Designing an LTE Base Station Antenna with the Finite Arrays Method

This white paper demonstrates how an LTE base station antenna may be modeled with the finite arrays (DGFM) method in FEKO.

Introduction

Long term evolution (LTE) protocols for mobile data connections operate at various different frequency bands around the globe. This application note demonstrates how the finite arrays method (also known as Domain Green's Function or DGFM) may be used to model an LTE base station with three antennas operating at 1.8 GHz.

Requirements

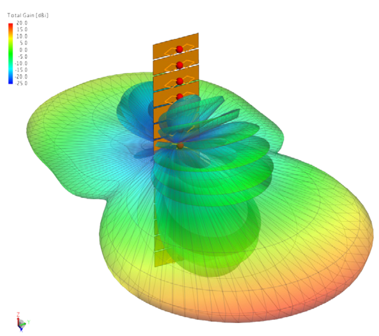
The base station is required to have 3 antennas of the following transmission specifications:

1. Elevation main-lobe squint =10° below the horizon, relative to the mounting point
2. Elevation main-lobe -3dB width between 7° and 9°
3. Azimuth main-lobe -3dB width between 40° and 60°

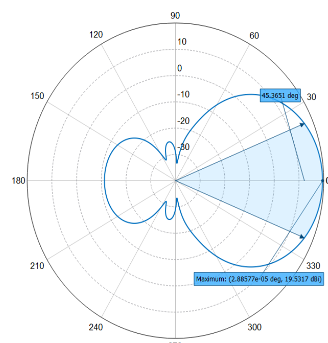
Single Antenna

The panel antenna to be used in this project was designed using Antenna Magus. The base element of the array is a biquad antenna, designed for 1.8 GHz. The array specification was also synthesized with Antenna Magus and consists of 14 identical elements. Although physically identical, these elements are fed with appropriate magnitude and phase of excitation to create the desired squint patterns. This arrangement is very well suited to simulation with the DGFM in FEKO.

The single panel antenna was modeled with both the MLFMM and DGFM and even in this relatively small array the DGFM is significantly less expensive in terms of memory required. The DGFM required only 5.7 MByte to model the array, while the MLFMM required 95.6 MByte.



3D gain pattern



Azimuth scan plane

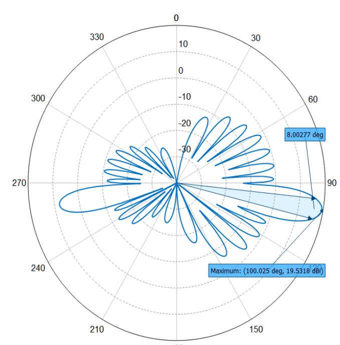
Antenna performance:

- Elevation main-lobe squint = 10.025°
- Elevation main-lobe -3dB width = 8.003°
- Azimuth main-lobe -3dB width = 45.37°

All measures are thus within specification for this design.

Memory requirements:

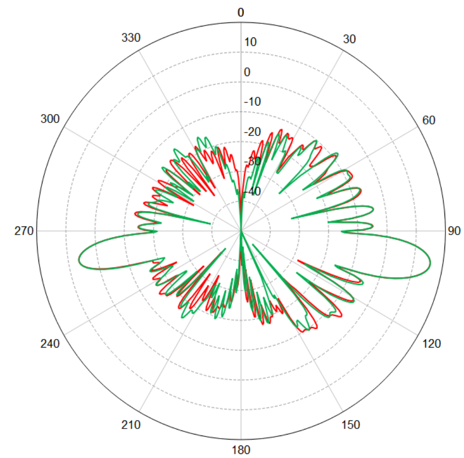
- DGFM = 5.7 MByte
- MLFMM = 95.6 MByte



Elevation scan plane

Radiation patterns for single LTE panel antenna at 1.8 GHz

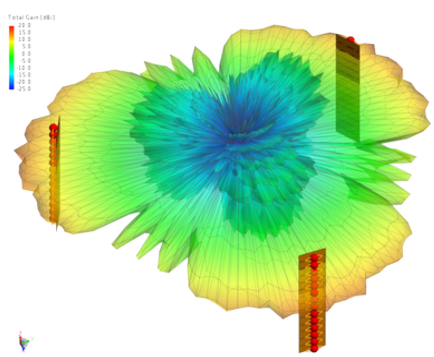
The radiation patterns computed with the DGFM was also compared to MLFMM computations of the same geometry. The excellent comparison provides users with confidence that the DGFM is indeed providing good results in a very efficient manner.



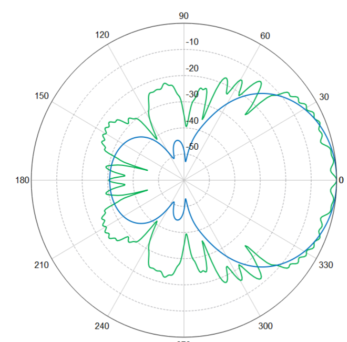
Comparison of DGFM (green) and MLFMM (red) solutions for radiation patterns of a single LTE panel antenna at 1.8 GHz

Combining Antennas for Azimuth Coverage

Antennas such as the panel antenna proposed here do not cover a great enough azimuth scan to be useful on their own. They are therefore usually mounted on base station towers or buildings in configurations that add up to a larger azimuth coverage. In this case study, three panels will be combined. The three panels thus utilize 3 x 14 = 42 identical transmitting elements, which is even better suited to DGFM simulation than the smaller number of elements of the single array.



3D gain pattern



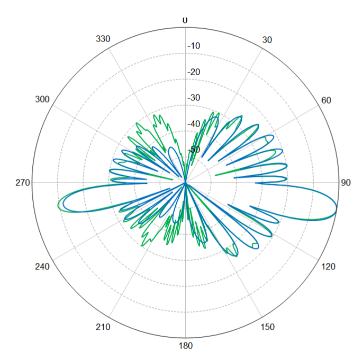
Azimuth scan plane comparison

Antenna performance for first sector (other sector the same):

- Elevation main-lobe squint = 9.865°
- Elevation main-lobe -3dB width = 7.504°
- Azimuth main-lobe -3dB width ~ 54°

All measures are thus within specification for this design.

- Memory requirements:
- DGFM = 24.7 MByte
- MLFMM = 306.71 MByte



Elevation scan plane

Normalized radiation patterns for 3 x LTE panel antennas operating together for improved azimuth coverage (blue = single LTE panel reference, green = 3 x panel combination)

In this multi-panel configuration the panels have started interfering with each other and the main-lobe is demonstrating a ripple in the azimuth scan plane. If the -3dB main-lobe width measurement is applied in a strict sense, the width is 27.25° as the ripple on the curve drops below this level momentarily. The lowest point of this drop is at -4.38dB. Ignoring this temporary, very shallow drop below the required -3dB level and measuring to the beam width where the gain drops below -3dB permanently results in the estimated -3dB beam-width of 54°, which is reported above.

The DGFM is a highly efficient method for simulation of arrays such as this one (multiple similar radiating elements) and it clearly demonstrates the ability to predict fine detail such as this spurious ripple on radiation patterns.