EMF VISUAL

THE REFERENCE SOFTWARE IN ELECTROMAGNETIC EXPOSURE SIMULATION
Worldwide, the telecommunication regulatory bodies are paying more and more attention to human exposure to RF emissions. The authorization for installing new antennas is nowadays dependent upon a proof of compliance with local reference levels.

As a result, an accurate simulation of human exposure to electromagnetic fields is essential. This is the only way to calculate and consider the cumulated level of exposure generated by new antennas in their future installation sites together with all those already in place, used for cellular networks (2G, 3G, 4G, Tetra) or radio services (FM, TV, WLAN, ...).

EMF Visual software, reference in the industry, offers reliable and fast calculations. It allows the visualization of electromagnetic fields in a determined zone (near-field/far-field), taking into account the multiple emitters and their interaction with surrounding buildings.

The simulation results can be compared directly with reference levels given by ICNIRP, Safety Code 6, FCC, etc. thus providing clear and easy-to-understand evaluations of the compliance of a site.

In this new version, EMF Visual is even more powerful thanks to new advanced features. It now uses GPU resources which allow to cover larger areas for exposure evaluation, and enables the use of the GIS database or 3D objects conversion for a direct loading of virtual 3D scenes while interfacing with SketchUp software.

**EMF Visual,**
electromagnetic exposure simulation software

- Completely redesign interface
- GPU-accelerated computing for fast exposure evaluation
- Precise and fast creation of 3D environment
- Beam Steering function for simulations using 5G Massive MIMO antennas

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**Main features**

**Product category**
- Electromagnetic exposure simulation software

**Simulation capabilities**
- EMF Visual is a prediction, analysis and communication tool, which can accurately simulate exposure in both near and far field of the antennas while taking into account its environment

**User profile**
- Cellular network operators/installer, broadcast companies, regulatory bodies, municipalities.

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**System Configuration**

**Software**
- EMF Visual Standard (CPU) or Advanced (GPU)
- SE-SKP-EMF (plugin for SketchUp®)
- SE-AGETIM-LIGHT-EMF (3D creation)
- SE-FFT-EMF (3D Converter)
- BSA Synthesis (Custom Antenna creation)

**Services**
- Training
- Hotline

Included | Optional
STEP 1: 3D SCENARIO CONSTRUCTION

The creation of 3D scenario for EMF Visual can be done:

- by importing 3D objects from the EMF Visual generic database. A wide choice of 3D objects to represent ground, buildings, houses, masts, towers, indoor objects, etc… is available in the generic database.
- by using the Option SE-SKP-EMF: plugin for SketchUp1.

1https://www.sketchup.com/  
2https://3dwarehouse.sketchup.com

- By using the Option SE-AGETIM-LIGHT-EMF: 3D object/scenario creation for EMF Visual from SIG database.

- By using the Option SE-FFT-EMF (File Format Transfer): 3D files converter for EMF Visual.
STEP 2: ANTENNA SELECTION AND INSTALLATION

EMF Visual software can use antenna models from the existing database or a custom antennas created by BSA Synthesis Option.

- A complete database of generic models of the most current antennas used in 2G, 3G, 4G (700, 900, 1800, 1900, 2100, 2600 MHz) and 5G (3.5, 28, 39 GHz) cellular networks.
- An additional database of FM and Wifi antennas.

Antenna configuration tools.
- Geometric visualization of the antenna main beam cone in the scene together with graphic tools for adjusting position, tilt, azimuth and power.
THE 5TH GENERATION OF MOBILE RADIO COMMUNICATION (5G) use Massive MIMO antennas with beam steering capability to control actively the direction of propagation.

EMF Visual integrates a Massive MIMO antenna database with 2D array antennas working at 3.5GHz, 28GHz, 39GHz together with a dedicated function for adjusting easily the beam steering range in azimuth and elevation. With Beam Steering function for Massive MIMO antennas, EMF Visual allows to show either a particular orientation of the main lobe or the global envelop with all the possible orientations at the same time for site compliance checking purpose.

In addition to the antennas in the database, the user can also define custom 5G antennas operating over a desired frequency band, with custom beam steering range & resolution, size, and number of elements.

BSA SYNTHESIS OPTION: DEFINE ANTENNA CHARACTERISTICS AND CREATE CUSTOMIZED ANTENNAS.

- BSA Synthesis computes magnitude and phase for each unit cell to generate an antenna model that fits with far field radiation pattern:
  - vertical and horizontal -3dB beam width and frequency.
  - side lobe suppression.
  - number of cell units or antenna length.
  - front to back ratio.
- Analysis of antenna model from unit cell magnitude and phase data (1D and 2D array antenna).
- Exportation of the antenna model to the EMF Visual database.

STEP 3: COMPUTATION

After defining the computation volume around the area of interest, the electromagnetic field level calculation is launched. The calculation is based on optical geometry (ray tracing). It allows simulation to be performed over a wide area in terms of wavelength and the interactions with the environment of the radiating sources to be taken into account.

- Two computation modes are available according to the chosen option.
- Standard mode: CPU (Central Processing Unit) calculation
- Advanced mode: GPU (Graphics Processing Unit) calculation
• Definition of a computation volume around the area of interest.

• Accurate representations of the near field by considering the contribution of each sub-cell of the antenna.

• Selection of the active antenna.

• Adjustment of the mesh step (number of computation points).
• Non-uniform grid to improve resolution around the antennas and to speed up the calculations.
STEP 4: RESULT DISPLAY

Once the computation is finished, the user can use iso-surface or cut plane tools to display the level of exposure in the vicinity of the 3D environment.

- Multiple cut plane and multiple distance measuring possibilities for security perimeter definition.
- Evaluates the levels of exposure in terms of E-field (V/m), H-field (A/m), Power Density (W/m²), % of the E-field or % of the Power for multi-frequency sources.
- Determines the safety distances with respect to standards or recommendations (EU recommendation, ICNIRP, and so on ...).
- Visual post-processing of the results: choice of colour or transparency.

STEP 5: RESULT EXPORTATION

EMF Visual generates ASCII Txt file (permits result to be loaded in Excel, Matlab...).

For each volume and each band, one ASCII Txt file is created:
- contains the computed E-field value (V/m) is created.
- displays the E-field values for each antenna with the corresponding Cartesian coordinates.
- It is possible to generate a bitmap file, represented the cut plane.

HARDWARE REQUIREMENTS

<table>
<thead>
<tr>
<th>Processor</th>
<th>PC Pentium &gt; 2 GHz</th>
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<tbody>
<tr>
<td>Graphical Board</td>
<td>NVIDIA using CUDA 5.0 (“Compute Capability” of the card greater than 1.1)</td>
</tr>
<tr>
<td>Interface</td>
<td>USB Port</td>
</tr>
<tr>
<td>Operating system</td>
<td>WIN7 / WIN8 / WIN10</td>
</tr>
<tr>
<td>Memory</td>
<td>&gt; 2 GB RAM</td>
</tr>
<tr>
<td>Free space</td>
<td>1 GB free space on hard disc</td>
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</tbody>
</table>
SE-AGETIM-LIGHT-EMF is a simple terrain generation tool. Any user should be able to generate a virtual 3D scene for EMF-VISUAL. The user can import existing data (planimetry, altimetry, photography), and slightly modify parts of it. The data are automatically treated (corrected, simplified, kept or ignored in the generation process...), and the result is a 3D scene ready to be imported by EMF-VISUAL.

The GIS (Geographical Information System) user interface of SE-AGETIM-LIGHT-EMF also requires the third party GlobalMapper™ software that is included in the SE-AGETIM-LIGHT-EMF software delivery.

The basic features of SE-AGETIM-LIGHT-EMF are the following:
- Source data acquisition via internet (format: shapefile, dted etc...)
- Terrain generation (minimizing GIS operation)
- Priority to the realism and aesthetic of the generated DB
- Robustness with regard to the quality of source data
- Opportunistic approach: if the source data is good, it is used, if not ignored.
SE-FFT-EMF (File Format Transfer) product is a 3D geometric data converter, from and to the EMF-VISUAL format (called SDM format). It handles meshed databases (polygons characterized by textures, colors, etc.) used to describe terrains, objects and targets.

SE-FFT-EMF enables the conversion from OpenFlight, OpenInventor, VRML or TDF formats, towards the SDM format and vice versa (except for the TDF format). It also enables the conversion from the SDM format to the BSG format.

SE-FFT-EMF is made of five groups of software:
- SE-FFT-2FLT, that converts database in the SDM format into OpenFlight files, and SE-FFT-FLT, that does the reverse conversion. The resulting SDM files can be imported by EMF-VISUAL. The resulting FLT files can be imported by the OpenFlight utility programs.
- SE-FFT-2IV, that converts database in the SDM format into OpenInventor or VRML files, and SE-FFT-IV that does the reverse conversion (OpenInventor and VRML files). The resulting SDM files can be imported by EMF-VISUAL. The resulting IV files can be imported by the OpenInventor utility programs.
- SE-FFT-TDF, that converts database in the TDF format into SDM files.
- SE-FFT-2BSG, that converts database in the SDM format into BSG files.
- SE-FFT-2SEDRIS, that converts database in the SDM format into SEDRIS STF files, and SE-FFT-SEDRIS that does the reverse conversion. The resulting SDM files can be imported by EMF-VISUAL. The resulting STF files can be imported by the SEDRIS utility programs.

For the OpenFlight module, the versions of the formats supported by the two software components are:
- FLT to SDM: OpenFlight 14.2 to 16.4 and SDM 3.0 for SE-FFT-FLT
- SDM to FLT: SDM 3.0 and 15.8 for SE-FFT-2FLT

For the OpenInventor/VRML module, the versions of the formats supported by the two software components are:
- IV to SDM: OpenInventor, VRML 1.0 and 2.0 and SDM 3.0 for SE-FFT-IV
- SDM to IV: SDM 3.0 and OpenInventor or VRML 2.0 for SE-FFT-2IV

For the TDF module, the TDF format versions handled are the 10.0 and 11.3 and the format SDM 3.0.

For the BSG module, the BSG format version handled is the 1.0 and the format SDM 3.0.

For the SEDRIS module, the versions of the formats supported by the two software components are:
- SEDRIS to SDM: SEDRIS 4.1 and SDM 3.0 for SE-FFT-SEDRIS
- SDM to SEDRIS: SDM 3.0 and SEDRIS 4.1 for SE-FFT-2SEDRIS
A plugin for the tool SketchUp is also available as an option. Thanks to this tool, the user can create, from scratch, a model or download it from the Trimble SketchUp library and convert it into the SDM Format.

All the formats compliant with SketchUp interface can be converted into the SDM format.

1 https://www.sketchup.com/
2 https://3dwarehouse.sketchup.com
About Microwave Vision Group (MVG)

Since its creation in 1986, The Microwave Vision Group (MVG) has developed a unique expertise in the visualization of electromagnetic waves. These waves are at the heart of our daily lives: Smartphones, computers, tablets, cars, trains, planes - none of these devices and vehicles would work without them. Year after year, the Group develops and markets systems that allow for the visualization of these waves, while evaluating the characteristics of antennas, and helping speed up the development of products using microwave frequencies.

The Group’s mission is to extend this unique technology to all sectors where it will bring strong added value. Since 2012, MVG is structured around 3 departments: AMS (Antenna Measurement Systems), EMC (Electro-Magnetic Compatibility), EIC (Environmental & Industrial Control).

MVG is present in 10 countries, and generates 90% of sales from exports. The Group has over 350 employees and a loyal customer base of international companies.