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IRWA Webinar

Qualcomm

5G IoT

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IoT opportunity extends across segments

Tracking

At port (Days)

3

Location

Spools shipped

Capacity

Camera



Industrial handhelds



IIoT gateways



On-premise compute and storage

Updating



Real-time inventory

- Lumber
- Hardware
- Technology
- Manufacturing
- Produce
- Automotive
- Earth / Soil
- Retail



Energy and metering



Street lighting



Retail



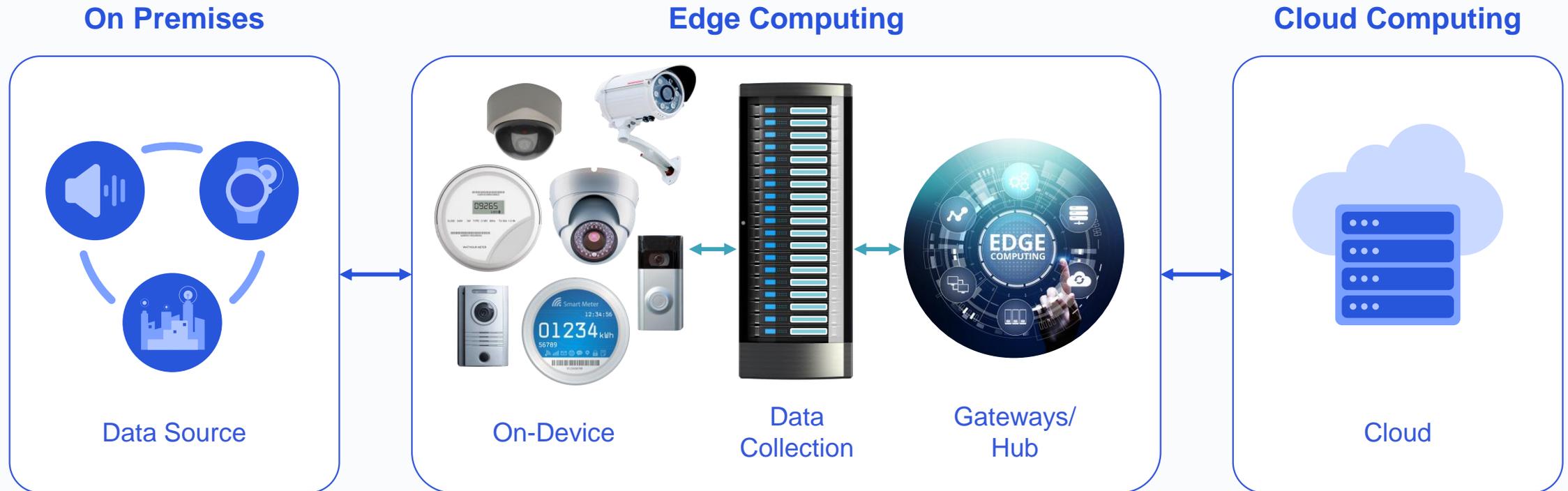
Digital signage/ Commercial AV



Robotics



Distributing Computing with Powerful Embedded Platforms Enabling AI at Edge in IoT



Edge Computing → A Distributed Computing Paradigm

Enablement of Data Computation closer to the data source

IoT = SoCs?

State-of-the-art 5G Modem-RF

Qualcomm
snapdragon

X65 5G modem-RF

Ushering the next 5G era

World's 1st
10 Gigabit 5G

World's 1st
3GPP Release 16

Upgradable architecture for rapid Release 16 rollout via software upgrades

Qualcomm Snapdragon X65 5G Modem-RF System and Qualcomm mmWave module are trademarks of Qualcomm Technologies, Inc. and/or its subsidiaries.

Qualcomm SDX65 000 JK050B9D

Mobile broadband

Fixed wireless access

Industrial IoT

5G private networks

Qualcomm Snapdragon X65

Qualcomm mmWave Module

mmWave

RF Transceiver

RF Front-End

Sub-6 GHz

Qualcomm

Qualcomm Snapdragon X65 5G Modem-RF System

Qualcomm Snapdragon X65 5G Modem-RF System is the world's first 10 Gigabit 5G and first 3GPP Release 16 modem-to-antenna solution. It is designed with an upgradable architecture to rapidly commercialize 5G Release 16 and extend 5G in mobile broadband, fixed wireless, industrial IoT and 5G private network applications.

Built to extend 5G into more application segments

- Mobile broadband – smartphones, tablets, PCs, mobile hotspots
- Fixed wireless – CPEs, home broadband, routers
- Industrial IoT
- 5G private networks

Features

- 10 Gbps peak speeds in 5G standalone and non-standalone modes
- 3GPP Release 16 support
- Upgradable architecture for rapid feature rollout
- 5G mmWave-sub6 aggregation
- Global 5G band support including the new n259 (41 GHz), n70, n53
- Advanced power-saving tech
 - Qualcomm 5G PowerSave 2.0
 - Qualcomm Wideband Envelope Tracking (7th gen)
 - Qualcomm AI-Enhanced Signal Boost

Specifications

- 5G Chipset: Qualcomm Snapdragon X65 Modem-RF System
- 5G Spectrum: mmWave-sub6 aggregation, sub-6 carrier aggregation (FDD-TDD, FDD-FDD, TDD-TDD), FDD-TDD support for uplink-CA, Dynamic Spectrum Sharing (DSS)
- 5G Modes: FDD, TDD, SA (standalone), NSA (non-standalone)
- 5G mmWave specs: 1000 MHz bandwidth, 10 carriers, 2x2 MIMO
- 5G sub-6 GHz specs: 300 MHz bandwidth, 256-QAM, 4x4 MIMO
- 5G Peak Download Speed: 10 Gbps
- 5G Global Multi-SIM support
- Cellular Technology: 5G NR, LTE, LAA, WCDMA (DB-DC-HSDPA), TD-SCDMA, CDMA 1x, GSM/EDGE, CBRS

Upgradable architecture and ultimate flexibility

Designed with an upgradeable architecture for rapid commercialization of the latest 3GPP Release 16 features into 5G mobile broadband products including smartphones, hotspots, fixed wireless devices as well as private network and industrial IoT applications. Snapdragon X65's expansive feature set, band support and spectrum aggregation capabilities offer ultimate 5G deployment flexibility to operators globally.

Unmatched data speeds and coverage

Break through the 10 Gbps barrier in both 5G non-standalone (NSA) and standalone (SA) modes. This modem-to-antenna solution features an all-new Qualcomm 545 mmWave Antenna Module, next-gen Qualcomm Wideband Envelope Tracking and Qualcomm AI-Enhanced Signal Boost to help achieve unmatched data speeds and coverage.

Leading power efficiency

Combines the power efficiency benefits of a 4 nm process with new Release 16 power-saving features and a tightly integrated modem-RF system, delivering superior power efficiency and all-day battery life.²

1 OEMs have flexibility to choose RF components.
2 Battery life varies significantly based on device, settings, usage, and other factors.

Snapdragon X65 Modem-RF System, Qualcomm 5G PowerSave 2.0, Qualcomm AI-Enhanced Signal Boost, Qualcomm Smart Transmit 2.0, Qualcomm RF Gaming Mode Boost and Qualcomm Wideband Envelope Tracking are products of Qualcomm Technologies, Inc. and/or its subsidiaries.

5G IoT Modem

Block Diagram



Product	Peak Download Speed	Peak Upload Speed	Cellular Technology	CPU Cores
 Qualcomm 315 5G IoT Modem Modem	1.54 Gbps ¹ 400 Mbps ²	330 Mbps 75 Mbps ³	FDD TDD 5G NR ⁴ 5G/4G spectrum sharing ⁴ SA (standalone) ⁴ TDD ⁴ FDD ⁴ sub-6 GHz ⁴	—
 212 LTE Modem Modem	127kbps (Rel.14 Cat-NB2)	158.5 kbps (Rel.14 Cat-NB2)	Rel.14 LTE Cat-NB2	ARM Cortex M3
 9205 LTE Modem Modem	588 kbps (Rel.14 Cat-M1) 127kbps (Rel.14 Cat-NB2)	1119 kbps (Rel.14 Cat-M1) 158.5 kbps (Rel.14 Cat-NB2)	Rel.12 EGPRS MSC12 Rel.14 LTE Cat-M1 Rel.14 LTE Cat-NB2	ARM Cortex A7
 9207 LTE Modem Chipset	10 Mbps	5 Mbps	DC-HSPA LTE TDD LTE FDD TD-SCDMA GSM	ARM Cortex A7

Robotics platform



Service Robot



Industrial Robot



Industrial Control



Automated Guided Vehicle



Self-driving Vehicle for Logistics



Consumption /Entertainment Robot



Industrial Drone

QRB5165 - Integrated premium tier robotics SoC

High-performance heterogeneous computing at ultra-low power consumption

5th generation Qualcomm® Artificial Intelligence (AI) Engine (15 TOPS) for running complex AI and deep learning workloads

Dedicated Qualcomm® Hexagon™ Tensor Accelerator (HTA) delivering 8 TOPS for accurate edge inferencing

Dedicated enhanced visual analytics hardware engine enables (EVA) computer vision apps, VIO, SLAM, DFS

Qualcomm® Spectra 480 CV-ISP featuring 2-Gigapixel/sec ISPs & 8K video, 4K HDR, 200MP photo, & 7-camera concurrency enable fully autonomous robots

From crypto to DRM, the Secure processing unit for ironclad security secures robots at every level

Qualcomm QRB5165, Qualcomm AI Engine, Qualcomm Hexagon Tensor Accelerator, Qualcomm Spectra, Qualcomm Neural Processing SDK, Qualcomm 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® CV SDK offers rich vision processing functionality

Robot 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

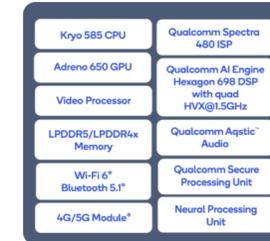
Operates in harsh industrial conditions & temperature range of -40C to 105C T_j, and has long lifecycle support

Communicates via industrial protocols such as EtherCAT, TSN

Connectivity options

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

QRB5165 Block Diagram



* Supported with a companion module

QRB5165 Specifications

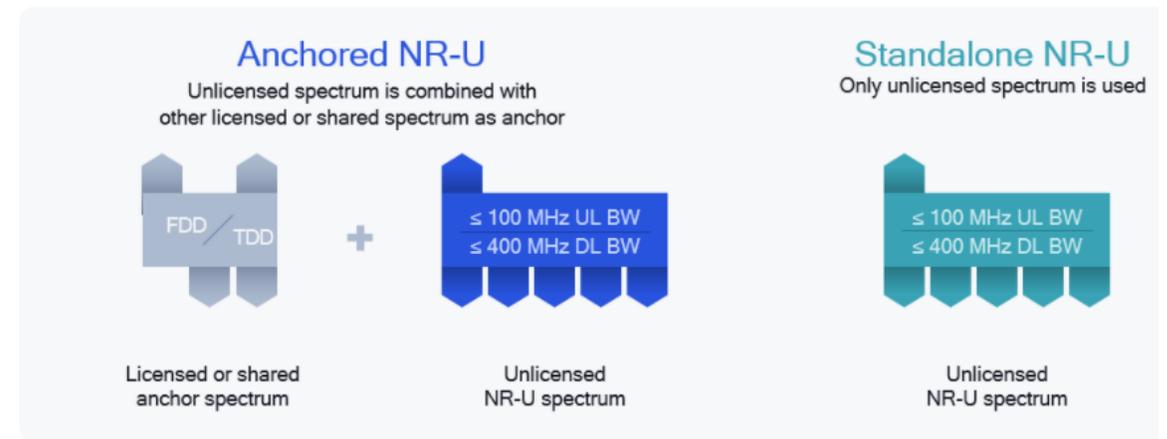
Package	124 x 12.7mm LPA, 124 x 14mm LPS MEP
CPU	Kryo 585 CPU, 64-bit, up to 2.84 GHz
ISP	Qualcomm Spectra 480 ISP with Dual 14-bit image signal processing
Camera	Up to 200 MP photo capture Up to 25 MP dual camera @ 30 FPS w/ Zero Shutter Lag Up to 64 MP single camera @ 30 FPS w/ Zero Shutter Lag Support for 12 cameras by D-PHY & 18 cameras by C-PHY (7 concurrent)
Video	8K video capture @ 30 FPS, Up to 10-bit color depth video capture, 4K video capture + 64 MP Photo, 4K video capture @ 120 FPS, 4K HDR video capture
GPU	Adreno 650 GPU w/ support for Open GL ES & Open CL
DSP	Hexagon 698 DSP with HVX, Hexagon Tensor Accelerator and Hexagon Scalar Accelerator
Memory	LPDDR5 up to 2750 MHz, LPDDR4X up to 2133 MHz Memory Density: up to 16 GB
Wireless Connectivity	WLAN 2 x 2 802.11ax with DBS, Bluetooth* 5.1
Security	Camera Security, Crypto Engine, Cryptographic Accelerator, Qualcomm Trusted Execution Environment, Secure Boot, Qualcomm* Crypto Engine Core is FIPS 140-2 certified

Qualcomm Spectra, Qualcomm Kryo, Qualcomm Secure Processing Unit, Qualcomm Trusted Execution Environment, Qualcomm Crypto Engine Core and Qualcomm Aqatic are products of Qualcomm Technologies, Inc. and/or its subsidiaries.

IoT = Features?

NR-U

- Release 16 not only supports the existing global 5 GHz unlicensed band widely used by Wi-Fi and LTE LAA today, but it can also open doors to the greenfield 6 GHz band that brings a massive 1200 MHz of unlicensed bandwidth in the U.S.
- Challenge today, example
 - NR frame structure is targeted for the DL traffic (eMBB)
 - DDDSU
 - DDDDDDDDSUU
 - DDDSUDDSUU
 - Note that selected countries consider allocating spectrum to vertical players (Korea November '21 auction)



Deploying 5G NR in unlicensed spectrum — two modes of operation.

Non-Public Networks

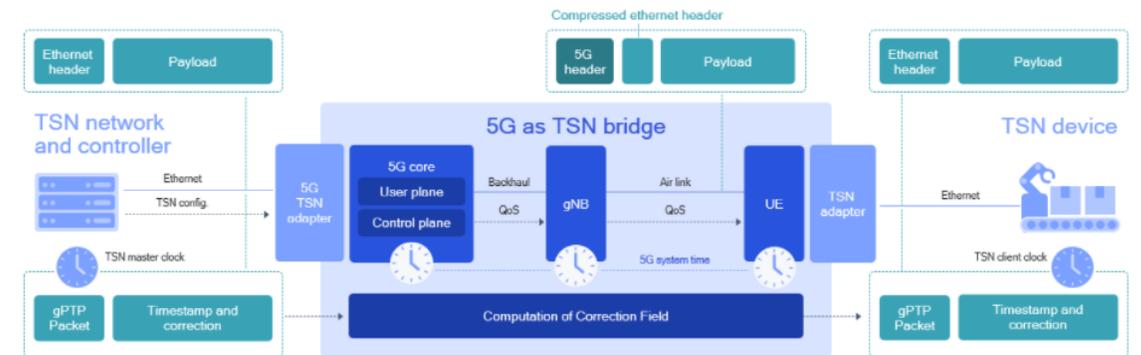
- The second Release 16 project that I want to highlight is the added support in the system architecture for private networks (called “non-public networks” or NPN, in 3GPP parlance). Private networks utilize dedicated resources (e.g., small cell base stations) that are independently managed, provide security and privacy that allow sensitive data to stay on-premise, and delivers optimizations for local applications (e.g., low latency). Private networks can benefit a wide range of new 5G deployments such as industrial IoT use cases.
- Challenge today, example
 - Flexibility of the deployment model is limited resulting in high cost



5G private networks bring benefits to industrial IoT.

TSN Integration

- As part of the effort for 5G to support new Industry 4.0 use cases (e.g., factory automation), 5G NR in Release 16 added support for TSN integration that can ensure time-deterministic delivery of data packets. The project includes system components such as synchronizing with precise time using generalized precision timing protocol (gPTP), mapping of TSN configuration into 5G quality-of-service (QoS) framework for deterministic messaging and traffic shaping and providing efficient transport of Ethernet frames via header compression.
- Challenge today, example
 - “Best effort” Ethernet



Integrating 5G as a TSN bridge.

Sidelink

- Utilizing 5G to enhance automotive safety is another focus area for Release 16. While Release 14 C-V2X introduced sidelink (V2V, V2I, V2P) to support basic safety use cases, Release 16 builds on Release 14/15 by introducing a NR-based sidelink that will enable new advanced safety use cases while also paving the path for autonomous driving. Release 16 supports reliable and efficient multicast communication based on HARQ feedback and uses distance as a new dimension at the physical layer, which enables “on-the-fly” multicast groups based on distance and applications.



NR-Light

- To broaden and optimize 5G's support for IoT, Rel-17 introduces NR-Light – a new class of devices that is more capable than eMTC/NB-IoT but supports different features and smaller bandwidth than 5G NR eMBB/URLLC. For example, NR-Light can occupy just 10 or 20 MHz of bandwidth and deliver 100 Mbps of downlink and 50 Mbps of uplink throughput, making it a suitable technology for use cases such as high-end wearables or industrial IoT cameras and sensors.



Figure 3: 5G NR-Light will expand the reach of 5G for IoT use cases

Positioning

- Accurate device positioning is a key enabler for many vertical applications. The benefit of cellular-based positioning, which complements existing GNSS systems, is that it **works well for both outdoor and indoor locations**. With the market pushing for better device positioning capabilities, 5G initially added positioning support in Rel-16, which defined the key techniques such as roundtrip time (RTT), angle of arrival/departure (AoA/AoD), and time difference of arrival (TDOA). Rel-17 will further enhance positioning accuracy, latency, capacity, and down to cm-level. This is going to be especially important for industrial IoT use cases.

Source sample text

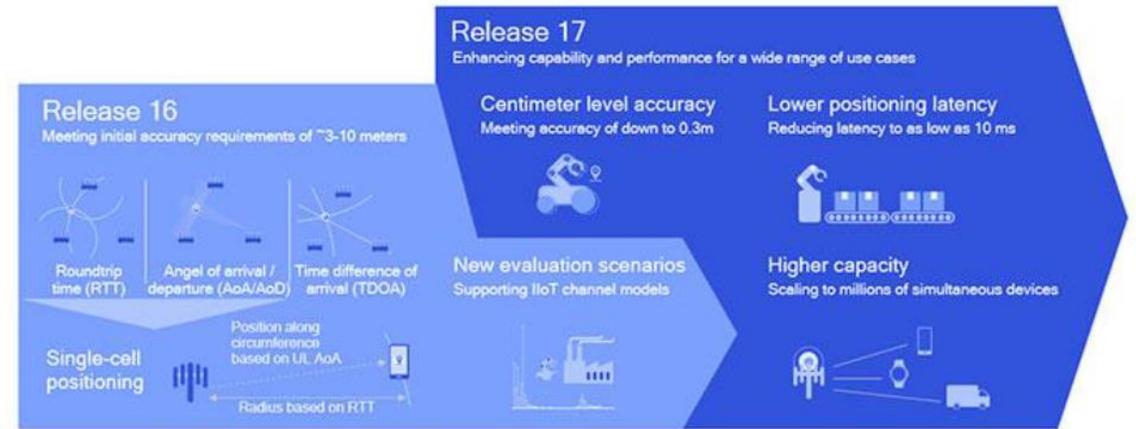


Figure 4: Enhancing 5G positioning capabilities and efficiencies

- 3GPP Rel-17 will start a study to characterize the performance of 5G networks for various uses cases belonging to this broader category (i.e., VR, AR, etc.).



Figure 5: Optimizing 5G network for boundless extended reality

IoT = Services?

IOT-as-a-Service (IOTaaS)

Digitization of high value industries

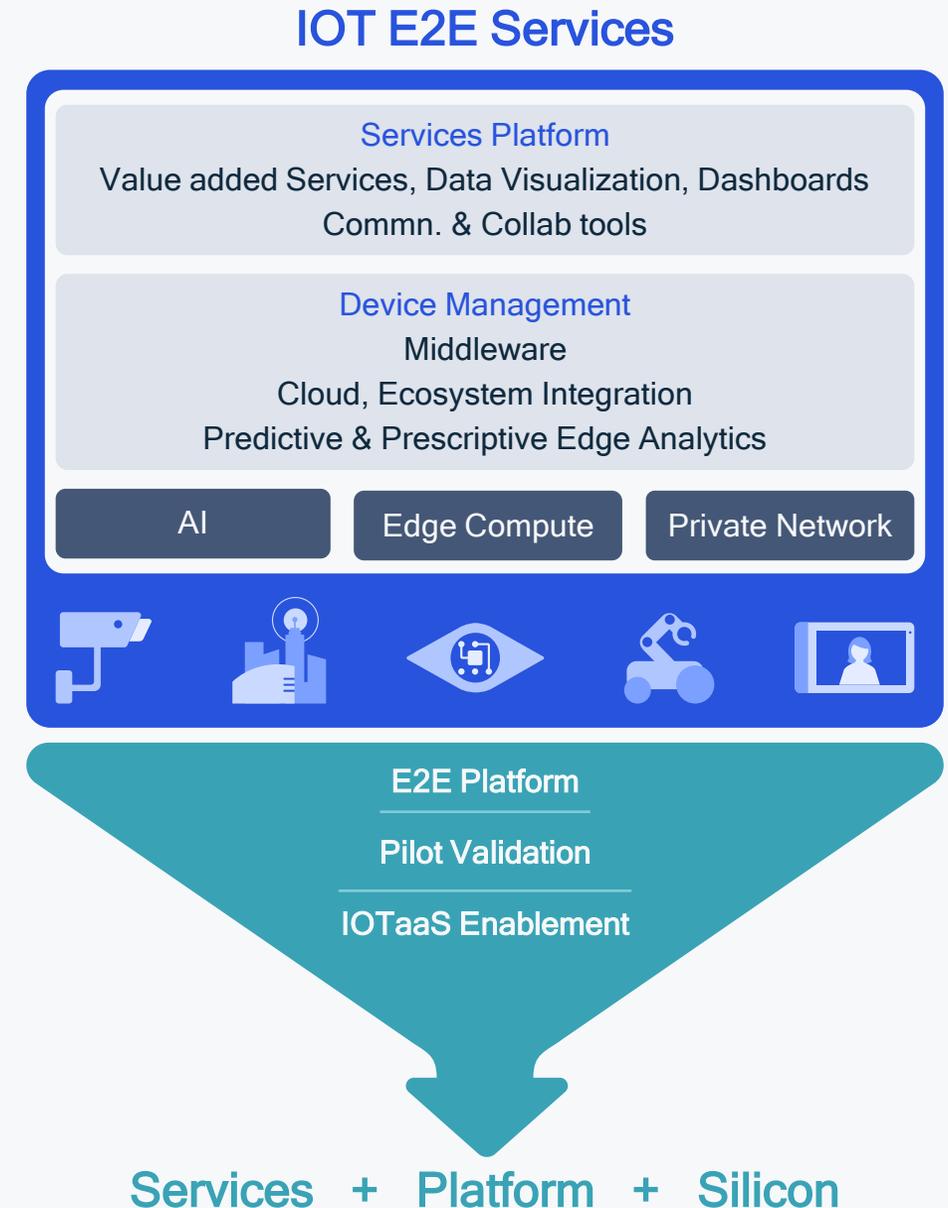
- Solve the difficult use cases
- Ready to deploy solutions and services
- Enable vertical solutions that scale

Add E2E value

- Technology push; Pre-integration; Pre-certification
- Utilize Qualcomm Technologies Ecosystem /Silicon

Partner with industry leaders

- IOTaaS customization
- GTM offering to specific industries
- Enable new use cases



CMaaS touch points

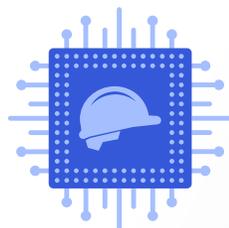
Construction safety industry is multi-functional
Ripe for disruption



Perimeter Inspection



Cloud



CMaaS

- Hard Hat
- Connected Worker
- Wearable AI Camera
- Thermal Safety Scan
- Digital workflow
- Remote Collaboration
- Connected Health Kiosk
- Drones for inspection
- Perimeter Lidar
- AI Camera for NLOS



Health Kiosk

WoS Screen



Const. Wearables



Thermal Camera



Connected Safety Helmet



Connected AI

Camera Access & Control



Lidar



Workflow Automation



Private Network + V-RAN

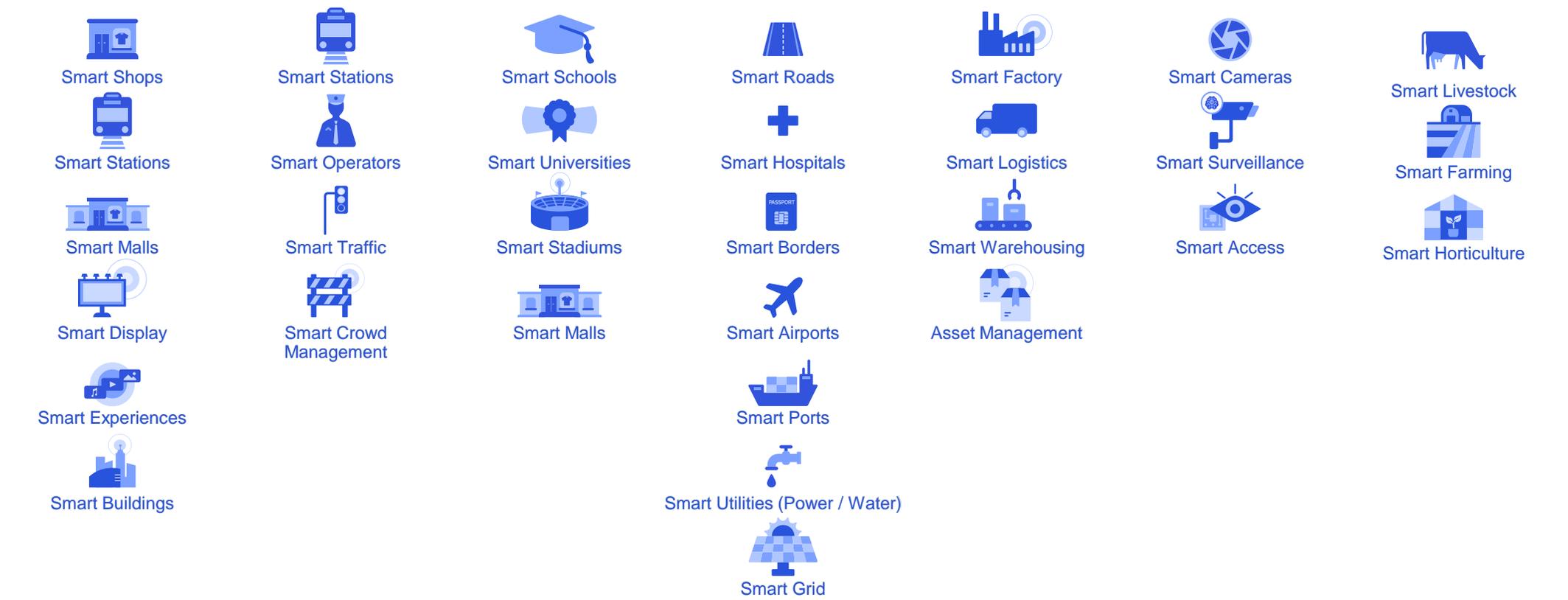
IoT-as-a-Service

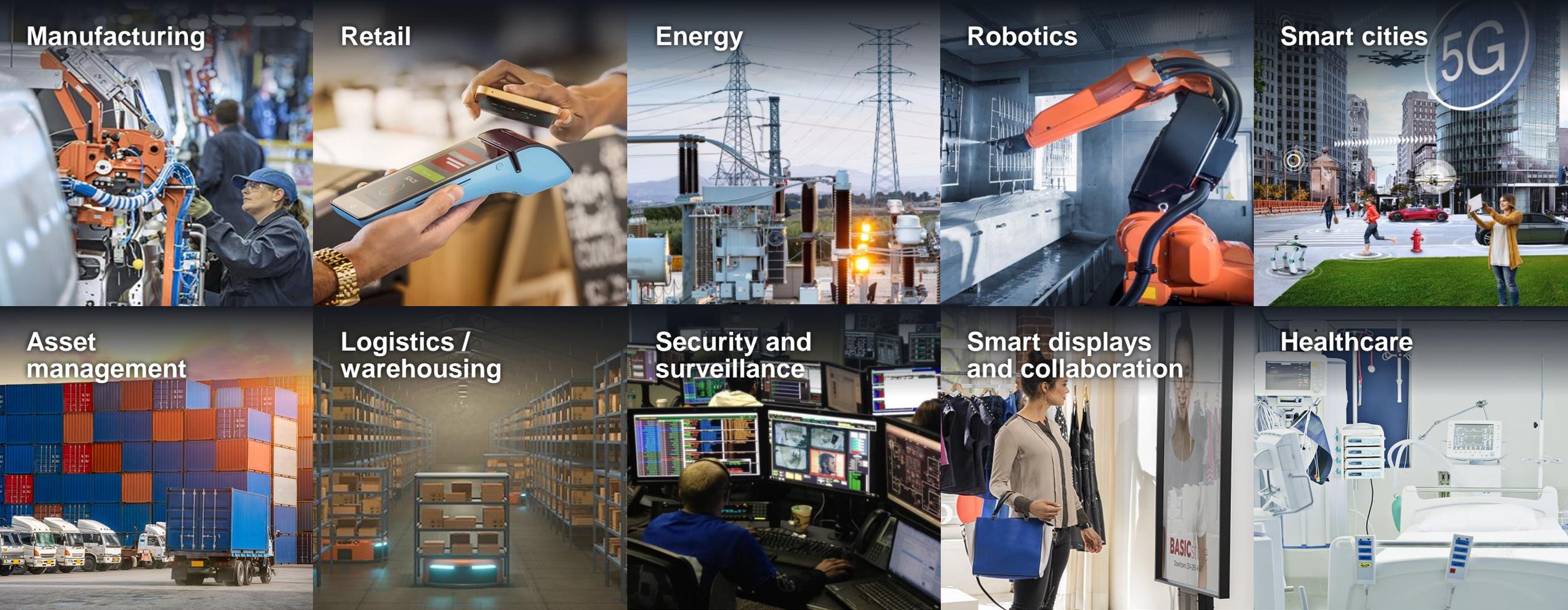
Smart Connected Spaces

Smart Verticals



Smart Spaces





With Fragmentation in IoT, need for a full-stack solution is eminent. E2E service by Qualcomm Technologies is driving the transformation of smart IoT And solving the challenge of Edge AI deployment at scale.



Thank you

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