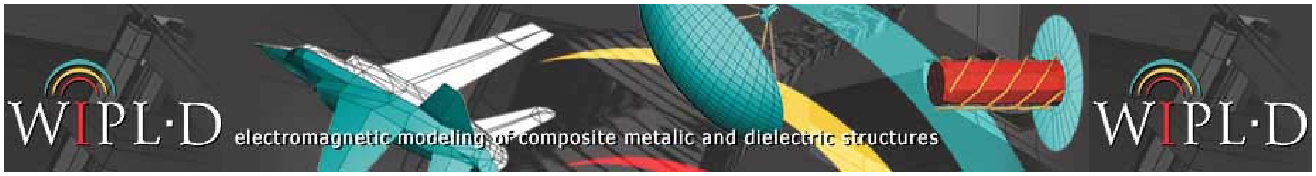


Antenna Placement - 58λ Long Platform Simulated in 201 Seconds

Simulation of antennas placed on large platforms is computationally very demanding. WIPL-D Pro applies a very efficient formulation of method of moments based on surface integral equations and higher order basis functions defined over a quadrilateral mesh. As a result, electrically very large structures are modeled with a relatively small number of unknowns. Even so, extremely large structures often can not be simulated on a PC.

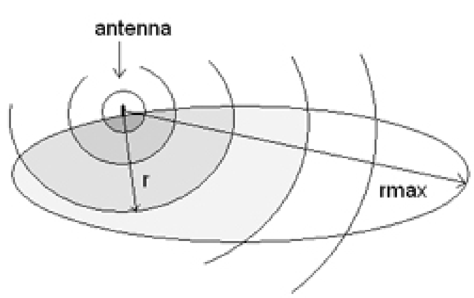
The new feature of WIPL-D Pro intended for antenna placement problems is “smart reduction”. It is based on adaptive reduction of current expansion order over parts of the model which are distant from the antenna or in shadow. This way, the number of unknowns is reduced 3-10 times, while very good accuracy of calculated radiation pattern or coupling between multiple antennas is preserved.

Adaptive Reduction of Expansion Order

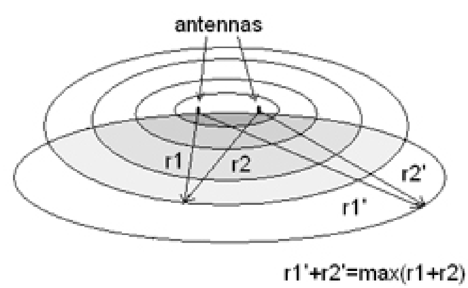
In the default formulation used by WIPL-D 3D EM solver, the platform is meshed into quadrilateral patches. The order of expansion defined over a patch is dependent on the electrical size of the patch. If the longest edge of the patch exceeds 1/6 of the wavelength, second order expansion is used. For each additional 1/3 of the wavelength, the order is increased by one.

One way to reduce the number of unknowns is to uniformly decrease the expansion order over the entire model by decreasing the reference frequency of the analysis. This leads to significant loss of accuracy.

However, if the expansion order is gradually decreased as we move away from the antenna, the number of unknowns can be dramatically decreased while good accuracy is preserved. This is done by the “smart reduction” option.

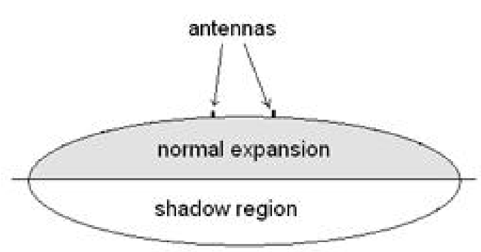


Gradual decrease of the expansion order with the increase of distance from the antenna



Gradual decrease of the expansion order – the case of two antennas

In addition, regions of the platform regarded by the user to be in shadow are additionally treated. Expansion orders on all patches in shadow are decreased uniformly. Since low-magnitude currents are likely to be induced over such region, error arisen from their rough approximation doesn’t greatly affect the behavior of the system, in terms of radiation pattern or coupling between multiple antennas.



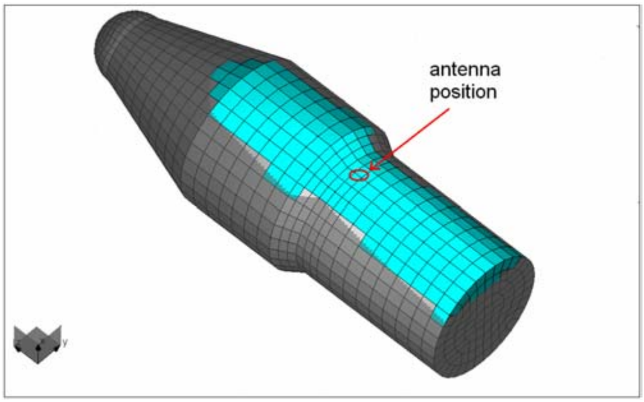
Decrease of expansion order in the shadow region

Case Study

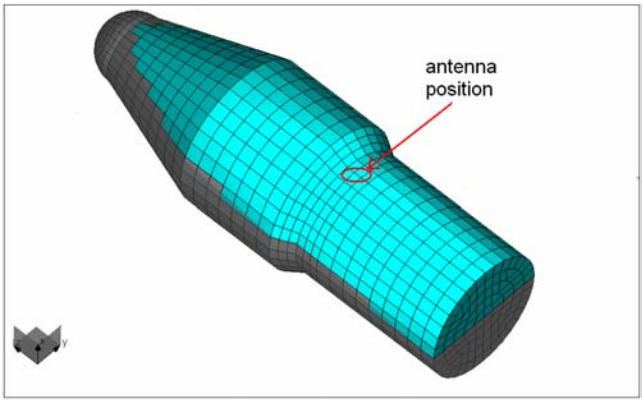
Half-wavelength dipole is placed along the *y* coordinate axis, above a large platform representing a payload fairing. The axis of the fairing is along the *z*-axis of the coordinate system. The fairing length is 8.66 meters, while the largest cross-section diameter is 2.9 meters. Simulation frequency is 2 GHz, which means that fairing length is about 58 λ.

With one symmetry plane applied, the model requires 44614 unknowns with default setting. Thus, 15.9 GB of memory would be needed for simulation.

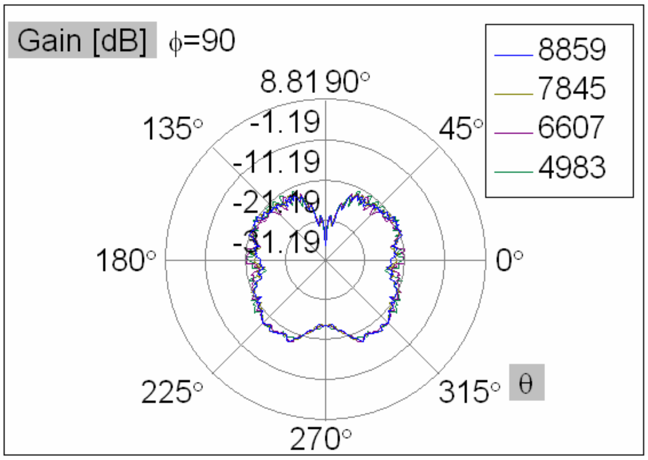
By applying the adaptive reduction of expansion orders and additional reduction in one shadow region, memory requirements are significantly diminished. Four different sizes of the shadow region were tried.



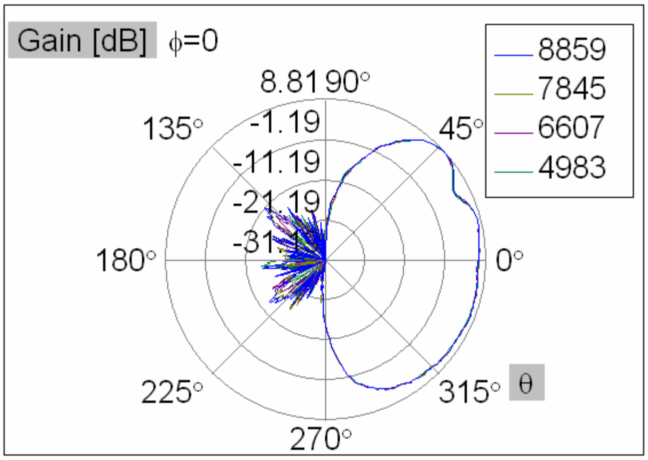
Maximum shadow region



Minimum shadow region



Radiation pattern – plane parallel to the dipole antenna



Radiation pattern – plane perpendicular to the dipole antenna axis

All the results show very good agreement. As the number of unknowns decreases down to about 5000, discrepancies occur at side-lobes with levels lower than 25 dB relative to the main-direction gain. At that point, the model employs 9 times less unknowns than the one with default formulation, occupying about 80 times less memory.

All four simulations were done on a Pentium 4 computer with a 3.2 GHz CPU, employing the iterative solver. In case of 8859 unknowns, iterative solver needed 93 iterations and 454 seconds to decrease the normalized residuum to 1e-4. The model with 4983 unknowns took 85 iterations, while the simulation lasted 201 seconds.