WEEK: 4

Lab: 3

Lab Title: SatSoft; Satellite Antenna Design and System Engineering Software

a. **Software Description;**

SatSoft is used for communication satellite antenna design, analysis, and coverage planning.
Students will be able to quickly assess antenna coverage and gain, conduct antenna trade studies, develop shaped beam and multi-beam antenna designs, and perform other satellite payload engineering tasks.

b. **Objective:**

The purpose of this lab is to familiarize the student with a software that is used by system engineer as well as the antenna specialists. Its graphical user interface is designed to enable users with a basic knowledge of antenna, to use the software productively.

c. **Procedure:**

1. Go to http://satsoft.com/
2. (Software has already been installed on computers)
3. Watch the tutorial videaos 1 and 2, and take notes,
4. Carry out the steps outlined below on the program,
5. Print each step and write the report.

Steps from tutorial 1:

- Create satellite, antenna, and polygon objects,
- Using online help, import antenna patterns,
- Customize toolbar buttons as explained,
- Rotate antenna boresight,
- Plot contours of directivity, e..i.r.p. and xpol C/I,
- Plot city pointing boxes,
- Copy city lists and performance tables into Excel,
- Prepare performance tables of directivity, e.i.r.p., xpol, slope, and worst case e.i.r.p. due to pointing.
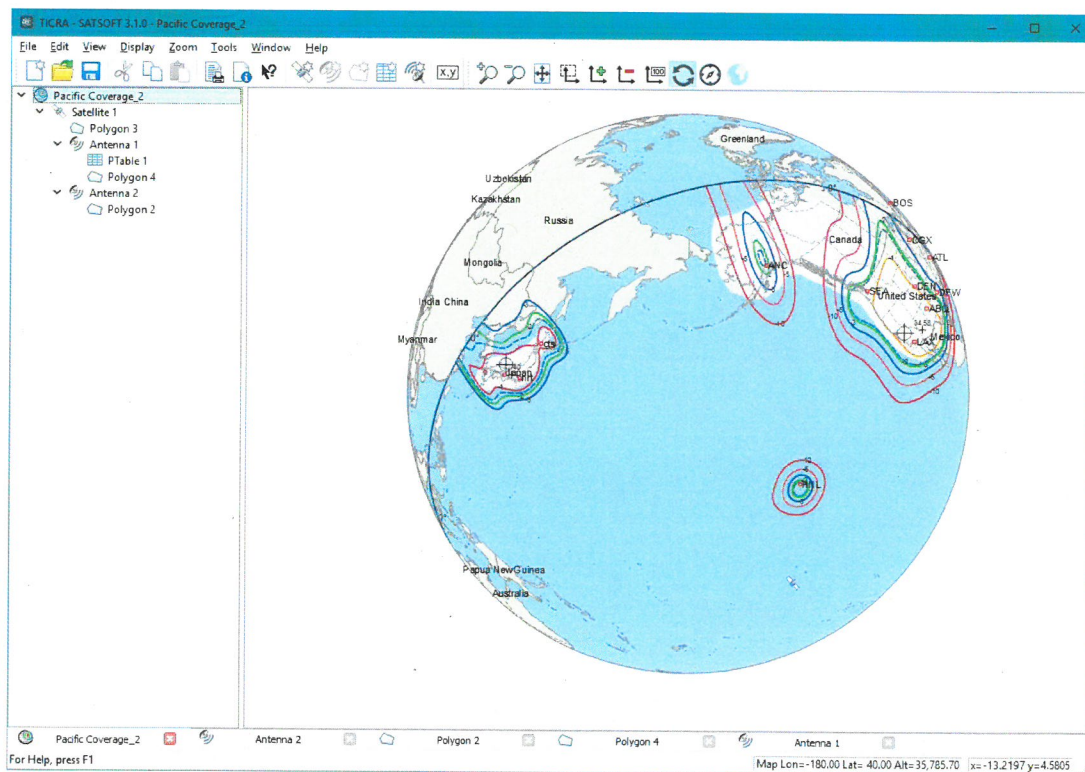
Steps from Tutorial 2:

- Import or create coverage polygon,
- Move boresight to center of coverage area,
- Select reflector antenna model,
- Specify reflector geometry,
- Create beamlet and synthesis station grids,
- Inspect results or synthesis in the log window,
- Expand the coverage to compensate for pointing error of the satellite (satsoft/pro).

SATSOFT

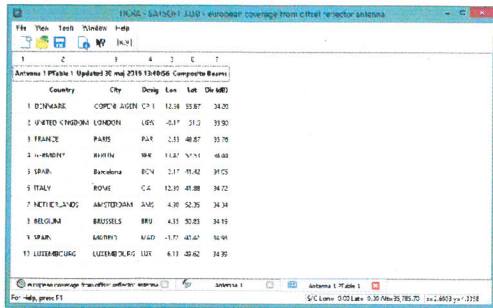## Satellite Antenna Design and Systems Engineering Software

SATSOFT speeds up the process of planning, designing, and marketing communication satellite payloads. Quickly assess antenna coverage and gain, conduct antenna trade-off studies, develop contoured beam and multi-beam antenna designs and complete many other tasks required for payload design and regulatory filings.

SATSOFT was written for the systems engineer as well as the antenna specialist. Its graphical user interface enables users with even a basic knowledge of antennas to use the software productively. Advanced tools will appeal to the antenna specialist.
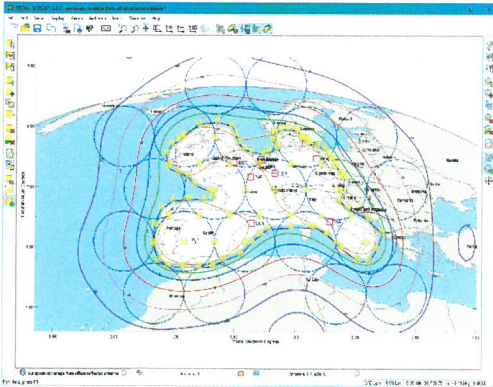

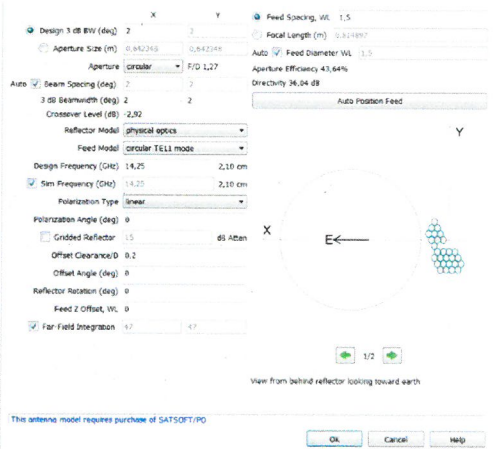*SATSOFT Composite View aggregates all objects in the scenario.*

TICRA

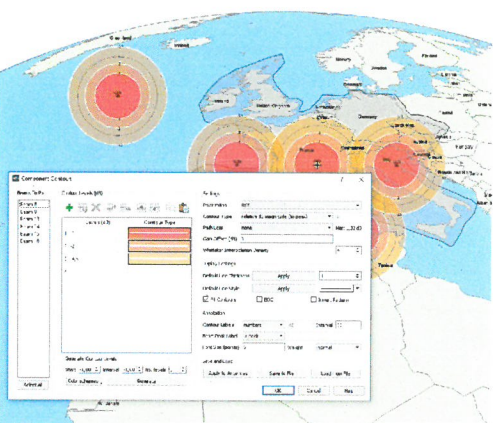*Performance tables of gain, EIRP, G/T and other parameters can be prepared for cities and synthesis stations.*

Shaped patterns can be synthesized using the integrated antenna models or imported component beam sets.

Specification of antenna model parameters is simplified by smart dialog boxes that provide instant performance feedback.

Contour type, levels, polarization, path-loss and other properties can be specified quickly and easily.

SATSOFT Highlights

Analyze Your Current System & Plan Your Next

SATSOFT provides essential tools for analyzing your current satellite communications system and planning your next one. Many tools are provided for designing and analyzing space-based communications antenna systems. Basic features include map and contour plotting, coordinate system conversions, file import/export, boresight adjustment, pointing boxes, elevation contours, performance tables, and other features. Context-sensitive help is available for dialog boxes, toolbar buttons, menus and views.

SATSOFT Complements Your Other Software

Windows clipboard support and extensive file import and export capabilities lets you do more with SATSOFT. Copy graphics to the clipboard for use with Microsoft Office programs. Import antenna patterns from other modeling programs such as GRASP and POS. Load patterns from the ITU database.

Simplified Antenna Pattern Synthesis

Complex algorithms simplify antenna beam-shaping exercises. Select an antenna model and specify its parameters. Create a coverage definition with the polygon editing tools and fill it with component beams and synthesis stations. A single click of the mouse optimizes, computes and displays the pattern.

Contour Plots of EIRP, G/T, and More

A fast contouring engine within SATSOFT produces plots quickly and accurately. Intelligent auto-ranging and zoom-in/zoom-out functions make it easy to view a desired range of data. Conversion from directivity or gain to other parameters is accomplished by specifying a dB offset. By applying slant-range path-loss compensation, flux density contours can be computed. SATSOFT will also plot copol/crosspol ratios for vector antenna patterns.

Maps From Any Altitude or Viewpoint

SATSOFT transforms antenna contours, geopolitical maps, coverage polygons, cities, and other features into any of nine different display coordinate systems, simply by making the desired choice. The four most commonly used antenna coordinate systems are provided for pattern import and display. Azimuth-Equidistant and Equirectangular (rectangular lat, long) projections are also provided. The earth is modeled as an oblate spheroid.

Interactive Antenna Boresight Rotation

Click and drag the antenna pattern to change its boresight, or specify the boresight angles directly. Antenna boresight may also be pointed at a fixed position on the map.

TICRA

SATSOFT Features

Automated Antenna Pattern Synthesis

Perform antenna trade studies using single beam, multi-beam, and contoured beam designs.

Synthesize contoured patterns from one or more coverage polygons. Single-click contoured pattern synthesis.

Automatic creation of component beam and synthesis station grids from coverage polygons.

Full suite of graphical editing tools to add, delete, move, or change parameters of beamlets and stations.

Mini-max optimizer works with all antenna models and imported component beam sets.

Show component and/or composite contours with a single click.

Create and edit tables of beamlet positions and polygon vertices.

Quickly trade performance with different antenna models, e.g., phased array vs. multifeed or shaped surface reflector (antenna models are optional).

Contour Plotting

Plot contours of directivity, EIRP, G/T, and other parameters.

Plot contours of copol/crosspol ratios for vector antenna patterns.

Full control over which beams in a multi-beam design are plotted.

Specify and plot component and composite contours independently.

Specify contour levels, line styles, colors, font, etc. Fill contours.

Slant-range path-loss compensation enables computation of flux density and carrier to thermal noise contours.

Intelligent auto-ranging and zoom-in/zoom-out functions.

Create plots at a precise scale for overlaying or as an aid in digitizing contours and polygons.

Contours can be filled with solid or transparent colors, allowing for easy interpretation. Predefined color schemes and an option for creating your own are available. Plot settings, incl. color schemes, contour levels, contour types, etc., can be saved to disk and loaded for easy application in other projects across your organisation.

Coordinate Systems and Maps

(u,v), (θ,φ), az/el, el/az, azimuth equidistant, orthographic, azimuth equal-area, and equirectangular coordinate systems.

The earth is modeled as an oblate spheroid consistent with the WGS84 geoid. DCW World map and city databases are provided.

City database (MS Access format) of over 1600 of the largest cities in the world connected via standard Windows ODBC drivers.

Plot pointing box, city name and/or designator at each city location.

Elliptical and rectangular pointing boxes computed from spacecraft roll, pitch, and yaw errors.

Interactive boresight adjustment. Click and drag the antenna pattern to change its boresight.

Specify boresight in (az, el), (lon, lat), or in terms of 3 Euler angles.

Plot meridians and parallels.

Mouse Coordinates Pane displays coordinates of the mouse in user selectable coordinate system.

Plot a sin space unit circle in any coordinate system.

Plot a boresight marker.

Plot visibility (elevation) contours with control of thickness, line style, color, and labeling.

Polygon Creation & Editing Tools

A full suite of editing functions is provided.

Use polygon labels for assigning individual gain and/or EIRP values to individual polygons in your antenna coverage area.

Create and edit polygons from a table of coordinates.

Move, copy, rotate, delete, undelete, split, join, downsample functions. Change line style, color, label, thickness, etc. Fill polygons.

Compute the solid angle subtended by the polygon and corresponding maximum directivity, and polygon centroid.

Create grids of polygons with the grid creation tool.

Easy export of polygon coordinates to Excel and other formats.

Performance Tables

Prepare tables of antenna performance at city and station locations.

Directivity, gain, EIRP, G/T, flux density, and other parameters can be tabulated in spreadsheet format.

Copy and paste tables into Excel and other applications, print, and export to file.

File Import and Export Capabilities

Import CPLAN work files.

Export performance tables in tab delimited format (for spreadsheet import) via file or clipboard.

Export vector graphics in Windows enhanced metafile (EMF) format.

Import scalar and vector antenna patterns defined in (u,v), (θ,φ), az/el, and el/az coordinate grids.

Import and export SATSOFT (CPLAN), GRASP, ACP4, Eutelsat, and STK antenna pattern files. Regular and irregular grids (measured patterns) can be imported.

Export synthesis station grids in SATSOFT (CPLAN) or TICRA's POS formats.

Import and export antenna contours in SATSOFT, STK, shapefile, and ITU Graphics Exchange (GXT) format.

Export reflector geometry as GRASP or POS projects.

Import and export coverage polygons and map data in SATSOFT (CPLAN), STK, shapefile, TICRA .pol and GXT formats.

Windows Clipboard Support

Copy vector graphics to clipboard for import to Microsoft Office and other applications.

Copy and paste antenna and polygon objects, city lists, performance tables, beamlet locations, polygon vertices, and feed excitations.

Miscellaneous

GUI conforms to standard Windows user interface guidelines.

Context sensitive help for dialog boxes, toolbar buttons and menus.

Tree view shows hierarchy of satellites, antennas, polygons, and facilitates copying and moving of these objects.

Drag and drop work files, pattern files, coverage polygon, contour, and GXT files from Windows Explorer.

Dynamic memory throughout, so the number and size of antenna patterns, contours, polygons, satellites, beamlets, and stations is limited only by available memory and disk space.

Customizable toolbars.

Antenna Models

Consistent interface to all antenna models. Beam layout, optimization, contouring, interpolation, etc., works in the same way for all models.

A Gaussian Beam model is provided for modeling circular and elliptical beams.

SATSOFT Professional (SATSOFT/PRO)

Plot Edge of Coverage (EOC) contours for a specified polygon.

Expand & contract polygons by the satellite pointing error.

Automatically expand coverage polygons by the satellite pointing error during synthesis station generation.

Resample antenna patterns for a specified resolution & coordinate system, for example, (u,v), (az,el), (lat,lon)

Create contoured beams designed to service a coverage area from multiple orbital slots.

Prepare performance tables with pointing error degradation, pattern slope, XPD, and axial ratio.

Draw pointing error ellipse at polygon vertices.

Multiple contoured beams can be synthesized simultaneously using any antenna model or imported component beam file.

TICRA

SATSOFT Options

SATSOFT/AR Analytic model of an offset reflector. Directivity determined by PO integration of an on-focus feed. Scan aberration and crosspol are neglected. All components beams are identical. Computation is extremely fast. Useful for preliminary design work.

SATSOFT/PAM Analytic model of a rectangular array fed by a Butler or Nolan Matrix with cos^r element pattern. Rectangular and triangular element lattices supported. Computation is extremely fast.

SATSOFT/PL Produces optimized sets of coverage polygons for creating constant flux multibeam antenna designs.
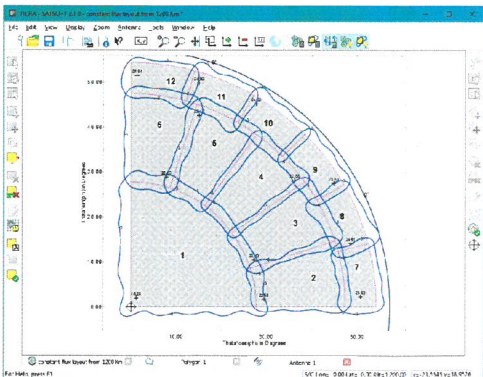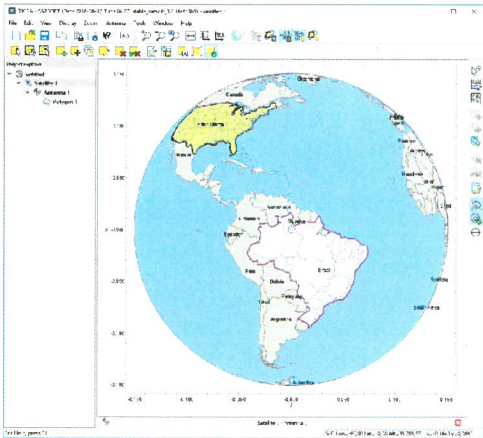
SATSOFT/PO Vector reflector modeling program using the physical optics method. Modelling of multi-feed reflectors as well as shaped reflectors. The shaped reflectors are optimized using the POS algorithm. Accurate far-field predictions of directivity and crosspol. Linear or circular polarization. Single and dual-mode feed models. Purchase of PO option includes use of the AR model.

SATSOFT/DMO Dual-mode optimizer for multibeam antenna designs which must accommodate a non-contiguous output multiplexer.
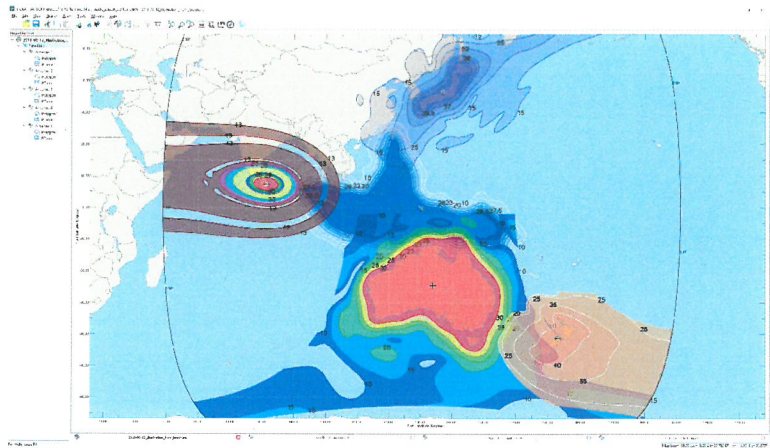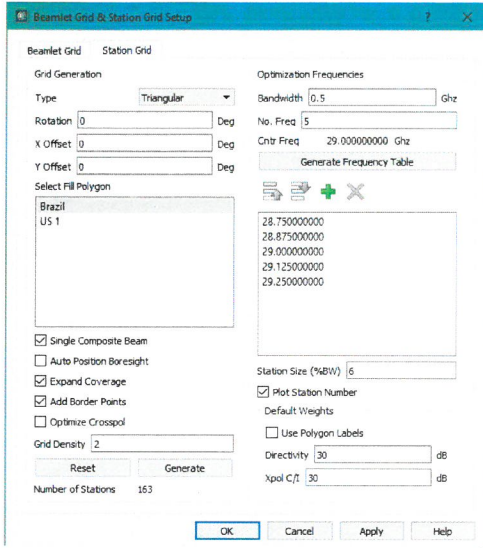
Multiple antenna patterns can easily be plotted in the same map. The antennas can be activated and deactivated by clicking the antenna icons in the project tree and overlapping patterns from multiple satellites can be viewed at the same time.

Component beam and synthesis station grids can be generated automatically for any set of coverage polygons.

Antenna Models

A Gaussian beam model is provided with SATSOFT for generating simple elliptical and circular beams. Several optional antenna models are available including an analytical reflector model, a high fidelity physical optics reflector model, and an analytic phased array model.

Shape multiple patterns with SATSOFT/PRO. Constant-flux polygon layouts are created with SATSOFT/PL.

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