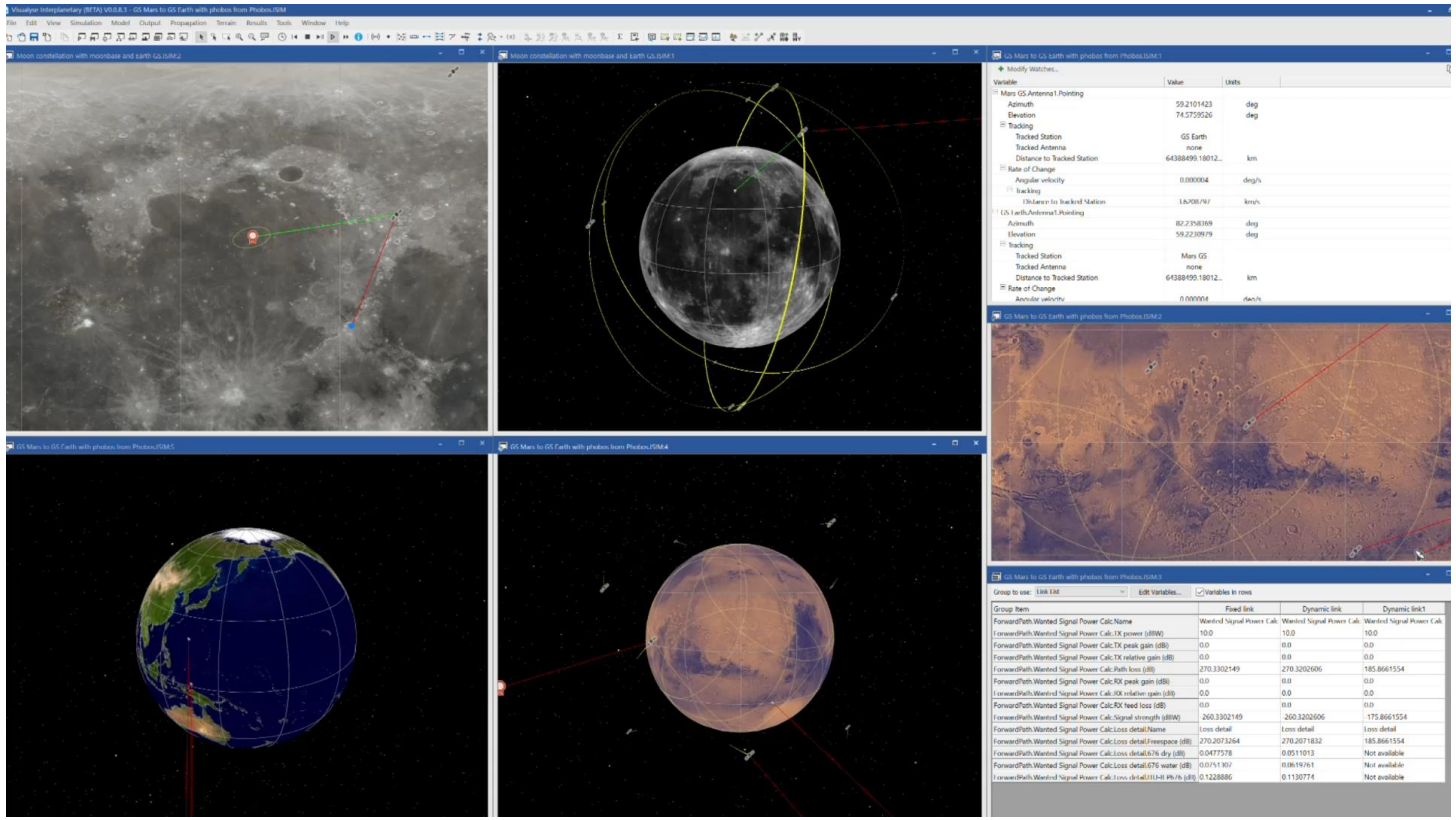

Visualyse Interplanetary

Missions around the Moon and Mars communicating with Earth

Constellations around Moon communicating with Lunar surface

TRANSFINITE SYSTEMS

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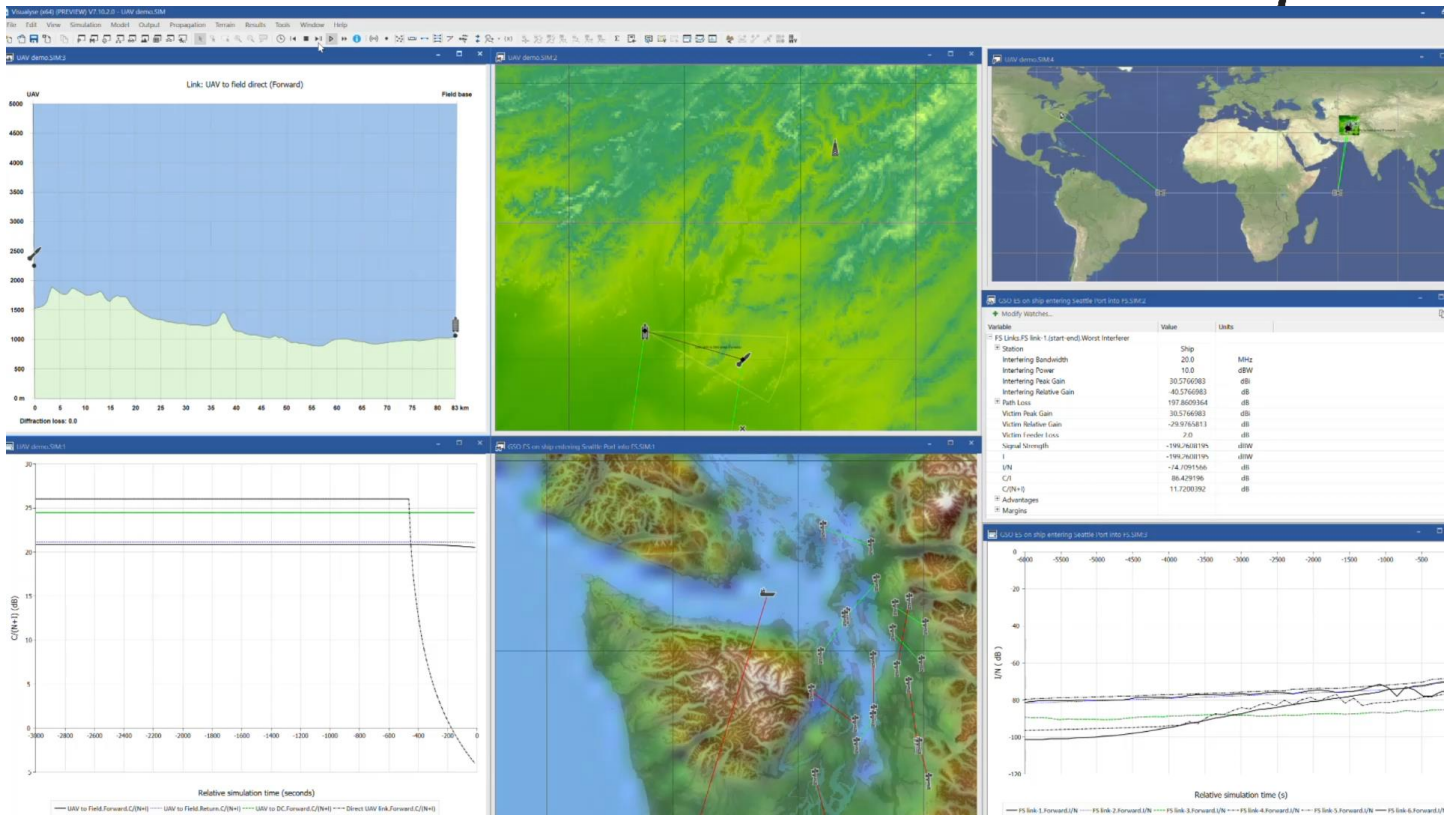

UAV on flight path with ground and satellite links
Earth station on vessel entering port interfering with fixed links
Waypoints set using Define Variable

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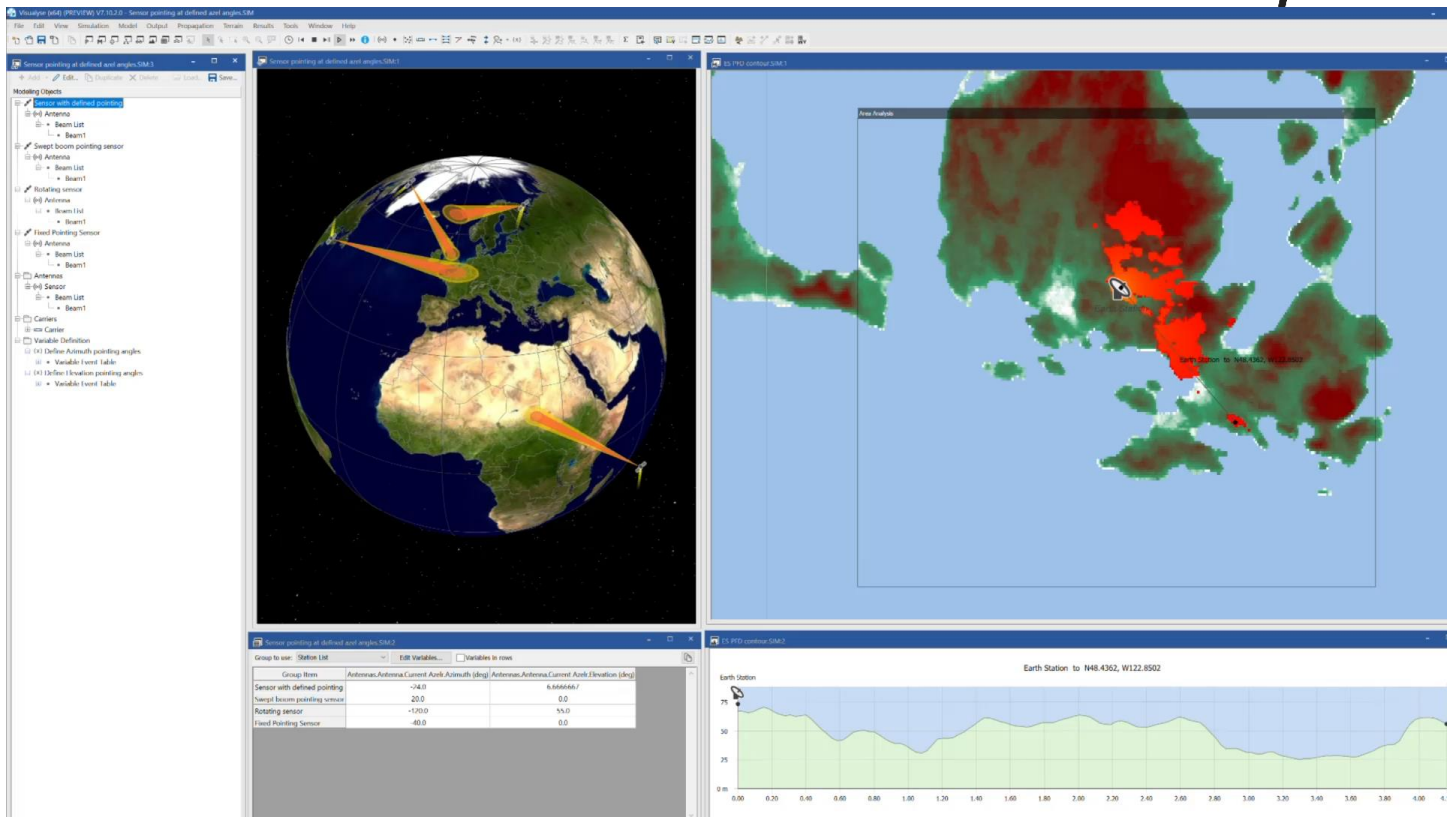


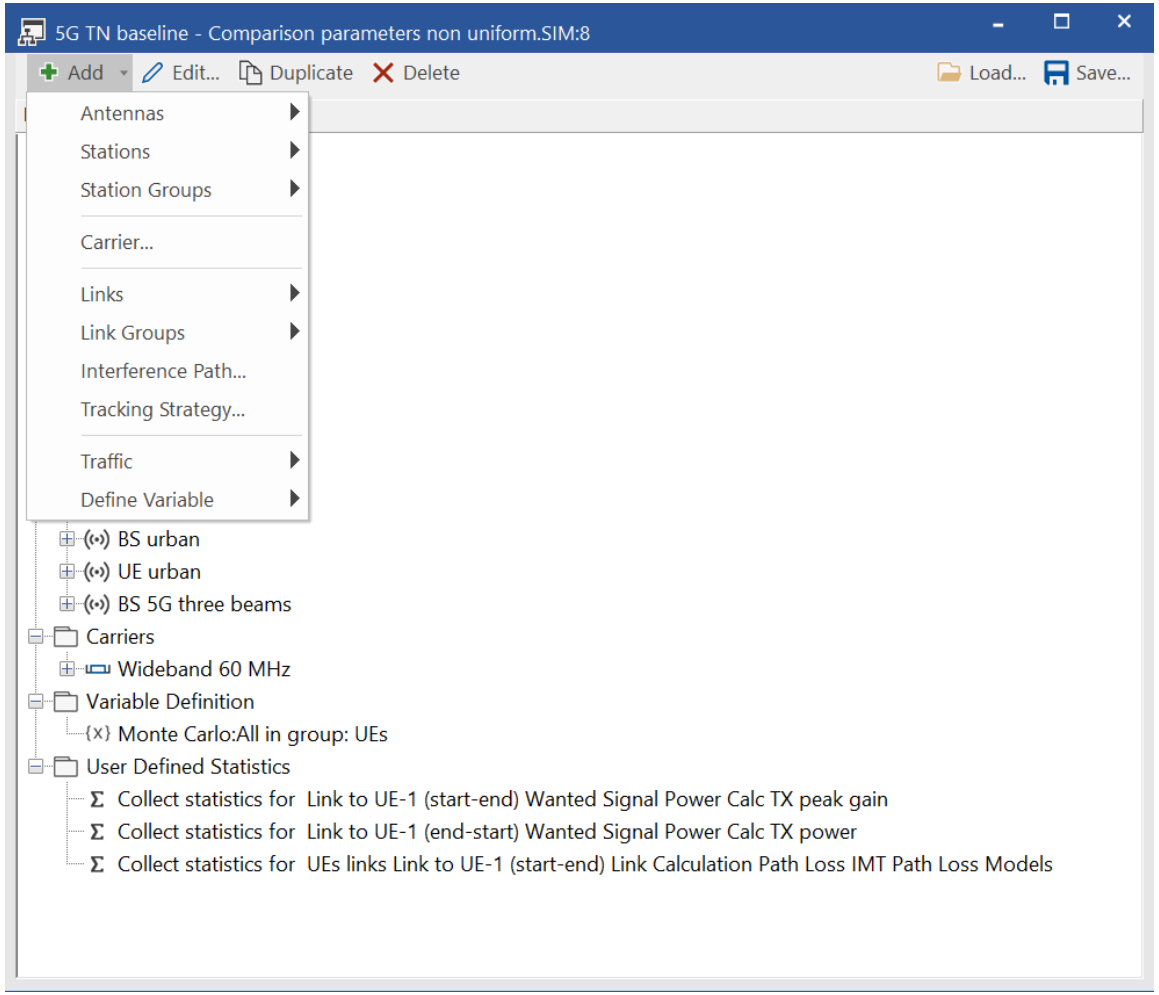
EESS sensor with pointing using Define Variable

Area Analysis calculating protection zone around a sensitive site

TRANSFINITE SYSTEMS

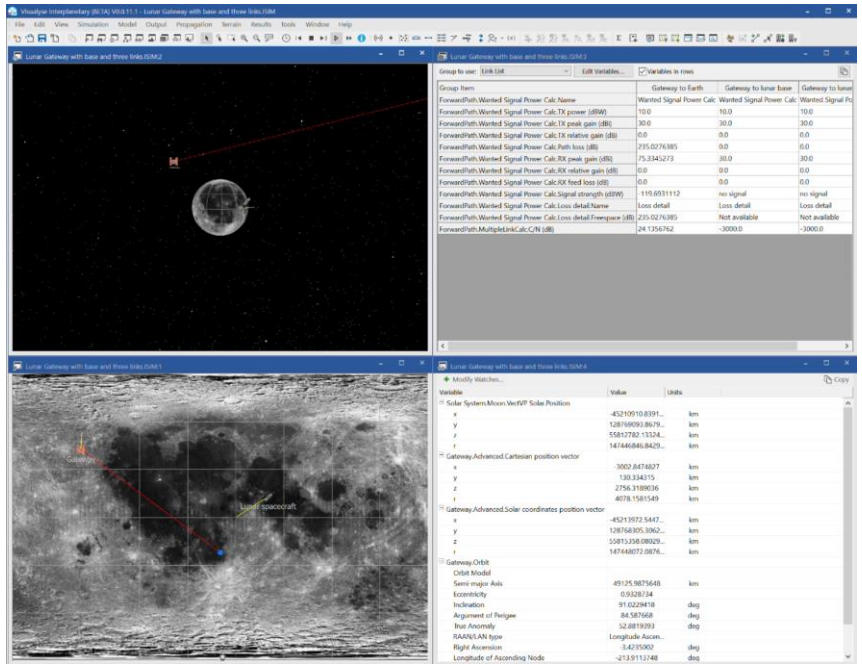
Visualyse Professional How it Works

- 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.



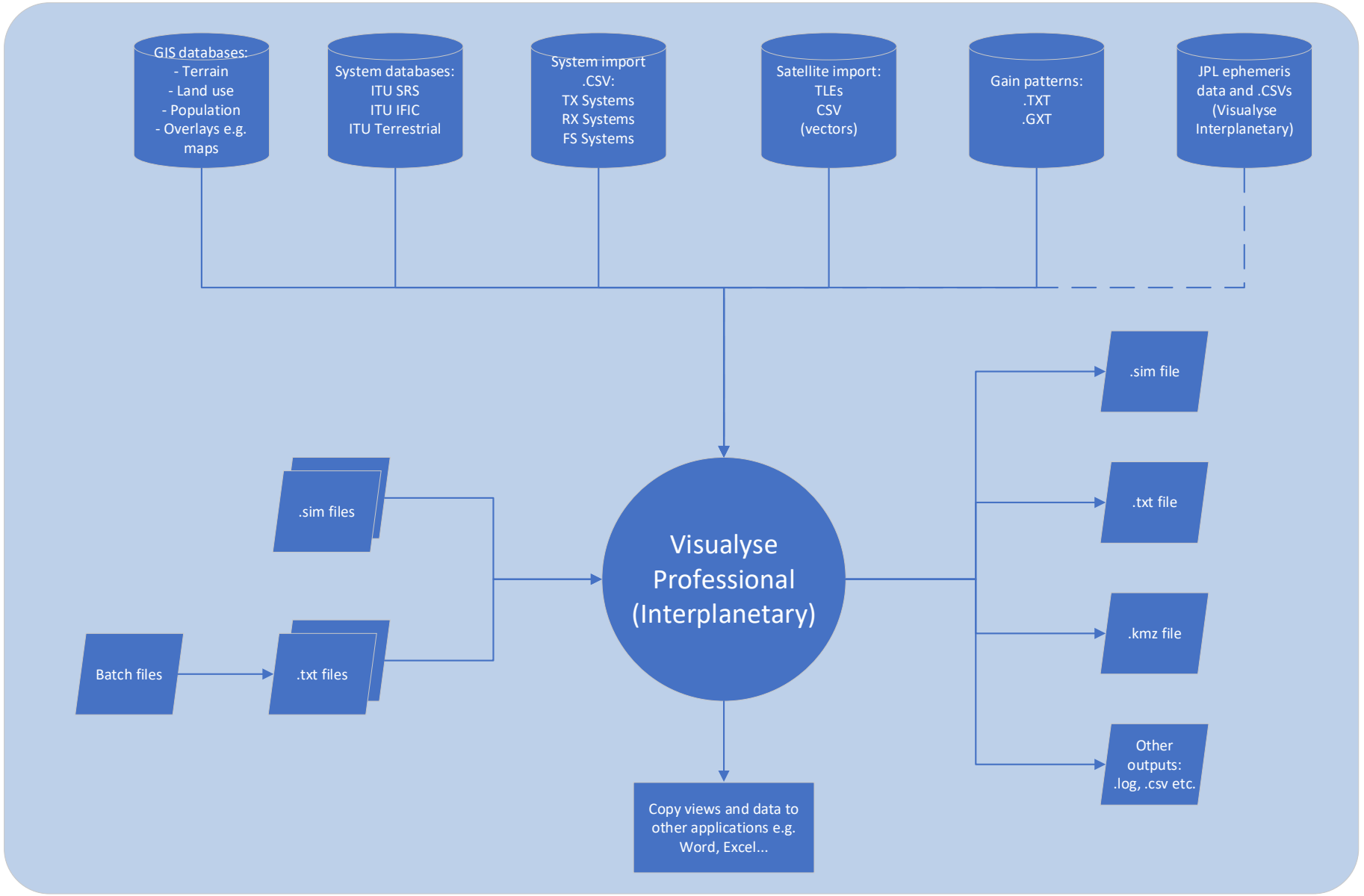
TRANSFINITE SYSTEMS

Visualyse Professional Versions



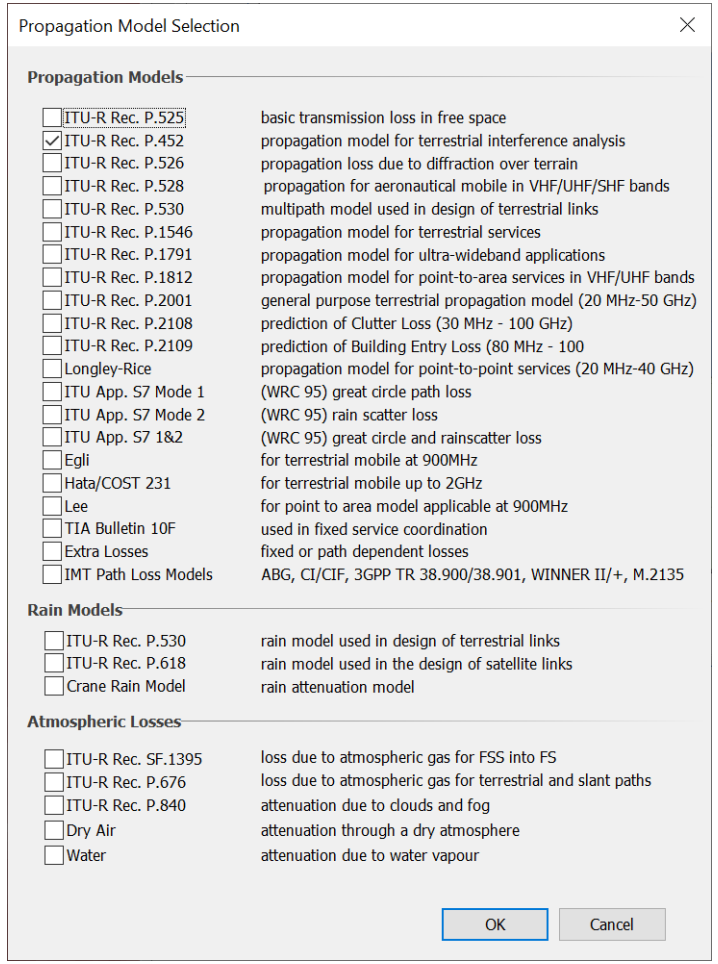
Version:	Visualyse Professional	Visualyse Interplanetary
Earth model:	Spherical	Ellipsoidal
Includes nutation etc.:	No	Yes
Coordinate system:	Earth Centred Inertial (ECI)	J2000.0 vectors
Celestial bodies:	Earth only	Solar system
Includes Doppler:	No	Yes
Orbit models:	Point mass, point mass plus J2	Point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

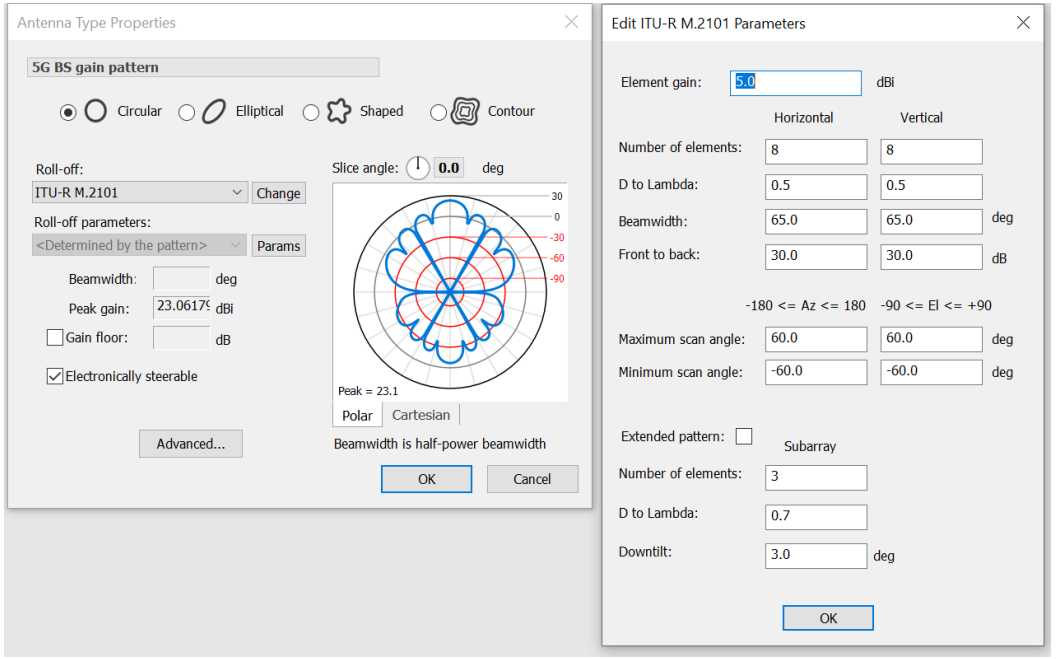
Interfaces: Files and Databases



Visualyse Professional Libraries and Update Process

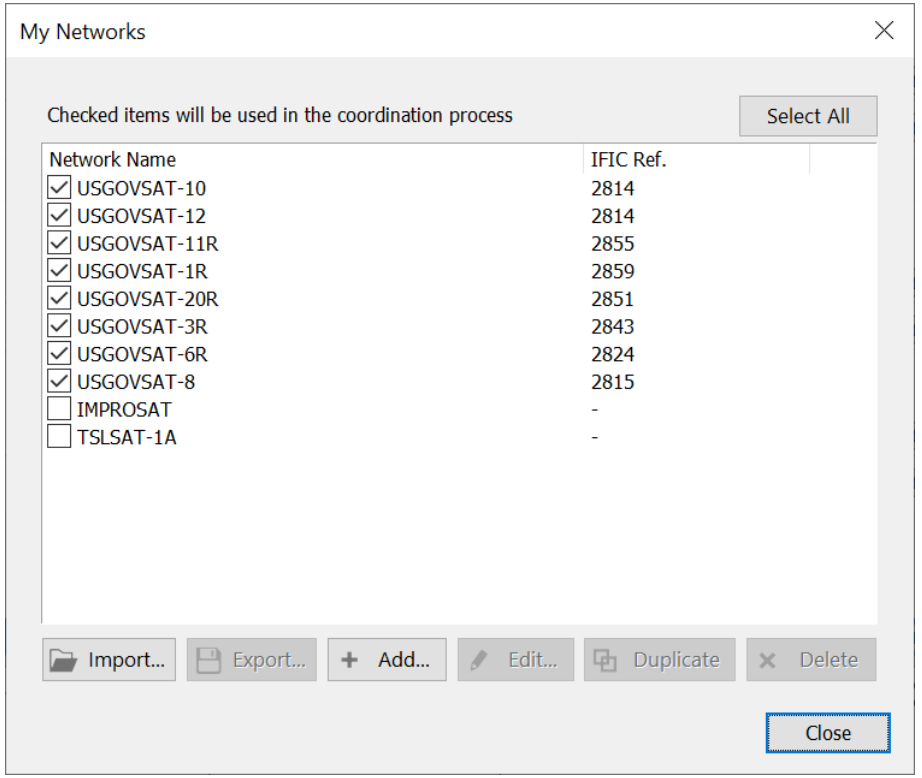
- The industry is always changing
- We intend to remain the leading tool for radiocommunication studies
- We keep track of work within industry bodies and international regulatory organisations (ITU, CEPT, 3GPP etc.)
- Frequently update propagation models and gain patterns
- Additional features included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



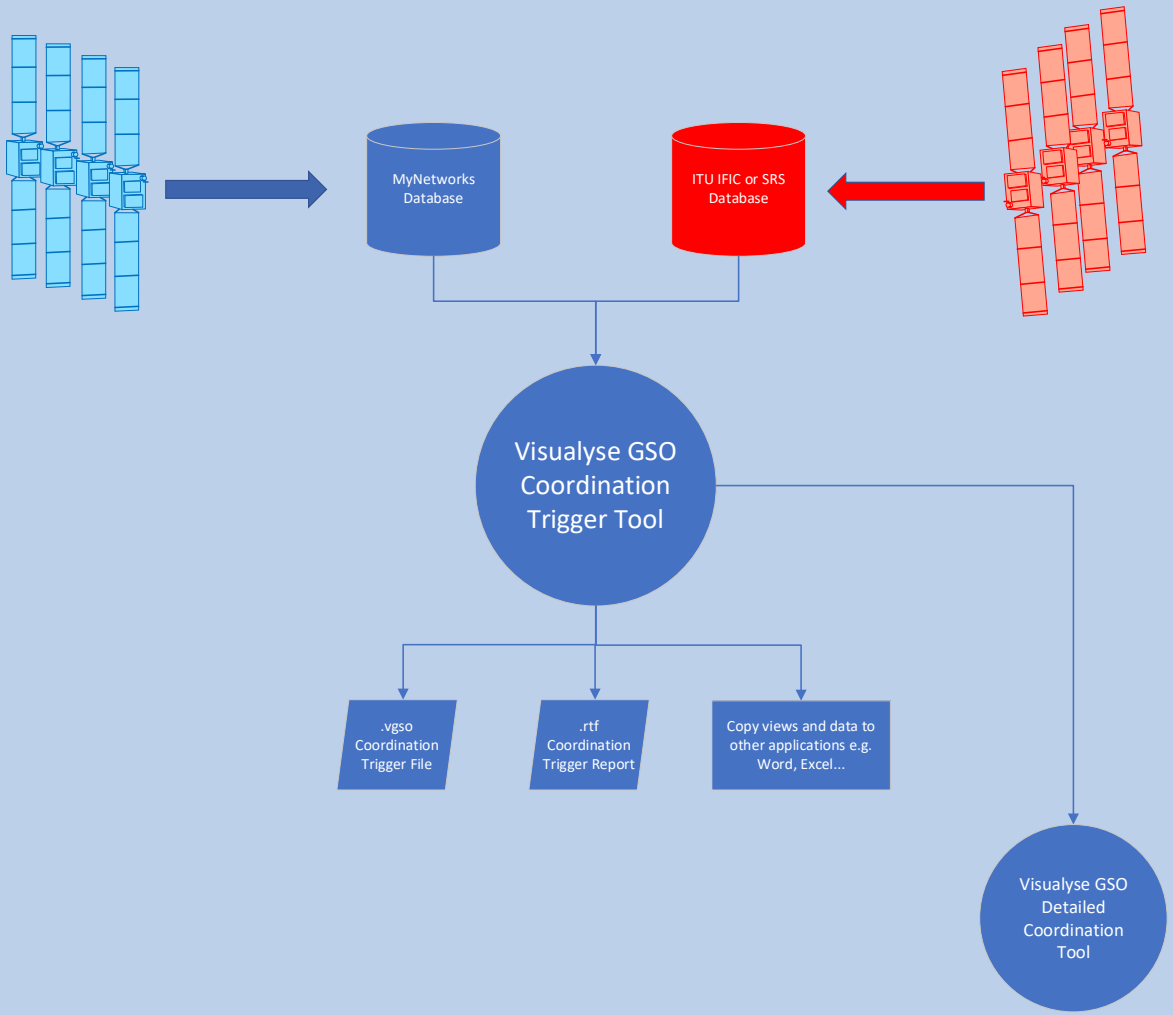


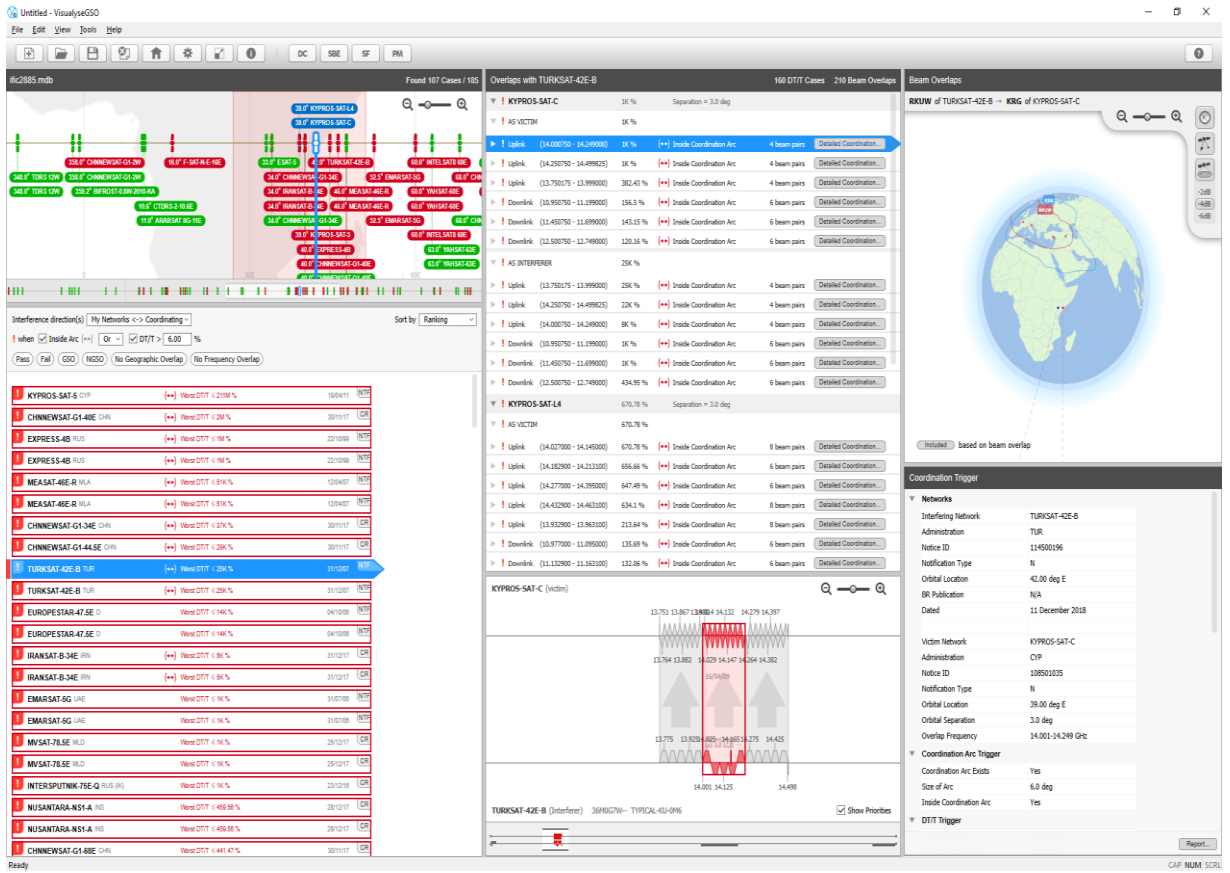
Visualyse GSO

- 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



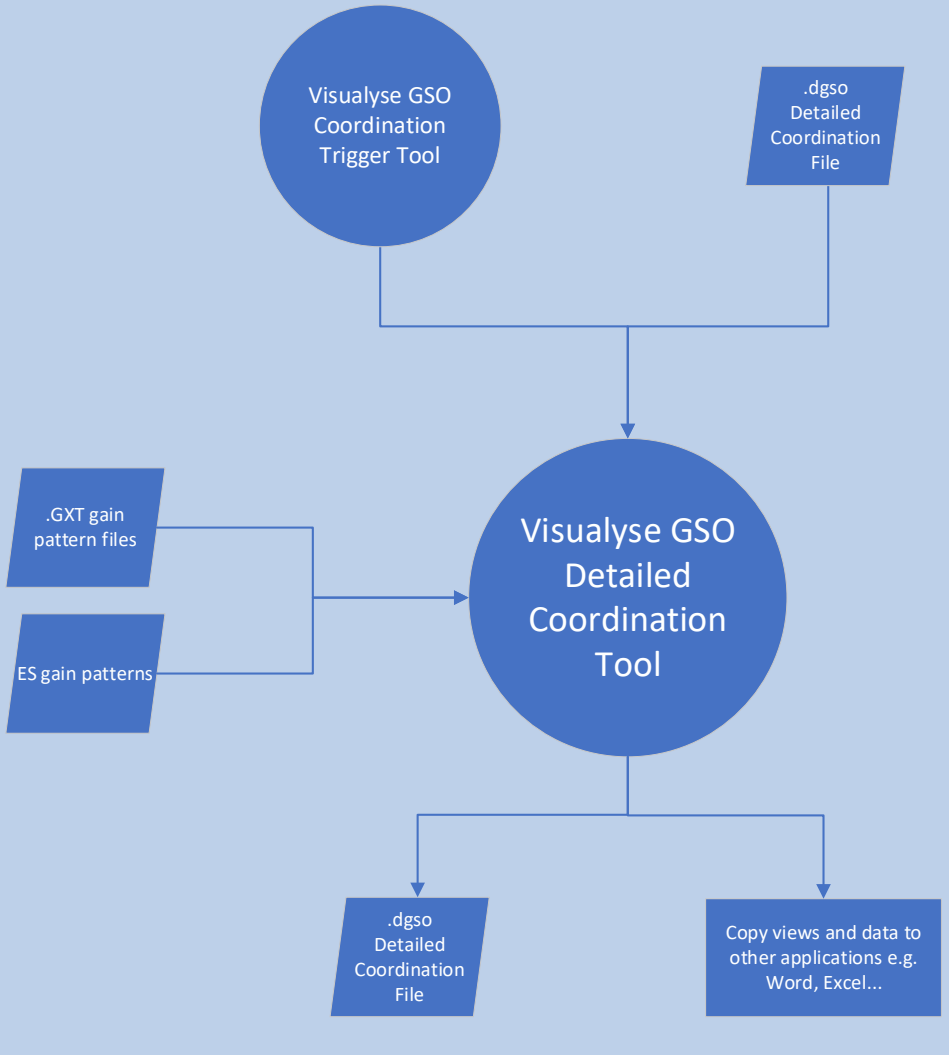


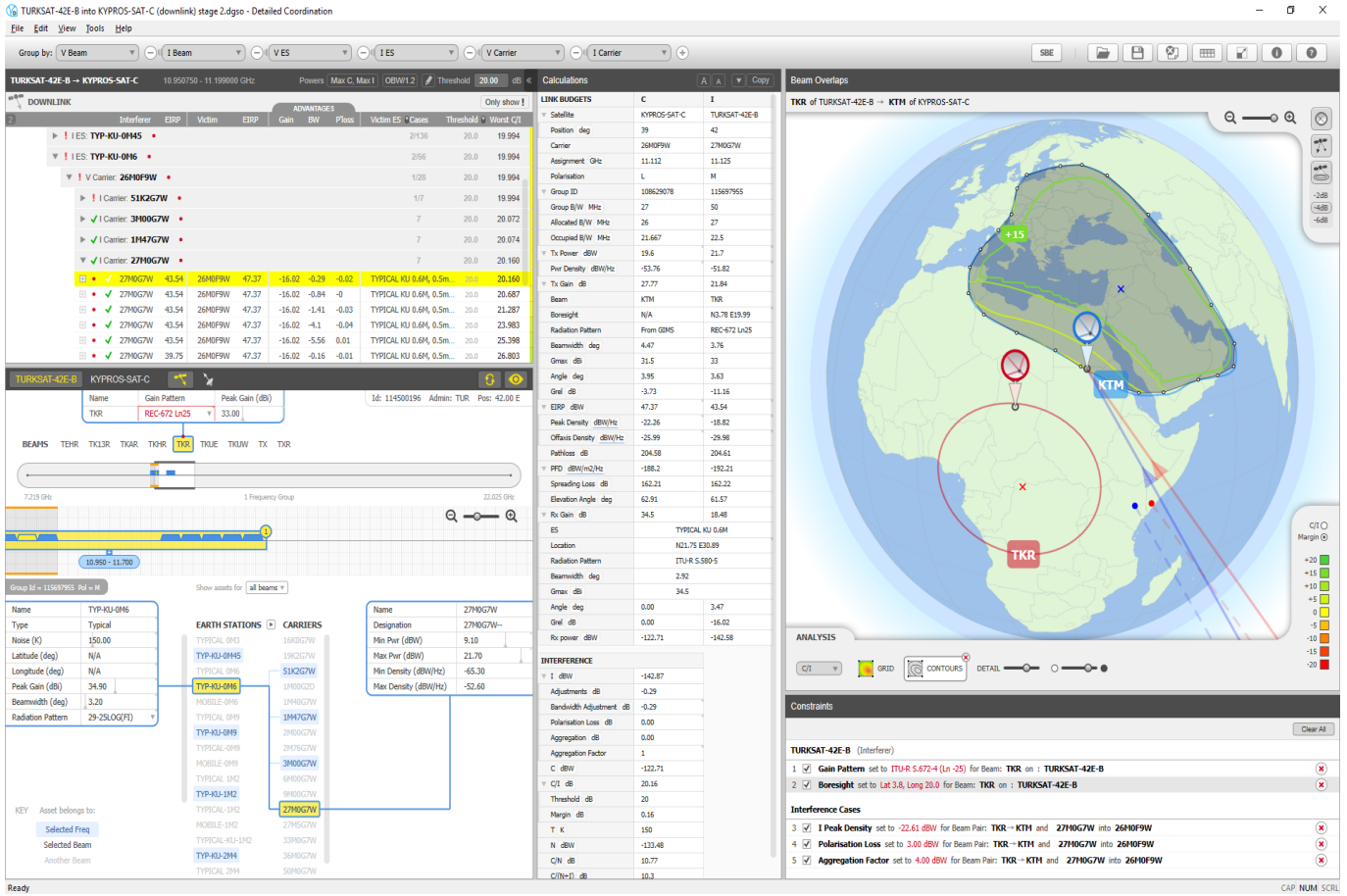
Designed for **both GSO and non-GSO** coordination trigger analysis

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





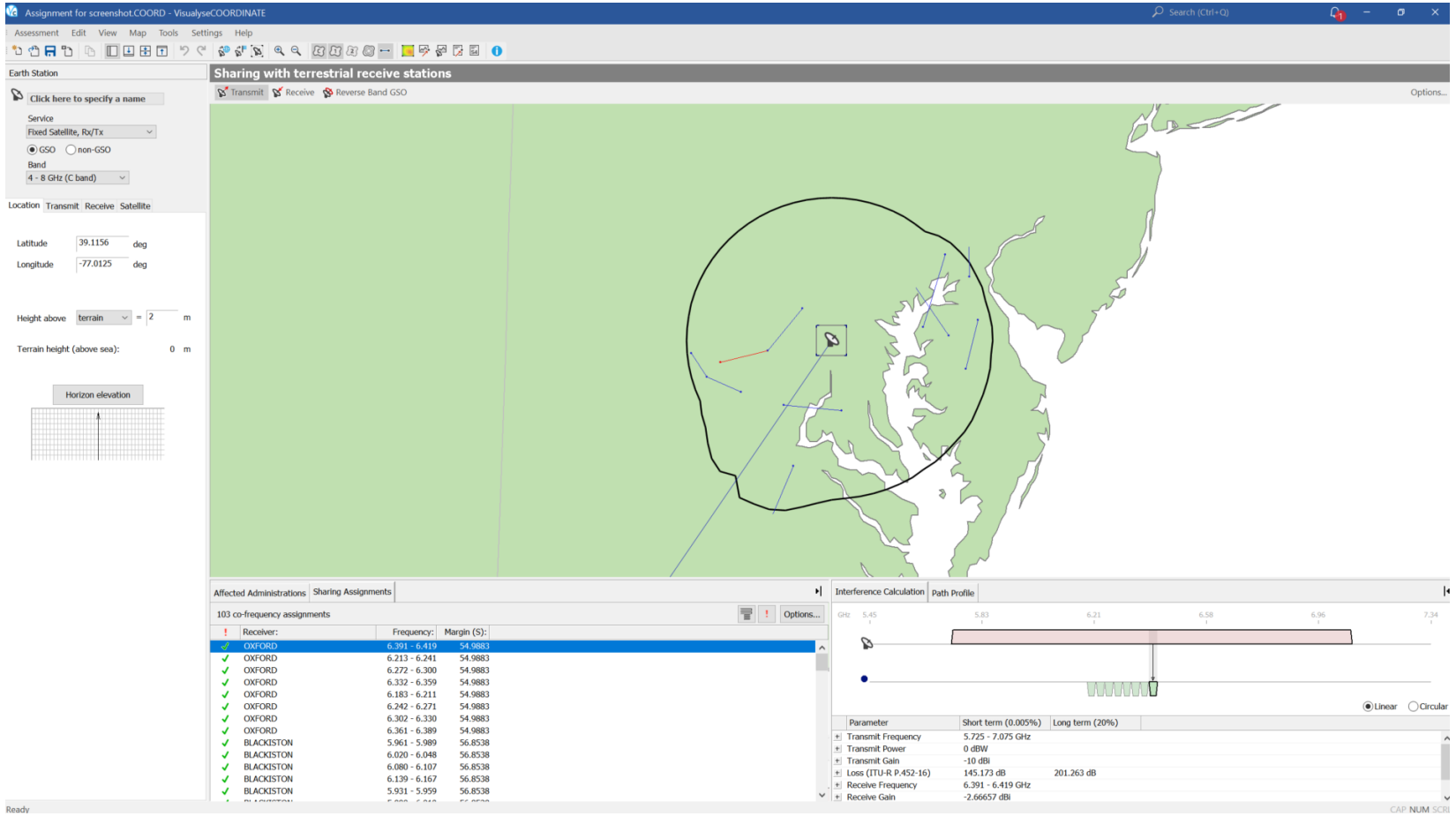
Designed for GSO to GSO satellite coordination

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



TRANSFINITE SYSTEMS

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

Visualyse EPFD Users and Requirements

Visualyse

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

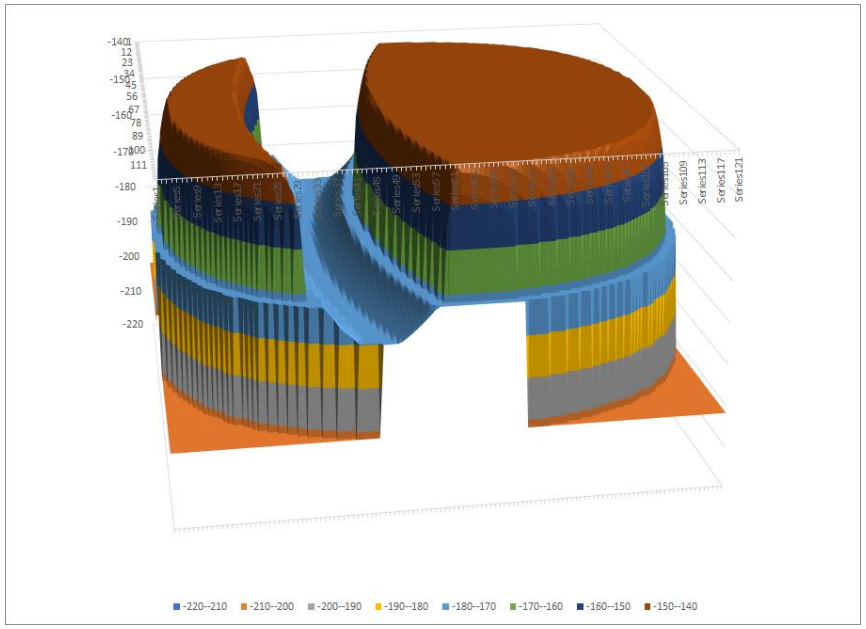
Regulators:

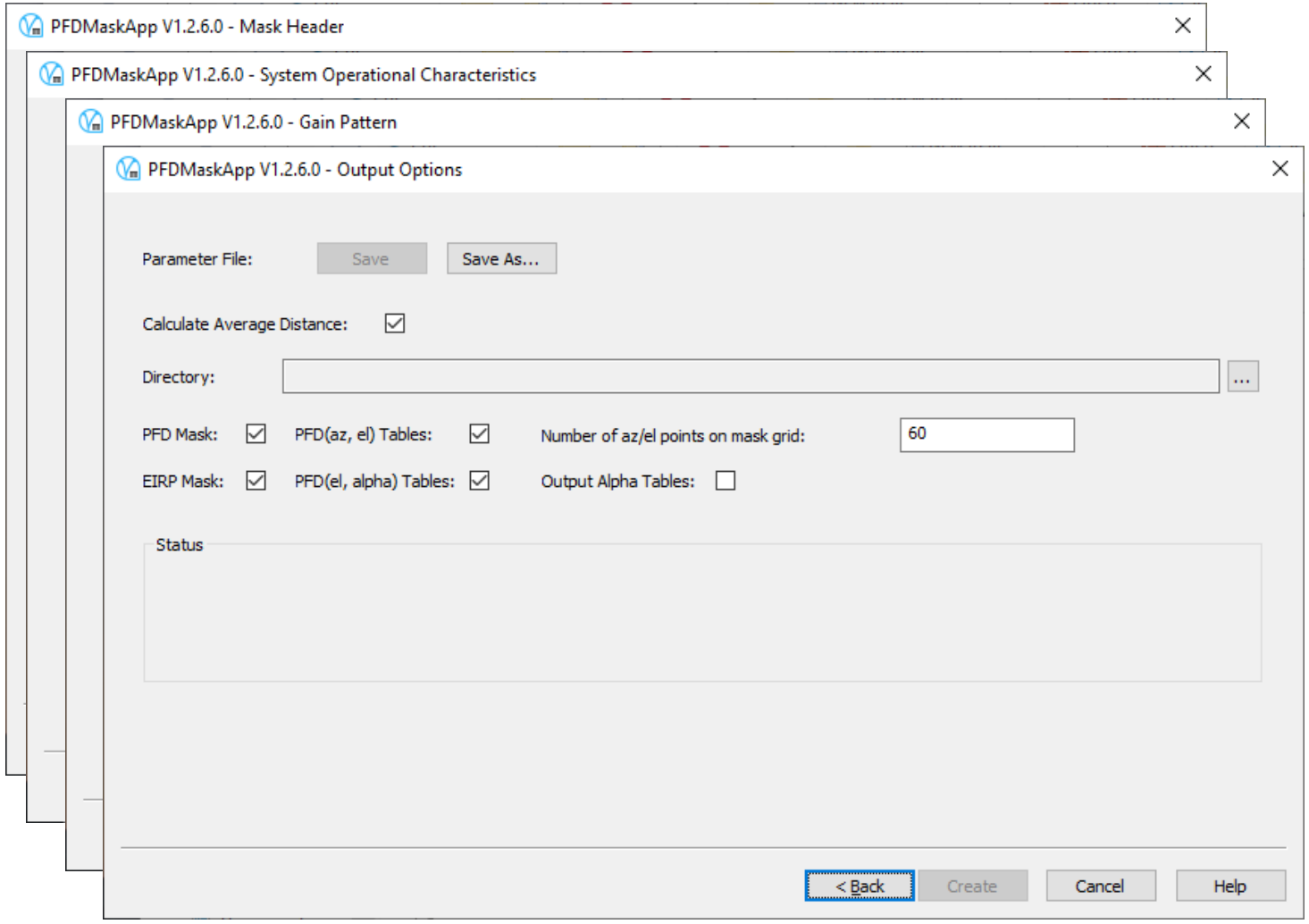
- Might want to do their own checks on individual systems
- Might want to check aggregate EPFD limits against Resolution 76 limits
- Might want to do their own checks on Q/V band systems under Resolution 770

TRANSFINITE SYSTEMS

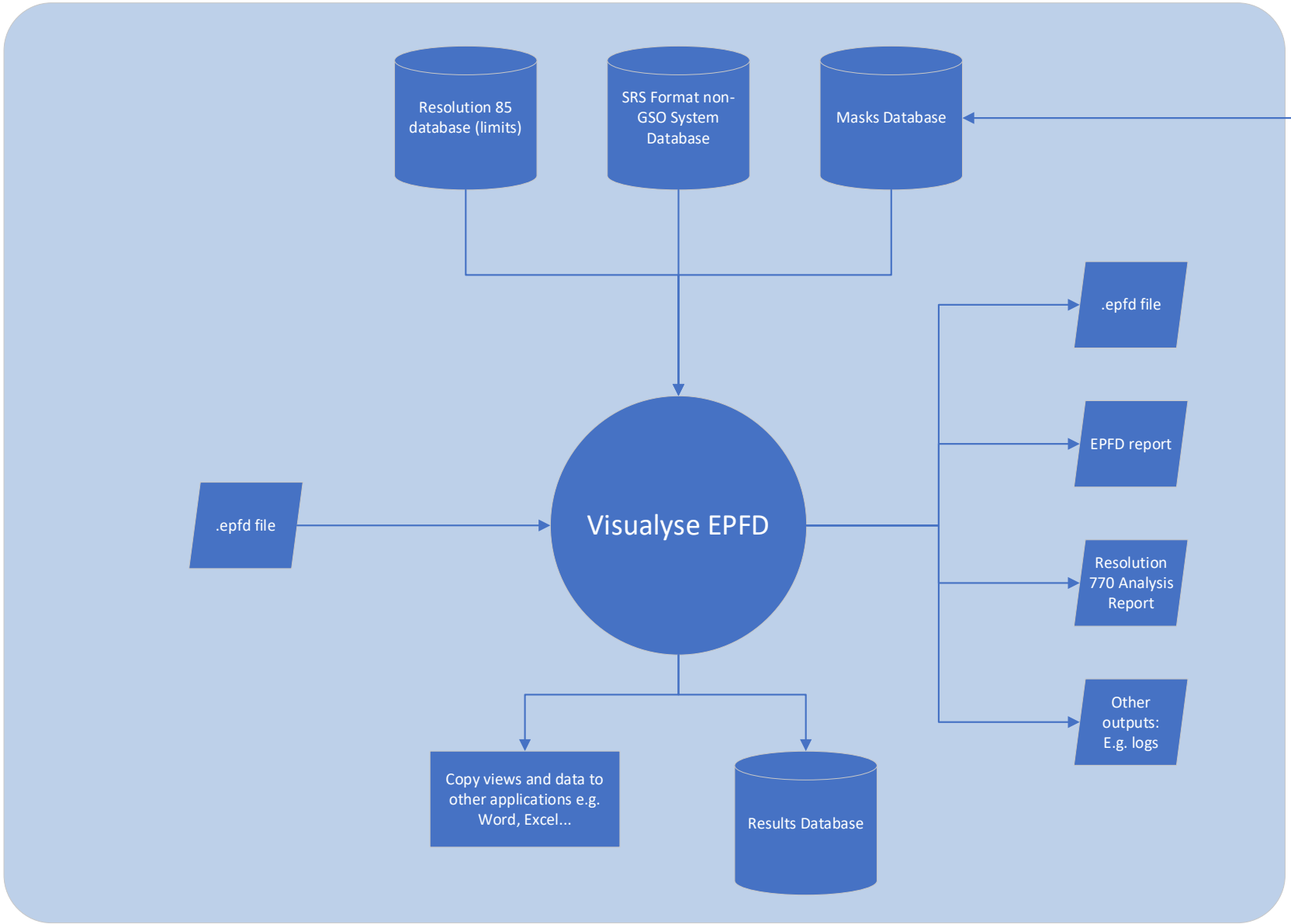
PFD Mask Generation Tool

- 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

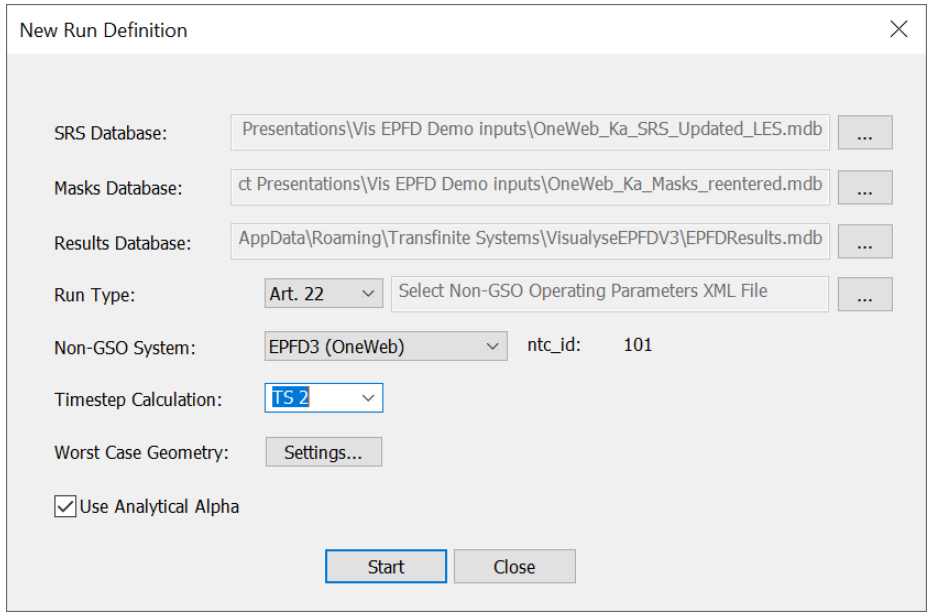


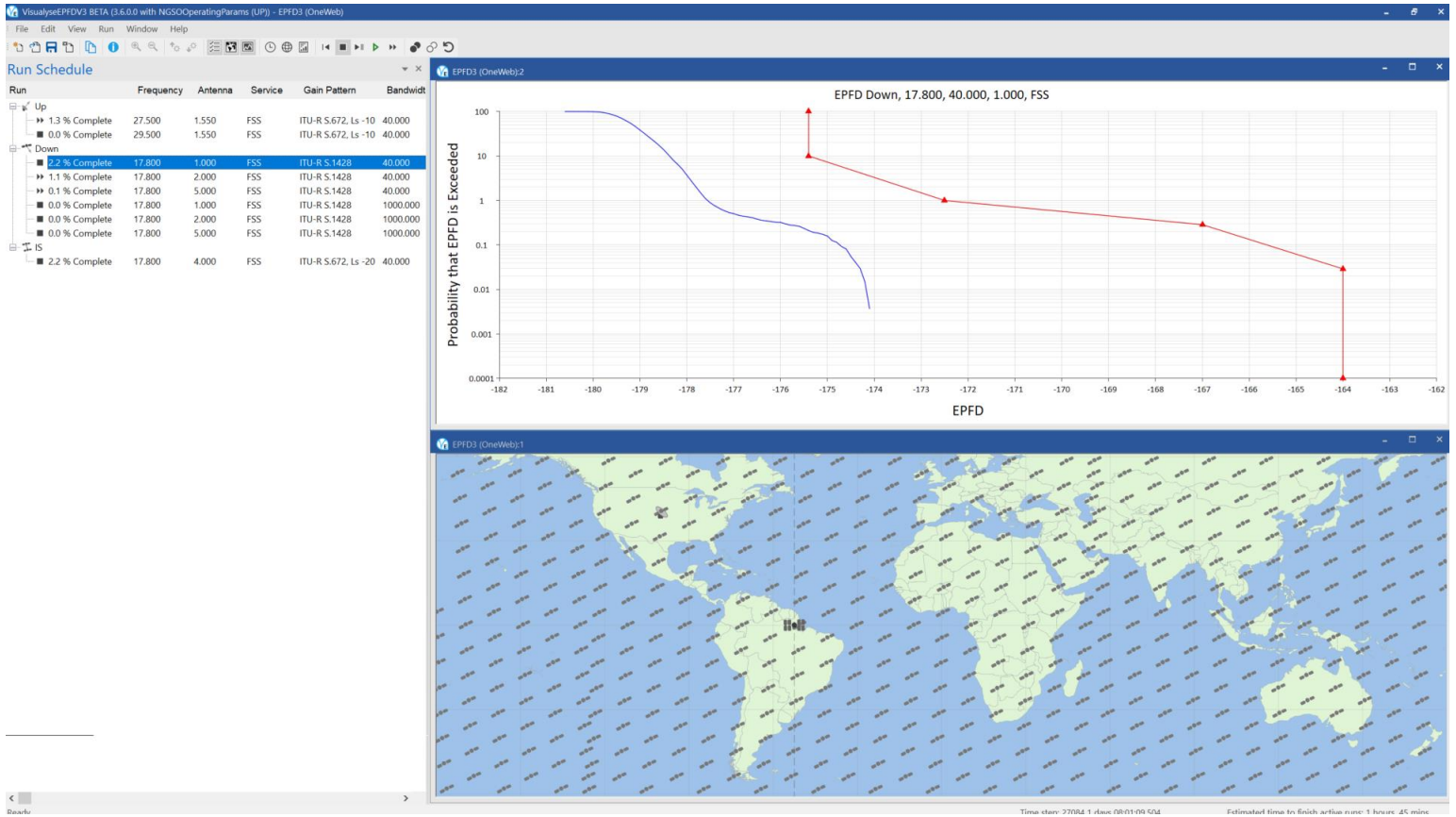


Visualyse EPFD Interfaces



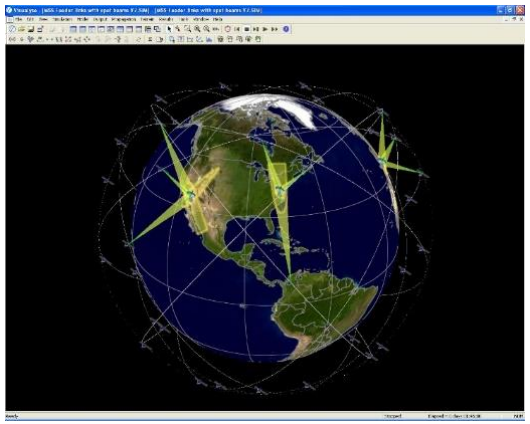
Visualyse EPFD Analysis

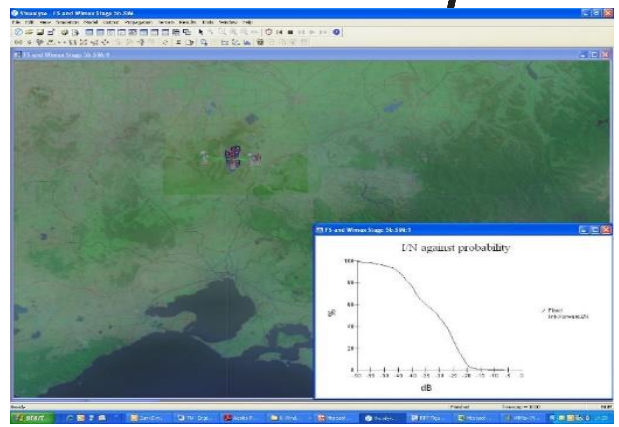


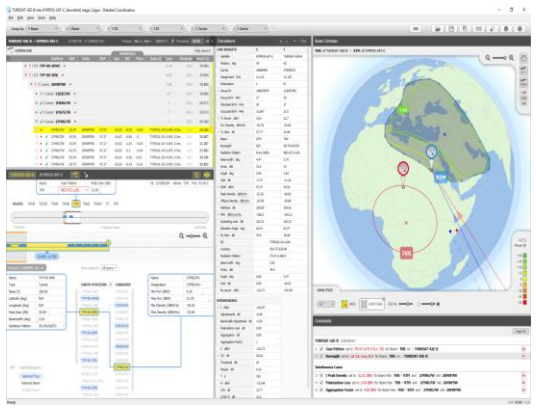


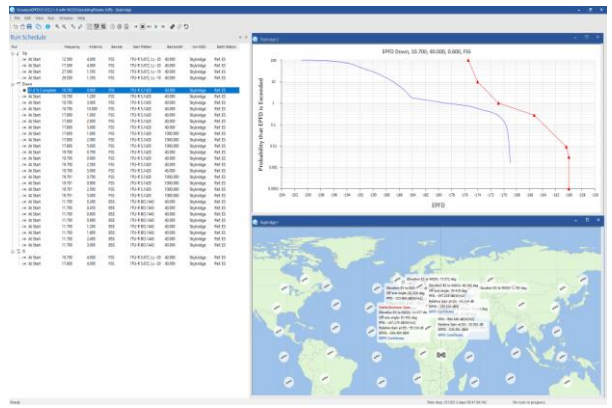
Why Visualyse Products?

- Best in class products
- Trusted world-wide
- Extensively tested
- Fully supported
- Fully featured
- Continually developed









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Thank you!

Visualyse

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

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