6G FOUNDRY

Qualcomm
Engineering Human Progress

The next air interface for a more capable, connected future

Unlocking more value from spectrum for all

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6G Foundry: Explore the next generation of wireless connectivity with Qualcomm experts.
Read Part 7 — Securing the future of mobile connectivity

6G development is accelerating and three foundational design priorities are shaping the next air interface to meet the demands of a more connected, capable future:

- The 6G air interface is being purposefully designed to deliver more coverage from both existing and new spectrum.
- Improving efficiencies across energy, spectrum and implementation complexity is a central design goal.
- The 6G radio access network (RAN) should be AI-native, making it more adaptive, predictive, and responsive to real-world conditions.

As we look toward a future in which AI-powered companions are seamlessly integrated into our daily lives, through smartphones, PCs and intelligent wearables, the role of wireless connectivity becomes even more foundational. At Qualcomm Technologies, we believe 6G will help more people benefit from this transformation by enabling new ways of living, working, and interacting.

But we also recognize the challenge. Many ask: why is the generational transition to 6G necessary? The answer lies in the air interface—the defining foundational layer of each wireless generation.

With 6G, we have the opportunity to redesign the air interface to be more efficient, adaptive, and pervasive from day one.

Welcome to the eighth installment of the 6G foundry series, where we explore how the next air interface is being purposefully envisioned and designed to unlock more value from spectrum, both existing and new, for a more capable, connected future. In this edition, we focus on how foundational air interface innovations are enabling 6G to deliver greater coverage, capacity, and efficiency without requiring more infrastructure. These advances are not only technical milestones, but they are also essential to meeting the growing demands of mobile broadband, AI-powered services on the move, and emerging use cases that will shape how we live, work, and interact in the decade ahead. In future updates from the 6G foundry, we will explore the technologies outlined in this design proposal in greater depth.

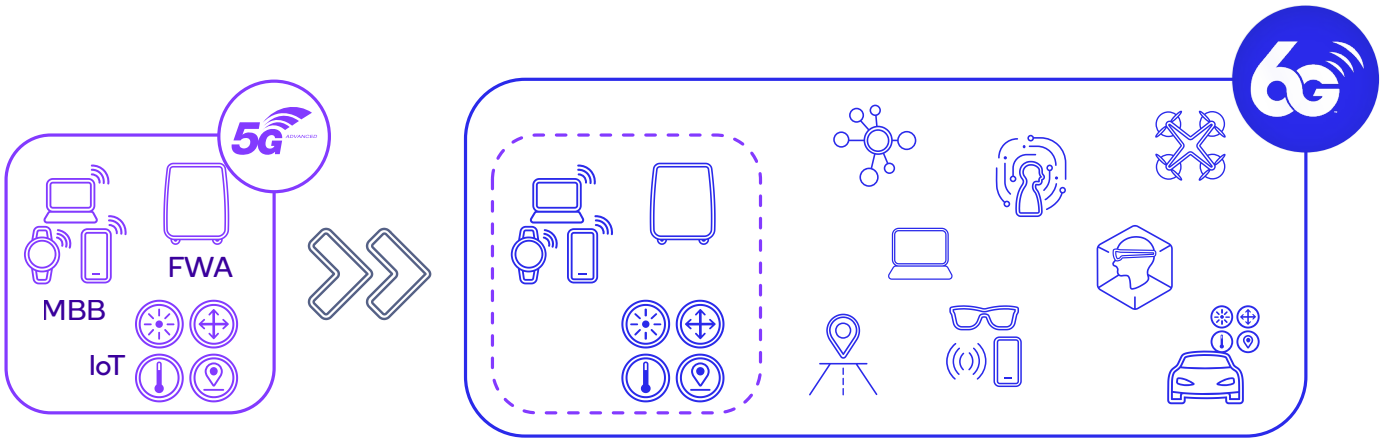
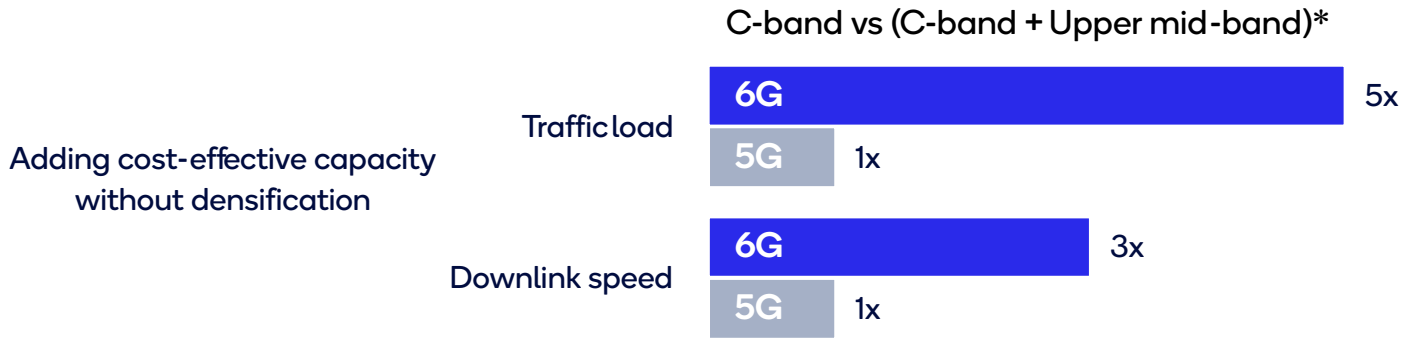


Figure 1. Enhancing existing services with 6G and adding new capabilities

Build a unified interface for diverse use cases

One of the most important lessons from 5G is that bolting on verticals after the fact, whether for IoT with reduced capacity (RedCap) devices, XR, or industrial automation, creates complexity and practical implementation challenges. With 6G, we're taking a different approach. From the start, the air interface is being designed to support a wide range of use cases through a single wide-area network and a single radio access technology (RAT) for a common, streamlined framework. However, this does not preclude the value private networks could bring to industry verticals, for example.

This unified interface will allow mobile broadband, low-power IoT, fixed wireless access, and even integrated sensing to coexist on the same infrastructure. For example, range extension modes for smartphones could enable IoT-like coverage without requiring separate networks. Flexible slot structures and waveform designs will allow the system to scale across different spectrum bands and device types, reducing fragmentation and simplifying deployment.



* Assumptions: 100 MHz BW in C-band, 400MHz BW inupper mid-band spectrum; traffic load for edge download speed of 100 Mbps

Figure 2. Enabling new 6G wide-area bands cost effectively

Unlock coverage and capacity gains without densification

A key goal of 6G is to deliver more performance without requiring more infrastructure. Through smarter MIMO design, advanced coding, and new waveform strategies, we're seeing significant gains in both coverage and capacity.

Our simulations show that 6G can deliver up to 50% more capacity in existing bands, even without new spectrum. When new spectrum is added, such as the globally targeted 6–8 GHz band, those gains multiply. In fact, by combining 400 MHz of new spectrum with advanced beamforming, we can achieve a 5x increase in traffic load support, all while maintaining wide-area coverage. These improvements reduce the need for network densification and make 6G more cost-effective to deploy.

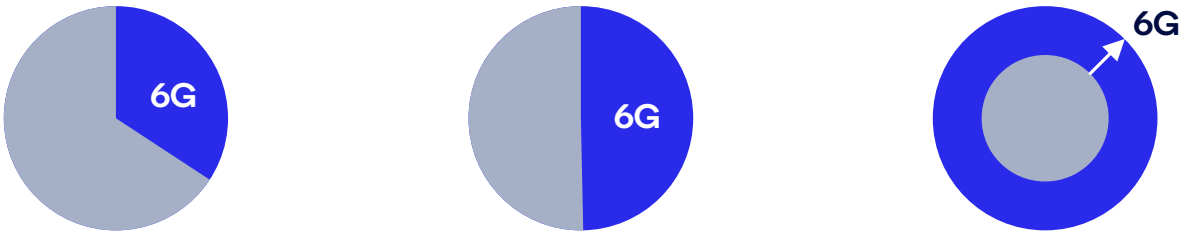


Figure 3. Decreasing the cost of hardware and deployment

Design for energy efficiency and cost-effective scaling

As transistor costs plateau and energy demands rise, efficiency becomes a critical design goal. We are designing 6G with energy and cost efficiency in mind—not just at the device level, but across the entire system, making general purpose compute easier to include.

We're targeting a 3x reduction in decoding complexity and a 2x reduction in memory footprint compared to 5G. These gains are made possible by smarter code designs and more efficient hardware architectures. On the device side, flexible waveform and antenna designs allow the system to adapt to user mobility and channel conditions, improving coverage while reducing power draw.

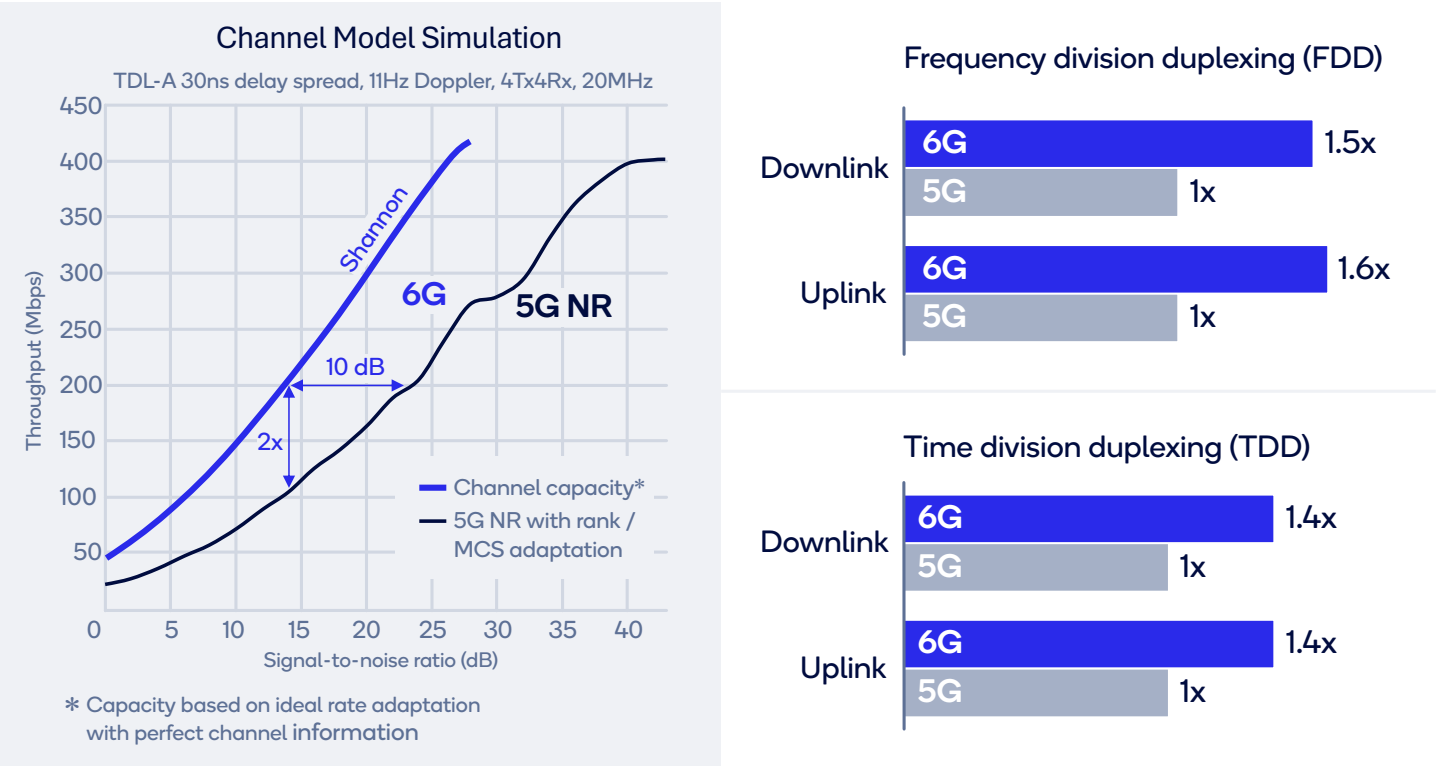


Figure 4. Improving spectral efficiency with 6G in existing 5G bands

Reduce complexity while enhancing performance

6G is not just about higher speeds but about smarter, more efficient communication. We are closing the gap to Shannon capacity through a combination of advanced coding, modulation, and signal processing techniques.

Probabilistic shaping and nonlinear MIMO demodulation are delivering up to 3 dB gains in real-world channels. Joint source-channel coding, powered by AI/ML, is showing 3–8 dB improvements by tailoring codes to real-world data distributions. And enhanced polar and LDPC code designs are reducing decoding iterations and memory usage while improving performance. These innovations make the air interface more robust, scalable, and efficient, especially at the edge of coverage where uplink performance can interfere with seamless user experiences.

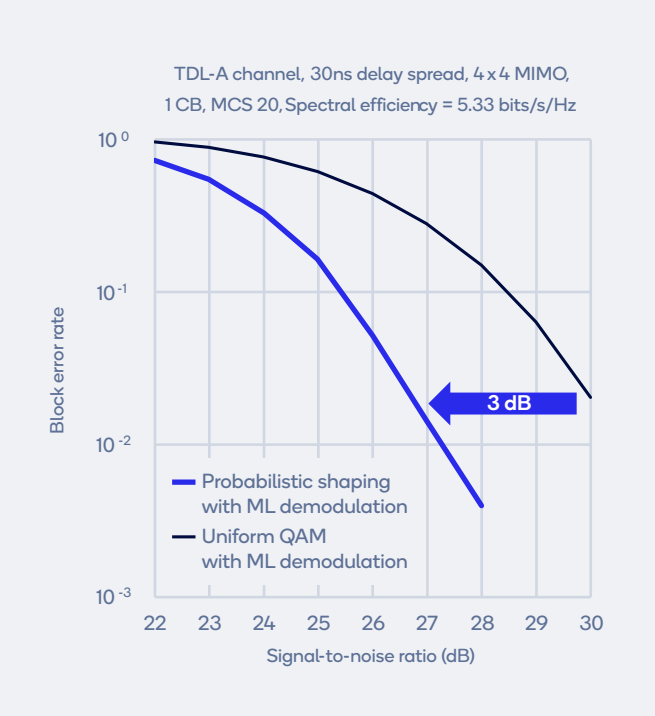


Figure 5. Performance gain with probabilistic shaping in a MIMO channel

Integrate AI/ML to make the air interface adaptive and predictive

Artificial intelligence is not an afterthought in 6G. Rather, it is a foundational element. We believe the 6G radio access network (RAN) should be AI-native, enabling the device and the RAN to leverage AI collaboratively across all protocol layers. To achieve this vision, we're embedding AI/ML into the air interface, making it more adaptive, predictive, and responsive to real-world conditions.

For the air interface, 6G will build upon the components already introduced in 5G Advanced. With 6G, AI models could be used to predict mobility and beam direction, enabling faster handovers and lower latency. Neural networks are compressing and reconstructing channel state information (CSI), reducing overhead while maintaining accuracy. And neural transceivers are being explored to jointly optimize transmission and reception, showing clear performance gains in early studies. These capabilities are already being standardized in 3GPP Release 19 and 20, with commercialization expected in the 6G timeframe.

Advance 6G through collaboration

The development of 6G will require broad alignment across the wireless ecosystem—from regulators and standards bodies to network operators, device manufacturers, and technology providers. At Qualcomm Technologies, we are committed to contributing constructively to this process.

Our approach is grounded in data-driven design, early prototyping, and transparent engagement with global partners. We are actively participating in 3GPP and other forums to help shape a 6G standard that is technically sound, commercially viable, and globally scalable. Through rigorous simulation, hardware prototyping, and digital twin modeling, we are validating performance under realistic deployment conditions.

We recognize that no single company can define 6G and we welcome collaboration. By working together, we can ensure that the next generation of wireless technology delivers meaningful improvements in coverage, efficiency, capability, and societal value.

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