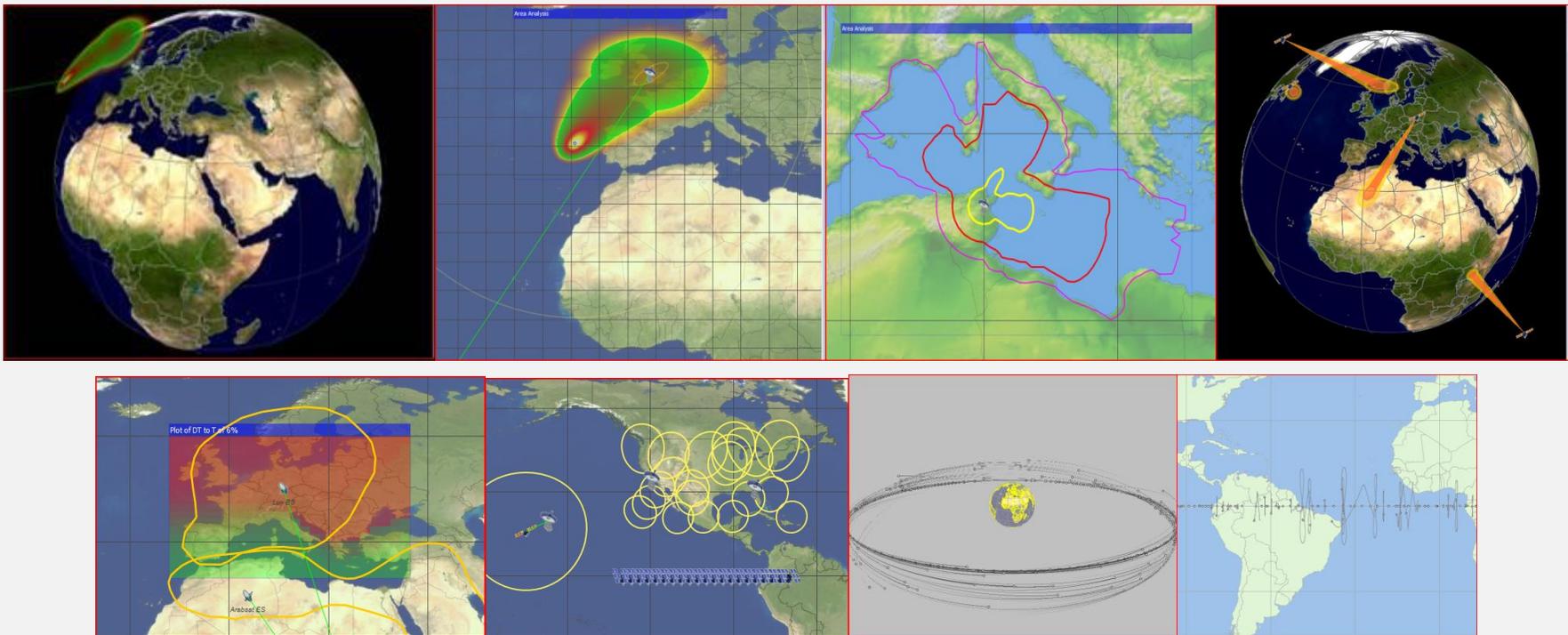


# VISUALYSE PROFESSIONAL VERSION 7

Satellite Systems Modeling and Analysis



## SPECTRUM AS A RARE NATURAL RESOURCE IS A TOP LEVEL STRATEGIC ISSUE.

*As satellite spectrum is squeezed from all sides and the demand for new bandwidth intensive services grows, the need for appropriate support from your software tools becomes apparent.*

*It's a safe bet that if you invested in a super new shiny toolkit that leaves you trying to hammer nails with a screwdriver, you would be disappointed*

*Visualyse Professional is the only tool you need for satellite communications modeling, interference analysis and spectrum management*

*To get an ROI higher than you thought possible, take a look at what you could do with Visualyse Professional.*

## Spectrum and Satellites

Satellite spectrum is increasingly a key enabler for the funding and development of all satellite based systems - managing that spectrum effectively is a vital skill in any organisation. Spectrum strategy is becoming a central part of the business proposition. Coordinated, licensed and well managed spectrum assets form a large part of many balance sheets.

With satellite spectrum being squeezed by commercial pressures from, among others, WiMax protagonists, the job of the satellite spectrum manager is now under pressure from many directions. One week you are looking at the intricacies of local clutter modeling and network topologies, the next you need to model a set of orbital elements and an operational tracking strategy for a non-GSO satellite network.

Satellite engineers and analysts are faced with many challenges when it comes to answering complex questions about communications, interference and spectrum sharing. They are also required to explain and support recommendations to board level management who may not have time to work through detailed technical papers. Presentations to a 'non-technical' audience are increasingly required.

The decision process in a satellite organization pivots around such questions as

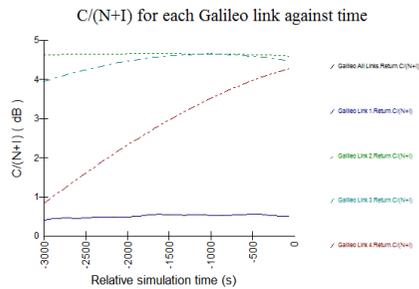
- What are the best bands for the services we want to offer?
- How much spectrum do we need in each band?
- What are the likely problems and issues in using that spectrum?
- What are the alternatives?
- What if .....?

Our proposition to the engineer and to senior management is that communications system modeling, spectrum management and interference analysis, as part of a vital business process will benefit beyond measure from an appropriate toolkit. Visualyse Professional is that toolkit.

Our definition of appropriate in this context is based on four supporting values

1. Computational Power
2. Usability
3. Return on Investment
4. Outstanding professional technical support

These values are demonstrated in all the products in the Visualyse range. The core product and sharpest tool in the box is Visualyse Professional.



*Powerful computation is ineffective if you cannot understand and explain your results to a wide Audience*

*Graphs and Pictures are invaluable aids - Visualyse has them all.*



## The Power of Visualyse Professional

Since the launch of Visualyse in 1995 desktop computing power has increased exponentially. The day is fast approaching when \$1,000 worth of PC will be able to do as many calculations per seconds as a mouse. In 1995 we had to make do with something less than the brain power of a large insect!!

So for us the important thing about power is what you do with it - if the power cannot be brought to bear on the problem at hand then it is of no use.

The true power in Visualyse comes from its simple structure and flexibility. Simple underlying modeling elements (stations, links, antennas etc.) are combined and quickly build up into scenarios. This object structure - where the elements are common to all communications systems, means that Visualyse can adapt to types of system that may emerge in the future - an essential requirement in our fast changing technology based industry.

If you have a very large number of stations or links to consider, Visualyse helps you create and manage these. Import of data is supported in several formats including BR-IFIC, two line element sets and an Excel based table of links and stations.

If you define a very complex scenario a full characterization of the results is likely to require lots of numbers, pictures and explanations. From examination of detailed link budgets, graphical representation of coverage and availability, statistical summary of interference and examination of the station dynamics - you need all these elements at your fingertips.

Here, the power of Visualyse as an explanatory tool becomes apparent. Low level numerical explanations, statistical summaries, sparkling graphics and step by step animations allow you to develop authoritative and impressive papers and presentations.

Visualyse Professional gives you power.

- ✓ Power to take on very complex numerical analysis.
- ✓ Power to visualize and explain your results.
- ✓ Power to look at all types of system - earth or space based, fixed or mobile.
- ✓ Power to enhance and add value to technical work through detailed numerical output and sparkling graphical illustration.

**Power that you can use and power that you can control.**



*User Friendly is an over-used term in Software Development. At Transfinite we prefer to think about Usability.*

*Ease of Use is an important factor but not the only thing that we need to consider. It's a question of the appropriate application of power*



## Usability and Productivity

At Transfinite we have invested a lot of our time in designing software that will save everyone else's time. In order to make proper use of the power the software has, it must be usable.

Usability can be defined in many terms - being easy to learn and easy to remember are two dimensions of usability that we have concentrated on. If you need to use Visualyse a few times per year, it should be possible to get a quick start on your first use and easy to pick up where you left off on you subsequent uses.

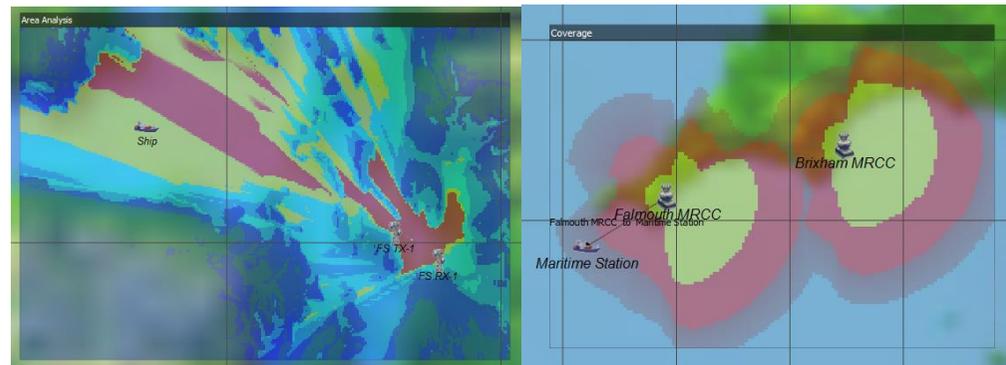
A few minutes with our tutorial documentation will have you setting up simulations - the fact that the objects you define have real world counterparts make them easier to remember. The availability of a library of pre-defined simulations and supporting documents, augmented by our technical support team, means that, in all likelihood, there is template for whatever study you want to do.

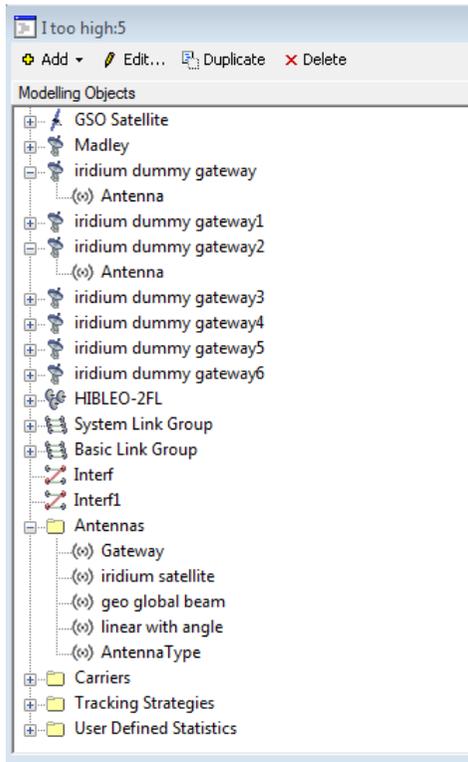
However, ease of use is not the start and end of usability, nor will a simple software package necessarily enhance your productivity. Usable, productive software must do what you want it to do - it must be effective and provide the functionality that you need.

This last requirement - utility - is the central goal of Visualyse Professional. The object based design means that it can be adapted to all types of system, the on-going software development and cross-fertilization from our consultancy work means the new features and enhancements to existing features.

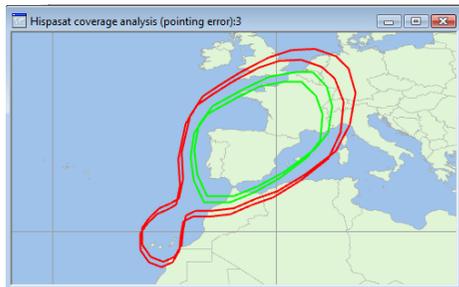
Ease of use remains high on our agenda - our aim is to make using Visualyse a rewarding experience which is both satisfying and enjoyable.

Visualyse finds a balance between ease of use and utility that really can boost your productivity. You may buy Visualyse Professional to look at sharing Ka band links with Iridium, but you will also find that when you are asked about co-existence of earth stations with WiMax in C-Band you can use the same tool to explore the answers.





*Visualyse is THE MOST cost effective way of studying Interference Analysis*



## Return on Investment

How can we justify our claim that Visualyse provides a positive return on your investment? It's quite simple, we know from our existing users that

1. Visualyse saves you time
2. Visualyse improves the quality of your analysis
3. Visualyse makes it possible for you to be more responsive
4. Visualyse saves you money
5. Visualyse enhances your effectiveness and capabilities.

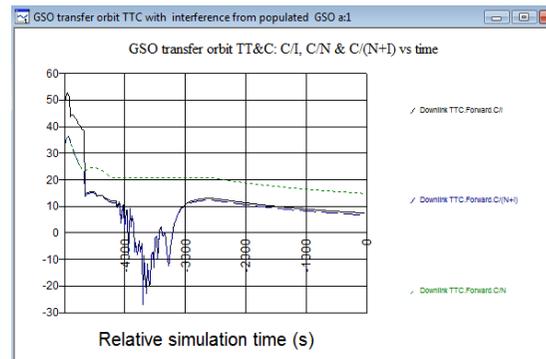
You save time because you do not need to worry about the development and testing of new software. You know that Visualyse is used around the world and has been used in 100's of studies that are peer reviewed in the ITU-R forum.

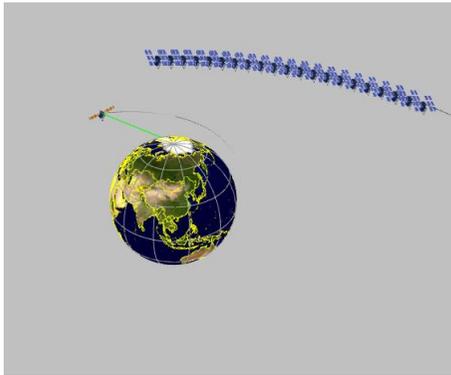
So you are freed up to concentrate on defining the study and thinking about the results. Thinking about numbers rather than thinking about calculating them is a great step forward.

Time is not the only factor in the development of software - cost, risk and on-going support are also important. Transfinite has already absorbed the cost of initial development and mitigated the risk. How much would it cost to develop software that would do even a tenth of what Visualyse does? Our track record shows that we are committed to providing on-going support.

The fast pace of change in the satellite communications industry and the increasingly short time for study work means you have to be ready to go - Visualyse gives you a head start.

If you are a Regulator, communication engineer, manager, consultant, or generally work within the exciting field of radio communications, you need *Visualyse*.





*Continually rated A1 by our Clients, Transfinite is justifiably proud of our technical support*

*Friendly, responsive and above all highly knowledgeable and expert, our team are totally committed to finding solutions and ways forward for you*

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## Technical Support

Support is always available from Transfinite.

Our standard Annual Maintenance and Support contract gives you access to product maintenance and upgrades plus technical support in applying the software to your problem.

Product support includes

- ✓ Installation support
- ✓ License management support
- ✓ On-going support of your PC environment
- ✓ Support in the use of the software
- ✓ Advice on best practice and the approach to your study management

Our technical support engineers are dedicated to finding a way forward for you. You will receive attention from an expert with 20 year's experience and a genuine world class reputation.

If you are an experienced engineer, the main use of technical support is likely to be in use of the software. We will help you through the initial phases of installation and getting started.

Once you gain experience we will give you help in the more advanced features of the software. Our team has in depth knowledge of the way study work is conducted and presented - hence we can advise on the best way to apply the software to many studies.

Your engineers are your greatest asset. They are the key to the future of your organization and deserve the best equipment and environment you can provide for them. Basic skills and technical expertise are a pre-requisite and can often be acquired on the job. However in many cases the learning curve is so steep that structured training is the best option.

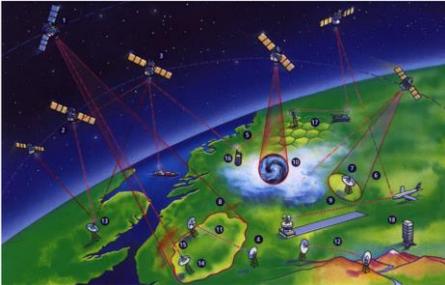
Transfinite provides in-depth training in the methods of radio interference analysis and in the procedures of the ITU (covering both satellite notification and study group work). Our courses include, but are not restricted to, hands on training with the software products in our Visualyse range

Training courses are available and can be run at our offices or a venue of your choice. We have a set of tried and tested materials and tutorial examples that make up our standard course - suitable for beginners/intermediate users or as a refresher. Alternatively we can provide advanced training to your specific need.

VISUALYSE CAN BE USED IN MANY TYPES OF STUDY DUE TO THE OPEN NATURE AND OBJECT BASED STRUCTURE OF THE SOFTWARE

*Visualyse Provides you with Tools and Blank Canvas.*

*Transfinite will provide you with templates and case studies, but in time you will find many applications*



## What does *Visualyse* Do?

Visualyse is, at heart, an engine for calculating carrier levels, interference levels and noise levels in radio links. It will produce  $C/I$ ,  $C/N$ ,  $C/N+I$ , pfd, EPFD, and  $I/N$  numbers and statistics for almost any spectrum sharing or interference analysis scenario you can think of?

It allows you to define geometry, dynamics and RF characteristics in a 3D environment that includes the earth as a central gravitational body and can also include terrain spot heights, geo-climatic factors and local clutter data.

However, this does not adequately capture the full capability of the software. So in the next few pages we are going to provide a technical description of the product.

### *Description of the Program Capabilities*

*Visualyse* is the de-facto industry standard, recognised, software tool for modeling and simulating radio systems.

The *Visual Interference Analysis Software* can be used to analyse a wide range of radio communication systems, both satellite and terrestrial systems, and the interactions between them.

*Visualyse* has been designed for interference modeling, with concepts such as station dynamics and link criteria such as  $C/(N+I)$  built in. You can define and analyse complex simulations that would take years of study using conventional tools - you can do this quickly, accurately and with full confidence in the results.

*Visualyse* is above all **Visual**, so that the results are not just numbers from a black box, but are accompanied by explanations with clear visual descriptions.

### *Object Orientation*

A key aim of *Visualyse* is to simulate any type of radio system - fixed, mobile, GSO Non-GSO, data, voice, communications, radar, TT+C - using the same familiar modeling objects and user interface.

For this reason it was designed using concepts based on 'real world' objects which will be familiar to all engineers. For example, you will need to define 'Stations', which have 'Antennas'. You will then need to 'Link' stations together and define your propagation environment.

This object orientation means that the same modeling approach is used for simple and for complex scenarios.

*You need to be sure that your results are in line with what you expected. Visualyse provides feedback to check every step of the way*

Variable	Value	Units
[-] GSO receiver		
[-] Receiver		
[-] Station	Geostationary...	
Receive Power	-100.0	dBW
Noise Figure	2.0	
Calculate Rain Noise	False	
System Noise Temperature	590.0	K
Noise/Hz	-200.89148	dBW/Hz
N	-140.89148	dBW
[+] Link Calculation		
[-] Worst Interferer		
[-] Station	Constellation-3	
Interfering Bandwidth	1.0	MHz
Interfering Power	0.0	dBW
Interfering Peak Gain	12.0	dBi
Interfering Relative Gain	-4.593771	dB
Path Loss	204.400218	dB
Victim Peak Gain	0.0	dBi
Victim Relative Gain	0.0	dB
Victim Feeder Loss	0.0	dB
Signal Strength	-196.993988	dBW
I	-196.993988	dBW
I/N	-56.102508	dB
C/I	96.993988	dB
C/(N+I)	40.891469	dB
[+] Advantages		
[+] Margins		
[-] All Interferers		
No. of Interferers	9	
I	-189.70954	dBW
I/N	-48.81806	dB
C/I	89.70954	dB
C/(N+I)	40.891423	dB
[+] Margins		
[-] Power Flux Density		
Number of Stations	9	
Bandwidth	4 KHz	
Worst Station	Constellation-3	
Worst Station Beams	1	
Worst Station Elevation	-79.986233	deg
Worst Station PFD	-182.615962	dBW/4KHz/m^2
Total PFD	-175.331514	dBW/4KHz/m^2
[+] Statistics		

## Verification of Results

*Visualyse* is not a black box.

The end results of many simulations are a single number or a statistical distribution of a single variable - in many cases you cannot guess before you do the calculation what the result will be and so have no intuition or expectation.

In these cases, the detailed step by step verification of the calculation, perhaps at a few critical points is essential. *Visualyse* allows you to view (in text or graphical form) all the variables that are used in a calculation. This includes user inputs and internally calculated variables.

Variables can be logged to file for external post-processing.

This native facility is often used to 'debug' simulation set up and more often to develop a feel for what is happening in a simulation which in turn leads to more confidence in the overall results.

## Stations and Antennas

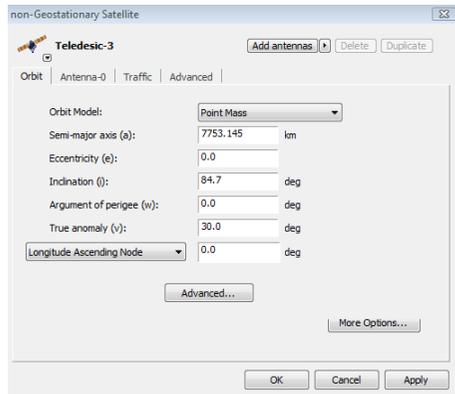
Where are your transmitters and receivers, where have they been and where are they going? This is all determined by the properties that you enter for the Station Objects in your simulations.

*Visualyse* conceptually includes many different types of Station. The distinction between types is in how you input positions and how future locations are calculated by the software.

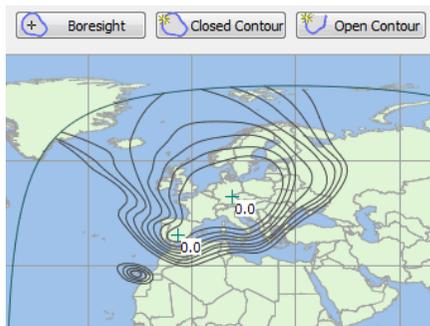
The positions and velocities of stations can be defined by one of the following:

- **earth stations** based upon latitude, longitude, and height above terrain, with optional speed and direction of movement
- **aircraft** based upon latitude, longitude, and height above sea level, with speed, direction of movement and climb rate
- classical orbit elements, such as semi-major axis, eccentricity, and inclination for **non-geostationary satellites**
- geostationary orbit longitude for **geostationary satellites**

Another function of stations is to point antennas. Stations can contain multiple antennas at different heights, and antennas can be multiple spots.



*GIMS Antenna patterns and a direct link to the GIMS database are just one way to define your coverage. You can also define multiple spots, look-up tables or pre-defined roll-offs*



*Connectivity is set-up through various types of link in the*

Antenna pointing can be specified to be:

- based on fixed azimuth and elevation angles
- pointed at another station or antenna
- scanning round at pre-determined scan rate or between specified angles
- driven by link requirements - in case the system models any kind of handover

Antenna performance or beam roll-off is the most important factor in much interference analysis. This performance is specified in the Antenna Objects that you define.

Each **beam** can have different gain characteristics.

The pattern can be specified using one of the four following options

1. pre-defined roll-off masks
2. look up tables
3. as GIMS contours
4. to produce a fixed PFD at given elevation angles on the ground

Over 75 pre-defined equations are available include ITU-R Recommendation 672 and 580 for the space circular spots. Gain tables can be either symmetric around the boresight axis or two-dimensional grids allowing shaped beams to be included.

Electronically steerable beams can be defined that re-shape to have a constant circular footprint on the ground whatever the orientation of the transmitter.

Shaped beam patterns can be defined for GSO satellites based on a series of equal gain contours, entered by a series of mouse clicks. These can be imported and exported using the ITU GIMS format.

### *Station Groups*

Stations can be collected together into groups for easy management. For example a single group could contain all the stations in NSO MSS or NSO FSS constellations - you can then manipulate the parameters of all the stations in the group in one go.

Some systems are defined by a large number of parameters. NGSO constellations, for example, could have a large number of satellites each with multiple spot beams. Visualyse includes a number of Wizards. Wizards are available to define constellations of NGSO satellites; multiple-hop fixed service systems, and service areas based on a terrestrial grid or the footprint of a beam.

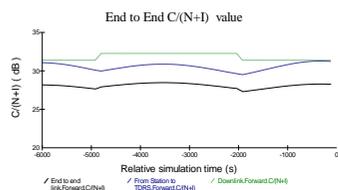


Large numbers of links, and end to end connectivity, diversity and coverage analysis are supported by Link Groups

Select Link Type

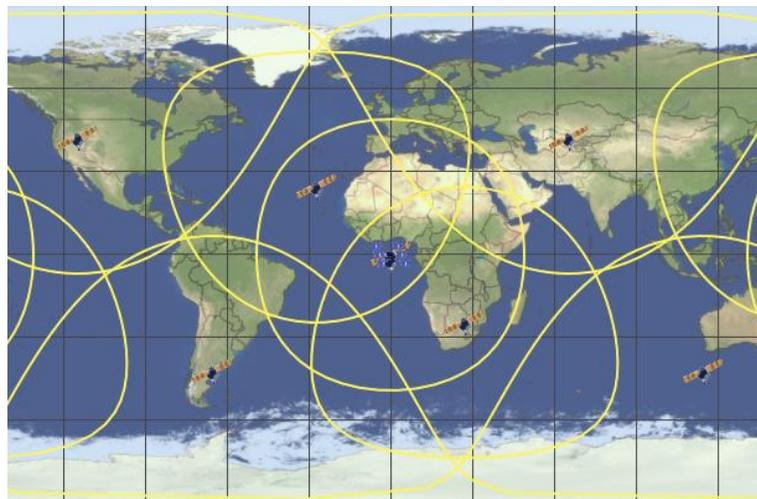
- Fixed link**  
 A Fixed Link has explicitly defined start and end stations that do not change during a simulation run
- Dynamic link**  
 Has an explicitly defined start station, but its end station is selected from a group based on some criteria
- Receive link**  
 A Receive link has an explicitly defined end but no start station
- Transmit link**  
 Defines a set of transmitting beams which can be used as a source of interference

Cancel



The Constellation Wizard defines a constellation in terms of the number of planes of satellites and number of satellites per plane.

Cellular beam coverage's are defined in terms of circular rings or hexagonal patterns. After running the Wizard, you can adjust any of the parameters for 'fine tuning' as required.



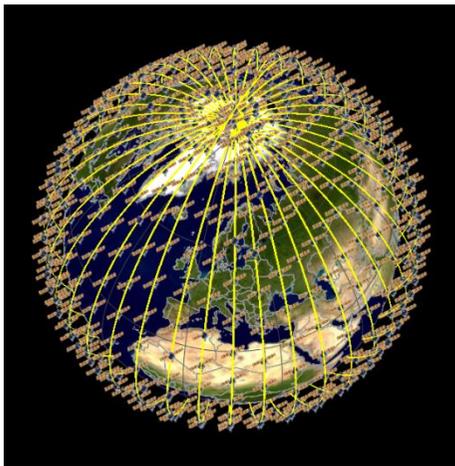
Links - defining your topology

Links in Visualyse are used to model connectivity and network topology. We have found that a classification into four types provides the flexibility to define any type of sharing scenario. These types are:

- **Transmit Link** - a station or group is transmitting but the receive station is not defined. An example would if a station or group is considered only as an interferer.
- **Receive Link** - a receive station is defined without a transmitter. An example would be a Radio Astronomy Earth Station, observing a deep space target.
- **Fixed Link** - both transmit and receive stations are defined and do not change for the link duration. Examples would be the Fixed Service systems and the Fixed Satellite Service systems.
- **Dynamic Link** - the geometry between transmitter and receiver changes. Use a Dynamic Link wherever the system might need to handover from station to station as the simulation evolves.



*The graphics are not just pretty pictures. Feedback and additional information can be seen in each window*



*Visualyse Views are designed to support you need to enjoy using the software, to provide feedback when you do something and to allow detailed verification of results*

Links can be either simplex or duplex. Each link has user definable carriers. Carrier characteristics include code type, access method, polarisation, symbol rate (for digital systems), and allocated and occupied bandwidth. For each link there can be power control or fixed receive signal level. For each link the  $C$ ,  $I$ ,  $N$ ,  $C/I$ ,  $C/N$ ,  $C/(N+I)$ , and  $\Delta T/T$  ( $I/N$ ) is calculated. The link budgets for  $C$  and the worst single entry  $I$  are also stored.

Visualyse can calculate PFD, EPFD and APFD for the standard reference bandwidths, and define station transmit characteristics based upon PFD masks.

### *Propagation Modeling the Electromagnetic Environment*

Visualyse allows you to characterize the electromagnetic environment based on a number of propagation models. You can select models for different circumstances (mobile vs. fixed, satellite, terrestrial, different frequency bands etc.)

Terrestrial propagation may be based on Recommendation ITU-R P 452, P1564 or P530-5

Dry air and water vapour attenuation, are also included for path which pass through the atmosphere using P676-2 or P 618-5.

Also available are propagation models such as Crane Rain, Egli, Hata, Lee, Appendix 28 / WRC 95 App. S.7, and TIA fade models.

### *Interference*

Interference paths can be quickly set up by selecting from the list of defined links the wanted path, and then selecting from the remaining links the interfering paths.

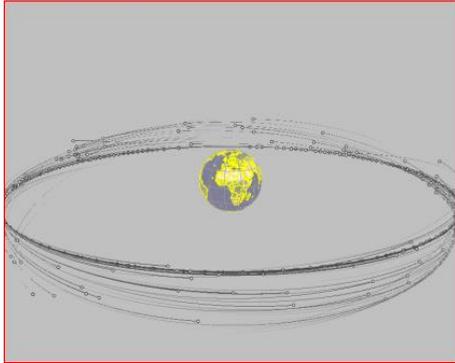
Any number of interfering paths can be defined in a single run.

Additional factors such as polarization, Net Filter Discrimination and bandwidth adjustment can be calculated.

### *Visualyse Views - graphical feedback, numerical detail*

Since 1994 Transfinite has focused on developing engineering software that is satisfying to use, provides appropriate feedback and allows detailed examination of results. These requirements are supported by the different Window types or Views that you can open within each simulation document.

Graphical views do more than add aesthetic pleasure; they provide essential and immediate feedback. A very simple example would be if you create a station and use an east longitude when you intended to use a west



*The high standard of the graphical outputs adds great value to your reports and presentations.*



longitude - you will see this immediately in either the **Platte Carree**, **Mercator** or **3D Views**.

Similarly, the plotting of orbit ground and space tracks (in 3D view) will show up any gross errors in the orbit parameters you are using.

All Map Views give you the option to overlay bitmaps as reference information. Maps for instance provide you with real physical references (roads, cities, etc) for you calculated data and simulation geometry

**Model View** gives you an overview of the objects that you have created. The view organizes objects in a hierarchical tree. You can see quickly the structure of you Links, Stations and other objects.

Our **Watch Window** allows you to select variables to monitor as the simulation evolves. You may be familiar with this type of facility as a debugging aid in many software development environments. It serves a similar purpose in Visualyse

**Table View** give you access to numerical values of parameter values across a large number of objects simultaneously. Parameters can be inputs, outputs or intermediate calculations. This supports your need to verify the simulation set-up and operation. .

Data can be exported for analysis and post processing. We directly support the display of simulation results in Google Earth.

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