VISUALYSE PROFESSIONAL VERSION 7

Analysing Radio Communication Systems

Challenges of Spectrum Management

The radio spectrum is increasingly a key enabler for the funding and development of communication services - 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 spectrum being squeezed by regulatory, technical and commercial forces, the job of the radio spectrum manager is now under pressure from many directions. One week you are looking at the intricacies of sharing between broadcast networks and mobile at UHF including terrain and clutter modelling and alternative network topologies, the next you need to model interference from UWB using dual slope propagation models, while the next interference from WiMax or LTE into satellite earth stations.

Radio 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.

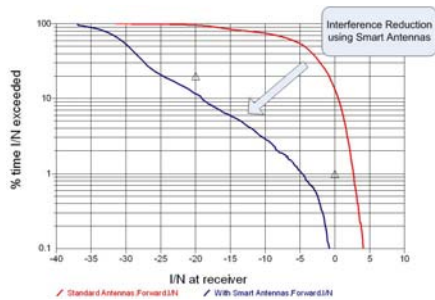The decision process in a organization can pivot around questions such as:

- How should we respond to the opportunities of the Digital Dividend?
- What form of spectrum usage rights (SURs) would be best for a forthcoming licence auction?
- What is the right Block Edge Mask (BEM) to protect us from adjacent services?
- Could we share some of the spectrum currently used by public bodies such as the military?
- What if ……?

Our proposition to the engineer and to senior management is that communications system modelling, 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.

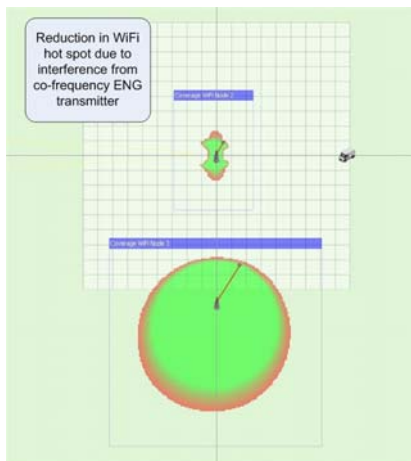Our definition of appropriate in this context is based on four supporting values:

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*.

The Power of *Visualyse Professional*

Since the launch of Visualyse Professional in 1995 desktop computing power has increased exponentially. 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 Professional comes from its simple structure and flexibility. Simple underlying modelling 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 Professional 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 Professional has tools to help you create and manage these. Import of data is supported in several formats including direct access to the BR-IFIC database and Excel based CSV files for point to point fixed service and station locations.
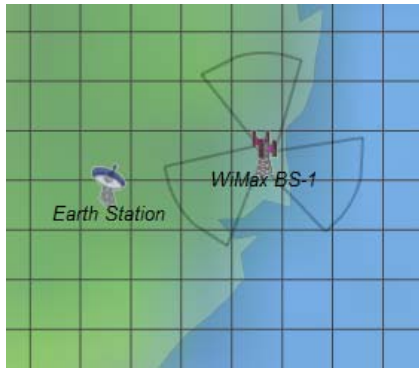
If you define a very complex scenario a full characterization of the results is likely to require lots of numbers, pictures and explanations. From examination of detailed link budgets, graphically representation of coverage and availability, statistical summary of interference and examination of the station dynamics – you need all these elements at your finger tips.

Here, the power of Visualyse Professional 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 – fixed, mobile, broadcasting, aeronautical, maritime, radio astronomy, earth exploration, meteorological, radiolocation, satellite…..

- ✓ Power to undertake all types of analysis – from basic link budgets including static minimum coupling loss to full Monte Carlo or dynamic simulations, and from representative networks to actual deployments.

- ✓ 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.

Interference Reduction using Smart Antennas

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

Graphs and Pictures are invaluable aids – and Visualyse Professional has them all.

Reduction in WiFi hot spot due to interference from co-frequency ENG transmitter

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.
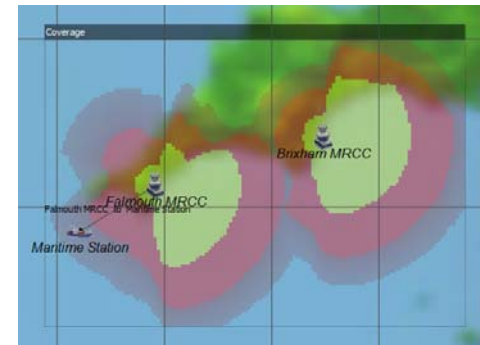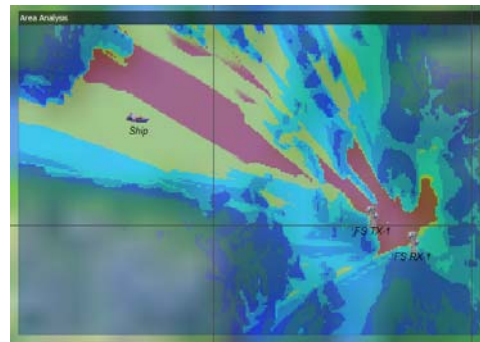
A few minutes with our tutorial documentation will have you setting up simulations – the fact that the objects you define have real world counterparts make them easier to remember. The availability of a library of pre-defined simulations and supporting documents, augmented by our technical support team, 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.
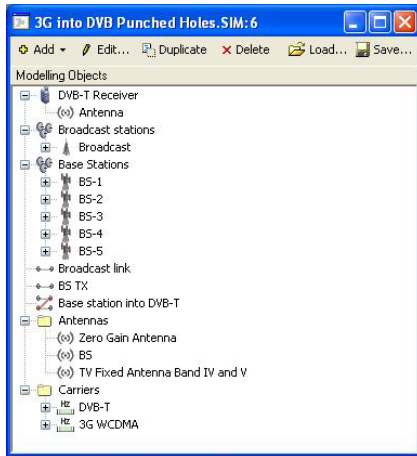
This last requirement – utility – is the central goal of Visualyse Professional. The object based design means that it can be adapted to all types of system, the on-going software development and cross-fertilization from our consultancy work means the new features and enhancements to existing features.

Ease of use remains high on our agenda – our aim is to make using Visualyse Professional 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 Monte Carlo modelling of sharing scenarios involving broadcasting and mobile services at UHF, but you will also find that when you are asked about detailed coordination of specific satellite earth stations with WiMax in C-Band you can use the same tool to explore the answers.
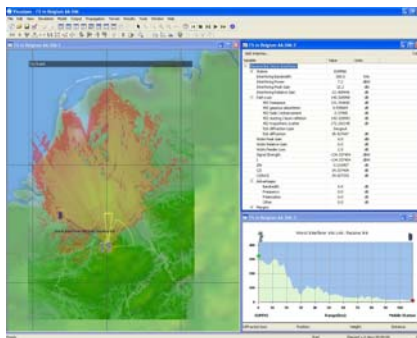
Return on Investment

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

1. Visualyse Professional saves you time

2. Visualyse Professional improves the quality of your analysis

3. Visualyse Professional makes it possible for you to be more responsive

4. Visualyse Professional saves you money

5. Visualyse Professional 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 Professional 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 Professional does? Our track record shows that we are committed to providing on-going support.

The fast pace of change in the communications industry and the increasingly short time for study work means you have to be ready to go – Visualyse Professional 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 Professional*.
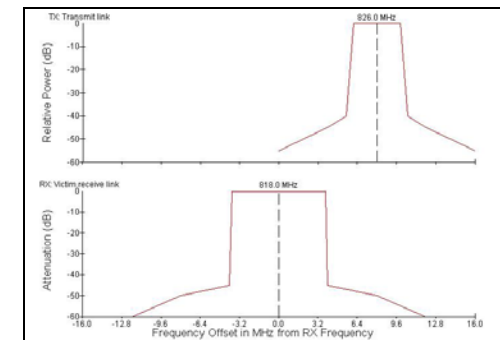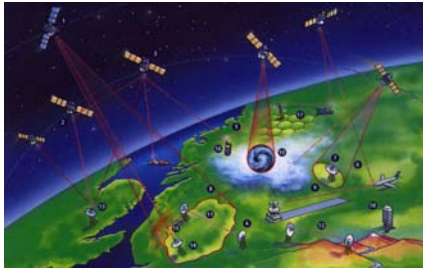
Technical Support

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 15 years 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 some cases it can be better to accelerate the learning curve using our structured training.

Transfinite provides in-depth training in the methods of radio interference analysis and in the procedures of the ITU. 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.
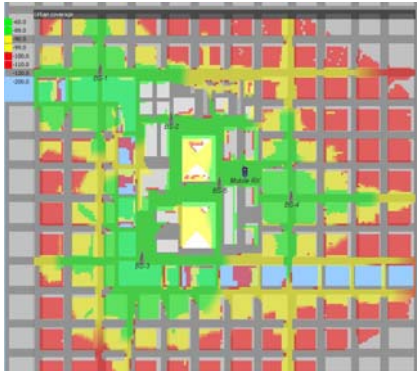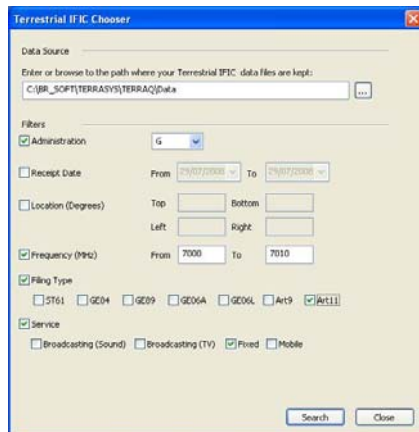
What does *Visualyse Professional* Do?

Visualyse Professional is, at heart, an engine for calculating signal levels, interference levels and noise levels in radio links. It will produce I, C/I, C/N, C/N+I, PFD (including PFD based SURs), 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 Professional is the de-facto industry standard, recognised, software tool for modelling and simulating radio systems.

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

Visualyse Professional has been designed for interference modelling, 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 Professional 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 Professional* is to simulate any type of radio system – fixed, mobile, broadcasting, aeronautical, maritime, satellite, radar, etc – using the same familiar modelling 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 modelling approach is used for simple and for complex scenarios.

Urban coverage example.SIM:1

Add Watches...		Copy
Variable	Value	Units
Receive link.Worst Interferer		
Station	BS-1	
Interfering Bandwidth	5.0	MHz
Interfering Power	0.0	dBW
Interfering Peak Gain	0.0	dBi
Interfering Relative Gain	0.0	dB
Path Loss	120.833801	dB
452 freespace	79.125212	dB
452 gaseous absorbtion	0.000736	dB
452 fade / enhancement	0.0	dB
452 ducting / layer reflection	265.967721	dB
452 troposheric scatter	293.854321	dB
Diffraction type	Deygout	
Diffraction	43.213003	dB
Victim Peak Gain	0.0	dBi
Victim Relative Gain	0.0	dB
Victim Feeder Loss	5.0	dB
Signal Strength	-125.833801	dBW
I	-125.833801	dBW
I/N	1.797099	dB
C/I	25.833801	dB
C/(N+I)	23.629752	dB
Advantages		
Margins		
Receive link.All Interferers		
No. of Interferers	5	
I	-125.802485	dBW
I/N	1.828415	dB
C/I	25.802485	dB
C/(N+I)	23.610873	dB

Urban coverage example.SIM:3

Range(km)

Diffraction loss: Not ; Position: | Height: | Distance:

Verification of Results

Visualyse Professional 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 Professional* allows you to view (in text or graphical form) the key variables that are used in a calculation. This includes user inputs and internally calculated variables. These 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 and a greater intuitive understanding of the issues involved.

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 Professional 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:

- **Terrestrial stations** are based upon latitude, longitude, and height above terrain, and are also used to model satellite earth stations

- **Mobile stations,** as terrestrial stations but with additional control on speed and direction

- **Maritime stations**, as mobile stations, but with height above sea level rather than terrain height

- **Aircraft**, as maritime stations, but with additional fields for climb / descent rates

- Classical orbit elements, such as semi-major axis, eccentricity, and inclination are used for **non-geostationary satellites**

- Geostationary orbit longitude is needed for **geostationary satellites**
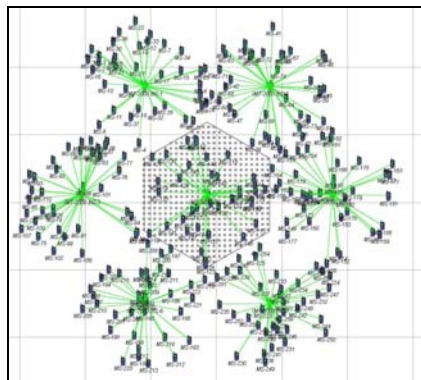
Another function of stations is to point antennas. Stations can contain multiple antennas at different heights, and antennas can have multiple spots.
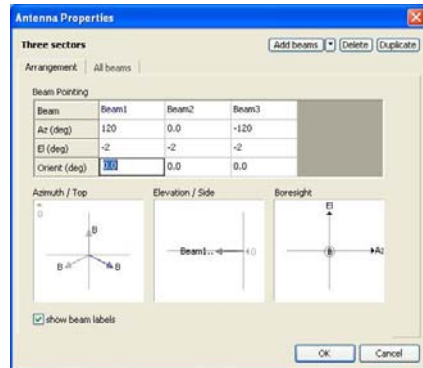
Antenna pointing can be specified to be:

- 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 a range of options including pre-defined roll off mask from ITU-R or ETSI specifications or from various forms of look-up table.

Over 80 pre-defined equations are available include ITU-R Recommendations F.699 and F.1336 for point to point and point to multiple antennas for fixed and mobile applications. 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 used to model smart antennas or beams can be arranged in sectorial arrangements – for example 120°, 90° or 60° sectors with or without downtilt.

Station Groups

Stations can be collected together into groups for easy management. For example a single group could contain all the base stations in network – you can then manipulate the parameters of all the stations in the group in one go using our Change Variable Wizard.
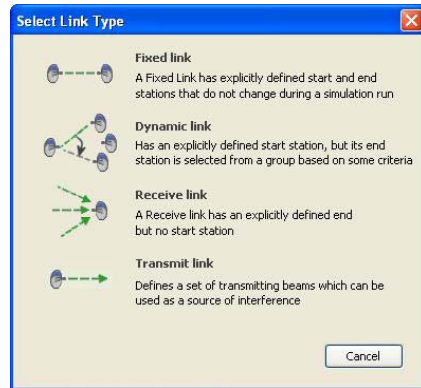
As well as a convenient way to manage large numbers of Stations, these Groups can contain Wizards that automate the act of station deployment – such as over a defined service area. Station Groups can also be created using some of the data import tools which include:

- Interface to ITU-R Terrestrial IFIC to read broadcasting, fixed and mobile assignments
- Point to point fixed service import tool
- Ability to read station locations defined by CSV file of (latitude, longitudes)
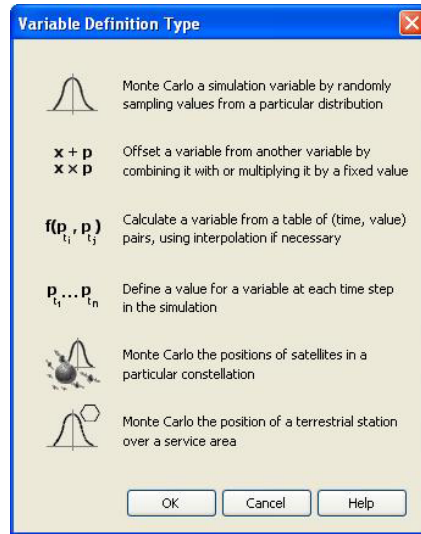
The Service Area Wizard and Define Variable Module

The Service Area Wizard can be used to deploy identical stations across a region defined by a rectangular area, country border, beam footprint (polygon), hexagonal patterns, or defined set of (lat, longs). This can be
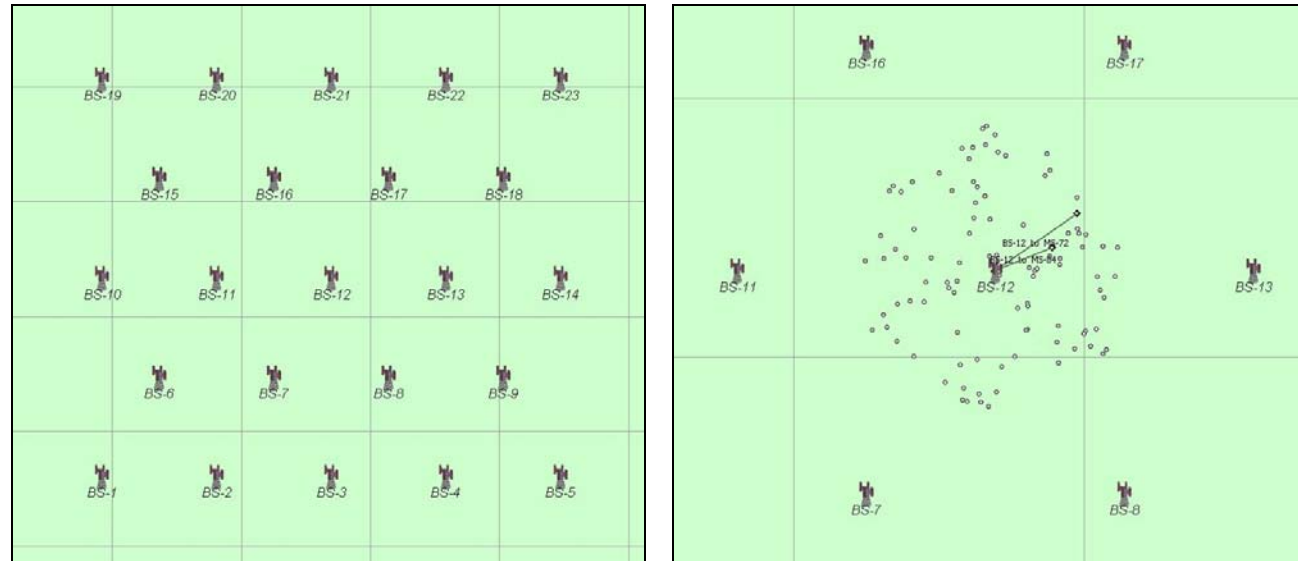
combined with the Monte Carlo Mobiles feature of the Define Variable Module which randomises the locations of mobiles within a hexagonal cell.
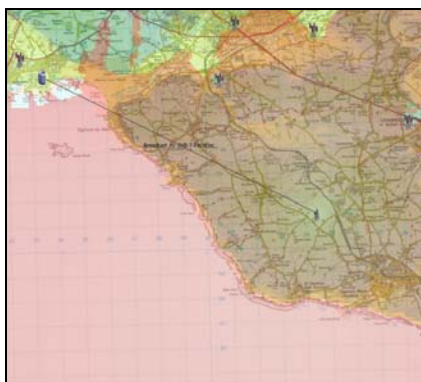

Links – defining your topology

Links in Visualyse Professional 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:
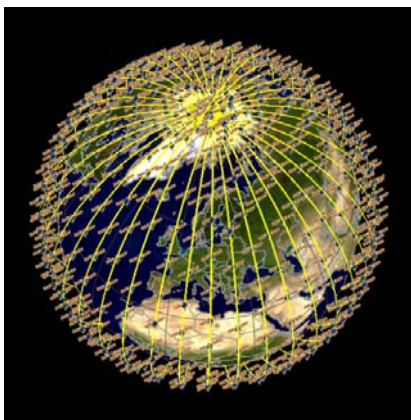
- **Transmit Link** - a station or group is transmitting but the receive station is not defined. An example would if a station or group is considered only as an interferer.

- **Receive Link** - a receive station is defined without a transmitter. An example would be a Radio Astronomy site, observing a deep space target.

- **Fixed Link** - both transmit and receive stations are defined and do not change for the link duration. An example would be a point to point fixed service link.

- **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 (such as a mobile with Monte Carlo-ed random position selecting base station and antenna at each time sample).

Links can be either simplex or duplex. Each link has user definable carriers. Carrier characteristics include spectrum masks, access method, polarisation, and the 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 I/N is

calculated. The link budgets for C and the worst single entry I are also stored.

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

Propagation Modelling the Electromagnetic Environment

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

Terrestrial propagation may be based on ITU-R Recommendations such as the complete models in ITU-R P.452, P.1564, and P.1812, or using combinations from P.525, P.526 and P.530 (multipath and/or fading). We provide interfaces to terrain and clutter database and their use within propagation models as appropriate, and can supply a range of terrain databases including a processed version of the SRTM.

We also have a generic short range propagation model based upon the algorithm in ITU-R Rec. P.1791, extended to be a flexible dual slope model with log-normal fades and indoor to outdoor loss models and the standard Hata / COST 231 model.

Dry air and water vapour attenuation, are also included for path which pass through the atmosphere using P.676-2 or P.618-5.

Also available are propagation models such as Crane Rain, Egli, Lee, App. S.7, and TIA fade models.

Interference Calculations

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.
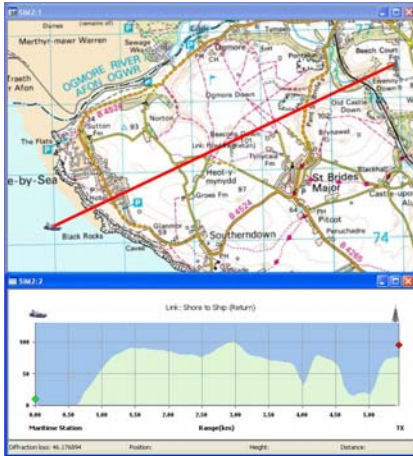
Any number of interfering paths can be defined in a single run, which can analyse in-band or adjacent / out-of-band scenarios. Interference can be either single entry or aggregate from any number of transmitters.

Additional factors such as polarization, net filter discrimination (NFD) and bandwidth adjustment can be included in the calculations.

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.

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

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

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

All map views give you the option to overlay point, vector or raster data as reference information. Maps for instance provide you with real physical references (roads, cities, etc) for your calculated data and simulation geometry.

An important tool is Visualyse Professional's **Area Analysis** feature, which allows you to see how a calculated value would vary across a geographic region, displaying the results either as contours or as coloured pixels. This easy to use feature has many applications, from coverage predictions to interference analysis, and the results can be shown in the Plate Carree, Mercator and 3D views and also exported to Google Earth.

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 your 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 and this view serves a similar purpose in Visualyse Professional.

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**.

Transfinite Systems Ltd

Contact	6C Rathbone Square
	24 Tanfield Road
	Croydon CR0 1BT
	UK
Phone:	+44-(0) 20-8240 6648
Fax:	+44-(0) 20-8240-4440
Email:	info@transfinite.com
Web:	www.transfinite.com