Reduction of Design Time for mmWave RF Frontend Components

Figure 1: Tmytek BBox beamformer box

5G New Radio (NR) mmWave, unlike previous standards, uses dynamic beam steering to maximize connectivity by aiming as much of the signal directly to the mobile device as possible. As a result, beamforming antennas represent a new area of development for many commercial manufacturers.

The BBox Beamformer Box

Tmytek uses NI AWR software to develop RF front-end components in its groundbreaking BBox beamformer box product line (Figure 1), a highly modulized 28/39-GHz beamforming system that enables 5G designers to successfully develop innovative antenna designs and baseband technology. The BBox system is a scalable and flexible system that includes a standard antenna kit, phase and amplitude controller, channel selector, up/down conversion and control host (Figure 2). It provides reliable steerable beams to test and support development of phased-array antennas and associated electronics, which must undergo rigorous calibrations and measurements under a large number of configurations through advanced over-the-air (OTA) testing to ensure optimal connectivity.

Tmytek designer Su-Wei Chang was developing a 47/53 GHz filter, one of the key components for the company's mmWave instrumentation equipment, as well as a 28-GHz phased-array antenna for 5G mmWave beamforming using antenna-in-package (AiP) modules. The modules were being designed for base station and user equipment.

The specifications for the 47-53 GHz filter passband and rejection band were proving difficult. In addition, the minimum feature was only about 20 µm, so accurate simulation was key since the fabrication cost was high.

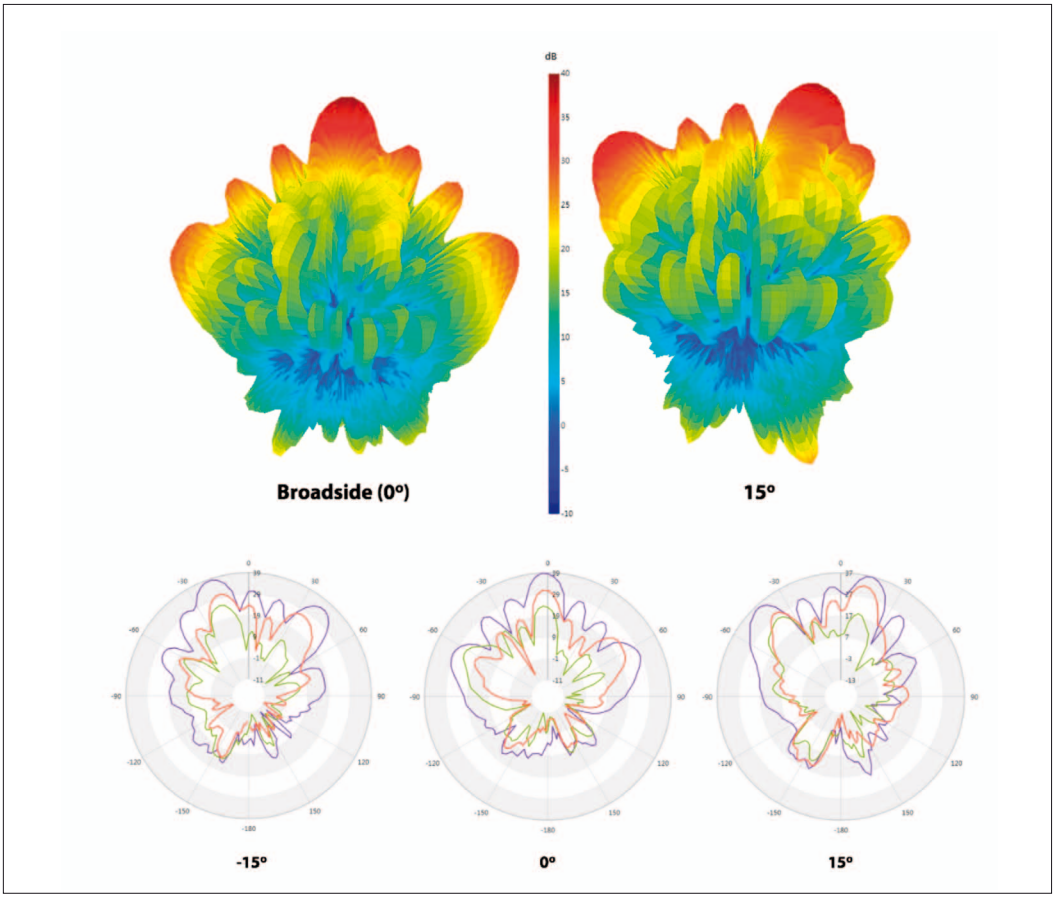

Figure 3: Simulated antenna radiation patterns for the BBox beamformer system

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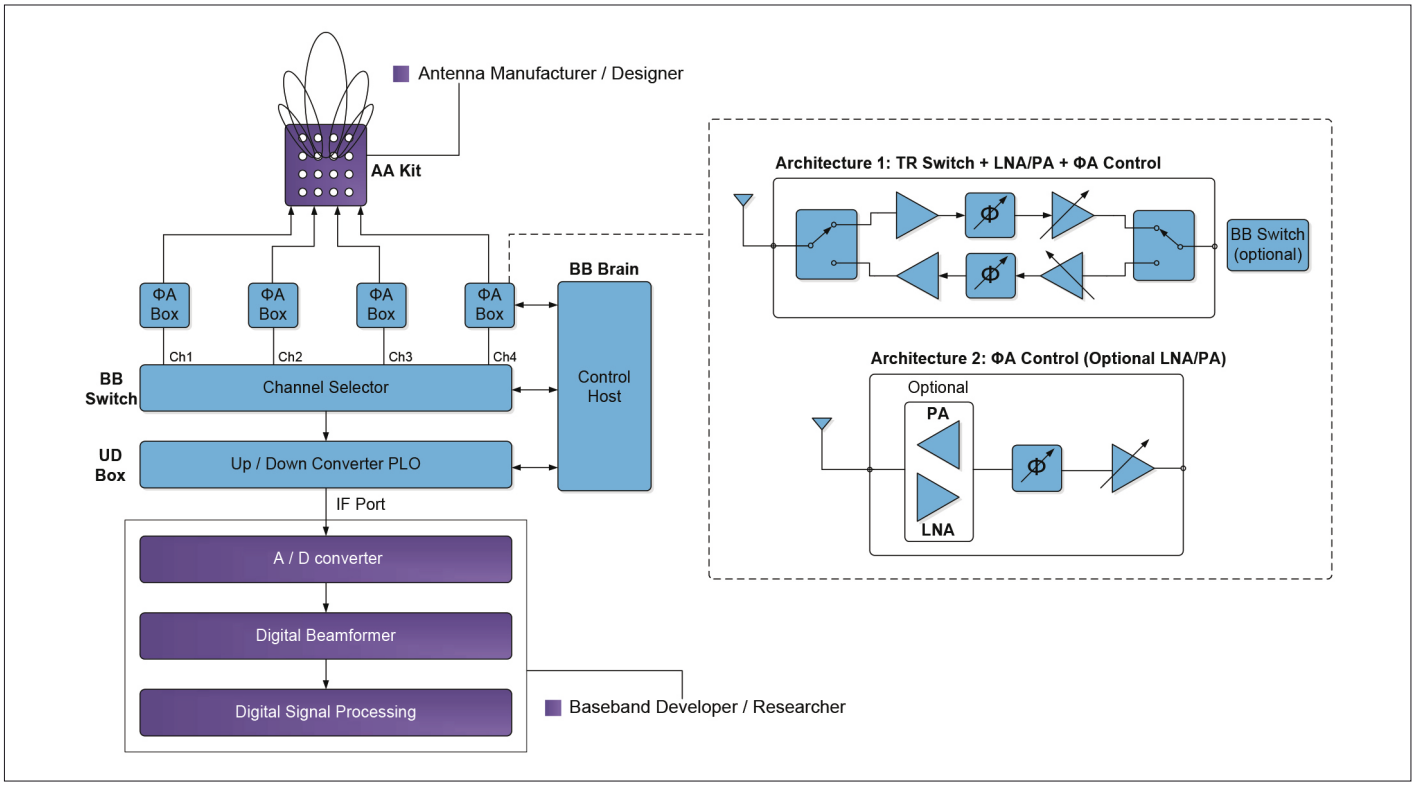

Figure 2: The BBox system

For the 28-GHz phased-array antenna, the system performance of the beamforming and beam shaping required system-level simulation, including antenna design, power combiner design, beamforming system design, and electromagnetic (EM) extraction of the layout.

Solution

The designer had used the NI AWR Design Environment platform as a graduate student and was familiar with the specialized technologies within the software for filter and phased-array antenna design, making it the right choice for his current project.

The iFilter filter synthesis wizard within Microwave Office circuit design software helped the designer to synthesize the filter with the desired specifications. It generated the circuit model and the layout, and enabled him to perform EM simulation of the layout file using the Analyst 3D finite-element method (FEM) EM simulator. Together, these tools helped the designer to finish the design within a short timeframe and delivered excellent agreement between the simulated and measured results.

The phased-array generator wizard in Visual System Simulator system design software was used to quickly evaluate the results for the 28 GHz phased-array antenna (Figure 3). The designer was able to implement a single antenna radiation pattern, which could be either EM simulation results or measured results and used the phased-array wizard for the beam steering and beam shaping. The tool provides different beam-shaping tapering methods, which helped him build the AiP module with only basic knowledge of the beamforming system. After building the module, he imported the layout into Microwave Office software and used the Analyst EM simulator to simulate and verify the design. The measured results matched well with his expectations.

Conclusion

The designer appreciated the integrated technologies and user interface of NI AWR software, which streamlined his design process. The iFilter synthesis and phased-array generator tools saved him a significant amount of time for the initial design, and the integrated system and circuit simulators enabled him to combine the EM results into a circuit model whose verified performance was validated within an RF link analysis at the system level. Overall, NI AWR software saved the designer an average of 20-30% in design time.

As industry leaders and innovators in mmWave component and system design, Tmytek believes its use of NI AWR software has the potential to help our engineers explore many new fields and applications in the future.

Benefits

- Innovative features
- Reduction in design time
- Co-simulation ability

Special thanks to Su-Wei Chang for his contributions to this success story. ◄

About the company

Tmytek develops active and passive insert millimeter-wave (mmWave) products and services that are integrated with software control, making them very user friendly. The company's mission is to contribute to and realize internet everywhere with its mmWave technology. Today, it is the world's leading 5G beamforming solution provider striving to make changes for a better future.