The path to 5G New Radio

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Qualcomm Research is a division of Qualcomm Technologies, Inc.

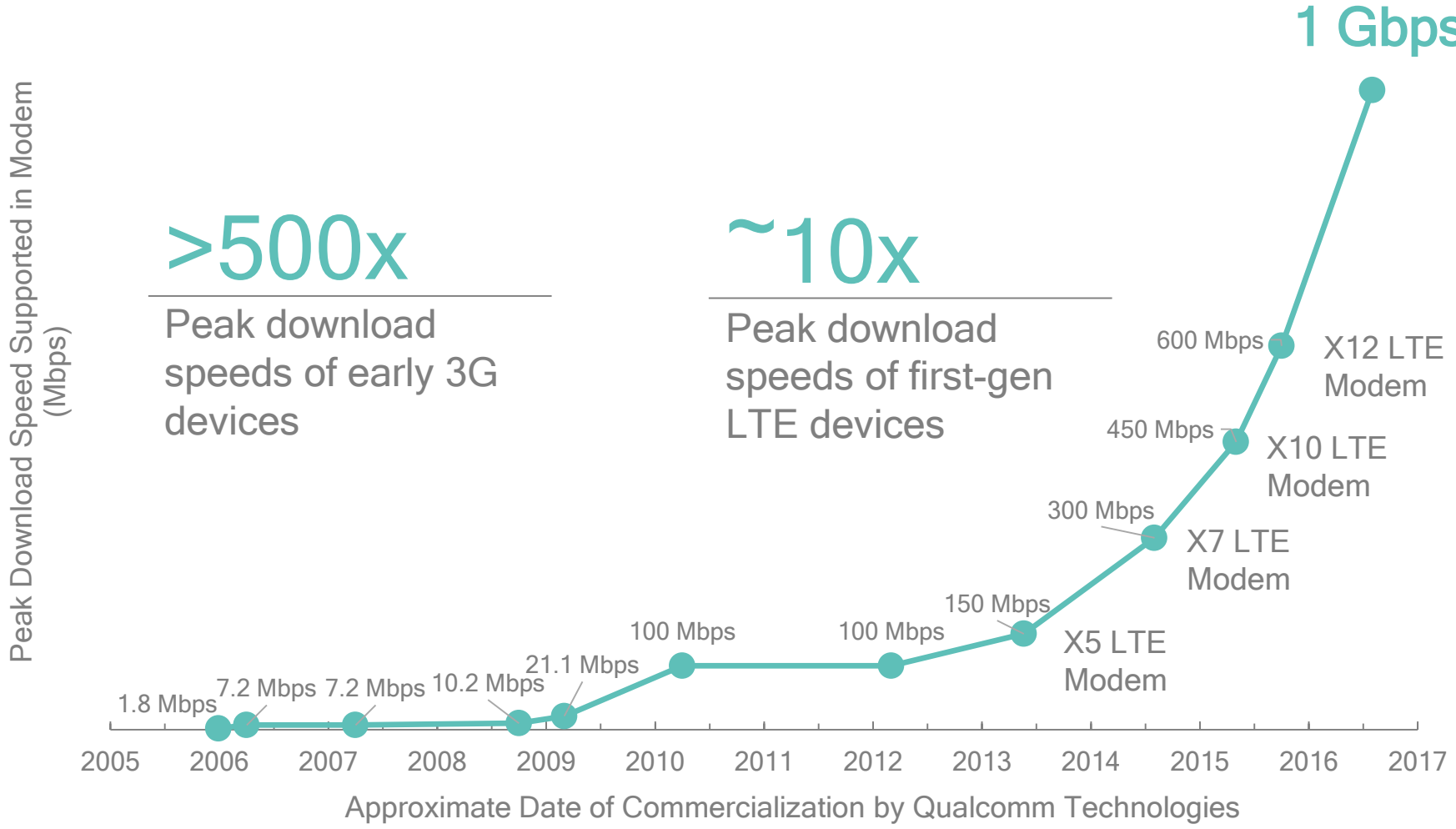
Path towards Gigabit LTE

Qualcomm® Snapdragon™ LTE modems and modem classes

Qualcomm® Snapdragon™ X16 LTE Modem
World's first Gigabit class LTE modem

>500x
Peak download speeds of early 3G devices

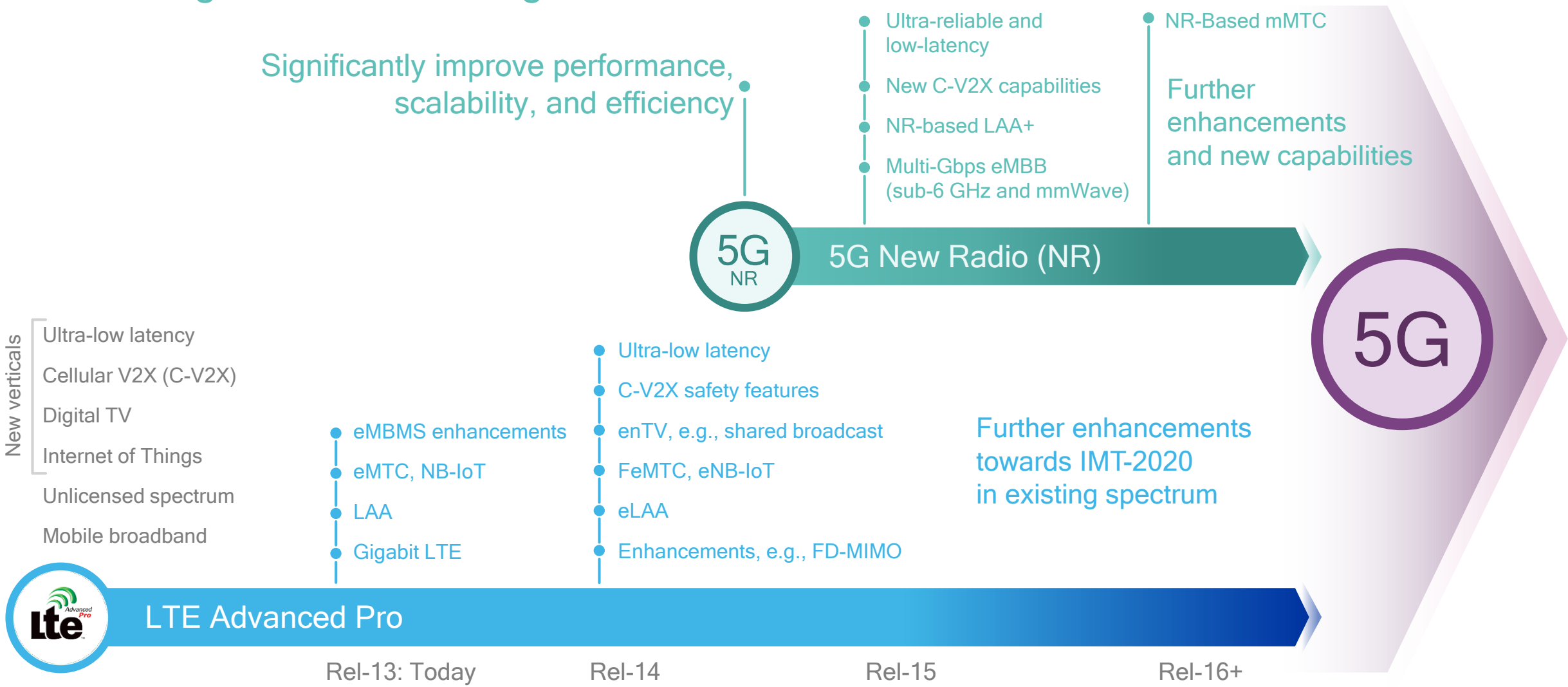
~10x
Peak download speeds of first-gen LTE devices



Qualcomm Snapdragon is a product of Qualcomm Technologies, Inc.
Subject to network availability; The Snapdragon X16 LTE modem supports Gigabit class peak download speeds of up to 979 Mbps; Firsts with respect to public announcement of a commercial LTE modem chipset

LTE Advanced Pro establishes the foundation for 5G

Pioneering 5G NR technologies and verticals



Our vision for 5G is a unifying connectivity fabric

Enabling always-available[1], secure cloud access

Enhanced mobile broadband

Mission-critical services

Massive Internet of Things

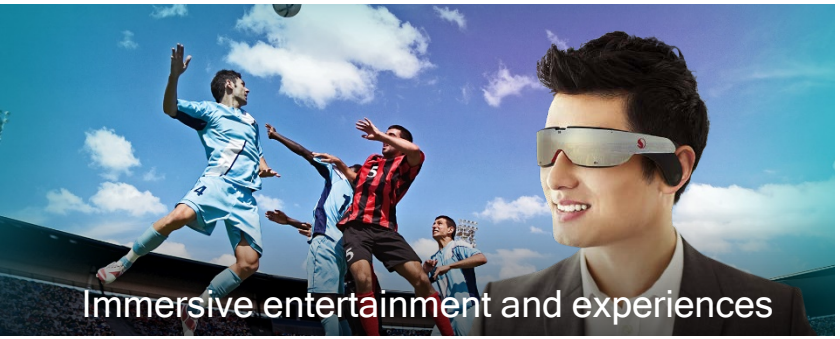
Unifying connectivity platform for future innovation

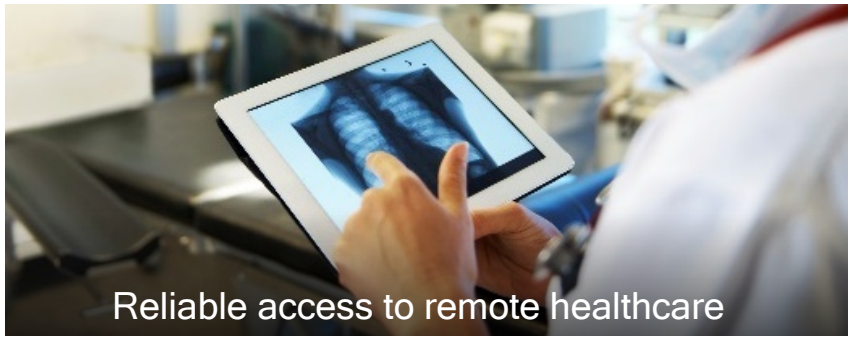
Convergence of spectrum types/bands, diverse services, and deployments, with new technologies to enable a robust, forward-compatible 5G platform

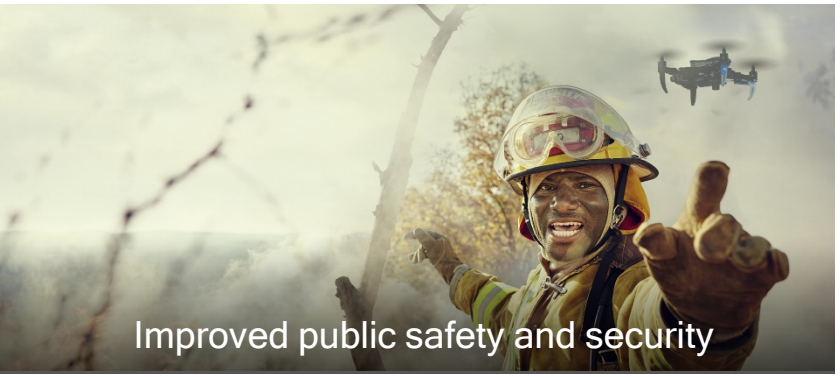
[1] Within network coverage area

5G will redefine a wide range of industries

A platform for new connected services–existing, emerging and unforeseen





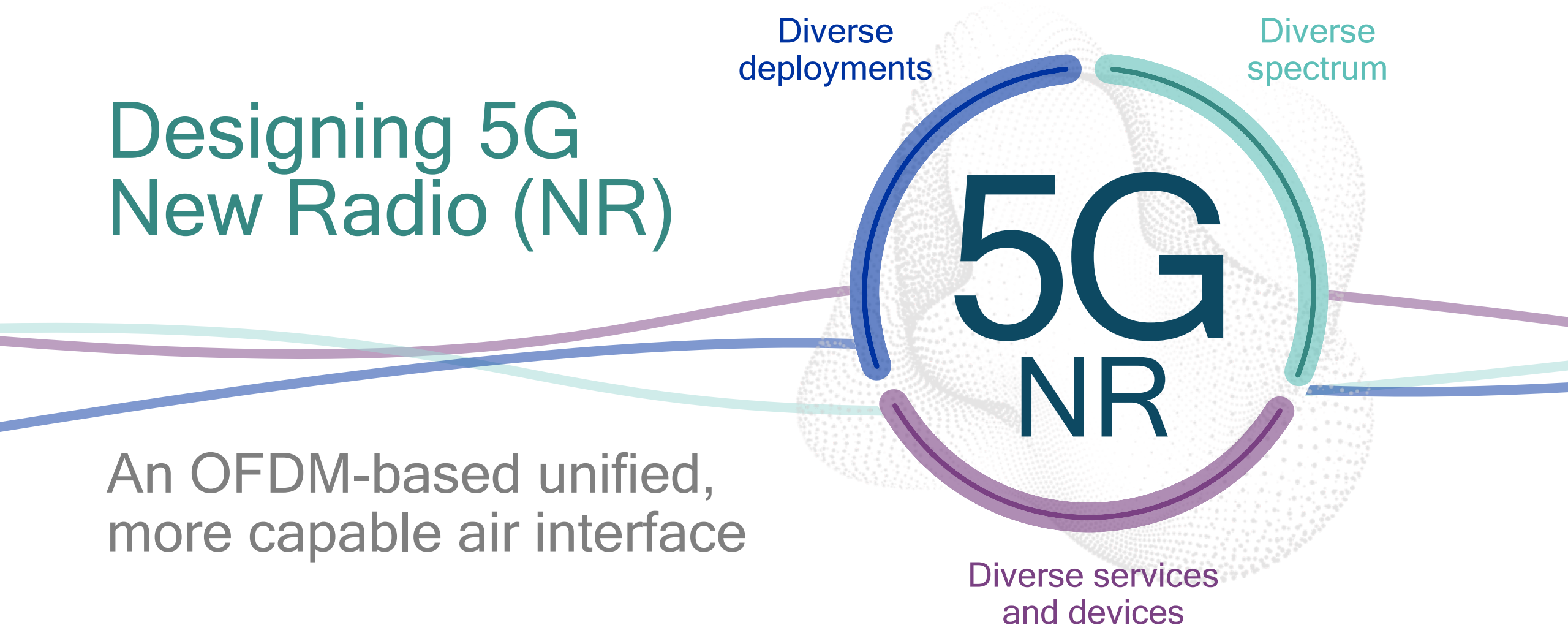


>$12 Trillion

Worth of goods and services by 2035

Learn more at: 5G Economy Study

Designing 5G New Radio (NR)



An OFDM-based unified, more capable air interface

5G NR will take mobile broadband to the next level

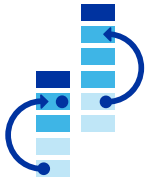
5G NR

Enhanced mobile broadband

Extreme throughput

Ultra-low latency

Uniform experience



New TDD/FDD design

Self-contained subframe, scalable TTI, advanced HARQ to significantly lower latency

Massive MIMO

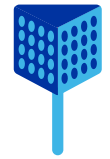
Reciprocity-based design to more efficiently increase capacity and coverage

Advanced channel coding

LDPC to deliver higher efficiency for larger block data transmissions

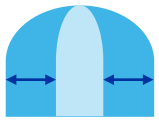
Device-centric mobility

Overhead reduction to improve mobility and energy efficiency



Mobilizing mmWave

Using vast available amount of higher-band spectrum to deliver extreme broadband services



Wider bandwidth

Scalable numerology to address diverse spectrum and deployments

Shared spectrum

More efficient use of limited spectrum resources with new sharing paradigms

Learn more at: https://www.qualcomm.com/5g-nr

1. 3GPP Rel-16+ will bring continued eMBB evolution, plus new features for massive IoT and mission-critical; 2. 3GPP Rel-15 focused on spectrum bands up to ~40 GHz; Rel-16+ will bring support for bands up to ~100 GHz

5G NR will continue the expansion into new verticals

By delivering even better efficiencies and new capabilities from Rel-15+

Massive Internet of Things

Scalable throughput
From kbps to multi-Gbps that provides new flexibilities to a wide range of devices

Extended coverage
For devices at hard-to-reach locations by supporting relays and managed multi-hop mesh

Lower power
More efficient and reduced signaling, such as device-centric mobility and on-demand broadcast

Higher node density
Better support for small data exchanges by using grant-free transmissions (e.g., RSMA[1])

Smart cities

Smart utilities

Connected retail

Connected buildings

Sensor networks

Asset tracking

Mission-critical services

Ultra-high reliability
Ultra-reliable transmissions that can be time multiplexed with nominal traffic through puncturing

Strong e2e security
Security enhancements to air interface, core network and service layer

Ultra-high availability
Multi-connectivity/redundant links for failure tolerance and extreme mobility

Low, bounded latency
Faster, more flexible frame structure and grant-free uplink access (e.g., RSMA)

Autonomous vehicles

Drones

Robotics

Medical

Industrial automation

Smart energy

1 Resource Spread Multiple Access

Getting the most out of every bit of diverse spectrum

Low bands below 1 GHz: longer range for e.g. mobile broadband and massive IoT
e.g. 600 MHz, 700 MHz, 850/900 MHz

Mid bands 1 GHz to 6 GHz: wider bandwidths for e.g. eMBB and mission-critical
e.g. 3.4-3.8 GHz, 3.8-4.2 GHz, 4.4-4.9 GHz

High bands above 24 GHz (mmWave): extreme bandwidths
e.g. 24.25-27.5 GHz, 27.5-29.5, 37-40, 64-71 GHz

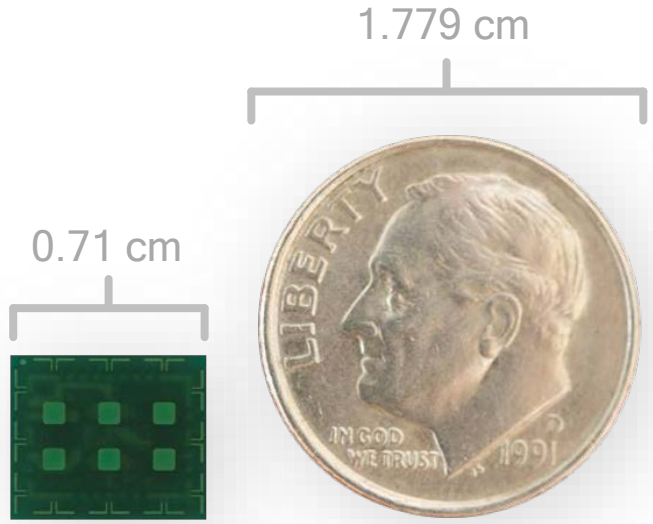
Licensed spectrum
Exclusive use

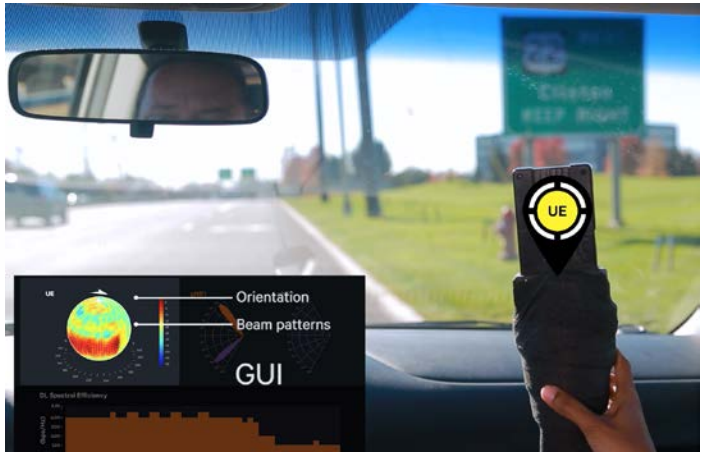
Shared spectrum
New shared spectrum paradigms

Unlicensed spectrum
Shared use

Driving the technology innovations to mobilizing mmWave

Working with operators on trials & early deployments starting late 2017/early 2018[1]





802.11ad 60 GHz chipset commercial for mobile devices

Qualcomm® 802.11ad 60 GHz technology with a 32-antenna array

5G mmWave prototype system and trial platform

End-to-end TDD system operating at 28 GHz demonstrating NLOS operation and robust mobility

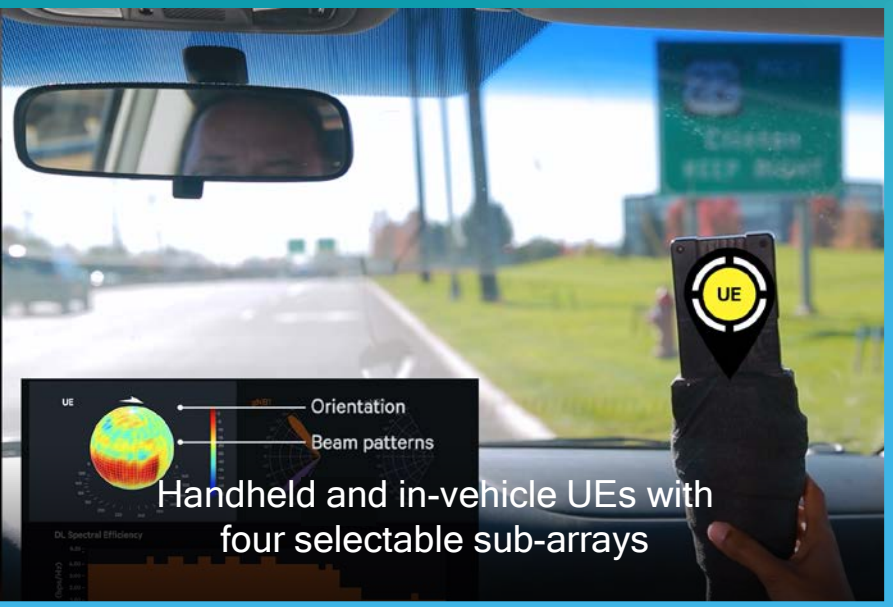
Qualcomm® Technologies' first 5G modem

28 GHz support, 4G/5G Multi-mode with dual connectivity, up to 5 Gbps download speed

Qualcomm Snapdragon and Qualcomm 802.11ad are products of Qualcomm Technologies, Inc.

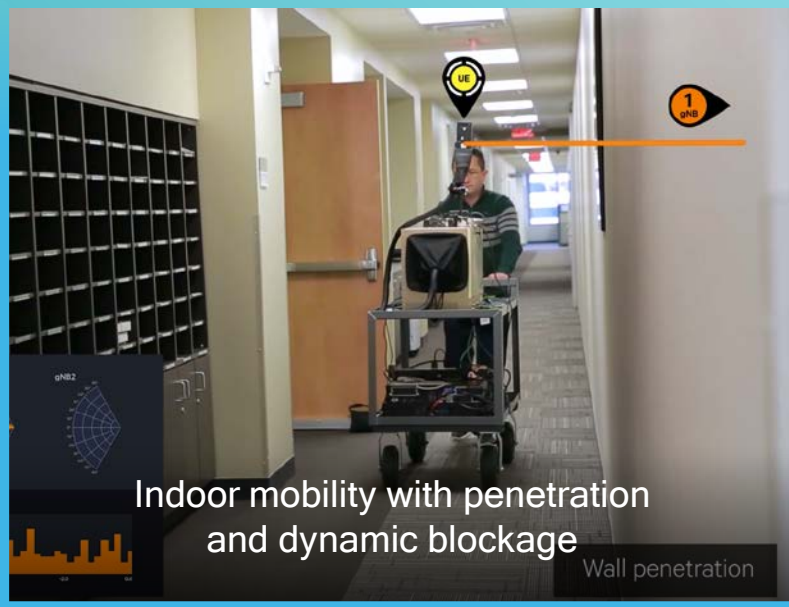
[1] For limited regional fixed wireless deployments, e.g. Korea and US (VZ 5GTF and KT 5G-SIG) operating at 28 and 39 GHz; also will be utilized for mobile wireless access trials to drive 5G NR standardization

Demonstrating NLOS operation and robust mobility

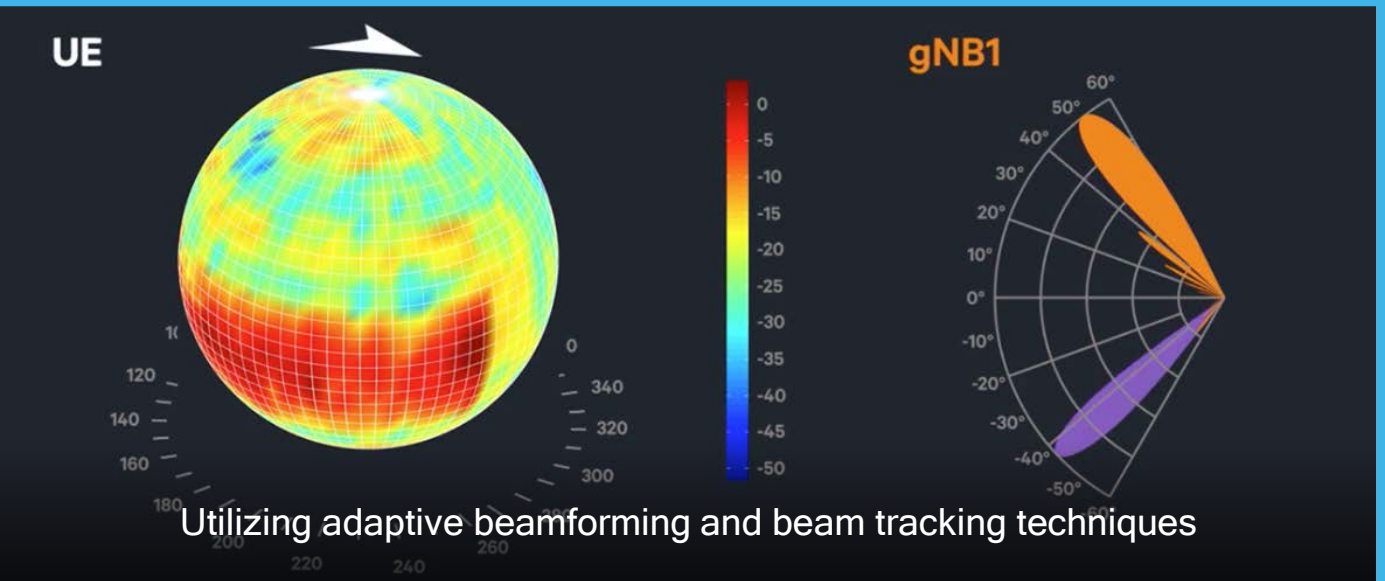


Handheld and in-vehicle UEs with four selectable sub-arrays

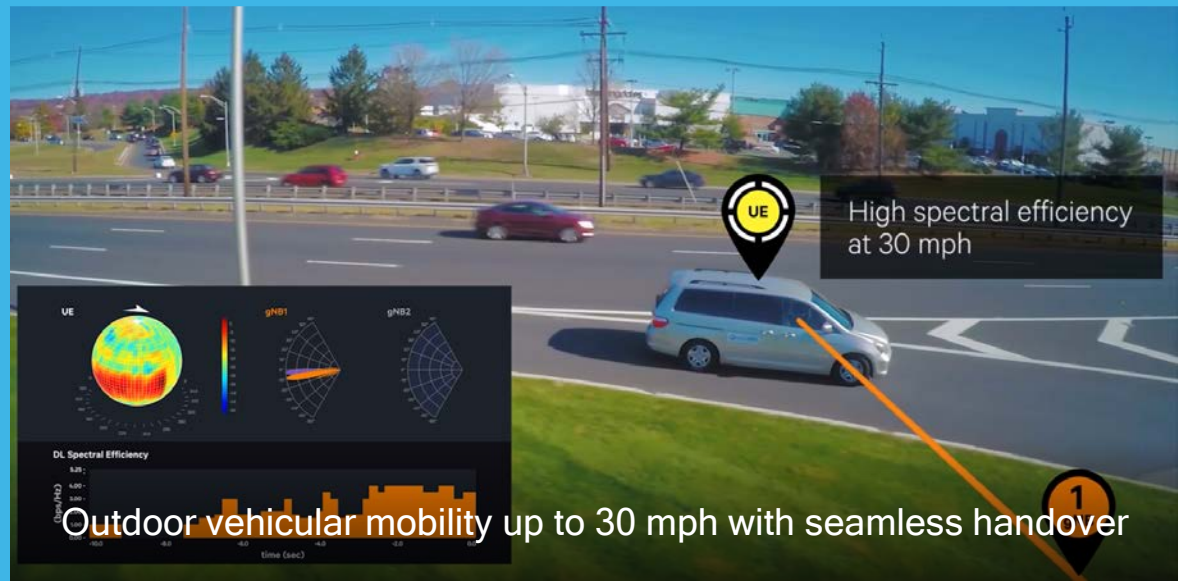
Multiple gNodeBs with 128 antenna elements



Indoor mobility with penetration and dynamic blockage



Utilizing adaptive beamforming and beam tracking techniques



Outdoor vehicular mobility up to 30 mph with seamless handover

Bringing the next level of performance for sub-6 GHz

Qualcomm Research 5G NR sub-6 GHz prototype system and trial platform

Operating in sub-6 GHz spectrum bands

Operates in 3.3 GHz - 5 GHz bands for flexible deployments to address the wide-range of 5G use cases

Achieving fiber-like speeds at low latency

Showcases advanced 5G NR technologies to efficiently achieve multi-Gbps data rates at sub-2 ms latency

Delivering wide-area coverage at ~4 GHz

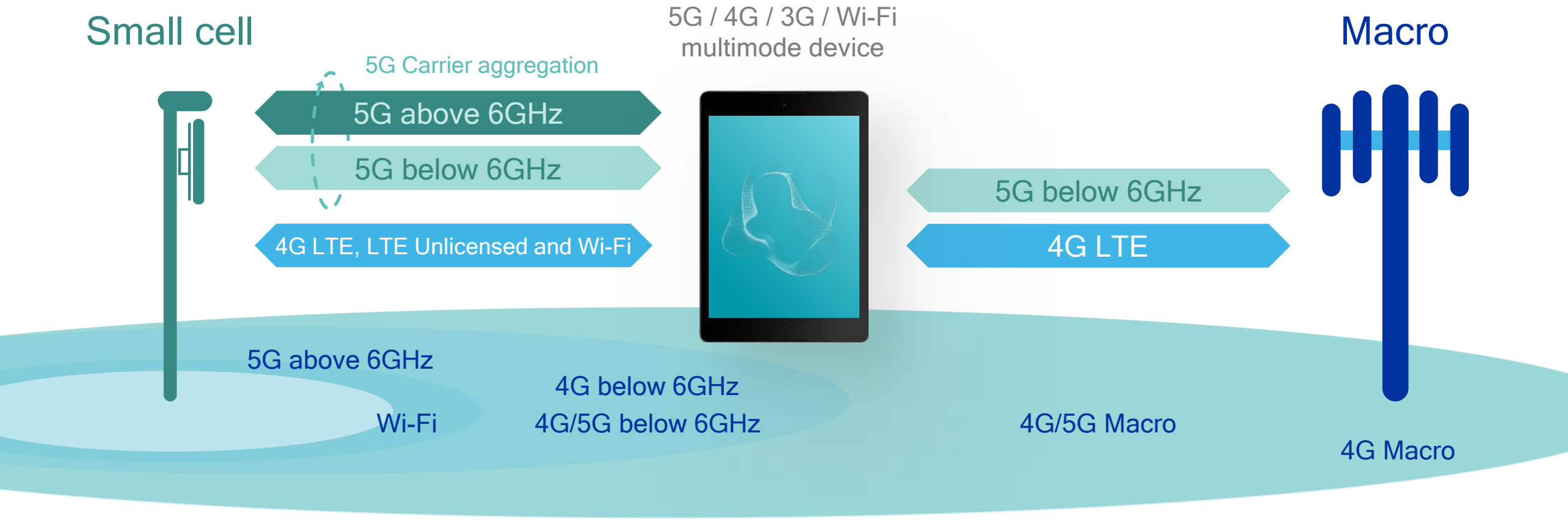
Utilizes advanced 5G NR technologies to increase capacity and coverage at ~4 GHz; also more uniformity

Enabling impactful 5G NR trials

Designed to flexibly track 3GPP standardization for impactful 5G NR trials starting 2H-2017

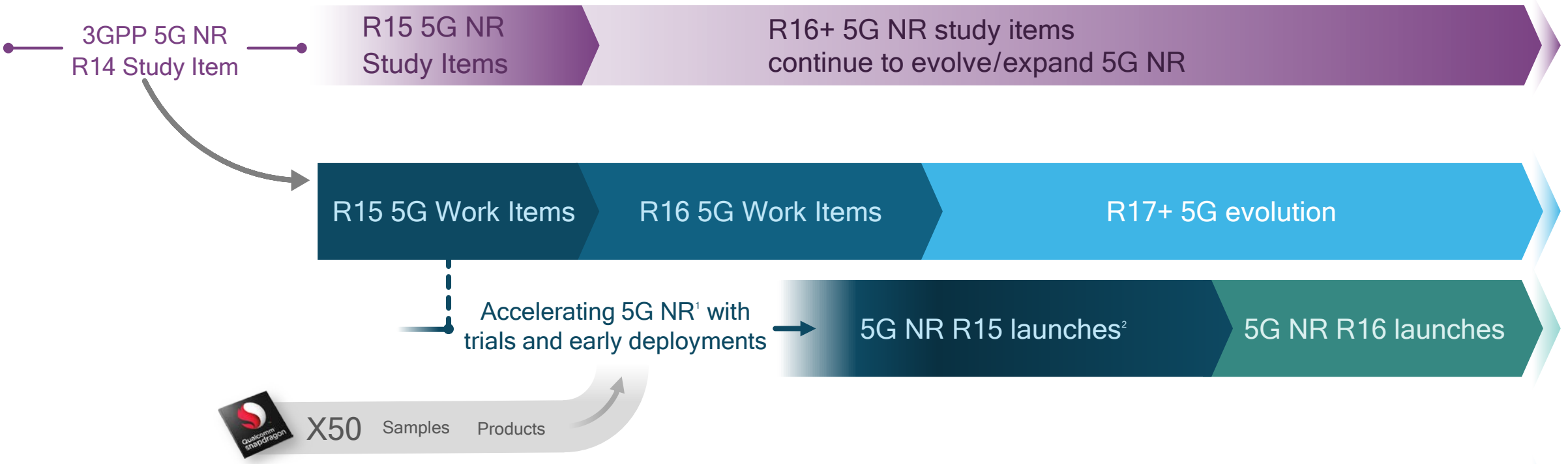
Simplifying 5G deployments with multi-connectivity

Fully leveraging 4G LTE and Wi-Fi investments for a seamless user experience



5G NR radio access designed to utilize LTE anchor for mobility management (non-standalone) or operate stand-alone with new multi-access 5G NextGen Core Network (NGCN)

Accelerating 5G NR–The global standard for 5G



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1. The latest plenary meeting of the 3GPP Technical Specifications Groups (TSG#72) has agreed on a detailed workplan for Release-15; 2. Forward compatibility with R16 and beyond

Thank you

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