Qualcomm @qualcomm_tech June 2018

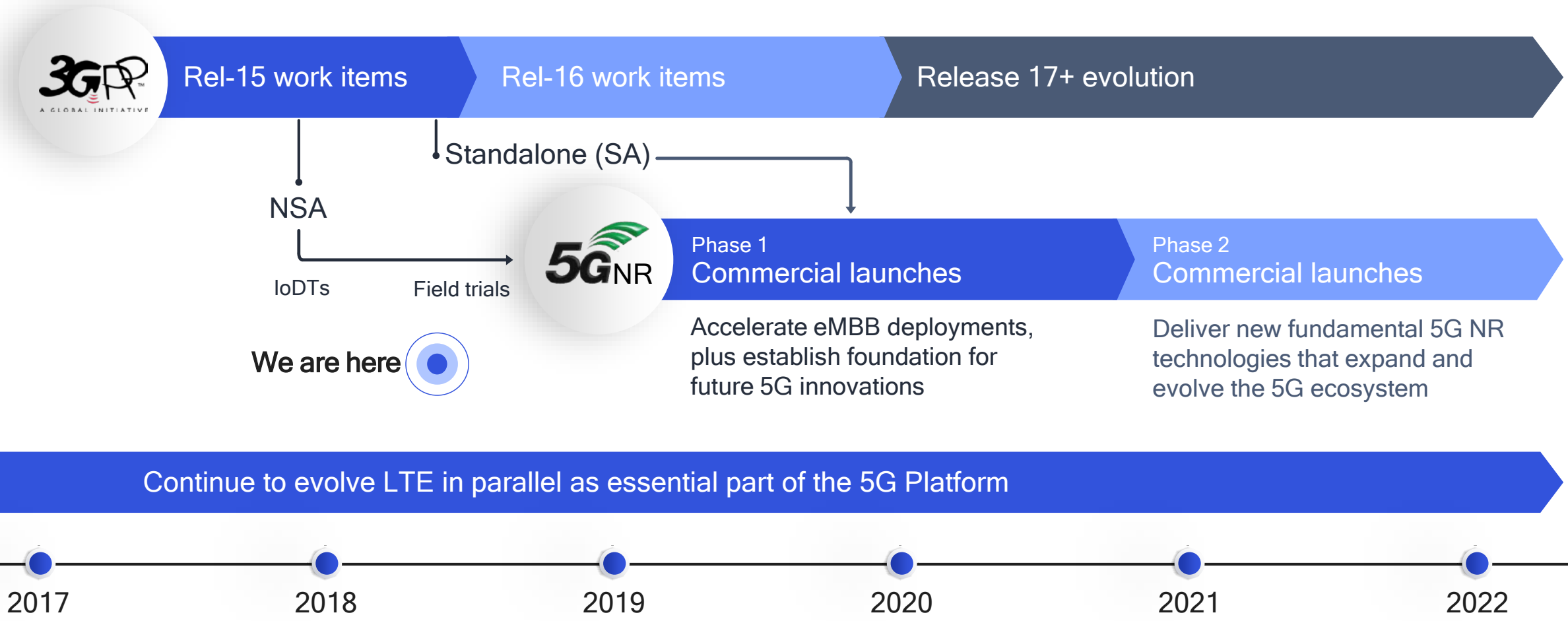
Making 5G NR a Commercial Reality for 2019

A unified, more capable 5G air interface

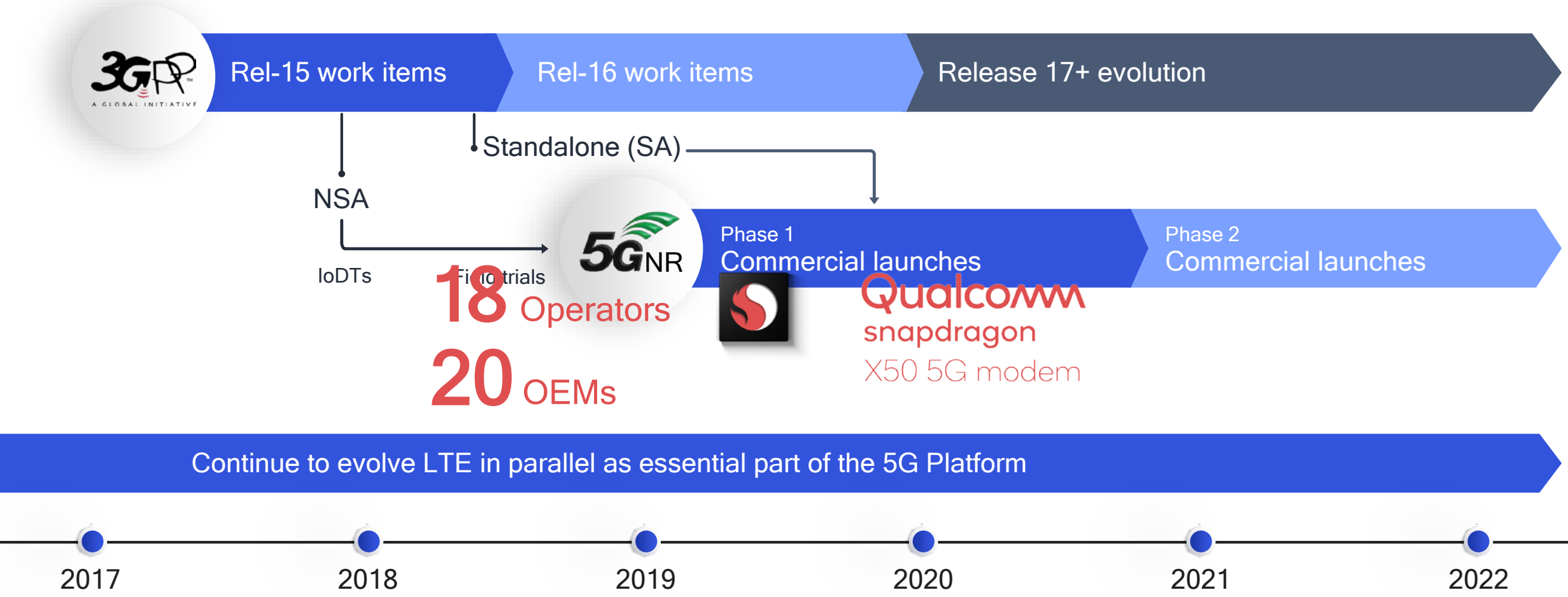
Dr. Hao Xu

Head of Qualcomm Research China

Making 5G a reality in 2019



Making 5G a reality in 2019



Qualcomm Snapdragon is a product of Qualcomm Technologies, Inc. and/or its subsidiaries.

Making 5G NR a reality in 2019

Qualcomm

Best-in-class 5G prototype systems

Designing and testing 5G technologies for many years

3GPP™
A GLOBAL INITIATIVE

5G NR standards and technology leadership

Our technology inventions are driving the 5G NR standard

AT&T BT 中国移动 China Mobile 中国电信 China Telecom
China Unicom Deutsche Telekom LG U+ KDDI kt
docomo orange Singtel SK telecom Sprint
TIM verizon Vodafone Group WIND 3
ERICSSON HUAWEI NOKIA SAMSUNG ZTE中兴

5G NR interoperability testing and trials

Leveraging prototype systems and our leading global network experience

Modem and RFFE leadership

Announced the Qualcomm Snapdragon X50 5G modem family

LTE foundational technologies

Qualcomm® snapdragon™

X50

5G Modem family

World's first 5G-NR multimode modems

- 2G/3G/4G/5G chipset support
- Sub-6 + mmWave
- Premium-tier smartphones in 2019

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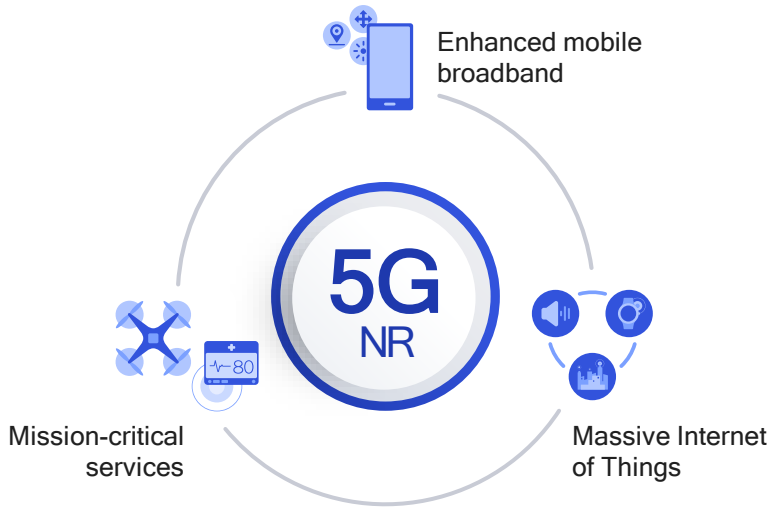
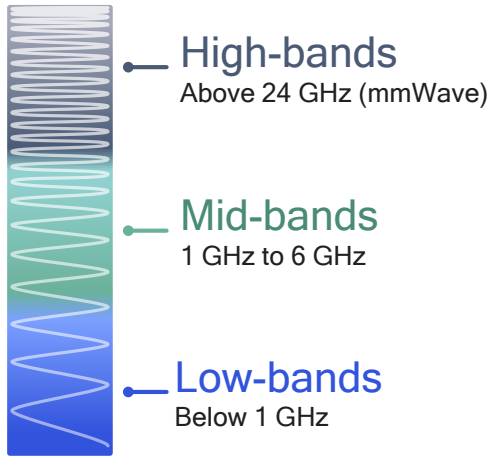
Designing a unified, more capable 5G air interface



Diverse services

Scalability to address an extreme variation of requirements



Diverse spectrum

Getting the most out of a wide array of spectrum bands/types

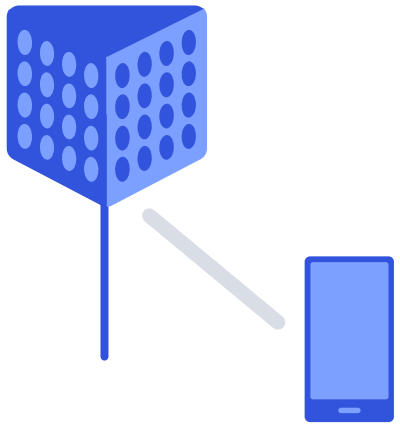
Diverse deployments

From macro to indoor hotspots, with support for diverse topologies

A unifying connectivity fabric for future innovation

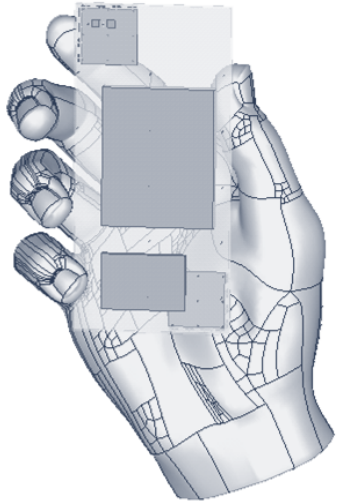
A platform for existing, emerging, and unforeseen connected services

Overcoming numerous challenges to mobilize mmWave



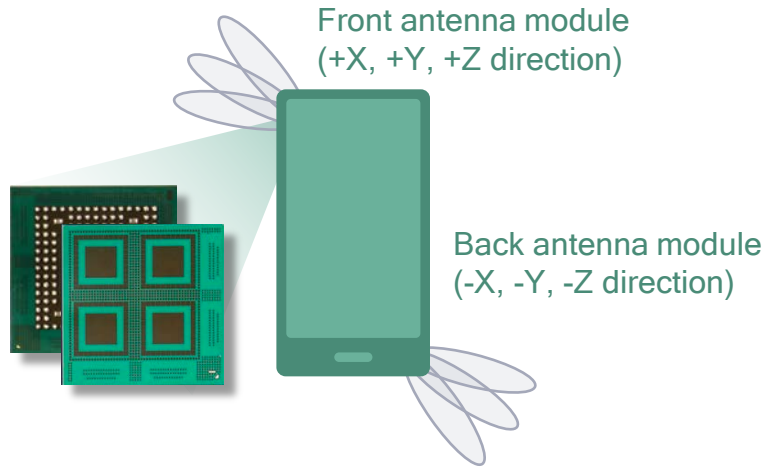
Coverage

Analog beamforming with narrow beamwidth to overcome significant path loss in bands above 24 GHz



Robustness

Adaptive beam steering and switching to overcome blockage from hand, head, body and foliage

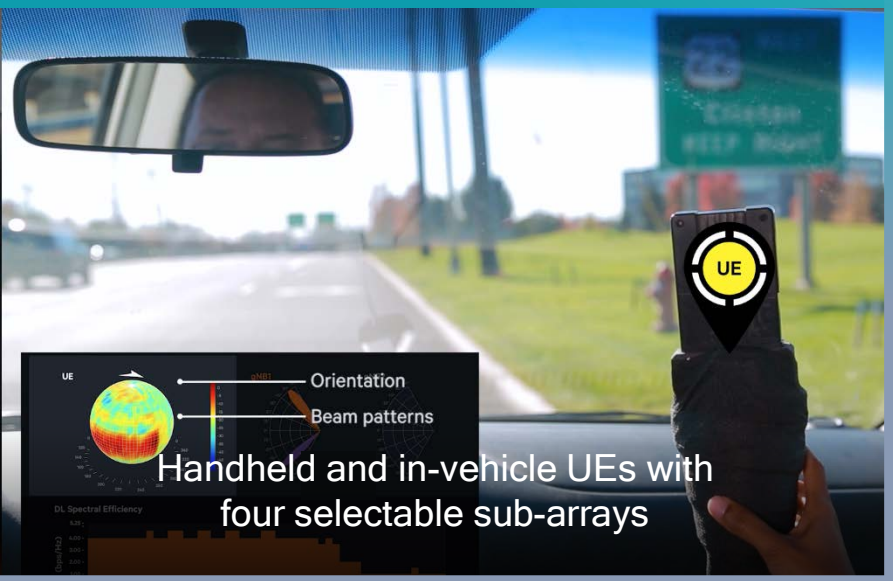


Device size/power

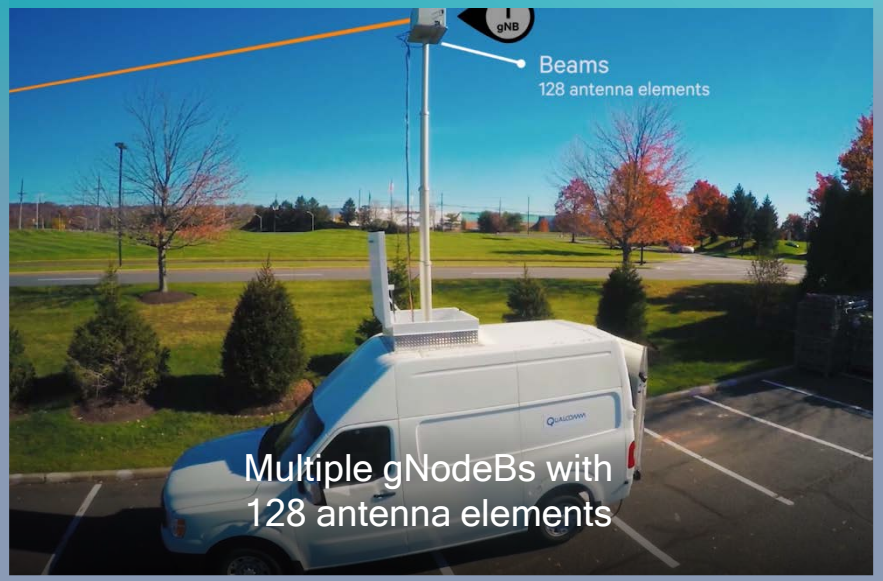
Different antenna configurations (face/edge) to fit mmWave design in smartphone form factor and thermal constraints

Mobilizing 5G mmWave in real-world environments

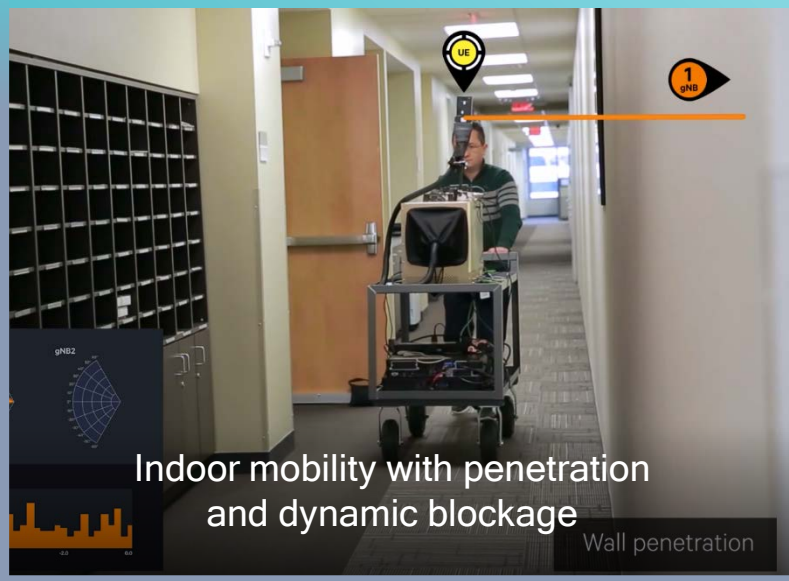
Demonstrating NLOS operation and robust mobility



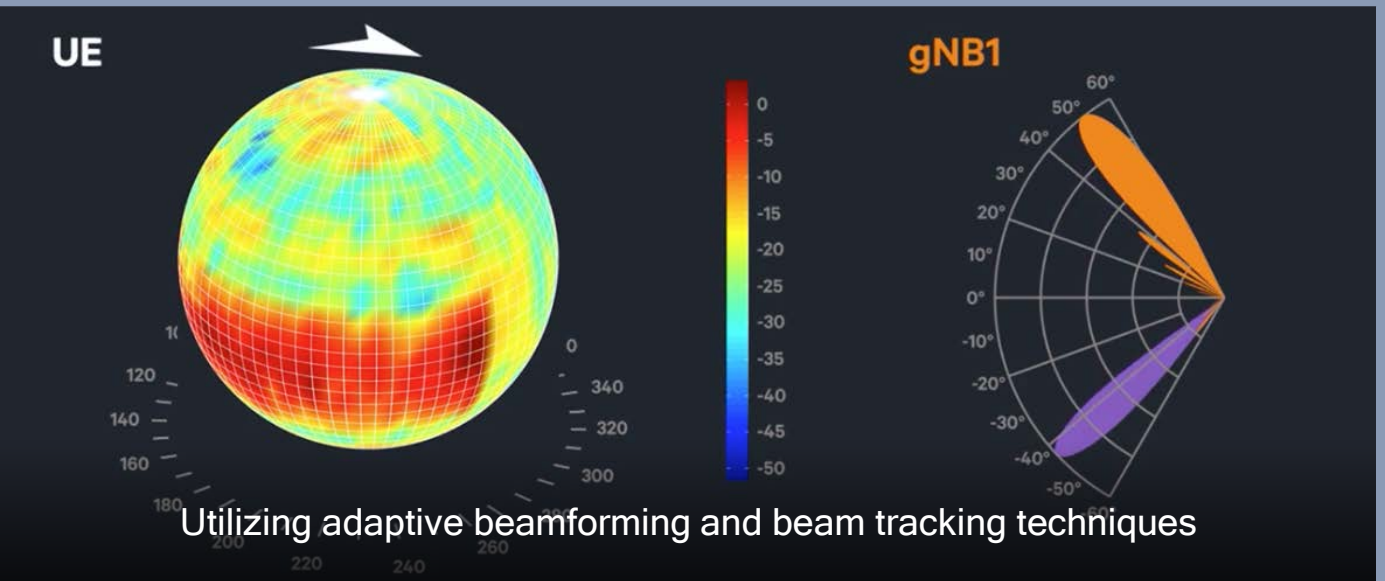
Handheld and in-vehicle UEs with four selectable sub-arrays



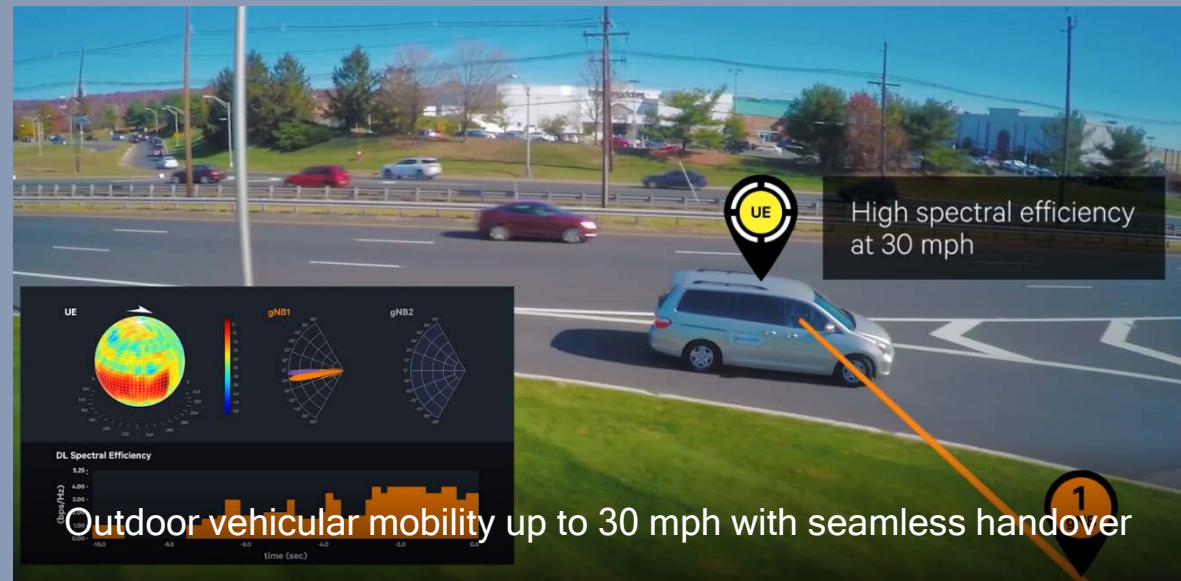
Multiple gNodeBs with 128 antenna elements



Indoor mobility with penetration and dynamic blockage



Utilizing adaptive beamforming and beam tracking techniques

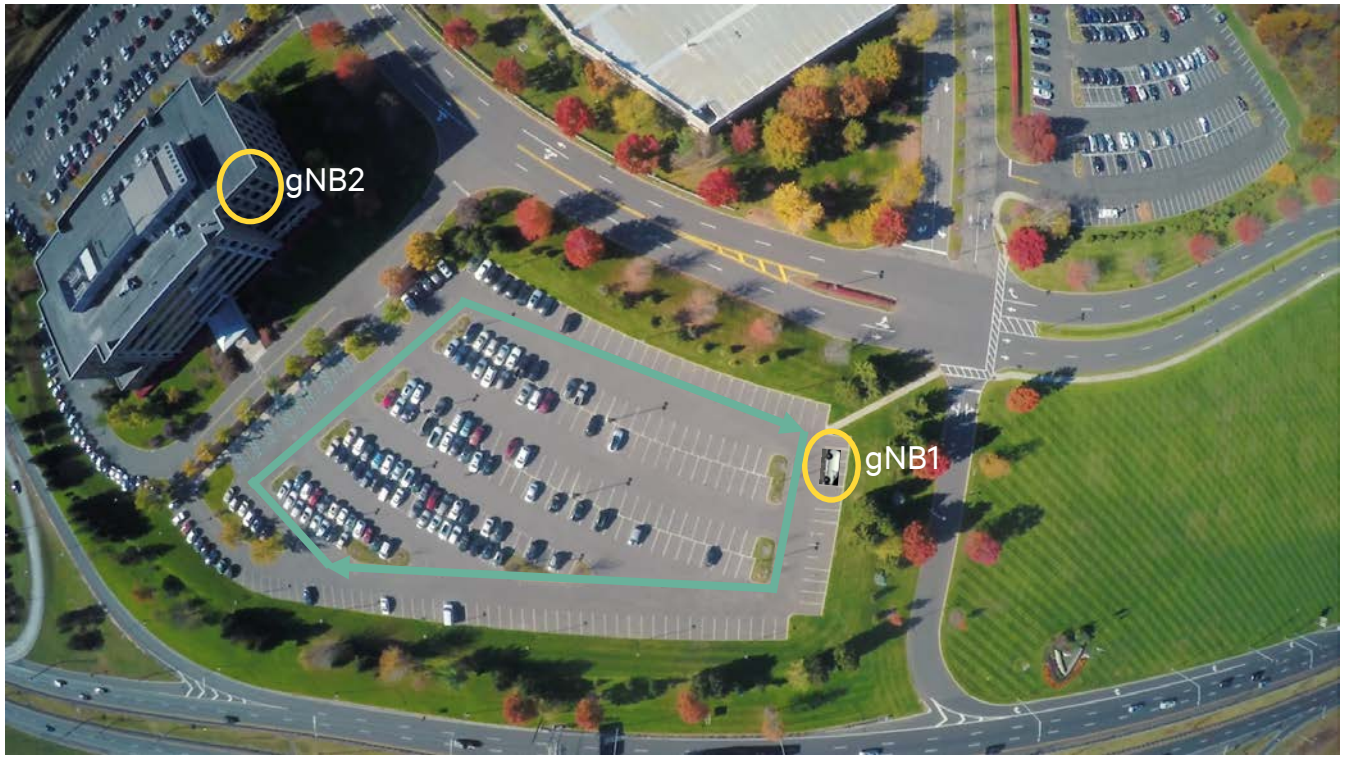


Outdoor vehicular mobility up to 30 mph with seamless handover

Outdoor OTA testbed

Enables the evaluation of mobility/handover, hand/head-blocking, and other scenarios

Handover testing



gNB

UE Handset Module

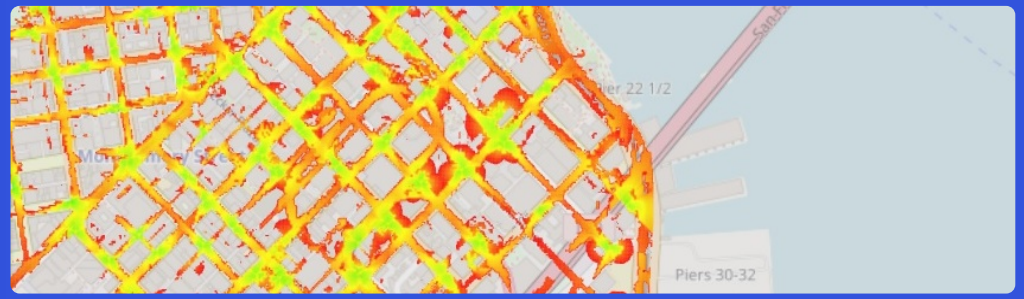
San Francisco Simulation

65% outdoor coverage

1.4 Gbps median burst rate

5x increase in capacity

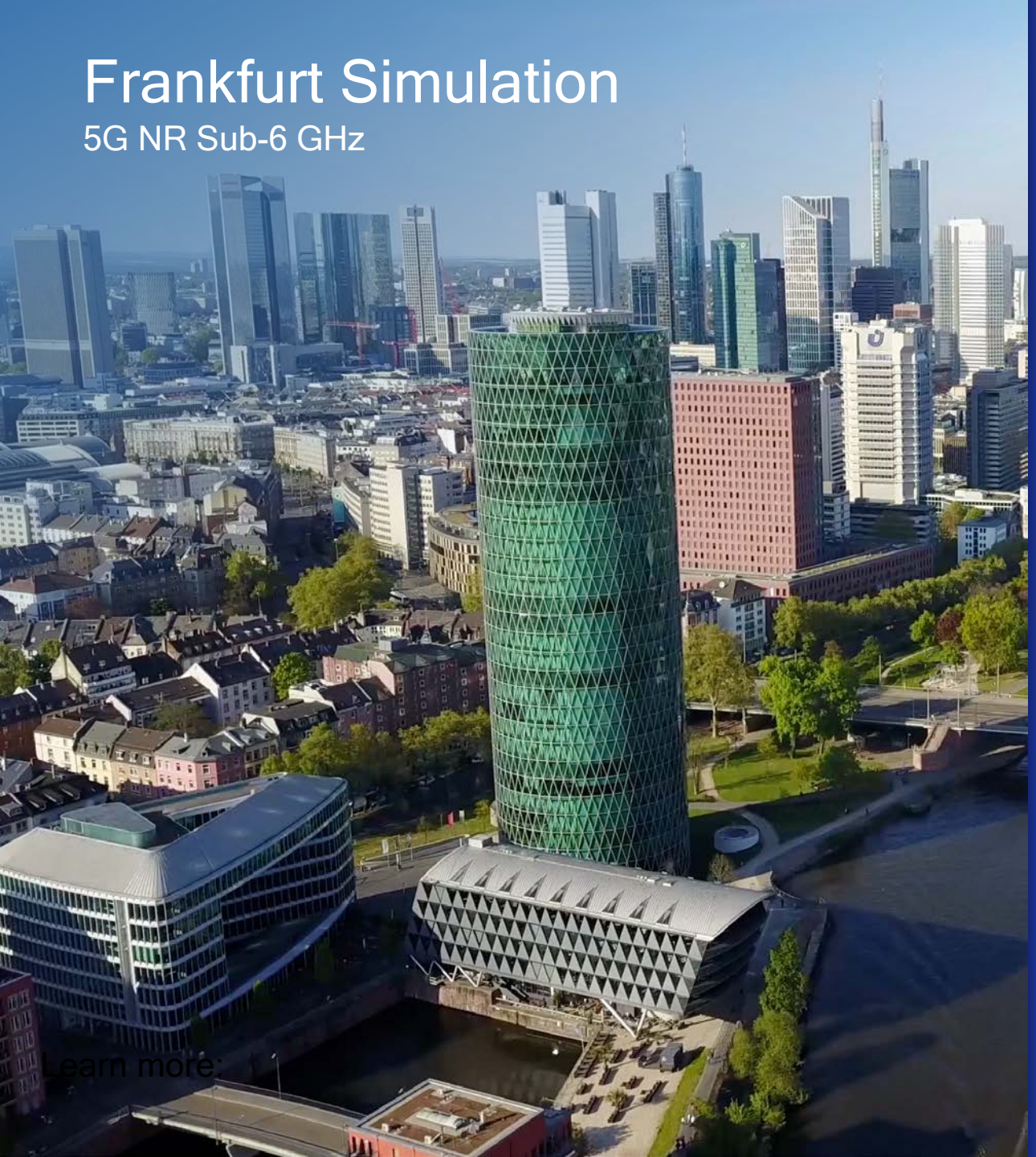
Collaborating with global operators to simulate 5G NR mmWave capacity and coverage



- Significant outdoor coverage possible utilizing actual existing LTE sites (10+ global cities)
- Will further benefit from LTE infrastructure (LAA small cells) to support Gigabit LTE launches
- Outdoor coverage only; frees up sub-6 GHz resources for out-to-indoor capacity
- Based on our extensive over-the-air testing and channel measurements

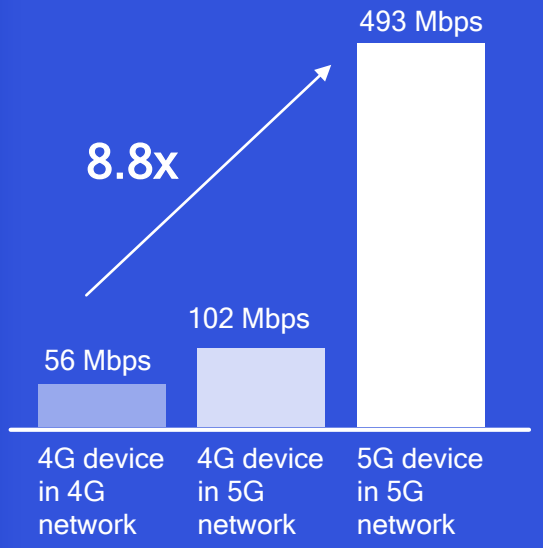
Frankfurt Simulation

5G NR Sub-6 GHz

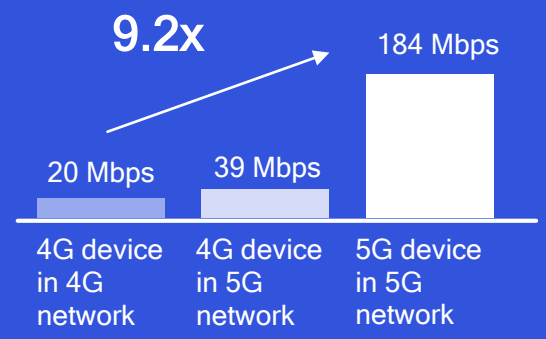


Learn more:

Industry-first simulation of real world performance reveals immense 5G user experience gains over 4G

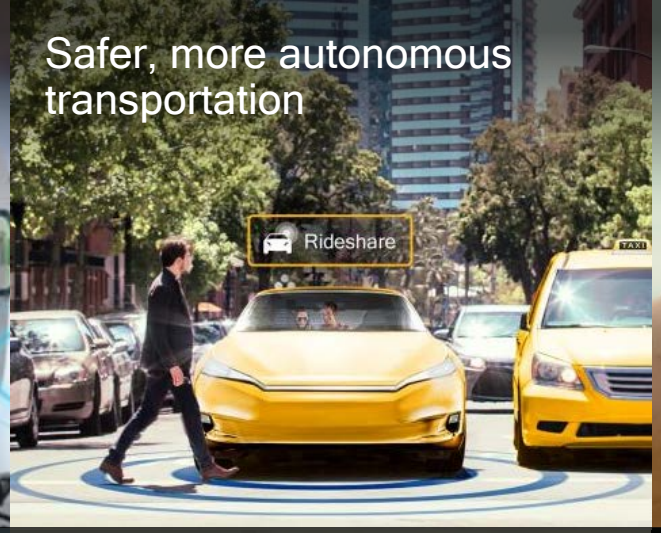


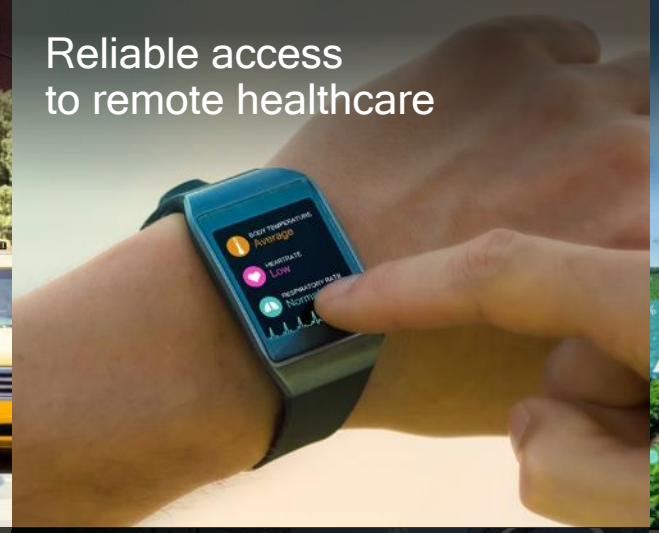
Median burst rate

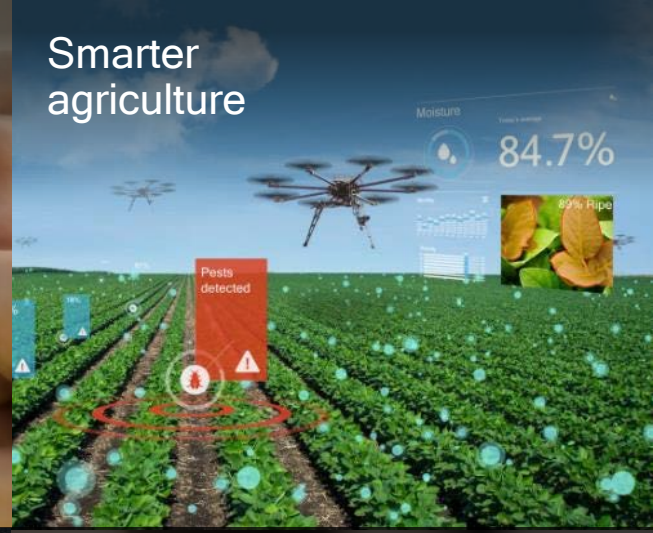


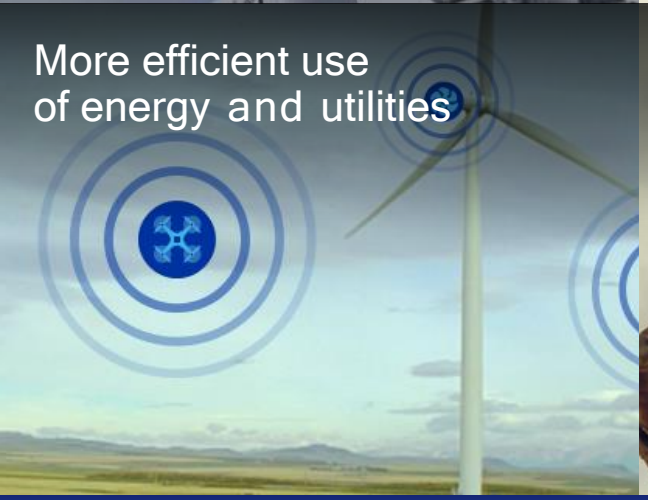
Cell-edge burst rate

Assumptions: Actual Frankfurt city layout; Max LTE bandwidth 80 MHz (carrier frequencies ranging from 700 MHz to 2.7 GHz); 5G NR total bandwidth 100 MHz (carrier frequency 3.5 GHz); Mix of macro and small cell base stations; Bursty Poisson traffic model; 50% indoor and 50% outdoor UEs; 75% LTE only devices / 25% 5G NR capable devices; NR TDD 3:1 DL/UL slot configuration.









5G

5G will expand the mobile ecosystem to new industries

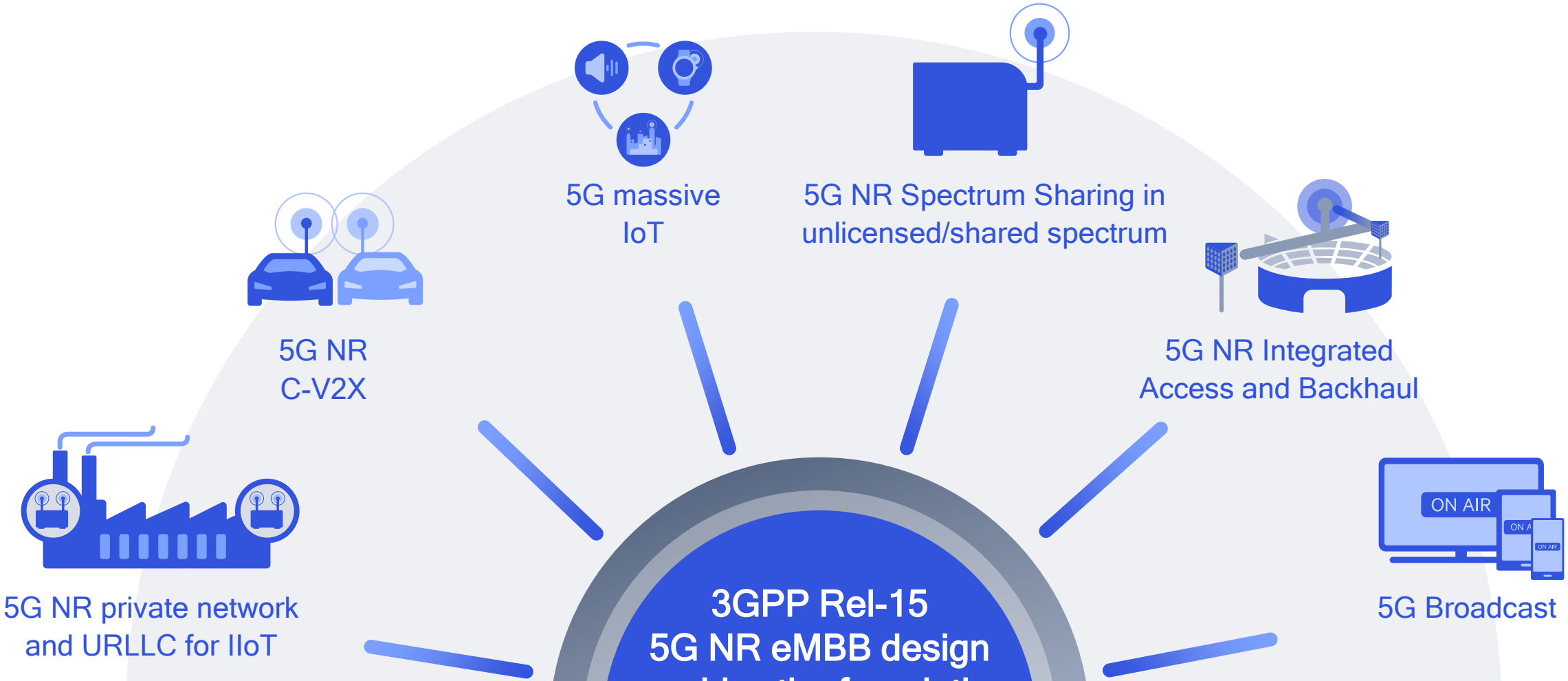
* The 5G Economy, an independent study from IHS Markit, Penn Schoen Berland and Berkeley Research Group, commissioned by Qualcomm

Powering the digital economy

>$12 Trillion

In goods and services by 2035*

Driving a rich 5G NR technology roadmap beyond eMBB



5G NR – opportunity for new spectrum sharing paradigms

Building on spectrum sharing technologies that we are pioneering today for LTE

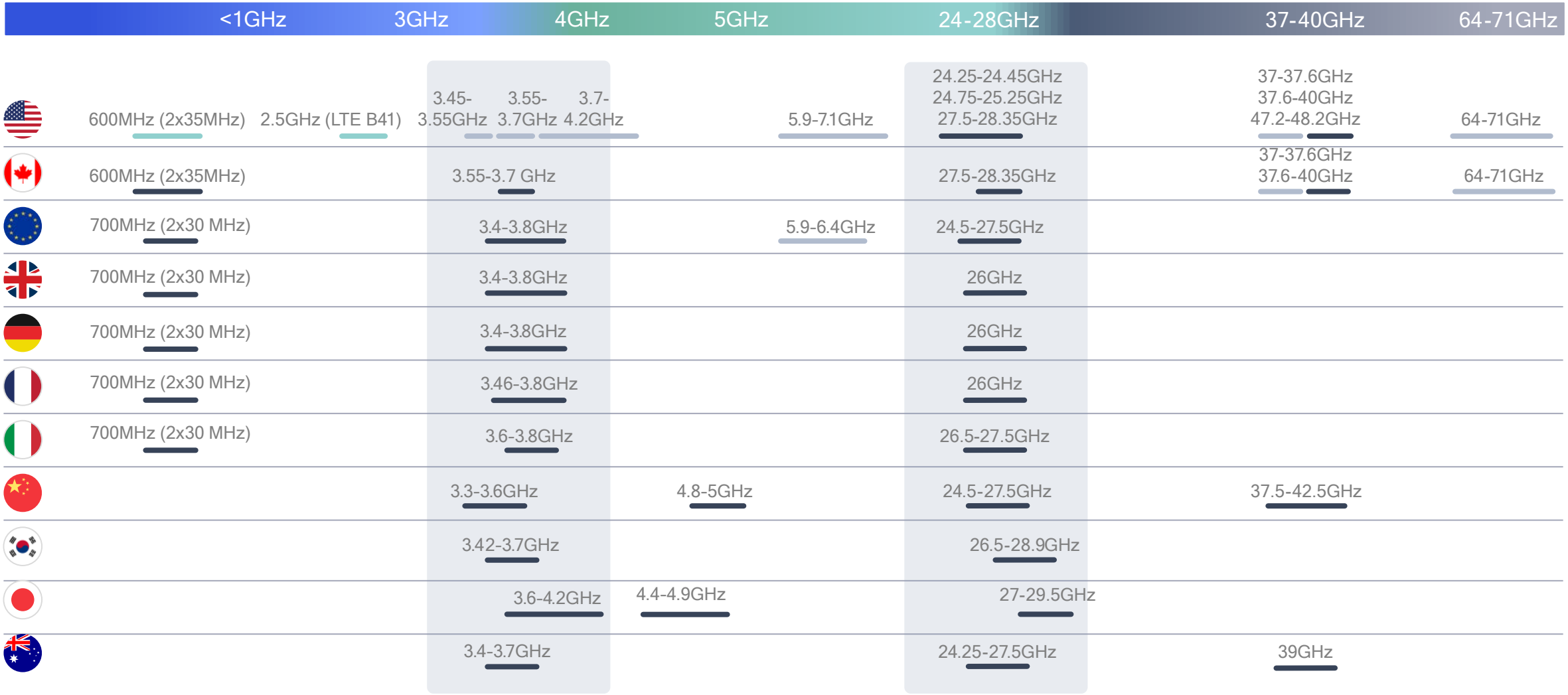
Evolution Path

- LTE-U / LAA
- LWA
- MulteFire
- CBRS / LSA

5G NR Spectrum Sharing

Revolution Path

- Flexible NR framework
- Time synch. and coordinated sharing
- Guaranteed QoS
- Exploiting spatial domain
- Vertical & horizontal sharing

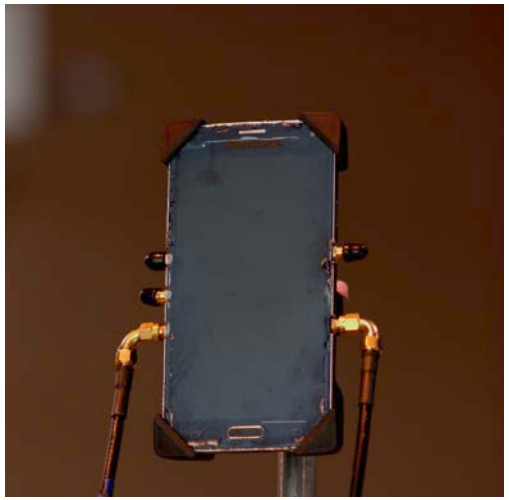


Designed for diverse spectrum bands/types

Global snapshot of 5G spectrum bands allocated or targeted

New 5G band

- Licensed
- Unlicensed / shared
- Existing band



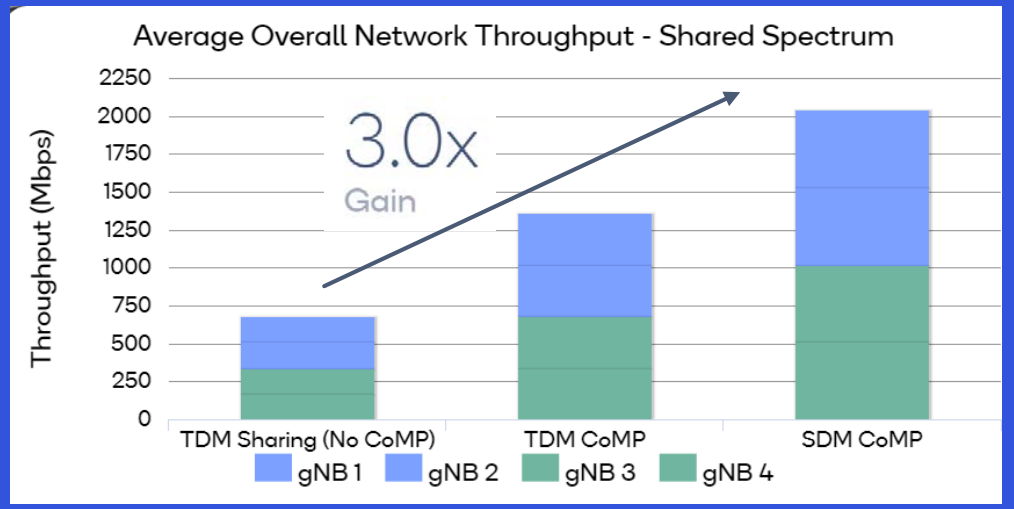
MWC 2018

Qualcomm

Demonstrating the potential new 5G NR spectrum sharing paradigms

Utilizes 5G NR spectrum sharing prototype – designed to also support testing of 5G NR in unlicensed spectrum

Significant performance gains utilizing advanced intra-operator CoMP and inter-operator SDM techniques



COMP = Coordinated Multi-Point
SDM = Spatial Domain Multiplexing

MWC 2018

Qualcomm

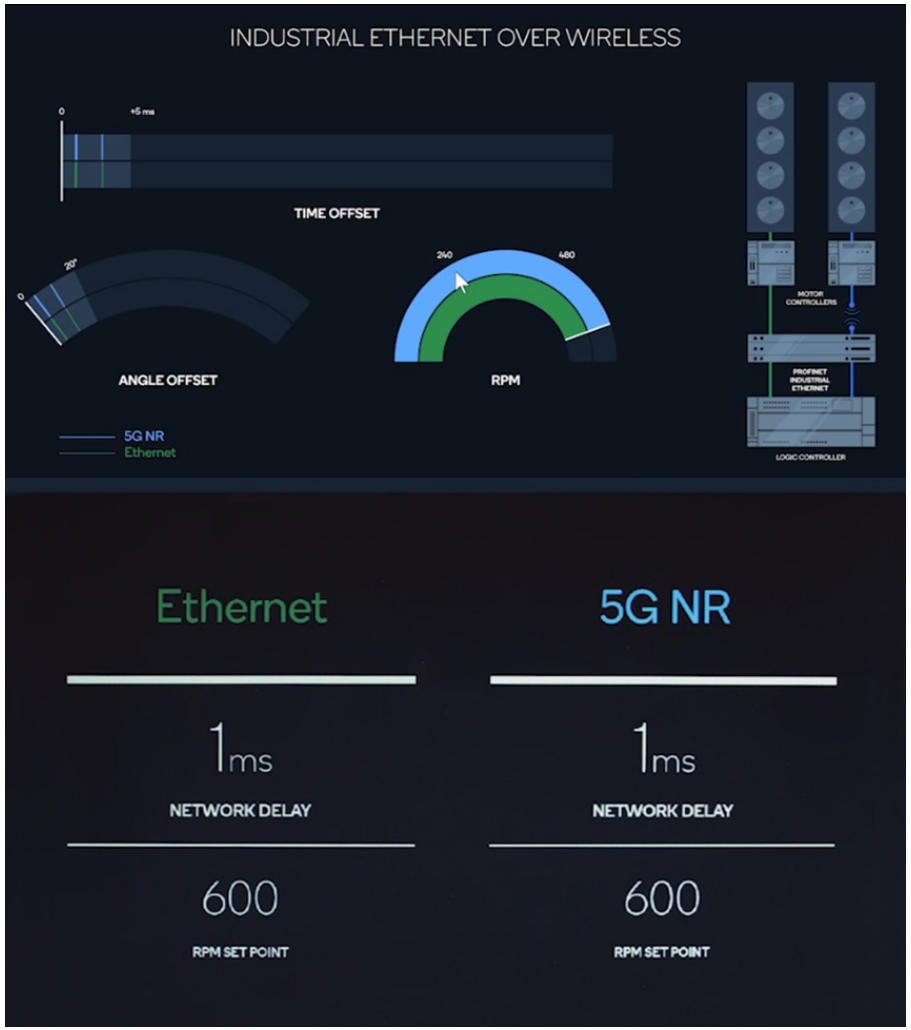
Industry-first demo of wireless PROFINET Industrial Ethernet over 5G NR

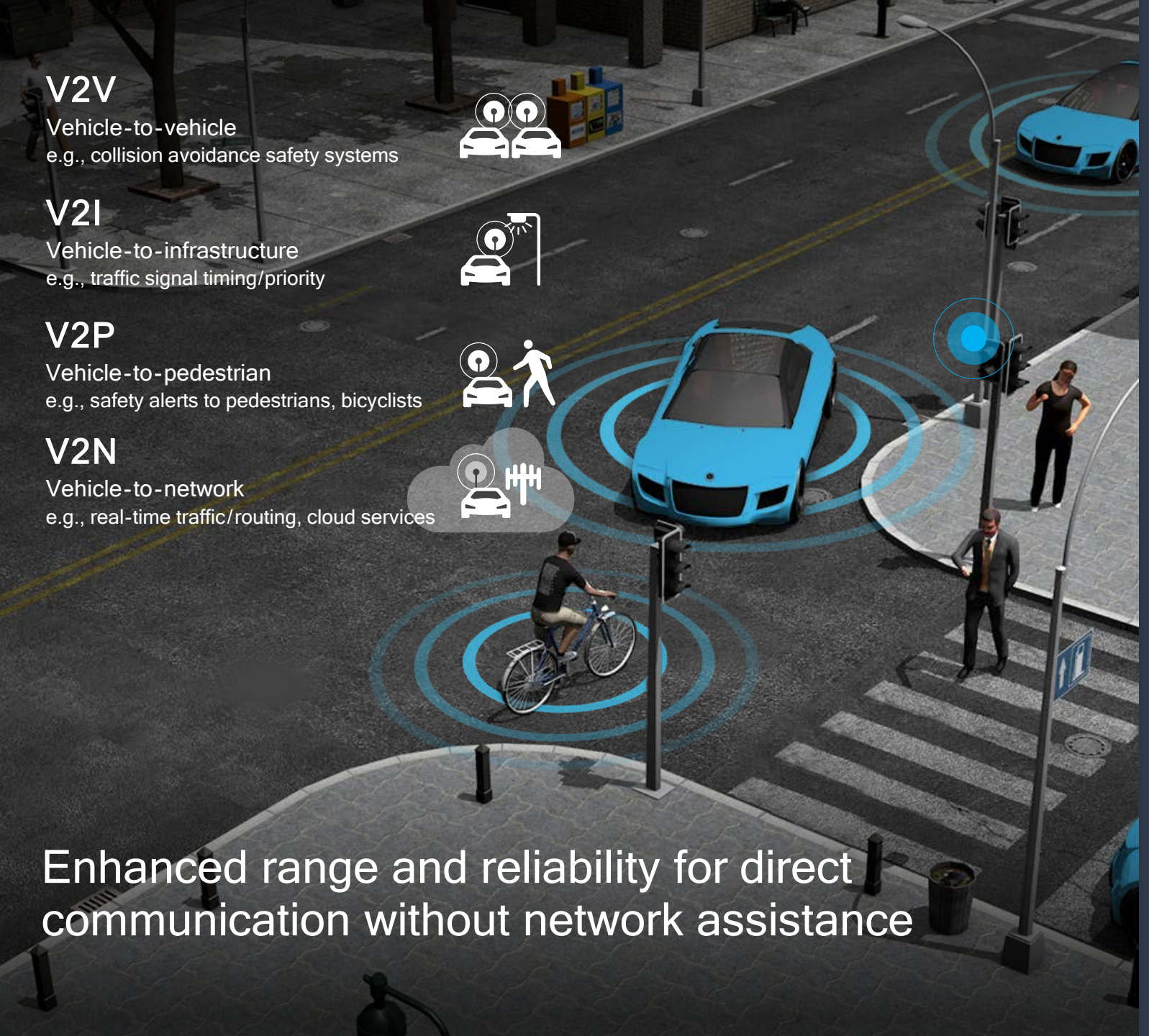
Showcases precise command-and-control of high-demand factory apps

Previews new use cases for 5G NR URLLC with sub-millisecond latencies

Highlights factory automation use case with 5G NR Private Networks

Enables wireline replacement and reconfigurable factories: a key concept of Industry 4.0





C-V2X

Establishes the foundation for safety use cases and a continued 5G NR C-V2X evolution for future autonomous vehicles

- C-V2X Release 14 completed in 2017
- Broad industry support – 5GAA
- Global trials started in 2017
- Our 1st announced C-V2X product in September, 2017

Learn more at: https://www.qualcomm.com/c-v2x

Qualcomm

5G NR

5G is the foundation to what's next. We are the foundation to 5G.

Learn more at www.qualcomm.com / 5G

Making 5G NR a commercial reality for 2019 eMBB deployments

Driving the expansion of 5G NR ecosystem and opportunity

Qualcomm

Thank you!

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