

2019 is the year of 5G

Deployments happening in regions across the globe



LG V50
ThinQ 5G



Motorola moto z³
+ 5G moto mod



Nubia Mini 5G



Samsung
Galaxy S10 5G



Samsung
Galaxy Fold



Xiaomi
Mi MIX 5G



ZTE Axon 10
Pro 5G



HTC 5G Hub



Inseego MiFi
5G NR



Netgear
Nighthawk 5G



WNC 5G NR
mobile hotspot



Askey 5G
CPE



WNC 5G NR
outdoor CPE



Quectel 5G
modules



Telit 5G
modules



Sierra Wireless
5G M.2 module

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



5G is Here

75+ design wins and growing ...

Commercializing mmWave

in a smartphone form factor



mmWave (60 GHz) viability in handset form factor
11ad in Asus Zenfone 4 Pro



Qualcomm® 5G NR mmWave prototype



Qualcomm® 5G NR mobile test device



5G NR mmWave Qualcomm® Reference Design



Qualcomm® Snapdragon™

X50

5G Modem family

World's first announced
5G NR multimode modems



5G NR standards compliant



Sub-6 + mmWave



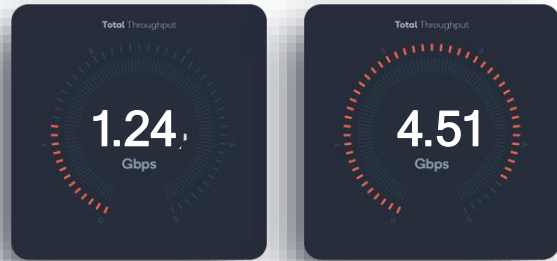
Premium-tier
smartphones in 2019



Multi-Gigabit over mmWave on working Qualcomm® Snapdragon™ X50 modem silicon

5G NR Interoperability and field trials using form factor mobile test device

Providing Qualcomm® Reference Design to accelerate commercial devices



First 5G NR mmWave over-the-air data call, with Ericsson

First 5G NR Sub 6 GHz over-the-air data call, with Ericsson



Qualcomm
snapdragon
X50 5G modem



More than 30 commercial 5G mobile devices scheduled to launch in 2019

October 2017

February 2018

2H 2018

September 2018

October 2018

1H 2019

Qualcomm
snapdragon
X50 5G modem family



World's first announced 5G NR modems



5G NR standards compliant

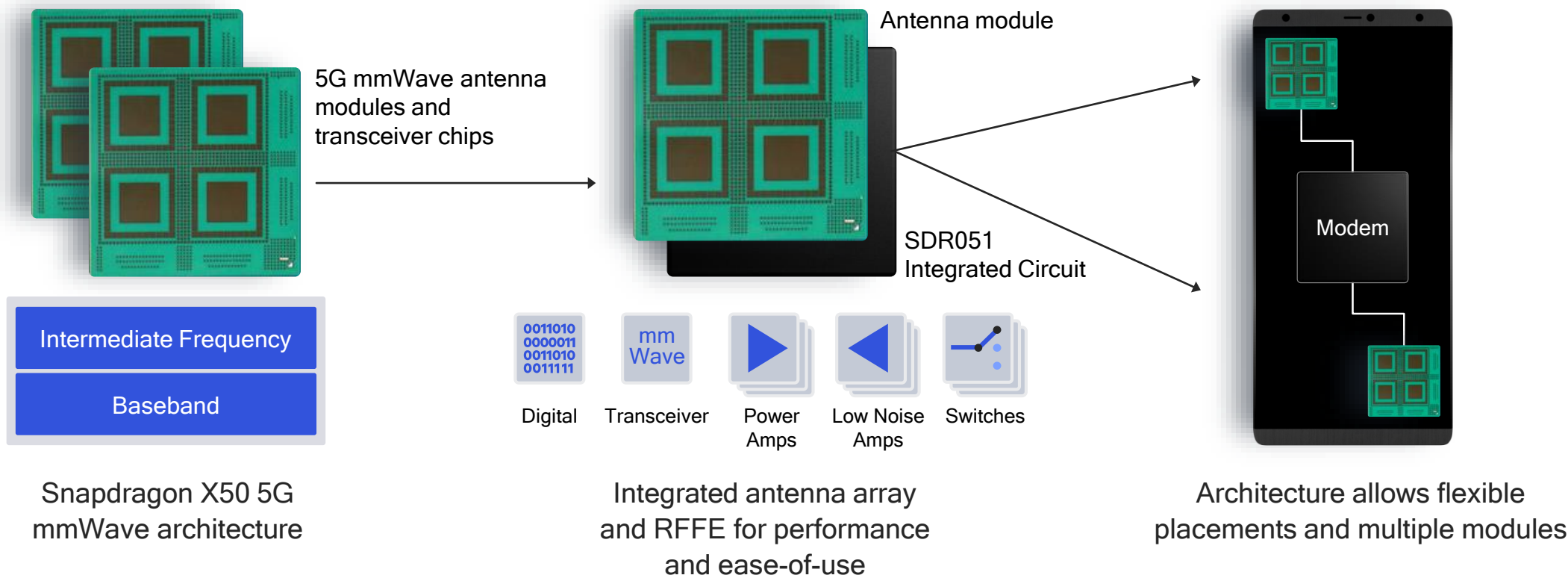


Sub-6 + mmWave



Premium-tier smartphones in 2019

Qualcomm® Snapdragon™ X50 modem mmWave solution



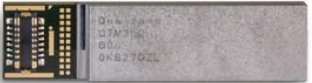
Qualcomm® QTM052 5G mmWave antenna module



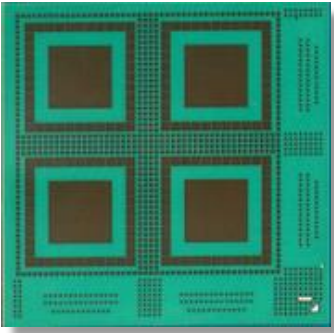
Rapid miniaturization of mmWave modules

July 2018

October 2018



2017

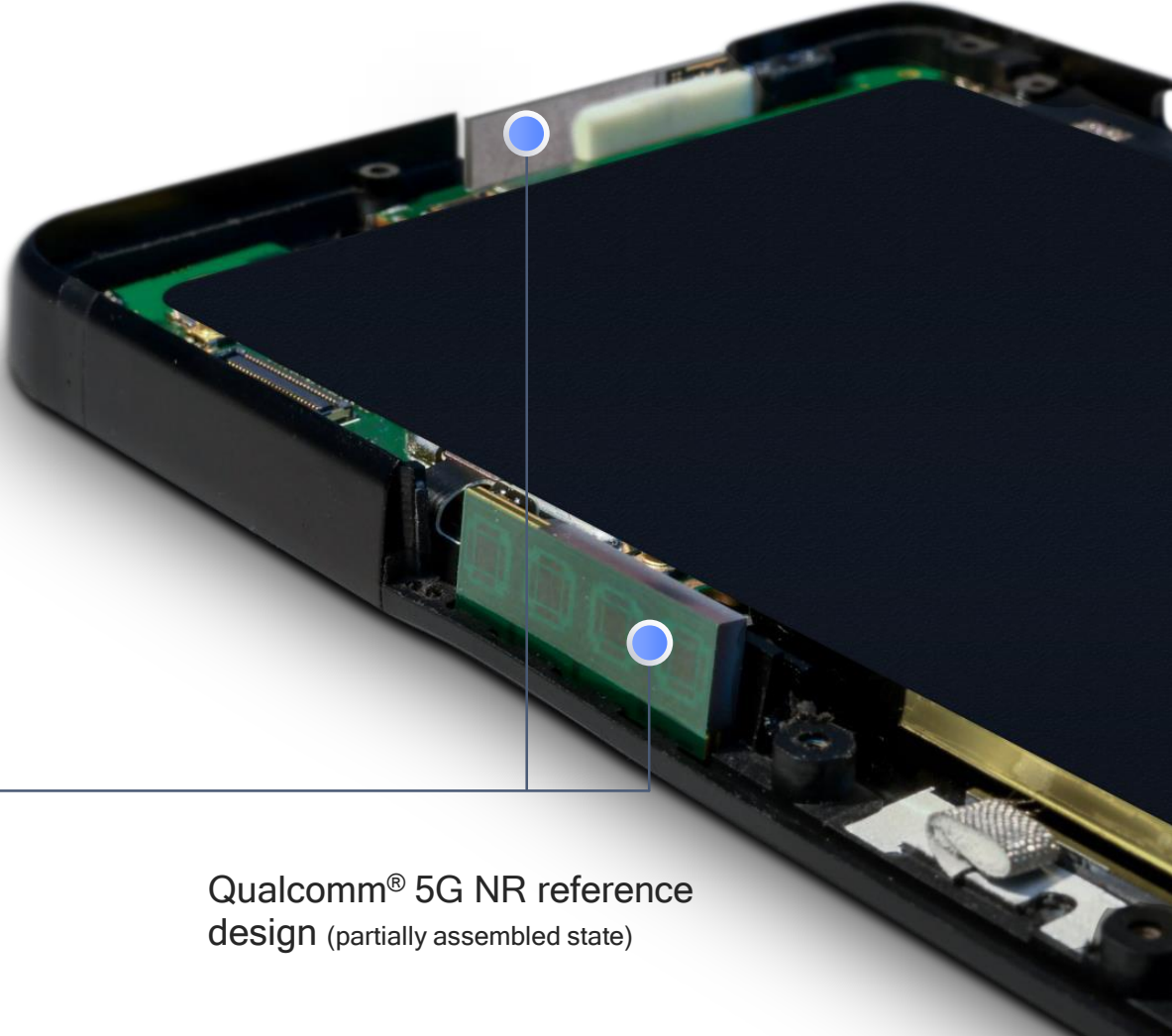


July 2018



25% smaller

October 2018



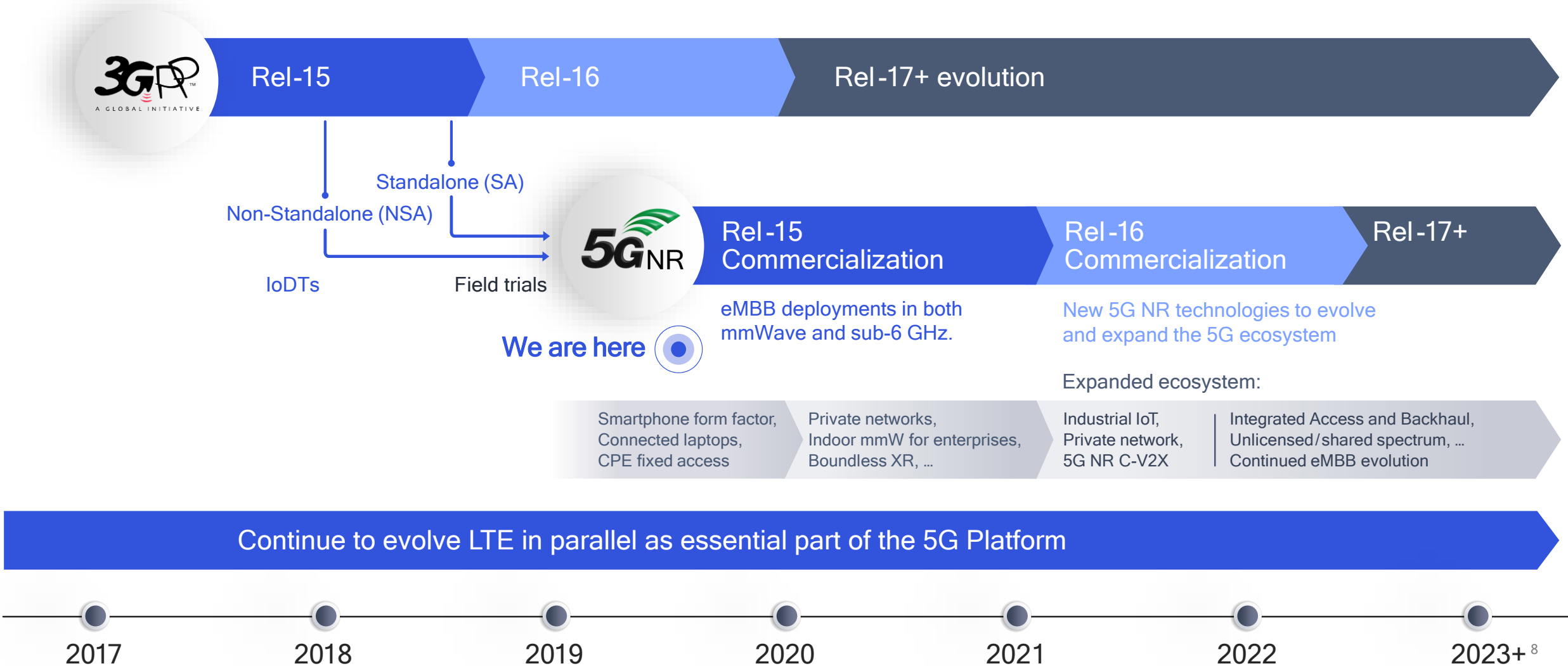
Qualcomm® 5G NR reference design (partially assembled state)

Qualcomm QTM052 is a product of Qualcomm Technologies, Inc. and/or its subsidiaries.
Qualcomm 5G NR Reference Design is a program of Qualcomm Technologies, Inc. and/or its subsidiaries.

The inevitable evolution of mmWave!

mmWave is different from 4G in its small cell nature → Dense deployment of nodes

Cost, energy consumption, technology challenges → Tremendous opportunity for a “capability” continuum



Evolution of mmWave: Opportunities for focus

Before 5G and After 5G: RF capabilities and antennas → System level design abstractions and constraints → System design intended for the appropriate channel structure

- Relative to 4G, making the RF and antennas work as desired with practical constraints (cost, power, process node variations, etc.) is hard!
- 5G mmWave PHY design is simpler!!
- Network/deployment planning/optimization is incredibly harder!!! →

Role of academia/engineering research in mmWave could be in making “non-sexy,” yet practically relevant problems worth pursuing!

General advise to a beginning graduate student in wireless:

- MIMO principles are easy to describe in a party chatter, but mathematically understanding how MIMO precisely works is a lot of hard work!
- Systems do not exist in vacuum, so learn some (a lot of!) physics!
- mmWave is not just theory, almost all of it is measurements-driven!
- **Is the PHY Layer Dead?**

Mischa Dohler, CTTC

Robert W. Heath Jr., The University of Texas at Austin

Angel Lozano, UPF

Constantinos B. Papadias, AIT

Reinaldo A. Valenzuela, Bell Labs

Number of RF bands and band combinations

By technology generation

