

June 2020

@DevSingh_QCOM

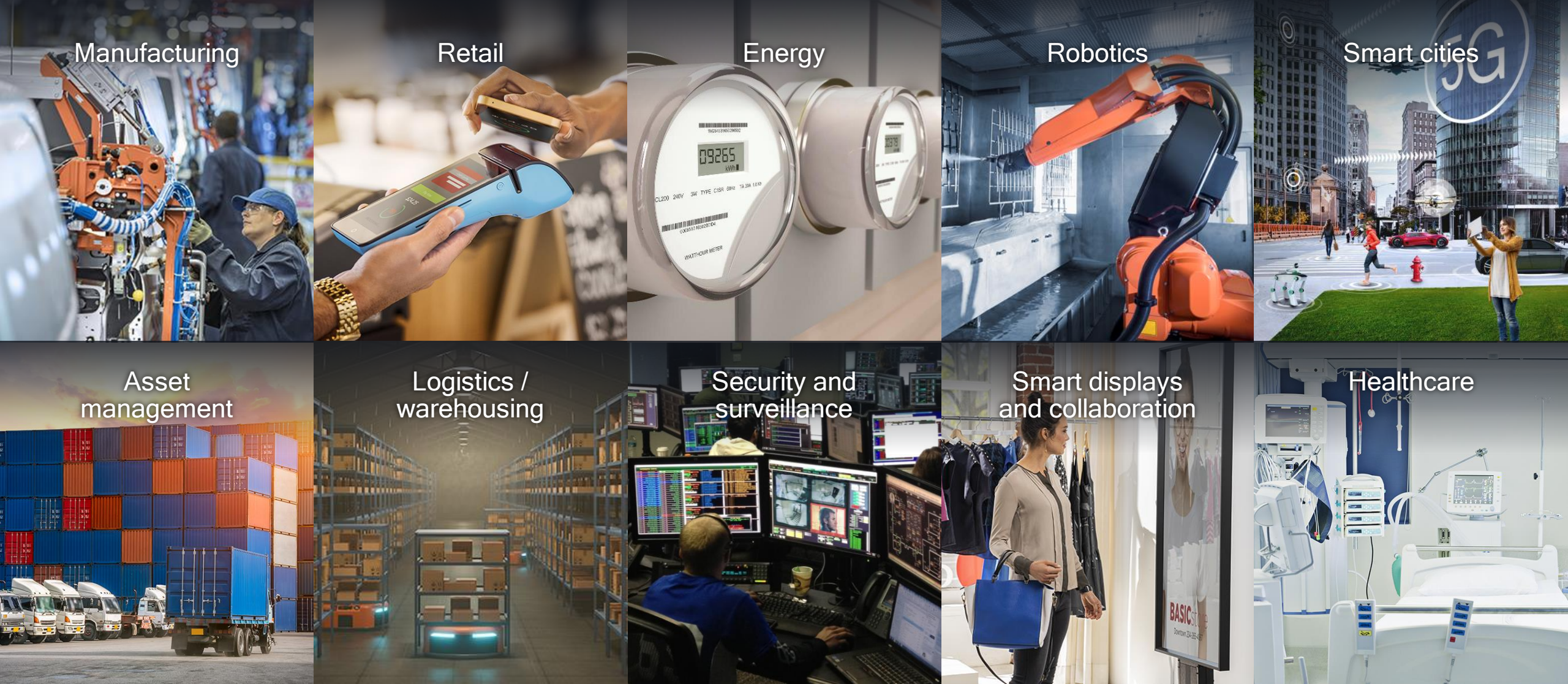
Qualcomm

Scaling 5G and AI for the Next Generation of Robotics

Dev Singh, Senior Director

Head of Robotics, Drones and Intelligent Machines
Qualcomm Technologies, Inc.





Manufacturing

Retail

Energy

Robotics

Smart cities

Asset management

Logistics / warehousing

Security and surveillance

Smart displays and collaboration

Healthcare

Driving digital transformation of business and enterprise
11,000+ customers across multiple segments

Entertainment



First responder and public safety



Warehouse/logistic



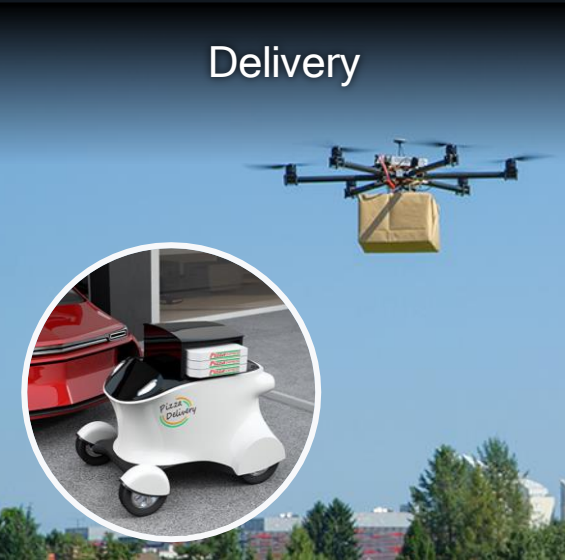
Factory



Retail



Delivery



Home care



Companion



Agriculture



Qualcomm Technologies are addressing diverse robotic challenges

Industrial



Logistics



Manufacturing



Construction



Agriculture



Forklifts



Drones

Commercial



Commercial floor cleaning



Hospital



Security



Package delivery



Retail



Commercial mowers



Drones

Consumer



Consumer floor care



Lawn care



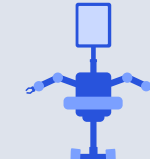
Pool cleaning



Toy



Technical education



Personal assistants



Drones

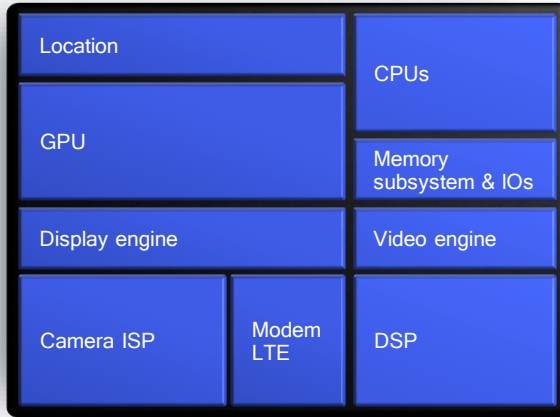
Robotic opportunities we are focused on

Alibaba Attabotics AWS Robomaker Brain Corp Cerevo Clearpath CloudMinds
Ecovacs FLIR Gotting Hitachi Intuition Robotics iRobot JD.com
JPL Kinova Robotics LG Misty Robotics NASA Naver Nilfisk Nuro

Numerous robotics products launched

NXT Nuwa Robotics Orion Panasonic Parrot Phoenix Contact
Preferred Networks Rexroth Robotis Roborock Samsung Sharp Siasun Siemens
Skydio Softbank Robotics Sony UBTech Weidmüller Yasikawa ZeroZero

Comprehensive Qualcomm Technologies for Robotics



High performance / integrated SOC
Optimized heterogeneous computing platform, at low power and small form-factors



AI / Machine learning

Detection, classification, navigation and engagement



Security

Authentication and execution



On-board intelligence

Hard real-time control for autonomous navigation
High-fidelity sensor processing
Precise localization



Camera

Computer vision



Connectivity

Wi-Fi, LTE/5G, CBRS



HLOS

Linux, ROS



Robotics industry

60M robots (& drones) deployed in 2020 - **doubled** by 2025¹

Robotics technology industry size to reach **\$170 billion** by 2027³



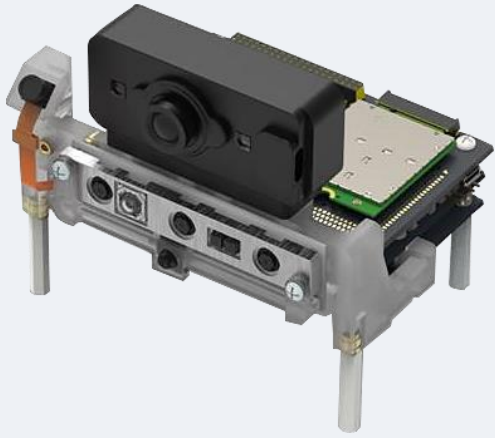
17M home cleaning robots in 2020¹ →
37M in 2025¹



1M professional service robots in 2020² →
5M in 2025²

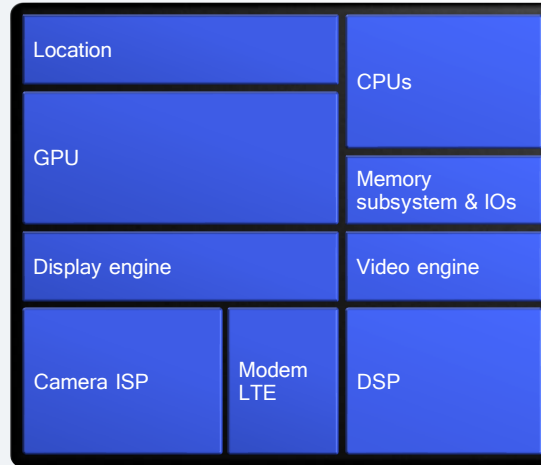


1.5M drones sold in 2020¹ →
4M in 2025¹



Qualcomm robotics RB3 platform

Launched a dedicated platform to build smart, power-efficient and cost-effective large industrial and enterprise robots to small battery-operated one's with challenging power and thermal dissipation requirements



High performance, heterogenous computing on Qualcomm® SDA/SDM845



Computer vision



Multimedia



Multiple cameras & sensors



Commercialization choices: dev kit, SOM, chip-on-board



Artificial intelligence (AI) engine for on-device machine learning



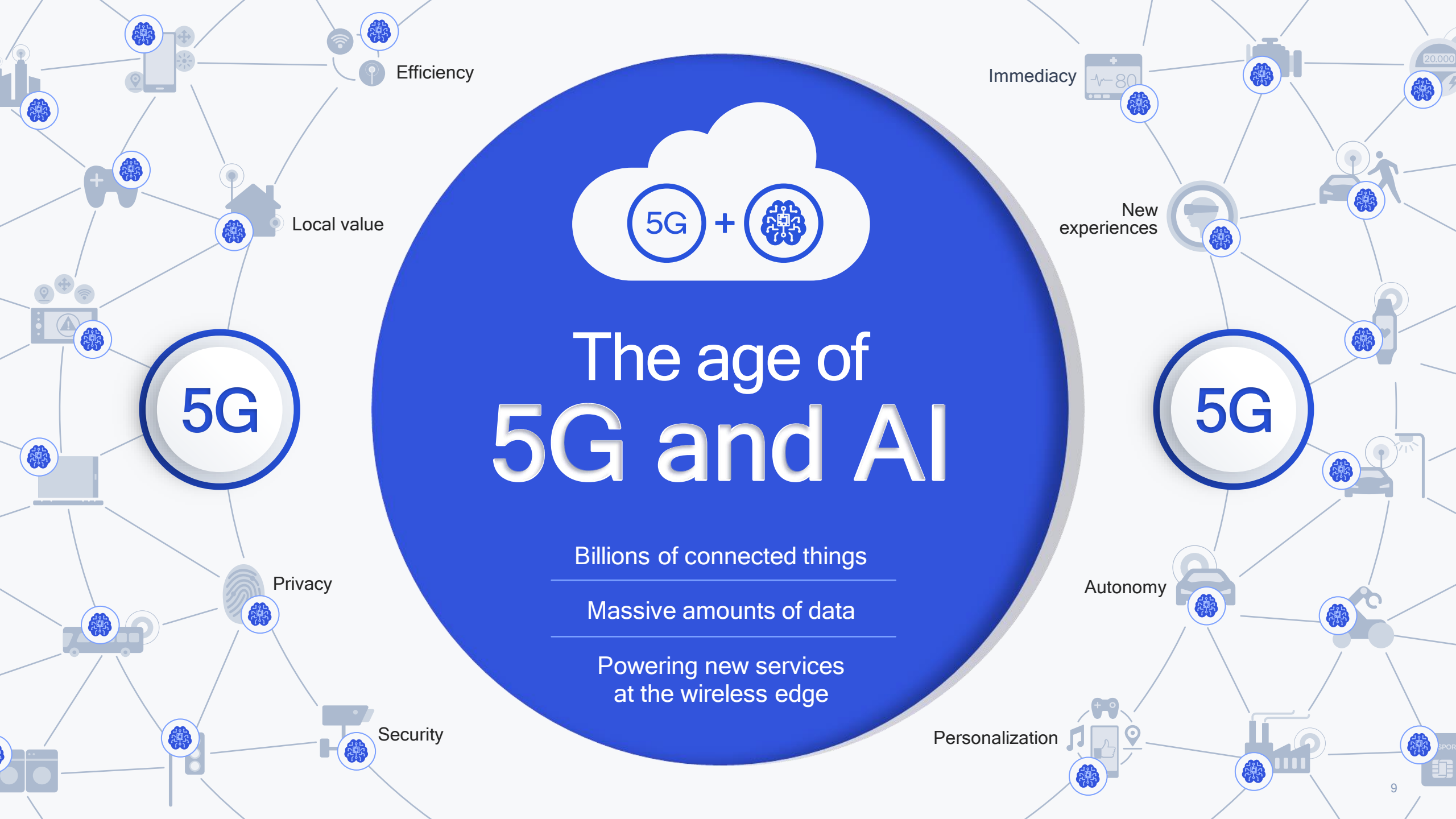
Linux, ROS, AWS RoboMaker



Vault-like hardware-based security



Wi-Fi and cellular connectivity (4G/LTE, CBRS and support for 5G)

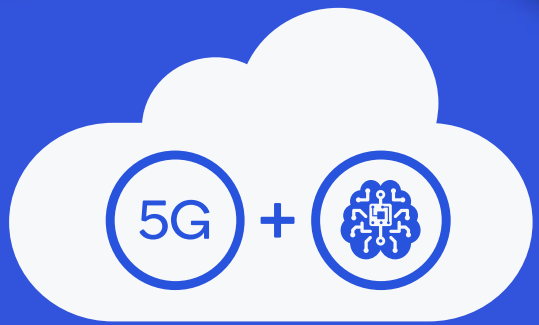


The age of 5G and AI

Billions of connected things

Massive amounts of data

Powering new services at the wireless edge



Efficiency

Local value

Privacy

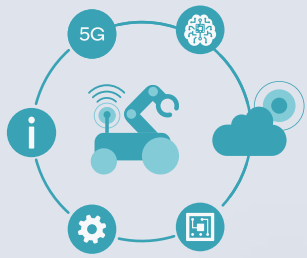
Security

Immediacy

New experiences

Autonomy

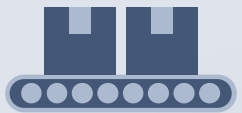
Personalization



Industry 4.0
5G Connectivity



Industry 3.0
Digitalization



Industry 2.0
Electrification



Industry 1.0
Mechanization

5G takes Industry 4.0 and Robotics to the next level

Connectivity

Security

Compute

Single 5G network

On-device processing and sensing

Scalable capacity and reliability

CV and AI for autonomous machines

Flexibility with wireless Ethernet

Edge services and data privacy



Qualcomm
robotics RB5
platform

World's first
5G and AI-enabled
robotics platform



Qualcomm
robotics RB5
platform



Scaling 5G and AI for next generation robotics

Qualcomm
robotics RB3
platform



2019

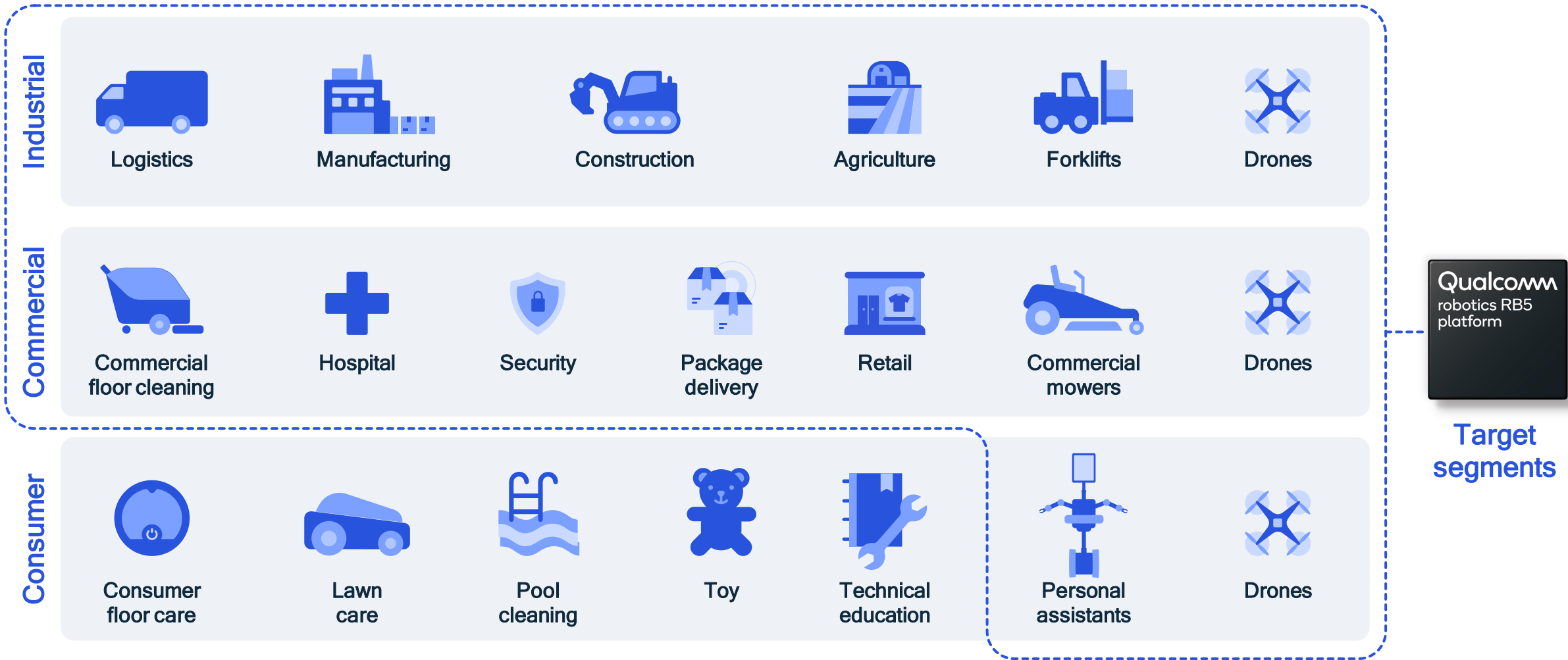
High-tier
Launch

Qualcomm
robotics RB5
platform



2020

Premium tier
Expand



Robotic opportunities and Qualcomm Robotics RB5 platform target segments

QRB5165 - Integrated premium tier robotics SoC

High-performance heterogeneous computing (**15 TOPS**) at ultra-low power consumption

5th generation Qualcomm® Artificial Intelligence (AI) Engine for **on-device machine learning**

Dedicated Qualcomm® Hexagon™ Tensor Accelerator delivering 8 TOPS for **accurate edge inferencing**

8K video, 4K HDR, 200MP photo, & 7-camera concurrency enable **fully autonomous robots**

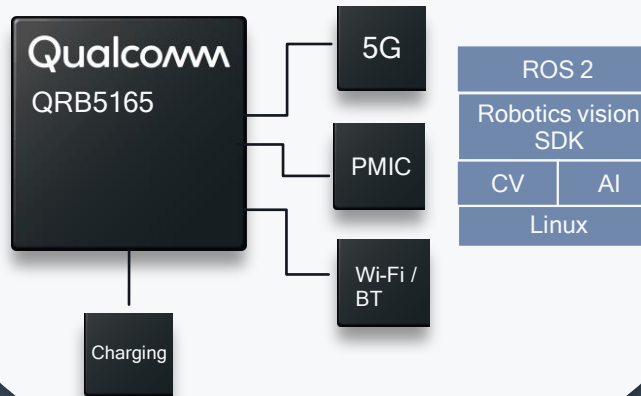
Qualcomm® Spectra™ 480 CV-ISP featuring 2-Gigapixel/sec ISPs & visual analytics hardware engine enables **computer vision apps**

From crypto to DRM, the secure processing unit **helps to secure robots at every level**

Cellular (LTE / 5G / CBRs) and Wi-Fi for **ubiquitous connectivity**

Qualcomm QRB5165, Qualcomm AI Engine, Qualcomm Hexagon Tensor Accelerator, Qualcomm Spectra 480, Qualcomm Neural Processing SDK, Qualcomm Fast CV Computer Vision SDK, Qualcomm Robotics Vision SDK are products of Qualcomm Technologies, Inc. and/or its subsidiaries.

Qualcomm robotics RB5 platform



AI, CV and Software

Qualcomm® Neural Processing SDK for **advanced on-device AI**

Qualcomm® FastCV Computer Vision SDK offers **rich vision processing** functionality

Qualcomm® Robotics Vision SDK provides **localization, feature recognition** and **obstacle detection**

Linux, Ubuntu, ROS 2, AWS RoboMaker round out **end-to-end robotic application** development

Industrial Grade

Operates in **harsh industrial conditions** & temperature range of -30°C to 105°C T_j , and has **long lifecycle** support

Communicates via **industrial protocols** such as EtherCAT & TSN

Flexible commercialization choices: System-on-Module, chip-on-board, package-on-package (POP)/non-POP packages

Vision Mezzanine

12MP Main camera, IMX577
Tracking camera, OV9282
Depth camera, Intel RealSense D435i
TOF camera, Panasonic V4T
GMSL2 camera, LI-AR0231
IMU, compass, pressure

Motor Control Mezzanine

Brushed DC control driver
Brushless DC control driver
Dynamixel smart motor driver
Stepper motor driver
Servo motor driver
I/O expansion

Sensor Mezzanine

Single and Dual IMU
Magnetometer
Pressure sensor
Temperature sensor
Chirp sensor
Digital PDM mic
Motor drivers
Dynamixel motors



Purpose built robotics development kit

Software

Ubuntu, Linux
Robot Operating System 2 (ROS 2)
AWS RoboMaker
Qualcomm Neural Processing SDK
Qualcomm Robotics Vision SDK
Qualcomm FastCV Computer Vision SDK

Industrial Mezzanine

EtherCAT
EtherNet/IP
Modbus-TCP
PROFINET

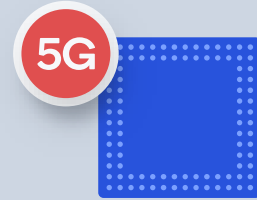
5G Mezzanine

Sub6, Quectel RM500Q-GL
Sub6 + mmWave, Quectel RM510Q-GL



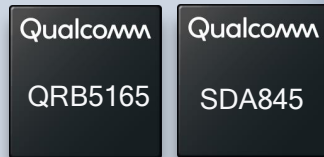
Building Better Robots, Drones & Intelligent Machines

Chipsets

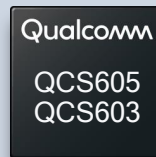


Purpose built silicon roadmap for Robotics

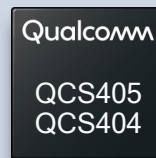
Best



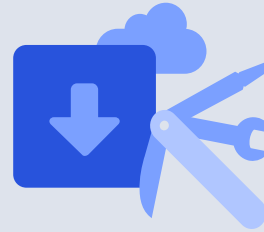
Better



Good



Software/Tools



Qualcomm Neural Processing Engine for AI/ML

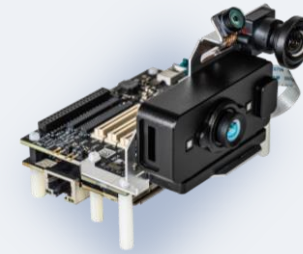
OpenCL and Qualcomm® Computer Vision SDK
OpenCV and Open GL
Machine Vision SDK

AWS RoboMaker

Linux

ROS 2

Hardware/Platforms



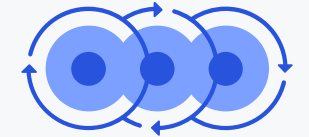
Prototype and commercialize robots quickly with fewer resource restraints

Qualcomm Robotics RB5 Platform

Qualcomm Robotics RB3 Platform

Qualcomm Flight™ Pro

Ecosystem & support



Collaboration with multiple ODM/CM, technology, and platform companies

Altek





ModalAI

TDK Invensense

Thundercomm



Thank you

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