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Our future is mobile

Accelerating innovation after Moore's law

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Leading mobile innovation for over 30 years

Digitized mobile communications



Analog to digital

Redefining computing



Desktop to smartphones

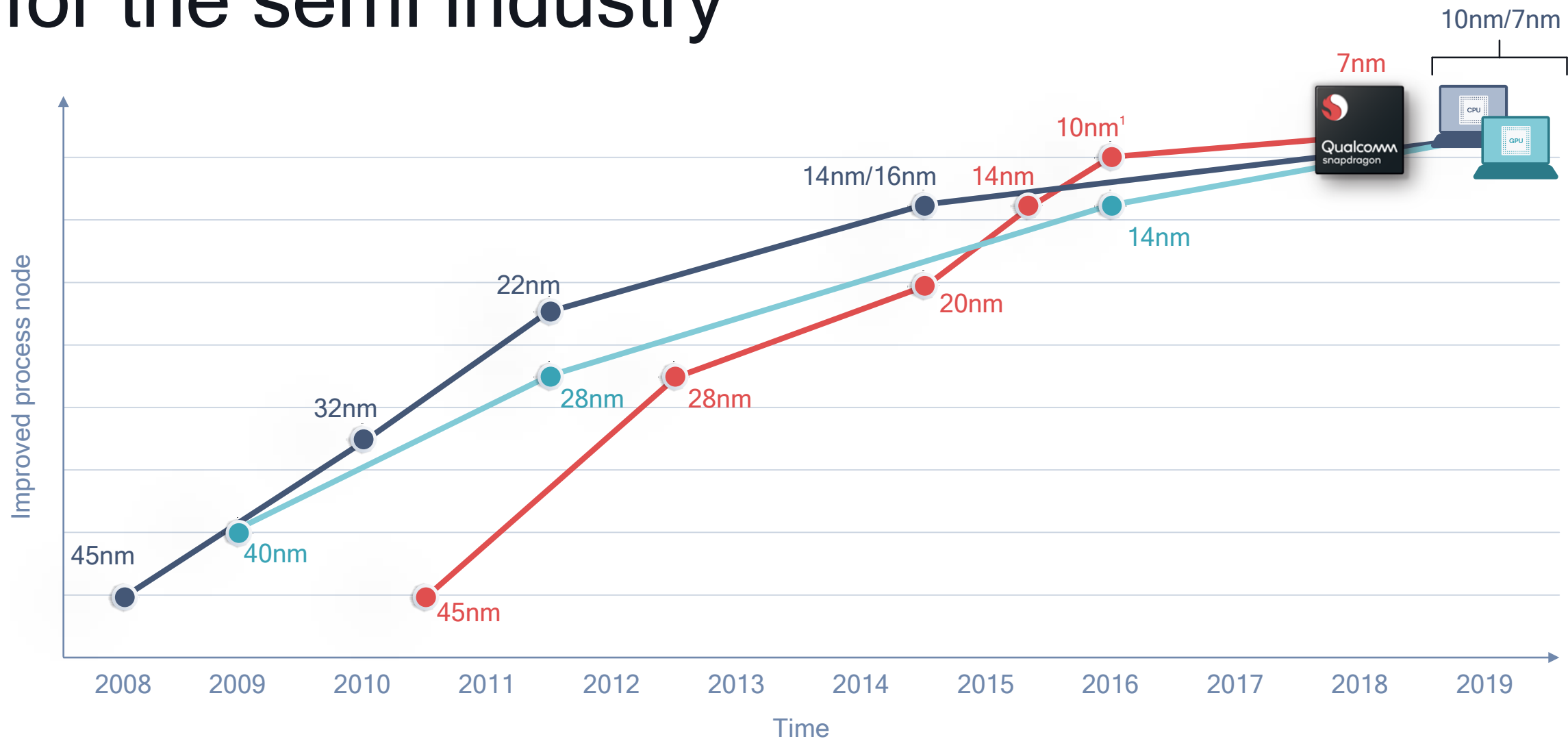
Transforming industries



Connecting virtually everything

Transforming how the world connects, computes and communicates

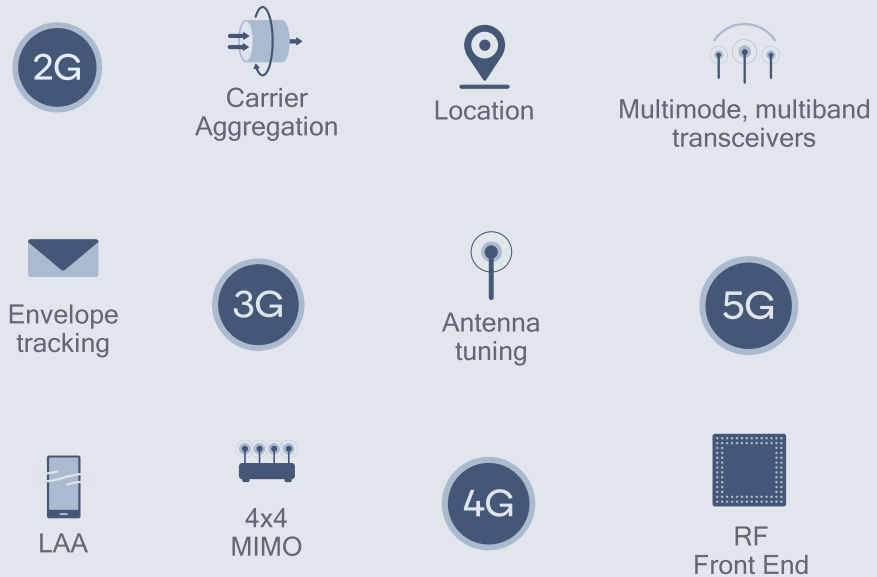
Mobile sets the direction for the semi industry



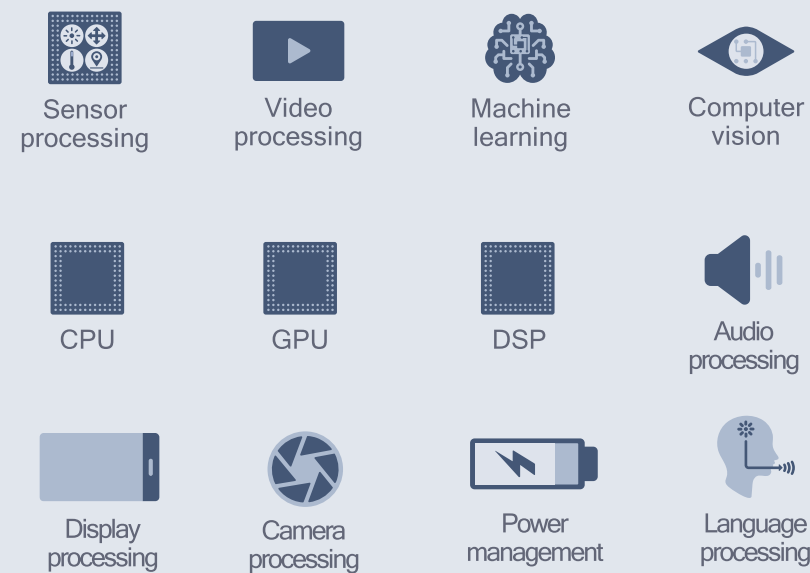
¹ First announced in 2016 and first commercial device launched 2017.

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

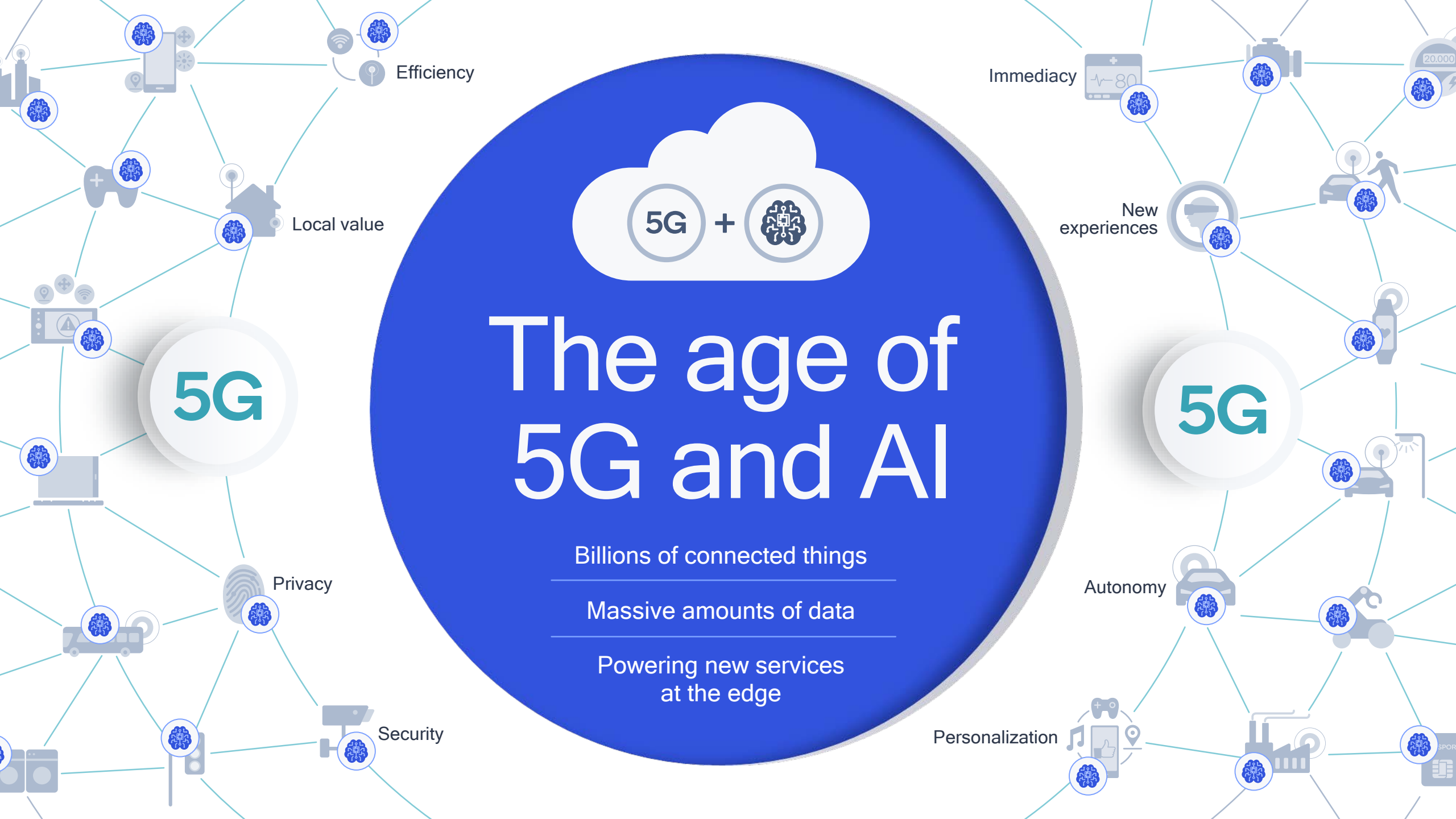
Connectivity



Processing



The future will be powered by intelligent, connected devices
System design leadership across advanced connectivity, processing, and more



5G + AI

The age of 5G and AI

Billions of connected things

Massive amounts of data

Powering new services at the edge

5G

5G

Efficiency

Local value

Privacy

Security

Immediacy

New experiences

Autonomy

Personalization

SPORTS



Driving transformation across industries

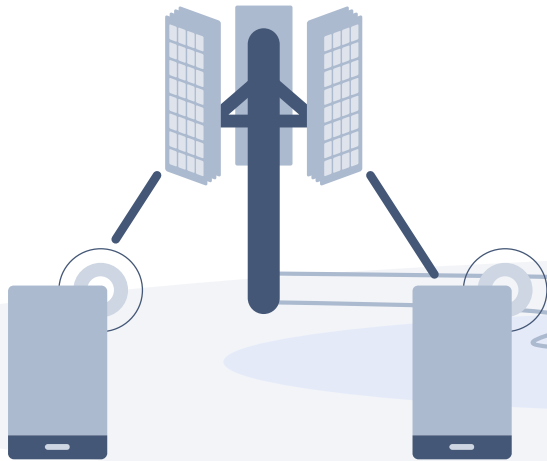
5G and distributed AI will provide a platform for future innovation

5G is the era of directional communications

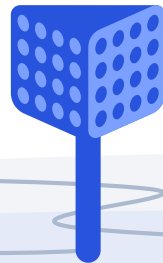
Overcoming numerous challenges with Massive MIMO and mmWave mobility

Sub-6Ghz

Massive MIMO 3D beamforming with up to 256 antenna elements

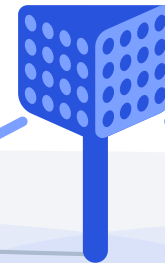


Directional antennas with adaptable 3D beamforming and beam tracking



mmWave

Seamless mobility with fast beam steering and switching



NLOS operation



Significant coverage with co-siting

Robust mobility in LOS and NLOS

Mobile size and power constraints

Extensive
simulations
show real-world

5G
performance

Reveal immense 5G user
experience gains over 4G

Source: Company data and internal analysis
Frankfurt: 3.5 GHz 5G NR + Gigabit LTE multimode vs. Gigabit LTE
San Francisco: 28 GHz 5G NR + Gigabit LTE multimode vs. Gigabit LTE



Frankfurt: 5G NR multimode
3.5GHz (sub-6 GHz)

5x

increase in capacity

>490 Mbps
median browsing speed

~7x

faster responsiveness



San Francisco: 5G NR multimode
28GHz mmWave

5x

increase in capacity

1.4 Gbps
median browsing speed

~23x

faster responsiveness

Mobile is becoming the most pervasive AI platform

More than 1 billion AI devices with Qualcomm technologies

10%

AI attach rate



2018

100%

AI attach rate



2025



Mobile



Automotive



XR



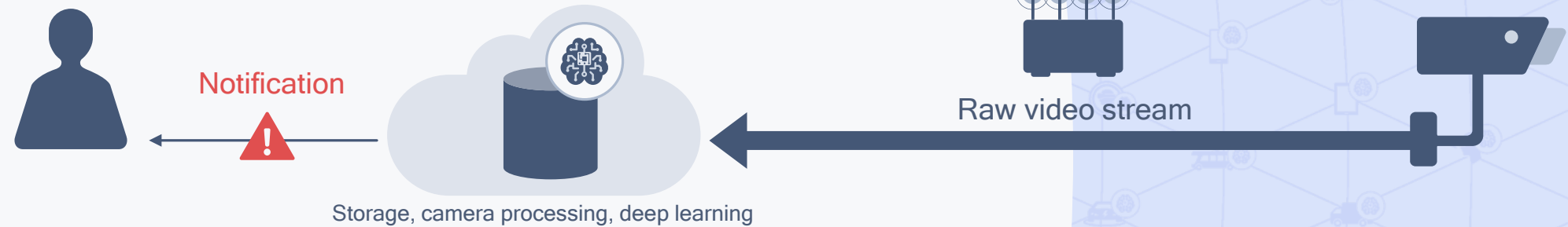
Mobile PCs



Smart speakers

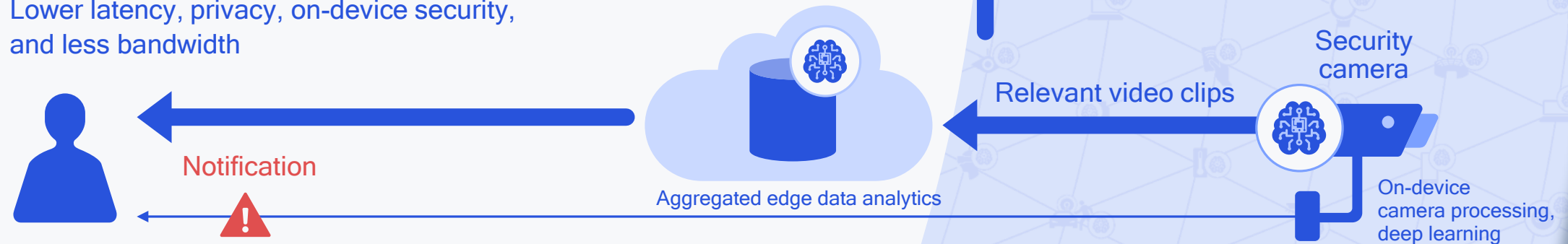
Not all data should go to the central cloud

Cloud-based processing



Wireless edge processing

Lower latency, privacy, on-device security, and less bandwidth



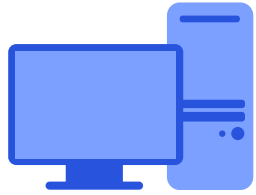
The challenge of AI workloads



On-device AI presents new challenges

Power and thermal efficiency are critical to the promise of AI

Semiconductor industry has evolved



1980s

Compute

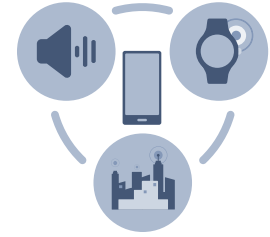
High-performance logic
100s of thousands of units
IDM
Pitch scaling



2000s

Mobile

Low-power logic
100s of millions of units
Fabless
Disruptive CMOS scaling



2020s

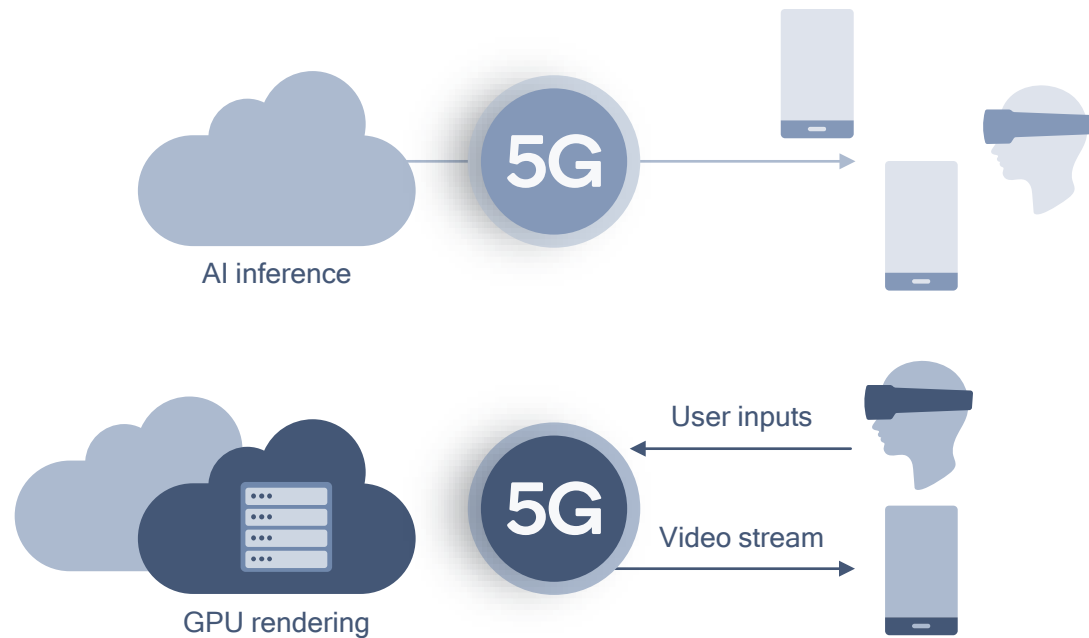
5G-IoT

CMOS, RF, AI:CIM
Billions of units
IP-less
System level integration

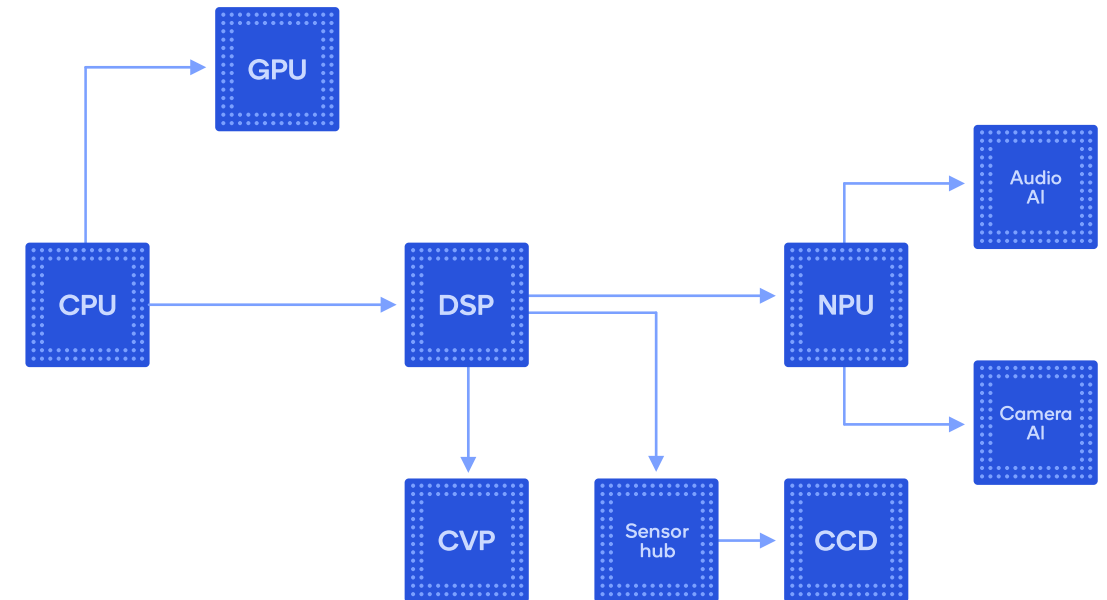
Industry-wide coordinated R&D is a key differentiator of the mobile industry

Computing is becoming more distributed and specialized

Key processing trends are aligned with movement towards 5G and AI



Shift in compute processing across cloud to client



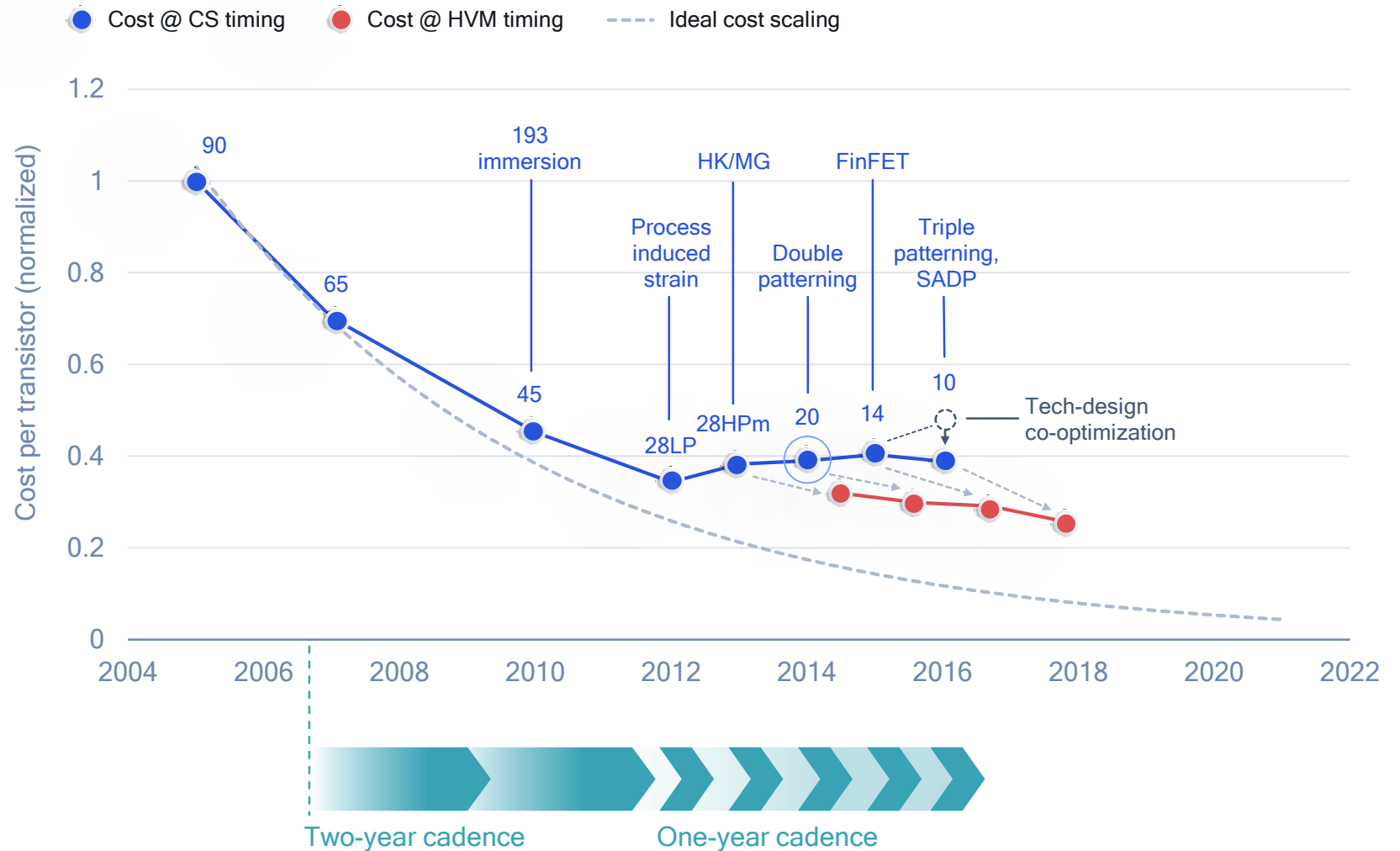
Ongoing shift from generic to **purpose-built** processing

System-level expertise needed to navigate architectural, software changes

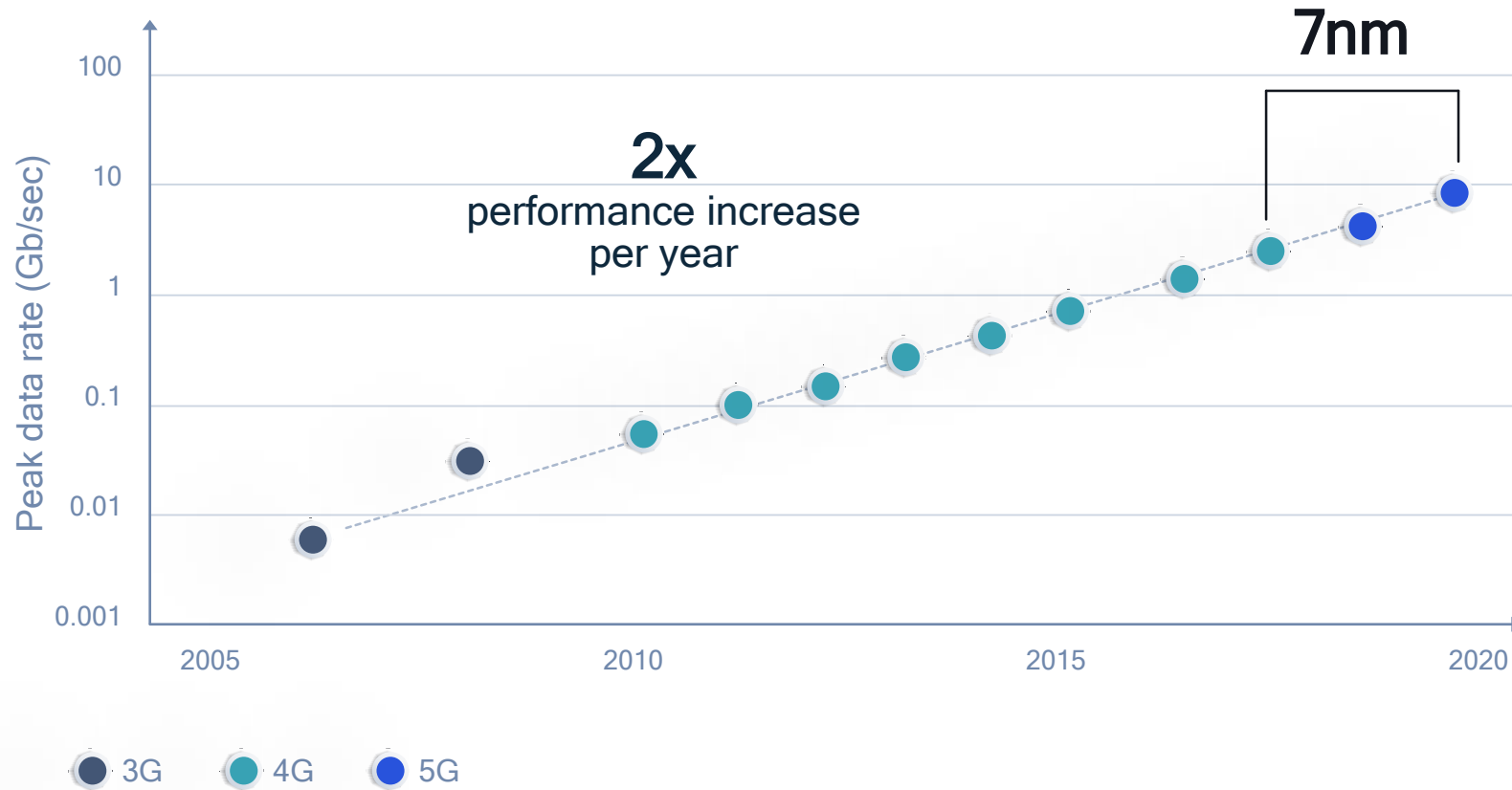
Challenges to Moore's Law presents a barrier

Historical benefits are challenged, slowing transitions as cadence increases

Cost per transistor trend



Mobile has pioneered strategies to overcome constraints



4G improvements*

20X

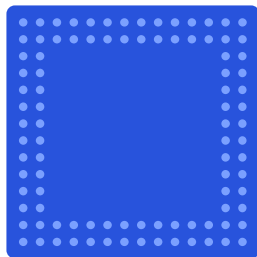
Performance increase

60%

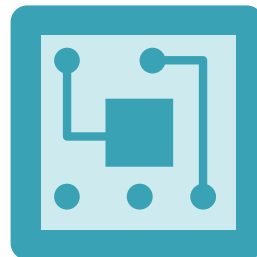
Battery life increase

Source: Qualcomm Technologies, Inc. internal analysis

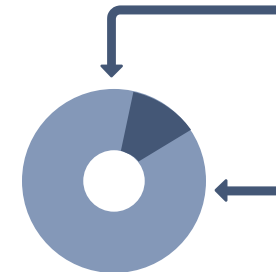
* Over last seven years



SoC repartition and
high-density packaging



Memory
customization



System optimization
and simplification

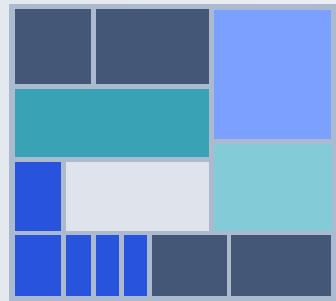
System design innovation for the next phase in the semi industry

Next-generation SoC design in the 5G era

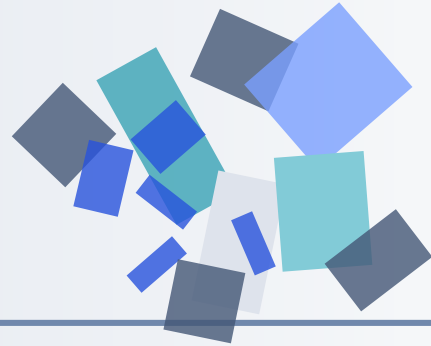
Integrates with all package technologies

Silicon interconnect

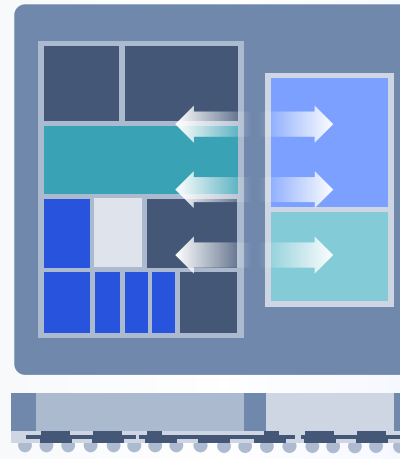
SoC - System on Chip



Die partitioning



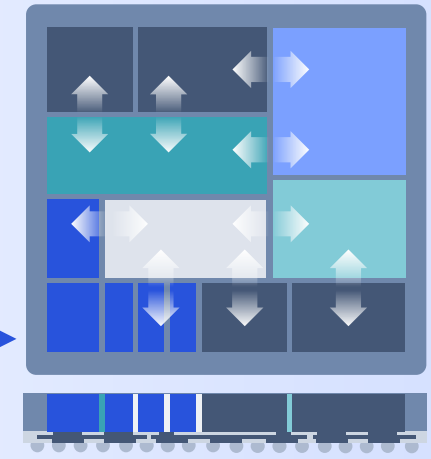
2019-2021



$\geq 7\text{nm}$

Package RDL interconnect

2022+



$\leq 5-7\text{nm}$

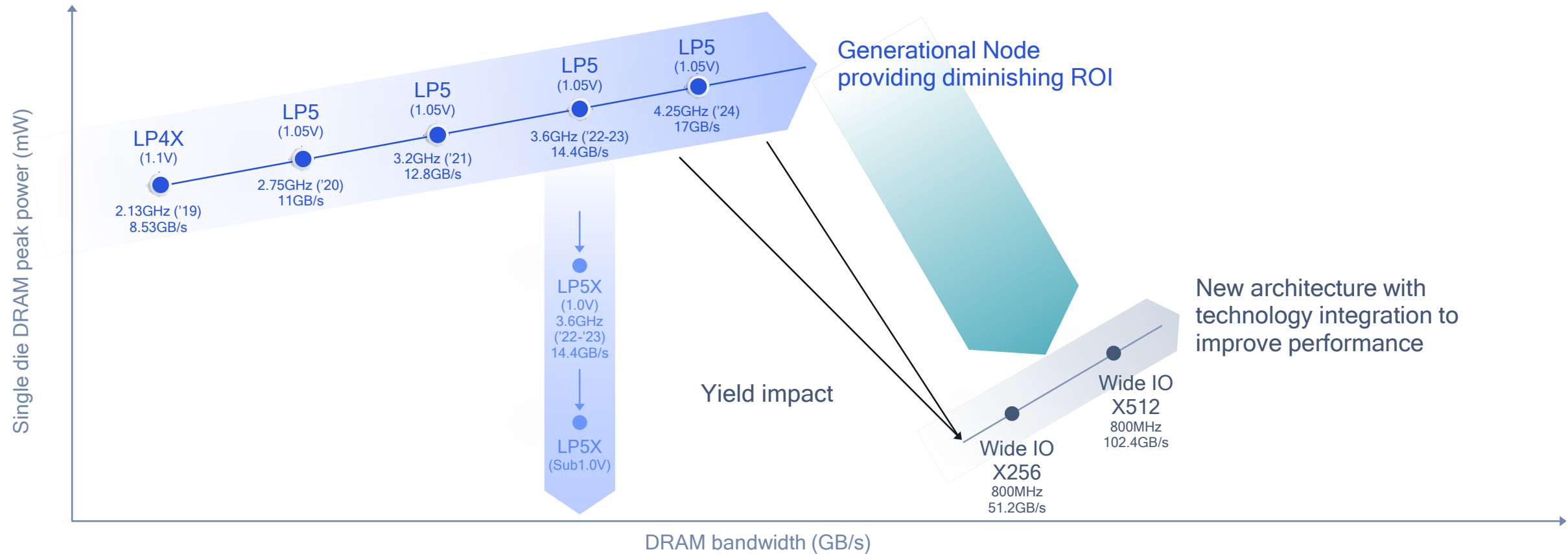
Sub-block IP partitioning

New architectures

New methodologies

New tools

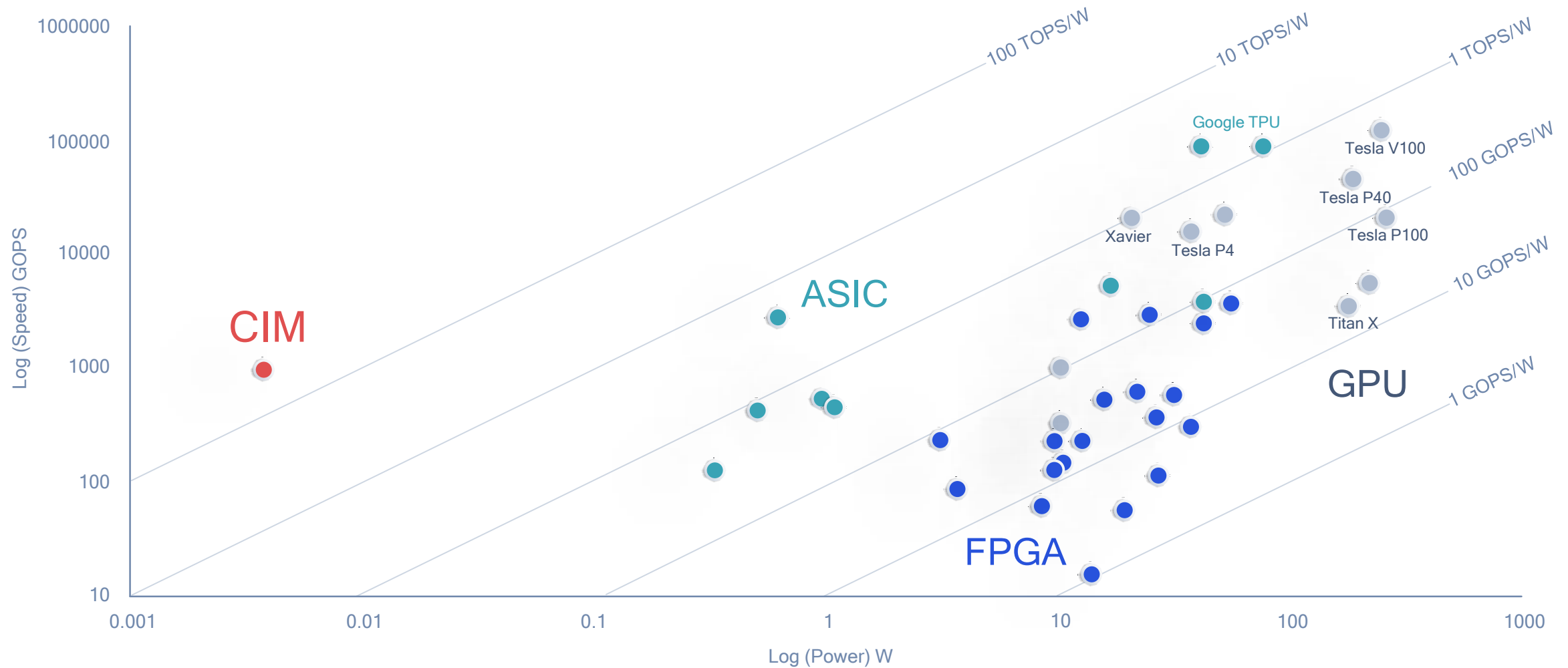
Process node progression over time



Source: Qualcomm Technologies, Inc. internal analysis

Moore's Law also impacting memory

Process innovation to support LP5 and new wide memory options to address unique bandwidth and power challenges



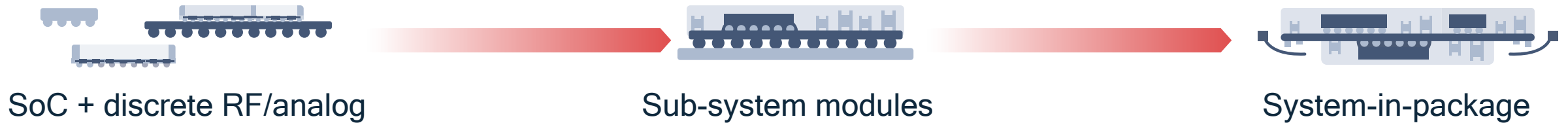
Source: IMEC benchmark

Addressing AI growth with compute in memory (CIM)

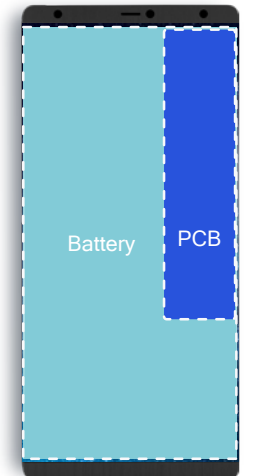
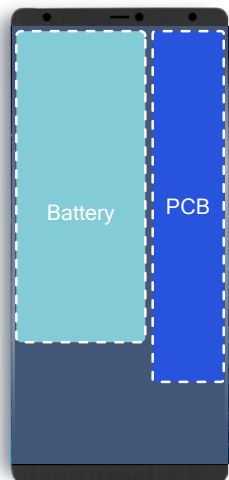
Higher TOPS per watt with CIM

Mobile system is evolving to become a package

Evolution of mobile design architectures

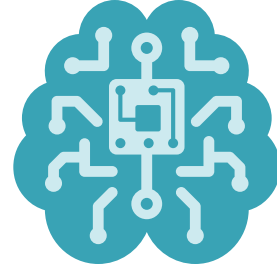


Evolution of mobile form factors

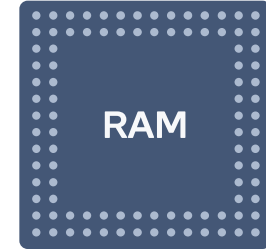




5G technology

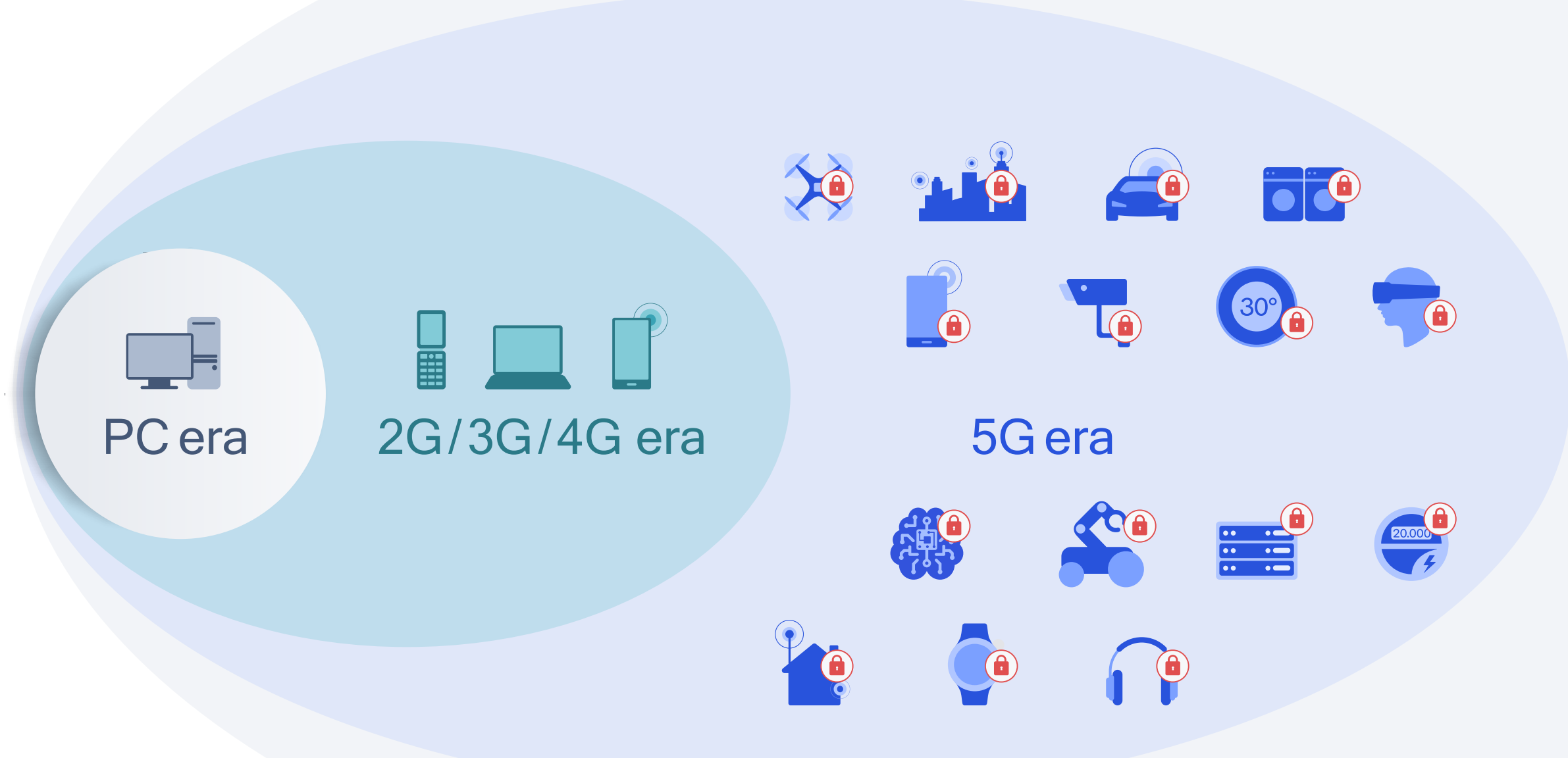


Artificial intelligence



Memory

Achieving this future requires the leading node



Security is paramount across network and endpoints

Surface area for security threats will grow exponentially with 5G

Agenda for US semiconductor industry leadership



Public/private collaboration



Continued industry R&D



Global ecosystem collaboration



Support for IP



21st century skills



Thank you

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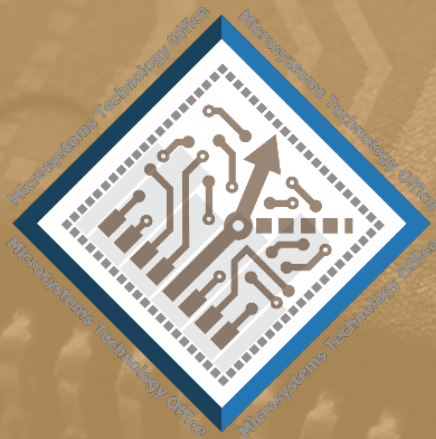
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