5G: Creating Value

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5G: a unifying connectivity fabric for the next decade

Supporting a wide variation of consumer and enterprise use cases

5G

Enhanced mobile broadband

- Multi-Gpbs data rates
- Uniformity
- Extreme capacity
- Deep awareness

Mobile devices

Networking

Mission-critical services

- Ultra-low latency
- High availability
- High reliability
- Strong security

Automotive

Robotics

Health

Massive Internet of Things

- Low cost
- Deep coverage
- Ultra-low energy
- High density

Wearables

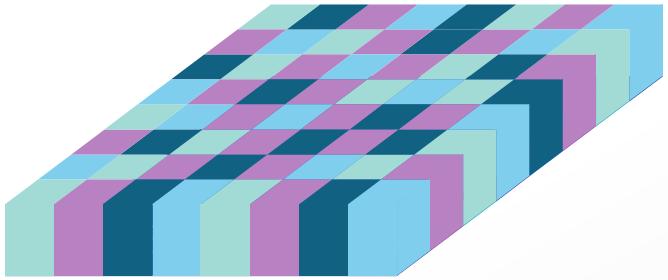
Smart cities

Smart homes

Extreme scalability + increased efficiency across all dimensions

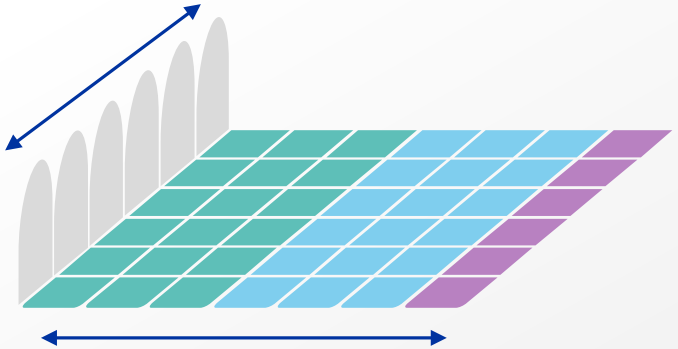
Designing a unified, more capable 5G air interface

Building on OFDM foundation



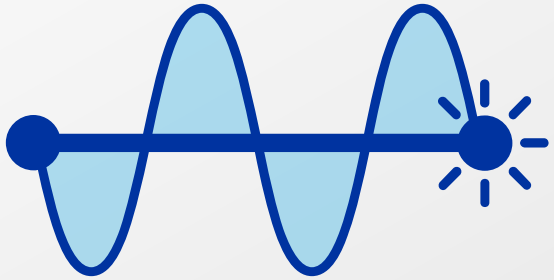
Optimized OFDM-based waveforms

OFDM adapted to extremes



A common, flexible framework

Designed for forward compatibility

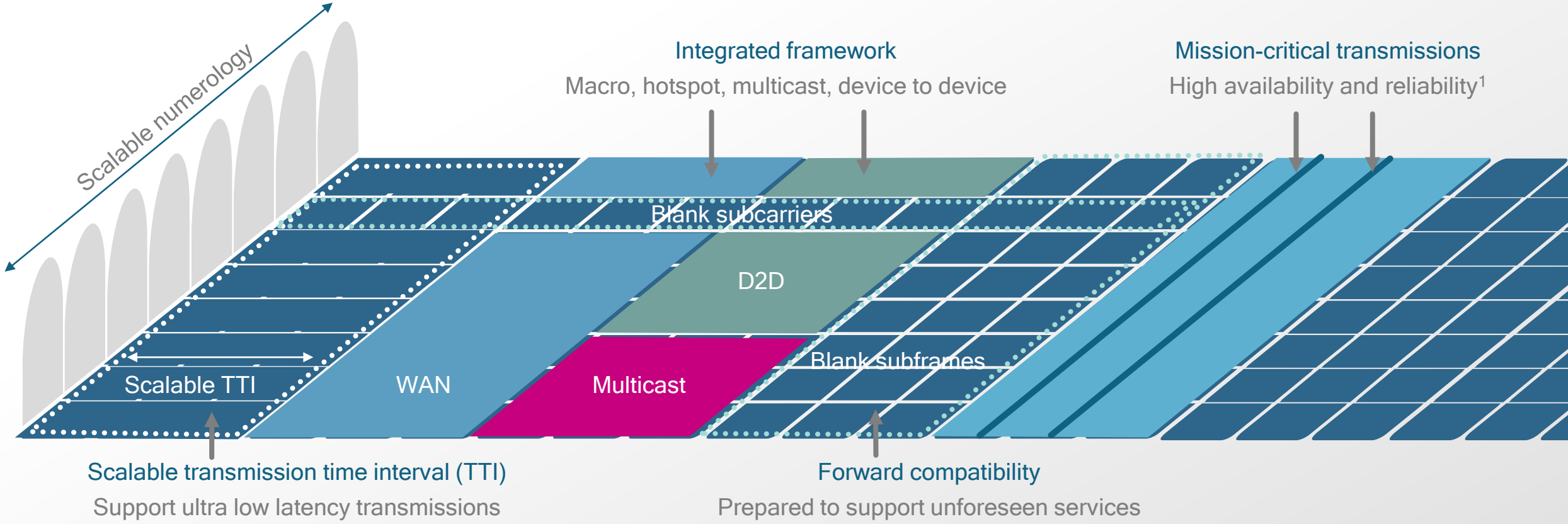


Advanced wireless technologies

Such as massive MIMO, mmWave

A flexible framework with forward compatibility

Efficiently multiplex envisioned & unforeseen 5G services on the same frequency

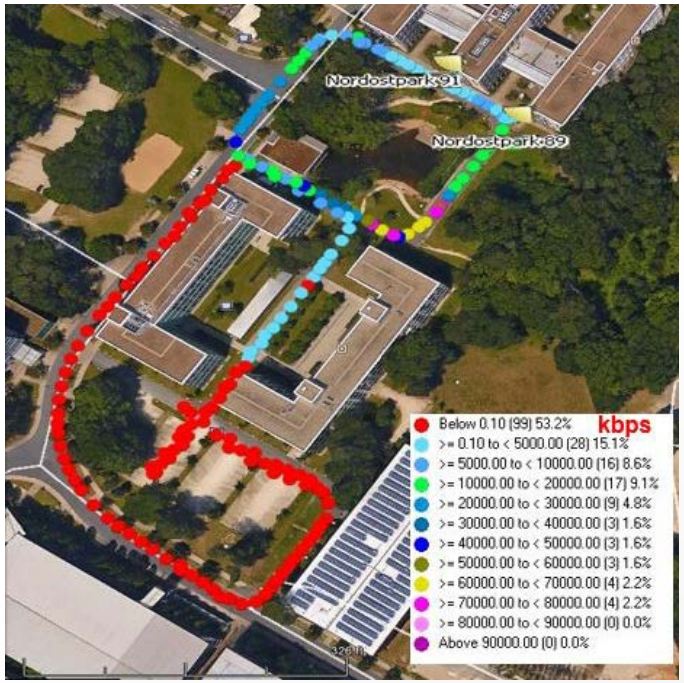


[1] Nominal 5G access to be designed such that it is capable to sustain puncturing from mission-critical transmission or bursty interference

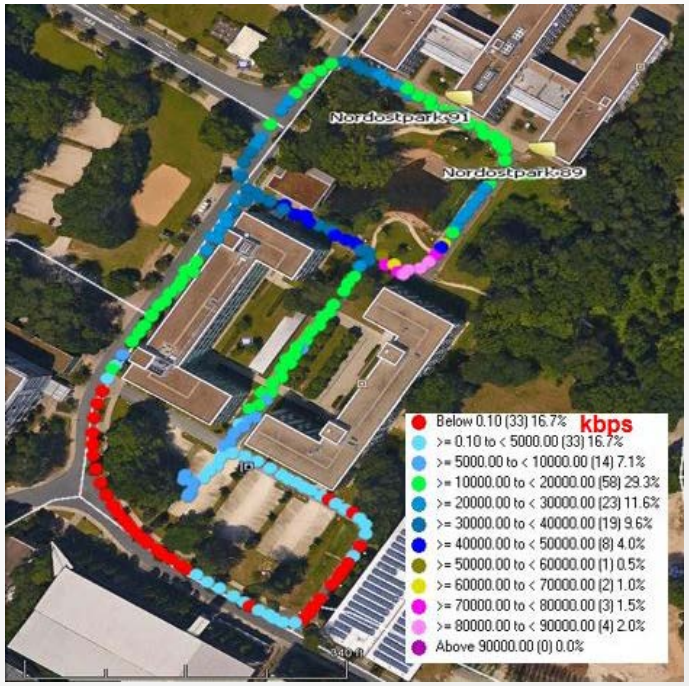
Unifying spectrum types for best performance

World's first over-the-air LAA trial aggregates licensed and unlicensed spectrum

LWA (Wi-Fi) test route[1]



LAA test route[1]



Coverage[2] in unlicensed

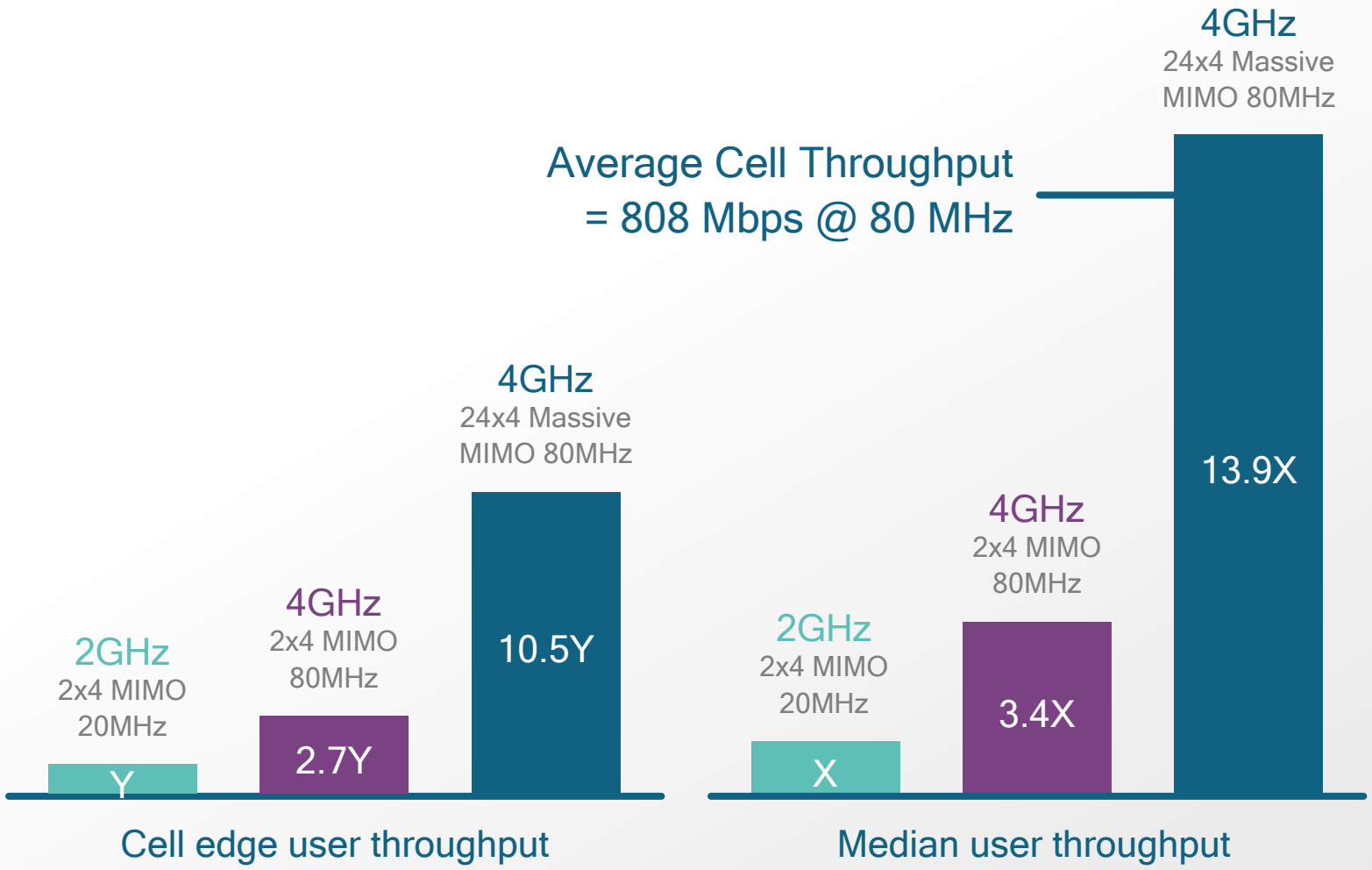
Mbps	Wi-Fi	LAA
>10	24% of route	x2.5 → 60% of route
>1	39% of route	x1.8 → 71% of route
>0	47% of route	x1.7 → 82% of route

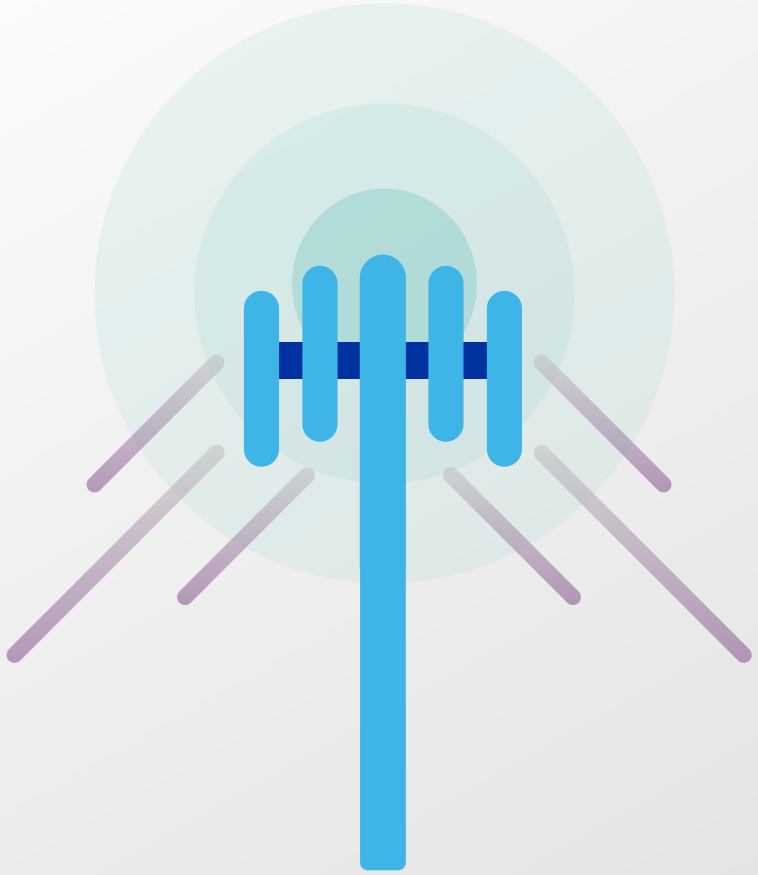
Increased Capacity | Increased Coverage | Demonstrated fair co-existence with Wi-Fi

1 Single small cell, LAA based on 3GPP release 13; LWA using 802.11ac; LTE on 10 MHz channel in 2600 MHz licensed spectrum with 4W transmit power; the following conditions are identical for LAA and Wi-Fi: 2x2 downlink MIMO, same 20 MHz channel in 5 GHz unlicensed spectrum with 1W transmit power. terminal transmit power 0.2W, mobility speed 6-8 mph; 2 Based on geo-binned measurements over test route

Leveraging higher spectrum bands for faster data rates

Massive MIMO allows reuse of existing cell sites at same transmit power





Macro site

1.7km inter-site distance

46 dBm transmit power

Source: Qualcomm Technologies, Inc. simulations; Macro-cell with 1.7km inter-site distance, 10 users per cell, 46 dBm Tx power at base station, 20MHz@2GHz and 80MHz@4GHz BW TDD, 2.4x Massive MIMO

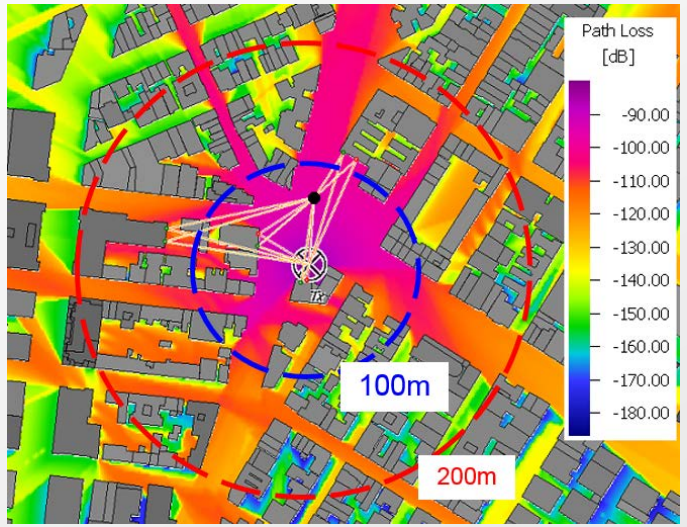
Deliver extreme mobile broadband with mmWave

Making mmWave a reality for mobile

60 GHz chipset commercial today for mobile devices

Qualcomm® VIVE™ 802.11ad technology with a 32-antenna array element

Developing robust 5G mmWave for enhanced mobile broadband



Manhattan 3D Map

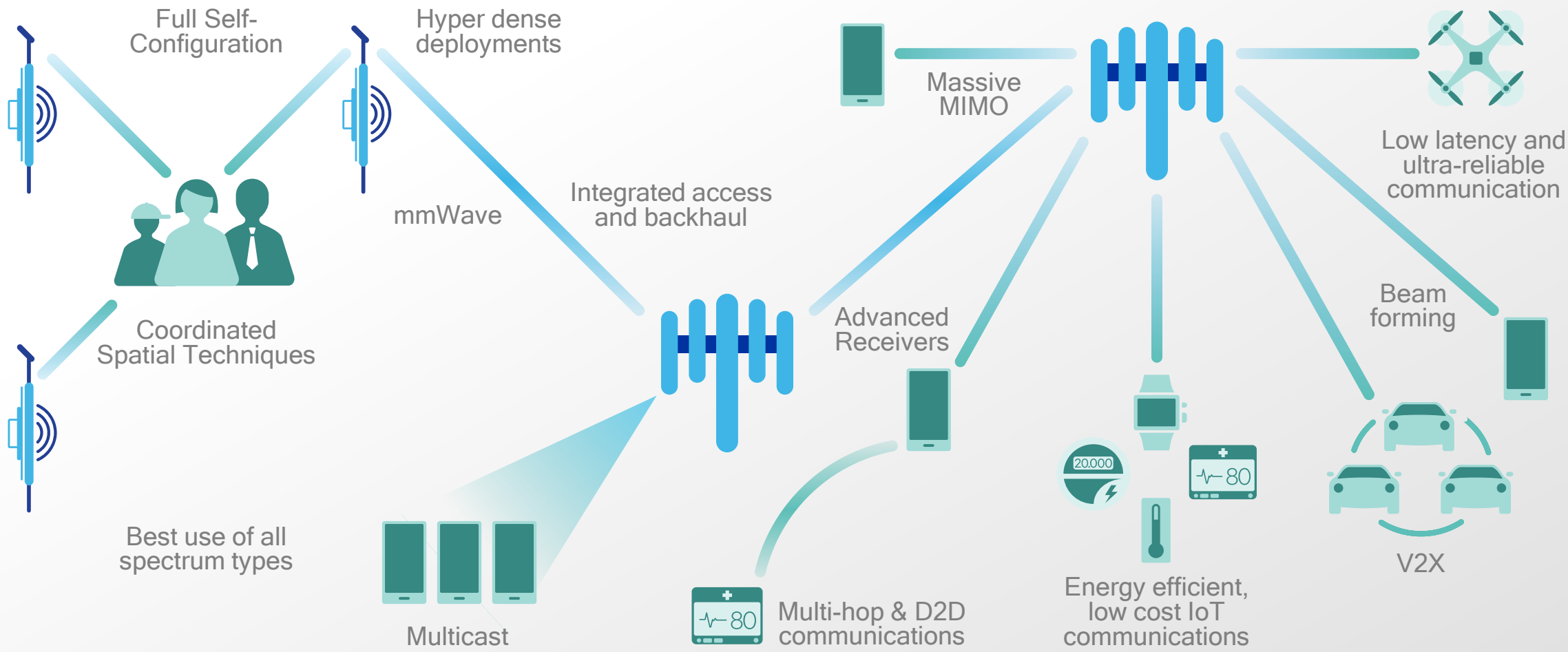
* Results from ray-tracing[1]

28 GHz outdoor example with ~150m dense urban LOS and NLOS coverage using directional beamforming[1]

Qualcomm VIVE is a product of Qualcomm Atheros, Inc.;
1 Based on Qualcomm Simulations

Natively incorporate advanced wireless technologies

Many technology enablers to meet 5G requirements and services



Pioneering 5G technologies today with LTE

We are driving 4G and 5G in parallel to their fullest potential

Advanced MIMO

Unlicensed spectrum

256QAM

Enhanced CA

FeICIC

Internet of Things

Carrier aggregation

FDD-TDD CA

Massive/FD-MIMO

CoMP

Device-to-device

Shared Broadcast

SON+

Dual connectivity

V2X

Low latency

5G

Rel-15 and beyond

Further backwards-compatible 4G enhancements

Rel-10/11/12

LTE Advanced

Rel-13 and beyond

LTE Advanced Pro

2015

2020+

Note: Estimated commercial dates. Not all features commercialized at the same time

Thank you

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