Web Based Spectrum Management For Defence Applications

Abstract: The web is increasingly the core of information technology architectures. Spectrum management is no exception, with the development of online portals to access spectrum related information and apply for spectrum products. This White Paper discusses such changes, considering how their requirements and approaches show themes common to both civil and defence applications. The paper concludes that the needs of modern defence spectrum managers can be addressed in large part by an innovative new spectrum management portal, developed from a leading edge civil requirements.

Web Based Spectrum Management

The internet continues to evolve and have an ever greater impact on every part of our lives. This includes the tools and methods used to manage the radio spectrum, which are being transformed by web service architectures.

While sometimes grouped into labels such as "Web 2.0" the reality is a range of developments which are being knitted together to provide new services more easily, cheaper, and to a wider group.

These new technologies include (but are not limited to):

- Locating services and intelligence on central server accessed over the internet
- Integration of services from multiple separate and specialised servers
- Providing desktop like user interfaces via web browsers
- Asynchronous access from multiple users, globally distributed and potentially in large numbers
- Scaleable central servers balancing load by farming tasks out to arrays of cores
- Exchange of data in common XML based formats
- Access to global databases for visualisation purposes (e.g. mapping)
- Integration with other information systems such as email and calendars

These developments will impact both civilian spectrum management and military requirements.

This White Paper looks at the latest developments in civilian web based spectrum management, and identifies common threads with defence requirements and also areas where there are differences.

The paper uses as its baseline work undertaken by Transfinite for Ofcom to develop a "Generic Radio Modelling Tool", later commercialised into Visualyse Spectrum Manager (SM).

The history and motivation of this project are described, followed by an overview of Visualyse SM.

GRMT Research Project

The Generic Radio Modelling Tool or GRMT was a $1m Ofcom sponsored research project undertaken by a team led by Transfinite Systems to investigate new technologies and concepts in spectrum management.

The starting point is that bands are more and more being reserved for the use of more than one type of services – the sharing environment is becoming 'heterogeneous' whereas it has been traditionally homogeneous. In addition, demand for spectrum means that guard bands are being squeezed.

Hence there is need for spectrum management tools to be able to analyse interference from 'anything into anything', to be "generic".

At the same time there were questions about how users would interface with such a tool. For mainstream spectrum products licensed by regulators such as Ofcom there was a need for a clean user interface and partially automated licensing system.

While in practice there might be human-in-the-loop (at least initially), the more that customisation of each analysis could be limited, or preferably avoided, the more cost effective and stream-lined the process would become.

Hence as far as possible the 'anything to anything' analysis would be undertaken without the user having

to learn and make decisions about intricacies of radio engineering, for instance the selection of appropriate propagation models.

Simultaneously there were operational requirements for the tool:

- To be accessible by a wide community within Ofcom and potentially stakeholders outside
- For time consuming and CPU intensive analysis to be undertaken not on the end users computer but on a remote server
- For access to be controlled via suitable security mechanisms
- For services to be available 24/7 with simultaneous access from multiple end users

The solution was to put the logic and processing on a central web server accessed via the internet or intranet.

A lot of these requirements are applicable to both civilian and military requirements, and aspects of the technical solution are therefore likely to be similar.

GRMT is currently installed and running on the Ofcom intranet. More information about GRMT can be found at the Ofcom web site here:

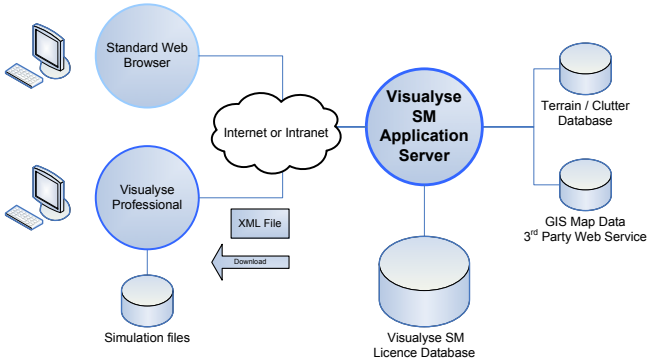
http://www.ofcom.org.uk/research/technology/research/speclib/grmt/

Visualyse Spectrum Manager

The research project that delivered GRMT was commercialised by Transfinite in the band management product, Visualyse Spectrum Manager.

Transfinite are owners of a block of spectrum with the UK that can be used by point to point (PtP) fixed links, point to multi-point (PtMP) cells, and satellite earth stations. We provide access to spectrum users to our block using Visualyse SM as our licensing portal.

Visualyse SM is a purely web based solution to spectrum management and licensing, presenting the user with a powerful user interface via a standard web browser. The top level architecture of Visualyse SM is shown in the figure below.



Visualyse SM manages the standard licence application and processing flow, managing the central store of spectrum licences and constraints.

Non-standard and specialised analysis can be undertaken by the Visualyse Professional study tool. Visualyse Professional can read licences downloaded in XML format for flexible what-if? analysis by an experienced radio engineer.

Rather than describing the product feature by feature we will consider defence requirements and look at the approach taken by Visualyse SM.

Defence Requirements

Secure Access

Visualyse SM was designed with security in mind. Log-in is managed via Active Directory, which provides administrators with services including,

- ability to assign policies,
- ability to deploy software, and
- to apply critical updates to an organization.

A key attribute of Active Directory is the secure log-in that uses the industry standard Kerberos protocol.

Users are given access rights that determine which services are available to them and what information is displayed. For example, there is the ability for end users to see only the licences for which they are responsible, not all within a band or location.

Defence requirements would be similar but with additional protection against denial of service and similar hostile activities.

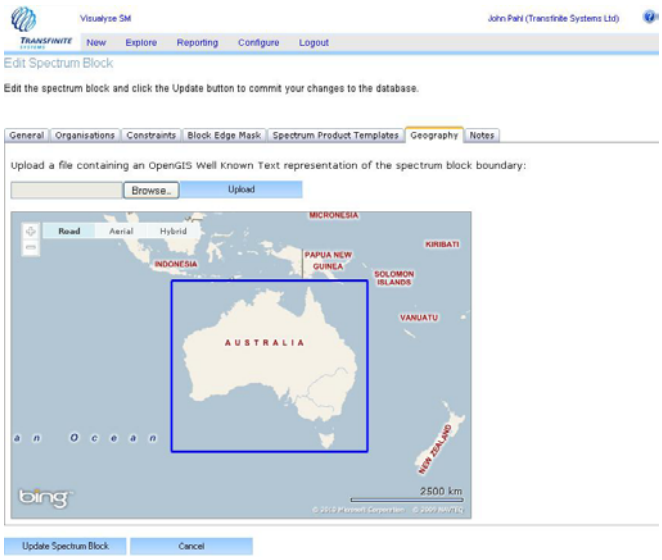
Global Access and Analysis

The services of Visualyse SM can be accessed from anywhere in the world that has access to the internet. In addition Visualyse SM is able to provide global spectrum management from a central server using global terrain databases and GIS data.

We currently work with the USGS SRTM 90m terrain database combined with the Microsoft Bing! mapping

service, but the architecture could use other sources if available.

The architecture is based upon logical elements called “Spectrum Blocks”. These can be used to define the spectrum plan for a country, and the structure can allow multiple countries to be defined. This allows the radio communication countries of an entire region, or potentially the entire globe, to be managed via a single Visualyse SM server.



This approach would facilitate those Defence organisations that have to be able to operate on a global basis. The Spectrum Block architecture could be used to encapsulate local country by country requirements within a single spectrum management solution.

A centralised server approach has the additional benefit that it reduces the over-head of managing global roll-out of updates. Providing access to spectrum services via a small set of well controlled sites means that when they are updated it would provide an instantaneous upgrade for all users.

Service Aware Application

Visualyse SM is built using standard web development technologies such as the Microsoft .NET framework and Microsoft SQL Server.

These are by nature service based, and so is what is described as “social”. Visualyse SM is itself built from components that exchange information via a standardised interface. It also communicates with external web services such as GIS data.

This could be extended to provide services to other applications within a secure environment. This ability can be of benefit to both civil and defence requirements – for example to exchange data between the two communities.

Load Balancing Techniques

Current information processing techniques aim to provide increased computing power through farms of processors. Visualyse SM is designed to be asynchronous operating over multiple cores, multiple CPUs and even multiple servers.

Complex analysis is broken down into jobs which are then managed across multiple processors by a job scheduler. This can be prioritised depending upon requirements.

The server based architecture means that additional load can be managed in a cost effective manner by splitting ever more of Visualyse SM’s processing over a greater number of servers.

This ability facilitates complex and data hungry Defence analysis. Requirements for data and CPU can be predicted as part of war gaming and capacity made available in advance.

Rather than being constrained by end user CPU or data capture requirements, managers can ensure their spectrum users have access to the best analysis tools from a central site.

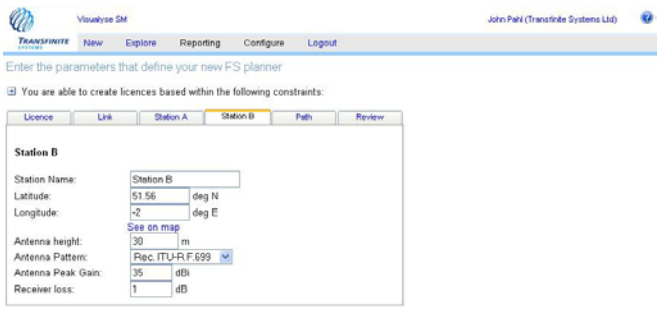
Product Based User Interface

Users of the radio communication systems that require access to spectrum should not need to understand the details of radio engineering.

The objective of Visualyse SM is to handle the complexity on behalf of the end user. This is implemented in a number of ways, most importantly via a Template based definition of spectrum products.

The Templates show the end user only those parameters that are necessary and in a form understandable to the end user. They handle basic tasks such as conversion of units, derivation of parameters such as necessary power, completing those fields that are common for a product type etc.

The end result is a user interface requiring the minimum number of fields to be entered:



These product based parameters are mapped to an underlying data dictionary that is used for all radio systems within the Visualyse SM database.

The Templates required will depend upon the application. The Visualyse SM architecture is designed to be expandable and can include those spectrum products required for Defence applications.

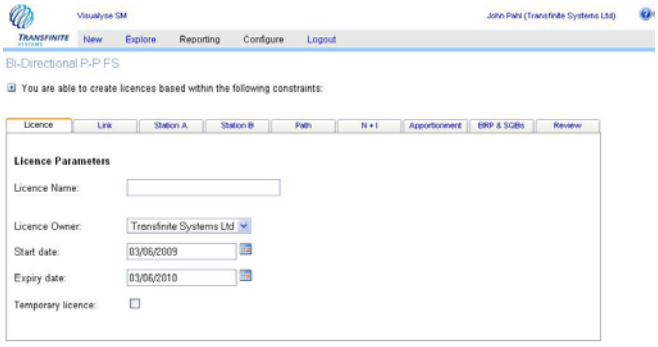
Time Dependent Licensing

Spectrum products built within Visualyse SM can include date and time requirements.

One potential application for Visualyse SM is to manage the licensing of Program Making and Special Events (PMSE), sometimes also called Services Auxiliary to Program making (SAP) / Services Auxiliary to Broadcasting (SAB).

These are likely to be short term or temporary assignments booked to operate for a time period well in advance of the application time.

Visualyse SM therefore has the ability to undertake compatibility assessment not just at specific locations and frequencies but also within specific time periods.



This would have direct applicability to Defence requirements, where there would be need for access to spectrum at specific times for specific missions.

Reporting Tools

Visualyse SM includes reporting tools built upon Microsoft SQL Server Reporting Services.

They are used to provide a range of levels of feedback on analysis and spectrum access. The first level of reports are given at a high level, including just the parameters needed for installers.

However there is the ability to “drill down” from high level reports all the way to the various tests undertaken to link budgets and propagation details.

This approach would also be useful for Defence applications, where there can be end users who just want the key parameters and also specialised radio engineers investigating detailed problems.

It also supports “help desk” style services, whereby an experienced engineer can find out more information – such as why an application to access the spectrum was denied, what changes could be made to improve compatibility etc.

Integration with Information Architecture

A spectrum management system will only be part of an overall information technology architecture. Both civil and defence applications will need to be fully integrated with other services.

An example of this is email. Visualyse SM is email aware, sending updates to users when spectrum access is approved or technical analysis is complete.

Data Import and Exchange

A key requirement is the ability to import data from existing sources and also exchange data with other tools.

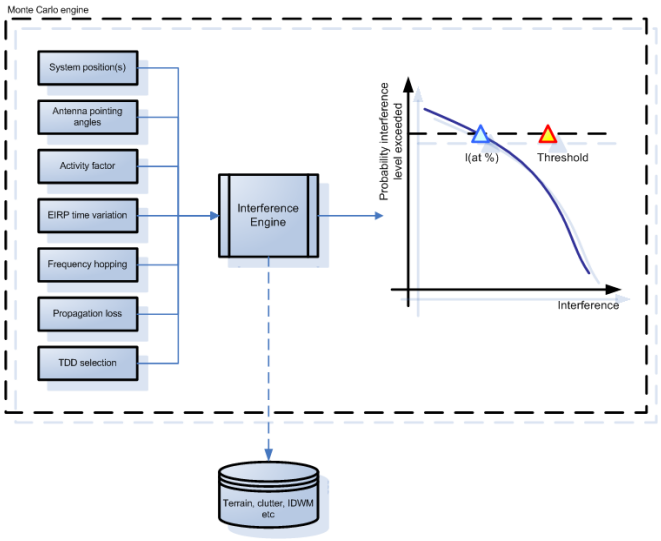
Visualyse SM is designed to make it easy to import from diverse sources including national and international data sets. For example we have tools to extract data from the ITU-R’s Terrestrial IFIC database into Visualyse SM.

In addition assignment data can be exported in XML format to our Visualyse Professional study tool.

Defence spectrum management applications will have similar requirements.

Automatic Generic Analysis

End users do not want to have to understand details of radio engineering, such as what propagation model to select under which conditions, or whether to use Minimum Coupling Loss (MCL) or Monte Carlo analysis.



This is true of both civil and defence applications, and Visualyse SM contains sufficient intelligence to select the appropriate models in many circumstances.

Visualyse is based upon the most detailed and accurate propagation models available from the experts in the radio engineering community. For interference analysis we have included the models within Recommendations ITU-R P.452 and P.1812

together with use of terrain data and clutter (if available). For wanted predictions we automatically change to whatever is appropriate for the service being planned, for example ITU-R P.525 and P.530.

The interference algorithm also analyses the scenario under consideration and automatically identifies which analysis methodology to use, whether worst case, terrain based or full Monte Carlo simulation.

Interference vs. Jamming

One area where there are significant differences between civil and military is in the need to model jamming into the radio services of hostile groups.

In civil spectrum planning interference is always something to be avoided. For defence application it is to be avoided if it is due to any wanted service or comes from hostile services undertaking jamming actions.

However it can be permitted if the victim is not one of the friendly services, and this would require modifications to the planning process and compatibility assessment.

Process Model

Another area of difference is in process management. The approval of spectrum access for Defence applications will have to take account of the overall mission planning and implementation requirements.

Furthermore there are likely to be different objectives in terms of priority of applications. Within civil environments there is often a policy of “First Come First Serve” or FCFS.

However Defence applications are likely to have mission related prioritisation requirements. This can be facilitated by using a component based architecture and also by use of new process support tools.

Local Analysis

In addition to a centralised spectrum management service to provide access to spectrum services, there will always be the requirement for additional local analysis.

Example requirements could be to consider in detail a specific issue or to undertake planning tasks in a de-centralised architecture. For instance, planning a mobile coverage for defence units in the field. A block of spectrum would be allocated and identified as in-use by the central server, but actual locations of base stations and powers would be selected by in-field operations.

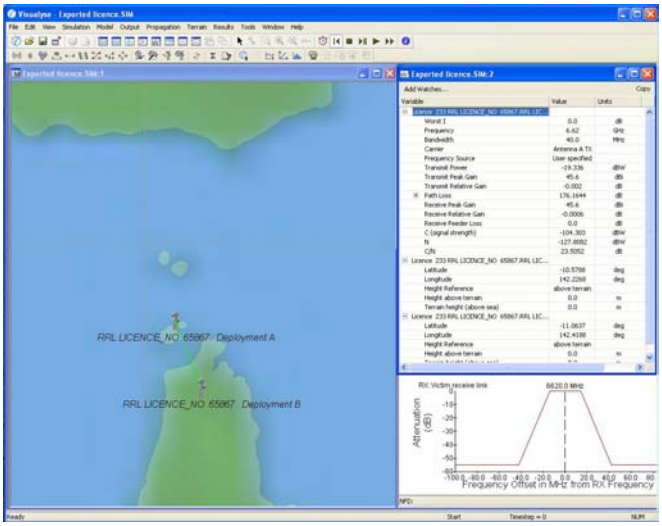
This split of tasks between central and local tools is replicated in the architecture of Visualyse SM. Visualyse SM is the central repository of all spectrum usage data but has the ability to:

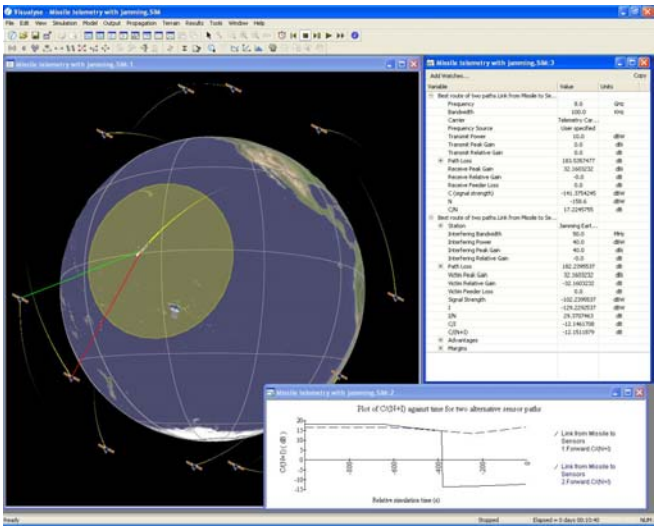
- Define, within Visualyse SM, block licences that cover a geographic and frequency area, but where individual transmitters and receivers are managed outside the central server
- Download licences into a local tool – in this case Visualyse Professional – to undertake more detailed analysis and planning.

These local tools can also provide additional features to build on the central Visualyse SM server. For example:

- Additional visualisation tools
- Management of multiple applications and batch style requests, via defined service interfaces
- Device dependent user interfaces (e.g. iPhone style applications)

The figure below shows screen shots from our Visualyse Professional study tool:





Conclusions

This White Paper has looked at the implications of web based spectrum management. Using the example of an operational spectrum licensing portal, Visualyse SM, it has looked at some of the key issues that must be addressed.

Commonalities and differences between Civil and Defence requirements have been highlighted and possible solutions suggested.

The analysis and concepts described here could be of benefit to those implementing complex Defence spectrum management systems including the Global Electromagnetic Spectrum Information System (GEMSIS).

The needs of modern defence spectrum managers can be addressed, in large part, by an innovative new spectrum management portal, developed from a leading edge civil requirements.

How We Can Help

Transfinite can assist you in spectrum management related activities including:

Consultancy projects and studies: our experts can support you by undertaking studies of radio communication systems, compatibility analysis, spectrum management licensing software requirements, and much more.

Analysis and planning software: our Visualyse Professional study tool can be used to analyse a wide range of sharing studies including radio communication systems used for defence applications

Web based spectrum management: our Visualyse Spectrum Manager provides an example of an operational integrated web based solution to support licence application and management. It could be part of a kernel for Defence requirements as part of a "*adopt before buy*" policy.

Planning Services: we can provide owners of blocks of spectrum a management service where by we provide you with access to our Visualyse SM server configured for your block which therefore undertakes planning, licence management and database management tasks.

About Transfinite

We are one of the leading consultancy and simulation software companies in the field of radio communications.

Our business activities can be broadly categorized into five main areas:

- Consultancy services
- Visualyse software products
- Bespoke software development
- Technical training
- Spectrum management

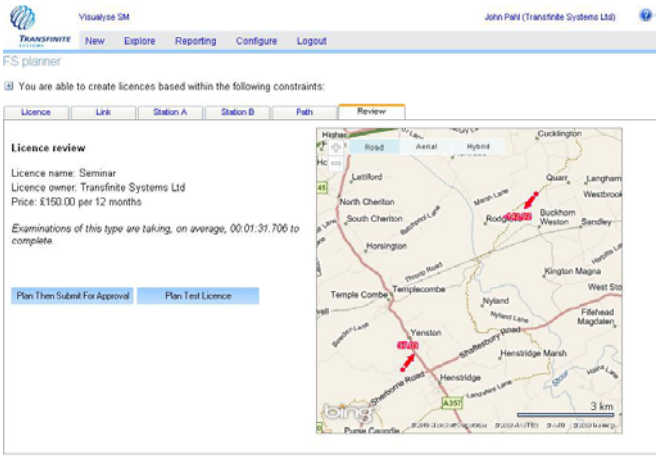
We develop the market leading Visualyse products:

- Visualyse Professional
- Visualyse GSO
- Visualyse Coordinate
- Visualyse Spectrum Manager

Our software has been installed at hundreds of sites, including leading administrations like Ofcom, the ACMA and Departments of Defence.

We are owners of a block of spectrum in the UK in the 28 GHz band which we manage as a private Spectrum Management Organisation (SMO). We can provide access to our spectrum using our Visualyse SM solution.

Operators can apply online for PtP fixed links, PtMP cells or satellite earth stations via our web site as in the figure below.



More information about these products and services is available at our web site or by contacting us as:

Address: Transfinite Systems Ltd
6C Rathbone Square
24 Tanfield Road
Croydon
Surrey CR0 1BT

Tel: +44 20 8240 6648

Email: info@transfinite.com

Web: http://www.transfinite.com

TRANSFINITE SYSTEMS

Email us at info@transfinite.com for further information or to give your views on this White Paper