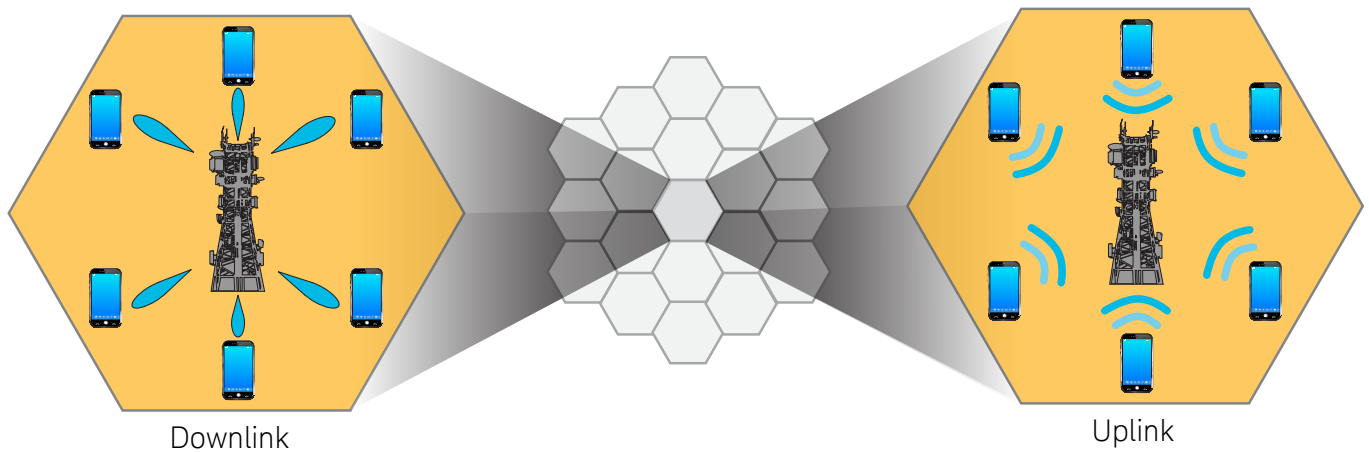


# Keysight Technologies

## Evolution to 5G Massive MIMO: Beamforming Simulation and Measurement

### Application Brief



Cellular evolution is accelerating due to the high expectations of 5G. The ever-increasing demand for more data and improved efficiency is driving radio access technology to higher frequency bands, which offers significantly more available bandwidth, and to smaller cells, operating at lower power and allowing network densification.

One revolutionary change is in the use of massive multiple-input / multiple-output (MIMO) antenna schemes, enabling spatial multiplexing and maximizing the reuse of scarce bandwidth. With massive MIMO beamforming, it becomes possible to move the network forward from the traditional point-to-multipoint paradigm to a real-time adaptive point-to-point link, with the base station tracking the user and steering its signal to them. Improved antenna gain overcomes path loss, enabling higher data rates per hertz compared with an isotropic signal at the same power.

All of this drives new requirements for the development and implementation of massive MIMO technology within the 5G ecosystem. This has implications for the tools required to simulate, design and test highly complex systems containing tens or hundreds of antennas and the associated communication pathways.

Keysight Technologies can help you take the lead - from evolution to revolution to reality. Gain the advantage from Keysight's ongoing collaboration in 5G research and standards setting. This expertise is swiftly embodied into Keysight test solutions, tuned for 5G.

## Beamforming design and verification challenges

Massive MIMO is a network-side (base-station) spatial multiplexing technique designed to improve data rates per user. The calibration and verification of multi-channel beamforming antennas requires a thorough understanding of the underlying technology and the effective application of appropriate test methods.

Commercial pressures to reduce cost and shorten project schedules mean there is no longer time to implement multiple hardware and software turns – design goals need to be met in shorter time and with fewer resources.

Much of the test equipment currently in place for communications systems is limited to a 6 GHz carrier frequency and a 160 MHz modulation bandwidth. 5G is breaking these 4G limitations, creating requirements for much wider bandwidths in higher frequency bands.

The required number of measurement channels remains an open and important question. Typical massive MIMO designs will range from tens to hundreds of antennas, beamforming in azimuth and elevation. Validation of system performance has the potential to become highly complex, time-consuming and expensive. For example, the cost of building large multi-port systems at mmWave frequencies quickly becomes prohibitive.

Reliable modelling is an important part of the development process. The ability to correlate simulation with actual measurements gives confidence that the final design meets design goals and greatly accelerates time-to-market. Because the communication system consists of complex analog and digital components, it is vital to model accurately in order to predict system-level performance.

Rapid advancements toward new 5G MIMO technology require a test solution that is both flexible and upgradeable to evaluate candidate waveforms at many different frequencies and modulation bandwidths.

At Keysight we continuously develop our simulation and test methods in order to offer solutions that carefully balance cost, coverage and measurement times. In design and test, our solutions help you innovate across new and existing technologies as you transform ideas into reality. Contact us to learn how we can help you take the lead in 5G MIMO.

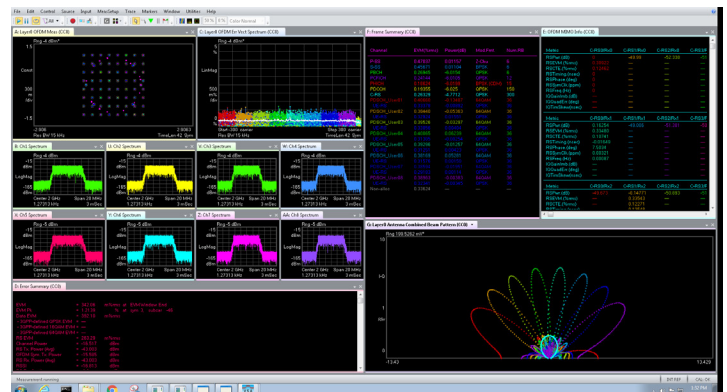
## Solutions for MIMO beamforming simulation and measurement

Keysight Technologies is uniquely positioned to help you by providing a solution approach to hardware, software, and measurement expertise, providing powerful simulation and verification of beamforming performance to improve efficiency and time to market for system designers.

Keysight solutions provide the following benefits:

- Shortened design cycles with pre-defined simulation, visualization and performance measurements.
- Adaptable for different radio access technologies with highly configurable frequency, bandwidth and modulation schemes.
- Scalable MIMO design, with physical capture hardware economically matched to your system needs.

Keysight's solutions enable deeper insights as we evolve toward 5G MIMO. System engineers can quickly view multiple antenna elements simultaneously, and can analyze RF performance, time, frequency and modulation domains, and validate beam tracking and beamforming performance of the base-station uplink and downlink.



Accelerate the development of massive MIMO base station designs, with signals simulating multiple User Equipment (UEs) in motion and analysis of system beam tracking and beam forming performance.

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