What simulation apps can do for wireless communication design

Let's take the example of active electronically scanned arrays, or phase antenna arrays. They have become popular for military use in radar and satellite applications and are now being applied to commercial purposes, due to the growing needs of higher data rates in communication devices. The size of a simple component can easily exceed tens of wavelengths, making its numerical analysis very memory intensive. As a result, models take a very long time, even when approximated values would be sufficient to evaluate a proof-of-concept design. Rapid prototyping would help reveal performance tendencies and determine design parameters quickly.
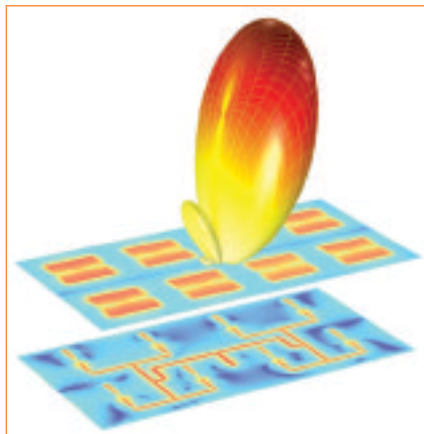

Figure 2. 4x2 phased microstrip patch antenna modelled using COMSOL Multiphysics software. The top plot shows the logarithmic electric field norm on the patch and the 3D far-field radiation pattern. The lower plot depicts the logarithmic electric field norm on feed line planes

Figure 2 shows a simulation of a 4x2 phased microstrip patch antenna array, which can steer the beam toward the desired direction. This example is significantly more memory intensive and will take a longer time to compute than a single microstrip patch antenna (Figure 3).

Simulation results shown in Figure 3 are based on a full finite element method (FEM) model of a single slot-coupled microstrip patch antenna – built on low-temperature co-fired ceramic (LTCC) layers, initially operating at 30 GHz.

Can we use the analysis of a single antenna to describe the behaviour of the entire array? The power and flexibility of COMSOL
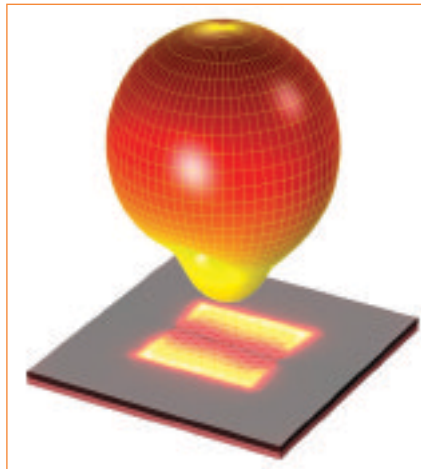

Figure 3. Single patch antenna. Logarithmic electric field norm on patch, mesh and 3D far-field radiation pattern are visualised

Multiphysics software allows simulation specialists to perform an accurate simulation of a single microstrip patch antenna, and then take into account user inputs such as array size, arithmetic phase progression and angular resolution to describe, for example, the 3D far-field of the entire array. COMSOL makes it easy for specialists to couple physics interfaces already available with equations or algorithms needed to model a specific application. In this case, the two-dimensional antenna array factor has been implemented to include the translational phase shifts and array element weighting coefficients needed to determine the radiation pattern of the entire array.

Can we present such a model to designers in a user friendly way? Simulation specialists are now provided with an intuitive workflow to create custom user interfaces based on their multiphysics simulation model. An app built for simulating the antenna array is shown in Figure 4.

This app allows the designer to change the physical size of the single microstrip patch antenna, as well as the thickness and material properties of each layer, in addition to other relevant parameters determined by the simulation specialist. In this particular example, the simulation specialist has included an interactive user experience by indicating whether the chosen design parameters are appropriate or not – by comparing the computed S-parameter (S11) value to the pass/fail target criterion. This app also includes a results report and documentation that concisely explains how the app is working. This last feature can be used in a variety of practical ways – from building reports for stakeholders and management, to use as a training tool for new hires in the company. Apps can also be easily deployed to colleagues and collaborators through a local installation of the COMSOL Server product, allowing authorised users to access apps through COMSOL Client or a major web browser.

We have a lot of work ahead of us before 5G is unveiled to the public. When designers are equipped with the right set of tools, they can freely collaborate with colleagues throughout their organisation and beyond. Working cross-departmentally will be key to competing and succeeding in the 5G race.
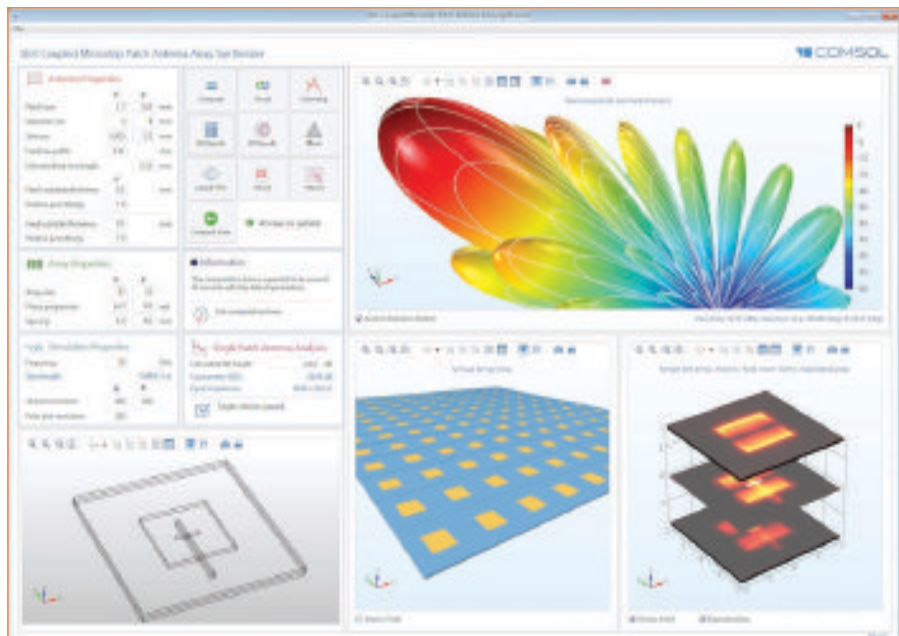

Figure 4. The user interface of the Slot-Coupled Microstrip Patch Antenna Array Synthesizer simulation app built using COMSOL's Application Builder tool