A.11.9 ANTENNA PLOTTING FUNCTIONALITY

Background and goals of the plotting functionality

Antennas are an important element in a radio compatibility study. A number of different antenna types can be modelled with varying patterns. The directivity of an antenna can have a significant impact on the results of an interference simulation, and it is therefore important that parameters such as the gain pattern and pointing direction are modelled accurately. In order to ensure this accuracy, it is helpful for the user to be able to visualise the gain pattern prior to running the simulation and also to validate the results.

The aims of the plotting tools in SEAMCAT are as follows:

1. Allow the user to plot full antenna pattern across all values of azimuth and elevation, i.e.
   a. Full horizontal pattern (0 to 360 degrees) at any value of elevation (-90 to 90 degrees)
   b. Full vertical pattern (-90 to 90 degrees) at any value of azimuth (0 to 360 degrees)
   c. Full 3D pattern
2. Allow configuration of any parameters which can affect the shape of the pattern depending on the type of antenna, e.g. frequency, electrical steering
3. To be applicable and consistent for all antenna types, while also allowing parameters specific to certain antenna types to be configured (e.g. electrical steering angles for beamforming)
4. Allow comparison of different antenna implementations on a single plot

Gain plot – single antenna

This tool plots the antenna pattern in both horizontal and vertical plane as well as a 3D plot.

The tool is accessed using the "Show gain plot" button within the antenna panel:

![Antenna Patterns Identification](image)

Figure 1 : Location of “Show gain plot” tool

Horizontal and vertical plots can be displayed as Cartesian X-Y plots or as polar plots. The user can switch between these 4 different plots through tabs below the plot.
The plot displays Gain (dBi) vs angle (deg). Gain is the total gain at the specified angle, taking into account the “Antenna Peak Gain” specified within the implementation. The angle ranges are as follows:

Horizontal plots: 0 to 360 degrees in azimuth where 0 is the azimuth boresight direction. The pattern is evaluated at an elevation angle specified by the user according to the “Slice Angle” input (default 0 degrees).

Vertical plots: -90 to 90 degrees in elevation where 0 is the horizontal plane. The plot is evaluated at an azimuth angle specified by the user according to the “Slice Angle” input (default 0 degrees).

Figure 2: Antenna gain plot view and Tab selection

The following Display options are available to configure the plot:

“Frequency [MHz]”: Only applicable to certain antenna types where the gain and pattern are a function of frequency or wavelength

“Granularity”: This determines the calculation resolution of the pattern in degrees

“Slice Angle [deg]”:

For Horizontal plots this is the Elevation angle in degrees at which the pattern is evaluated.

For Vertical plots this is the Azimuth angle in degrees at which the pattern is evaluated.

“Mechanical Tilt [deg]”: Display the effect of mechanical tilt in degrees.

“Link type”: Only applicable to beamforming antennas. The options are as follows:

“System link”: In this case the plot shows the maximum gain value at each angle if beamforming $l_{escan}$ and $l_{etilt}$ applied towards that angle

“Interference link”: In this case the plot shows the full beamforming pattern with $l_{escan}$ and $l_{etilt}$ fixed at zero in the direction of the mechanical pointing of the antenna

Changing any of the above parameters does not automatically update the plot. The user must press the “Recalculate” button in order to update the plot.
The following options are also available:

“Display evaluation points”: Option to show or hide plot markers at calculated points (according to the setting for “Granularity”). Removing the plot markers can improve the visibility of the plot.

“Render 3D plot” launches a 3D view of the plot in a separate window:

![3D plot view](image.png)

Figure 3: 3D plot view

In the 3D plot the gain is shown in a colour coding according to the scale on the right hand side. The orientation of the plot can be determined according to the axis shown on the right hand side:

- Blue: horizontal plane
- Red: Vertical plane

The user may rotate the display to view at different angles by dragging with the mouse.

The remainder of the options (“Save”, “Save Image”, “Close”, “Help”) are in line with the standard plotting functionality in SEAMCAT.

**Comparison tool for multiple antennas**

This tool expands on the functionality of the gain plot tool described above to allow multiple antenna patterns to be displayed on the same plot.

It can be accessed via the Tools Menu:
The functionality of the comparison tool is similar to the propagation model comparison tool – the aim is to allow the user to plot multiple antenna patterns of different type (or of the same type with different parameters), to allow the user to compare the differences in the patterns.

The user can add or remove antenna implementations using the panel on the left hand side. Each of these can be configured according to the specific parameters for that model using the middle panel. The parameters on the right hand “Link Configuration” panel provide the same functionality as in the standard gain plotting tool. These are applicable to each selected model independently (i.e. different values can be selected).

Under “Control panel” at the bottom, the user may set the following parameters which are applied to all plots:
“Granularity”: same as for the standard gain plotting tool – calculation resolution of the pattern

“limit for gain plot (dBi)”: Sets a minimum on the Y/angle axis of the plot, to allow comparisons to be more easily viewed in cases of antennas with deep nulls in the pattern.

The “Generate Compare Plot” button launches the plot in a separate window:

Figure 6: Example of plot comparison tool results