5G工业和物联网方案

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SECURE CONNECTIONS
FOR A SMARTER WORLD

内容提要

- 恩智浦在5G领域的成就
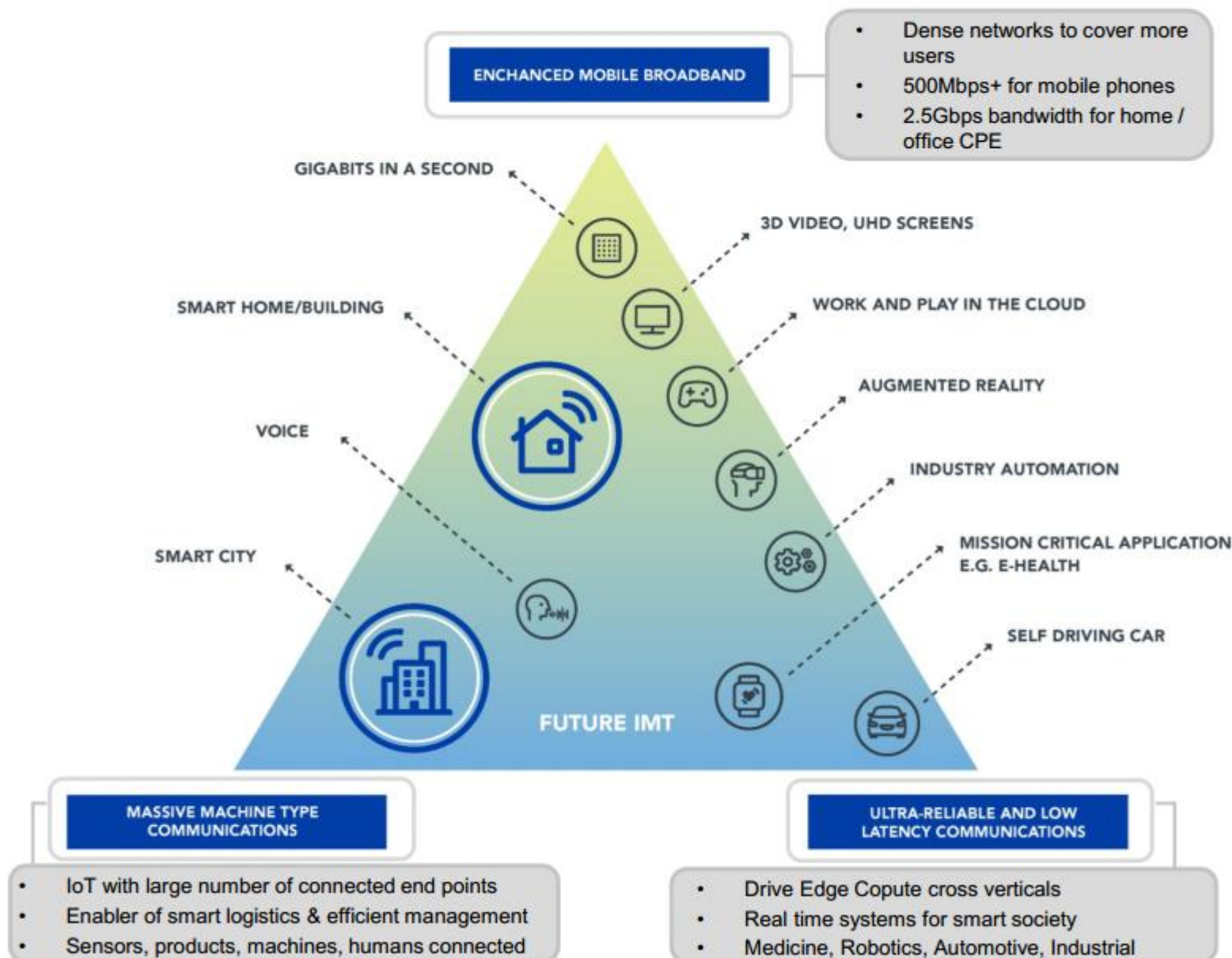
- 5G场景与特性

- 5G新技术

- 恩智浦端到端方案

- 开放包容的生态

- 工业和物联网典型场景

恩智浦在5G领域的成就

1) 恩智浦提供从天线到处理器的完整5G接入方案

2) 恩智浦助力和加速5G基站建设

3) 恩智浦可编程 Layerscape Access 系列基带处理产品用于

提供更高效的解决方案

4) 恩智浦同时提供传统架构和全新ORAN架构，提供有竞争力

的5G部署方案

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3GPP定义5G场景与特性

ENCHANCED MOBILE BROADBAND
- Dense networks to cover more users
- 500Mbps+ for mobile phones
- 2.5Gbps bandwidth for home / office CPE

GIGABITS IN A SECOND

3D VIDEO, UHD SCREENS

SMART HOME/BUILDING

WORK AND PLAY IN THE CLOUD

AUGMENTED REALITY

VOICE

INDUSTRY AUTOMATION

SMART CITY

MISSION CRITICAL APPLICATION E.G. E-HEALTH

SELF DRIVING CAR

FUTURE IMT

MASSIVE MACHINE TYPE COMMUNICATIONS
- IoT with large number of connected end points
- Enabler of smart logistics & efficient management
- Sensors, products, machines, humans connected

ULTRA-RELIABLE AND LOW LATENCY COMMUNICATIONS
- Drive Edge Copute cross verticals
- Real time systems for smart society
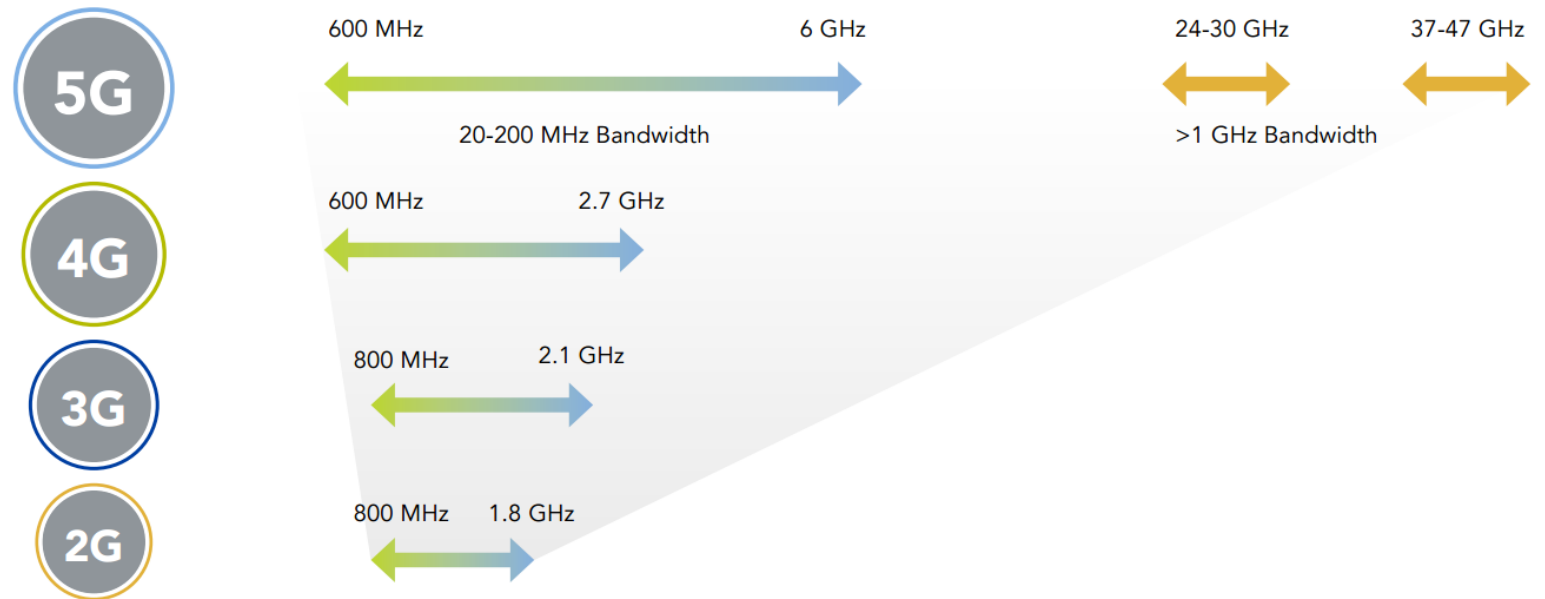- Medicine, Robotics, Automotive, Industrial

5G Technology Drivers

✓ **New frequencies & spectrum** (new transceivers and front-end modules)

✓ **New 3GPP waveforms** (new physical layer and baseband processing)

✓ **New deployment models** (non standalone → stand alone, O-Ran splits)

✓ **New latency requirements** (architectures tuned to applications, Access Edge processing)
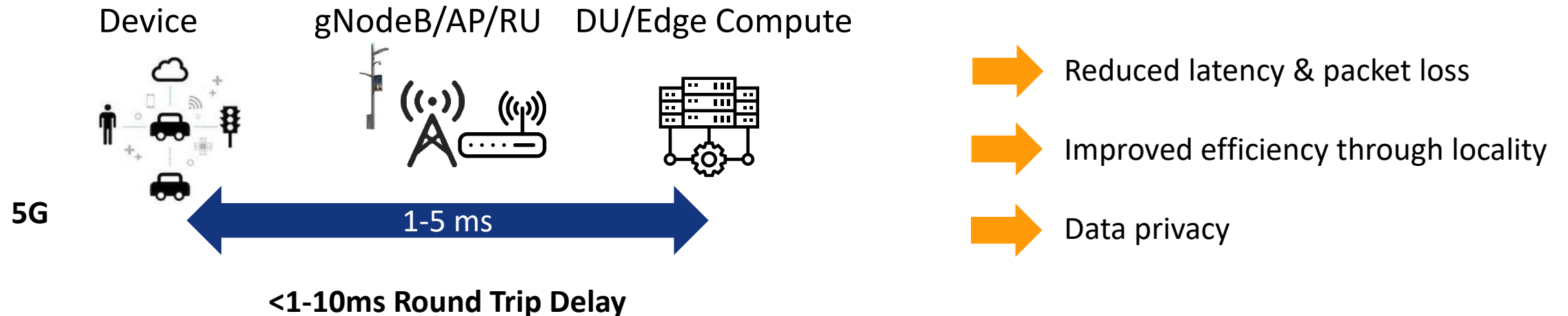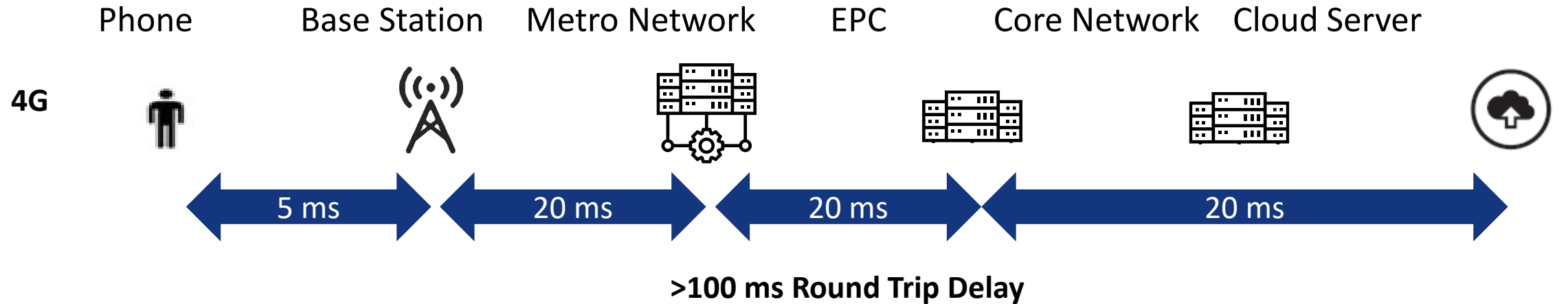
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5G新技术

As the rollout for 5G infrastructures expands, mobile network operators are modifying the existing infrastructure, adding what's needed to support the higher throughputs, greater device density and lower latency we'll need to run advanced 5G use cases, now and in future.

- New Spectrum
- New Antenna Configurations
- More Code

5G adds new frequency spectrum

低延迟与可靠性

Phone   Base Station   Metro Network   EPC   Core Network   Cloud Server

4G

5 ms   20 ms   20 ms   20 ms

>100 ms Round Trip Delay

Device   gNodeB/AP/RU   DU/Edge Compute

5G

1-5 ms

<1-10ms Round Trip Delay

➡ Reduced latency & packet loss

➡ Improved efficiency through locality

➡ Data privacy

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基于分层机制设计的5G部署方案

Preparing the infrastructure for 5G operation involves adding different layers of coverage, each providing the capacity / coverage trade-off needed for a given area or use case. Unlike 4G that consisted of high-power macro cells complemented here and there by small cells, the 5G deployments consist of high-power macro cells, mMIMO cells, small cells, with mmWave bridging the gap between them.

- **High-power Macro radios**
    - 25km
    - 2T2R to 8T8R, sub 6 GHz
- **Massive MIMO radios**
    - 1km
    - 32T32R to 64T64R, sub 6 GHz
- **mmWave radios**
    - 100 m
    - e.g. 256T256R, 24 GHz
    - serve as a backhaul
      for small cells and WiFi6/6E hotspots
- **Small Cells**
    - backpack-sized, low-power base stations
      that provide targeted capacity in network
      "hotspots"
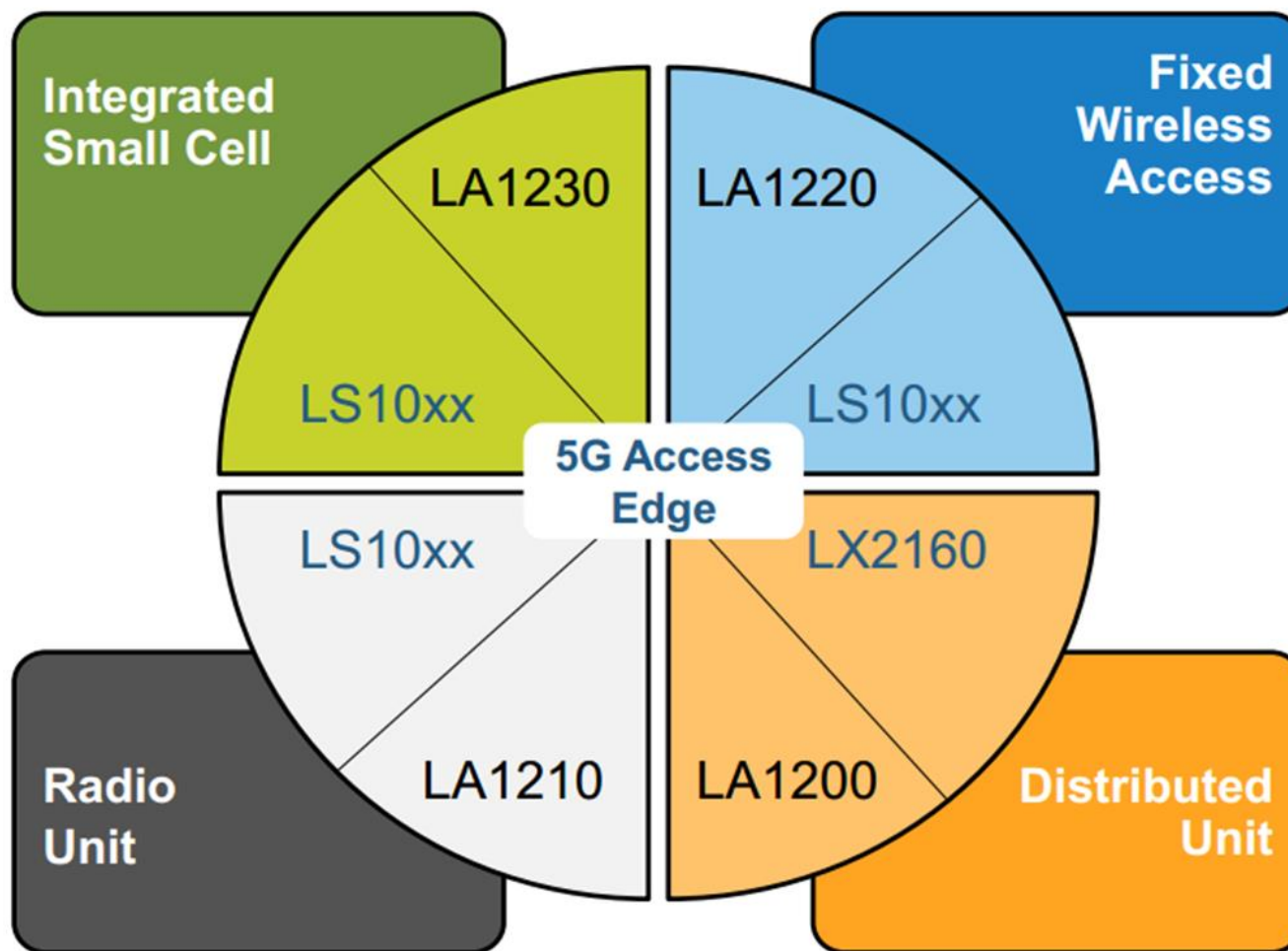   - largely driven by the need for
      5G operation.

恩智浦端到端5G解决方案

FWA = Fixed Wireless Access
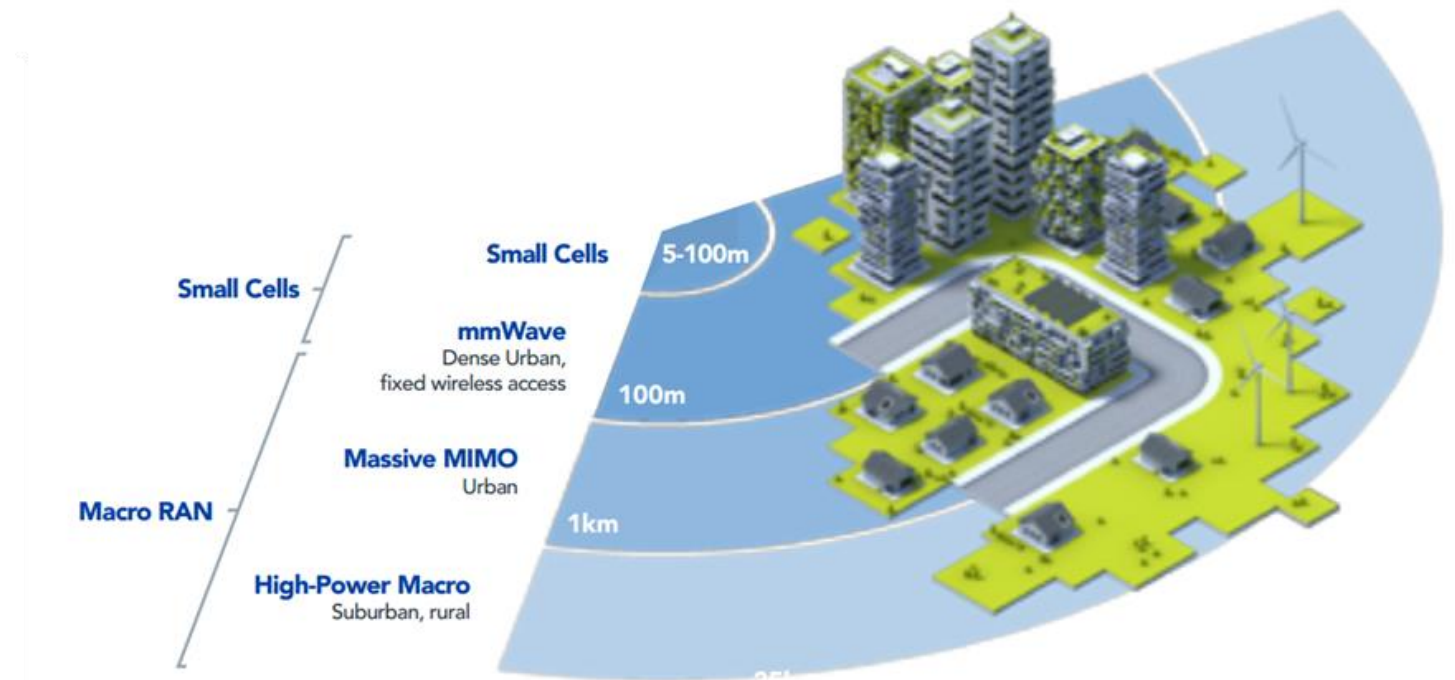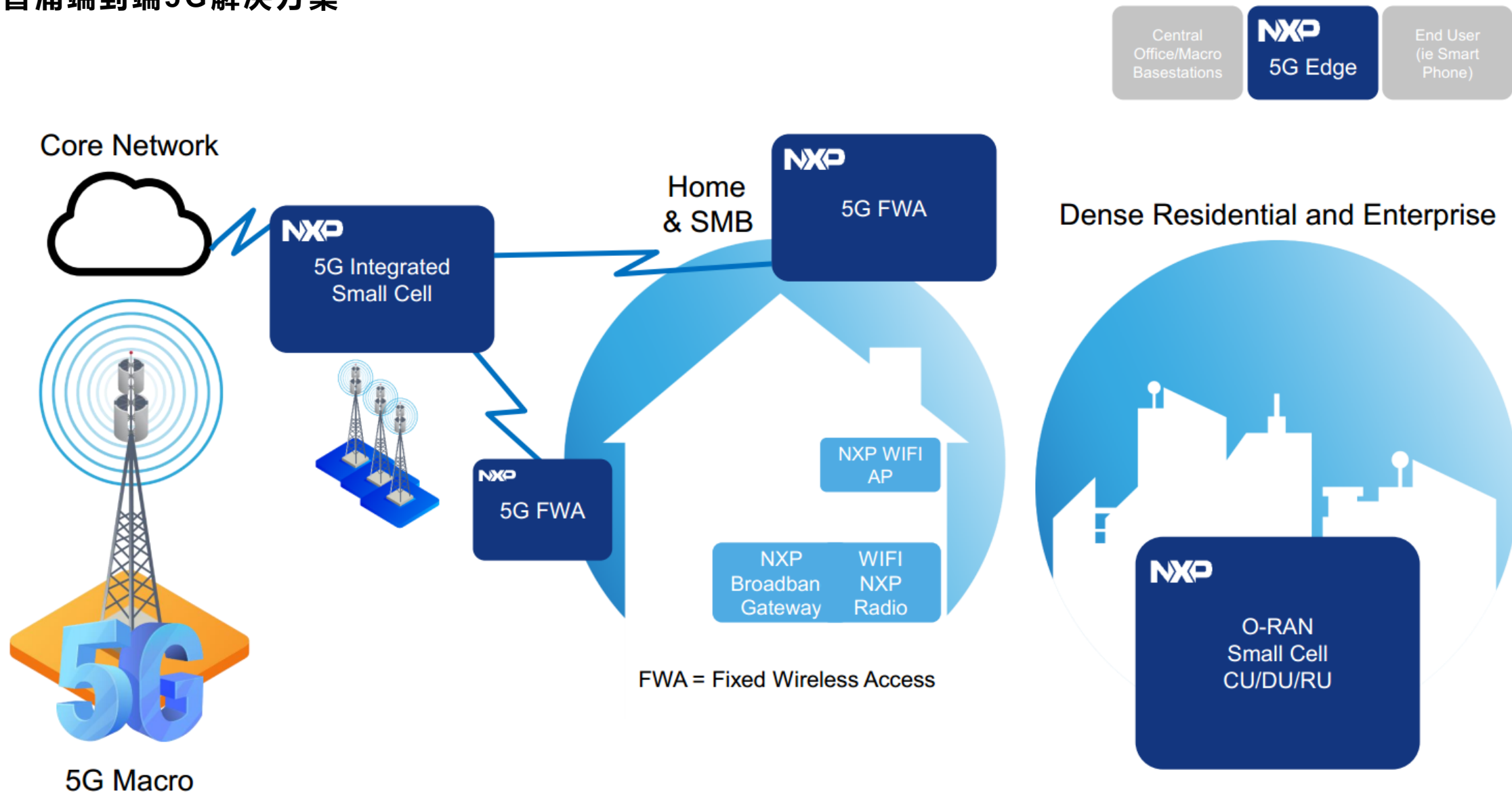
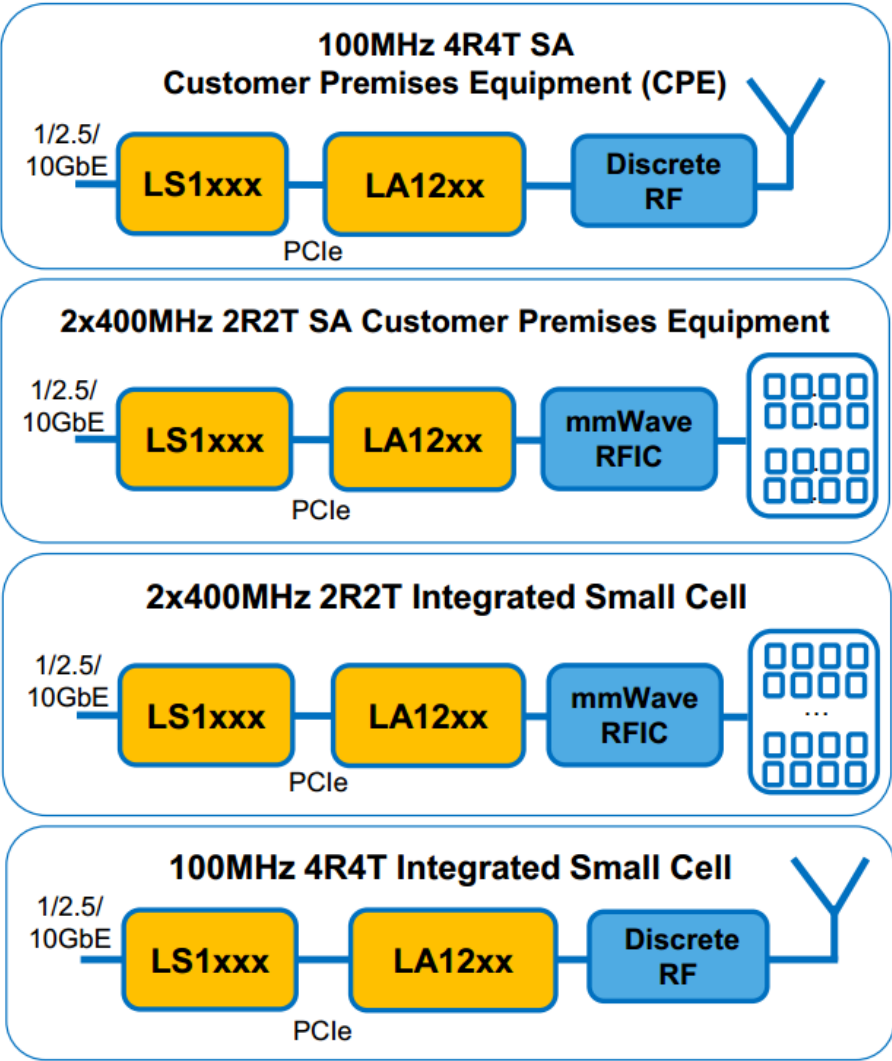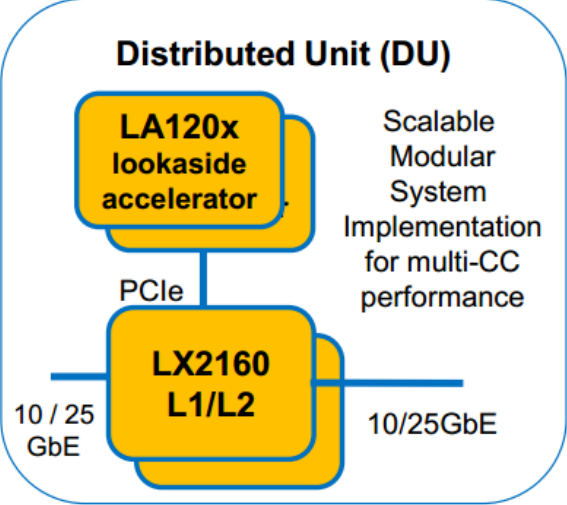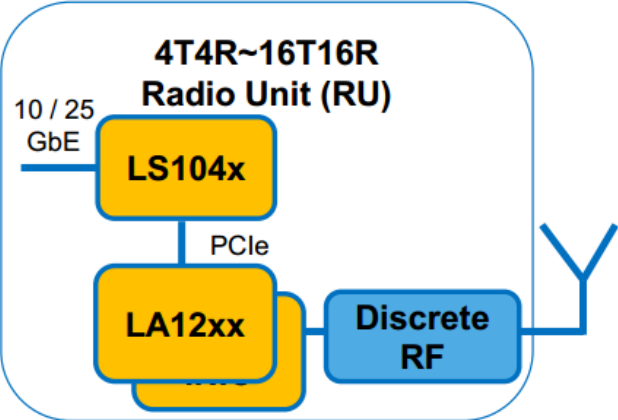# LAYERSCAPE ACCESS 系列产品应用于多种5G场景

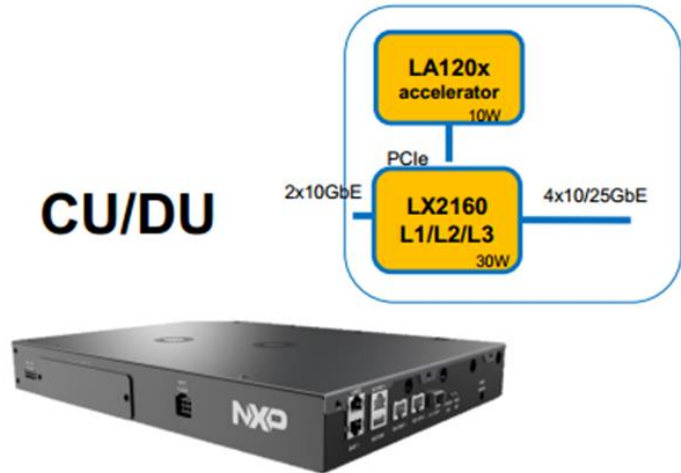**四大应用**

- 可扩展处理器平台
- 针对应用需求进行特定调优的方案
- 软件赋能

广泛的生态合作伙伴方案

- 软件协议栈(Level 1 to Level 2+)
- 支持mmWave 和 sub-6GHz 射频
- 制造商和集成商

针对5G NR FR1 和 FR2 的完整平台

4T4R~16T16R Radio Unit (RU)

10 / 25 GbE — **LS104x**

PCIe

LA12xx — **Discrete RF**

Distributed Unit (DU)

LA120x lookaside accelerator

PCIe

LX2160 L1/L2

10 / 25 GbE — 10/25GbE

Scalable Modular System Implementation for multi-CC performance

100MHz 4R4T SA Customer Premises Equipment (CPE)

1/2.5/ 10GbE — **LS1xxx** — **LA12xx** — **Discrete RF**

PCIe

2x400MHz 2R2T SA Customer Premises Equipment

1/2.5/ 10GbE — **LS1xxx** — **LA12xx** — **mmWave RFIC**

PCIe

2x400MHz 2R2T Integrated Small Cell

1/2.5/ 10GbE — **LS1xxx** — **LA12xx** — **mmWave RFIC**

PCIe

100MHz 4R4T Integrated Small Cell

1/2.5/ 10GbE — **LS1xxx** — **LA12xx** — **Discrete RF**

PCIe

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灵活扩展的 ORAN架构 DU 基带解决方案

System main components

- **16-Core ARM64b SoC (A72 @2.2GHz) Multicore**
  - 282GFLOP (32b) or 563 GOP (16b)
  - Multiple datapath accelerators
  - highspeed PCIe and Ethernet
- **High Performance Ethernet subsystem**
  - 114Gbps Ethernet bandwidth and L2 switching
  - Including QoS, IEEE1588, eCPRI classification
- **Look-aside FECA accelerator**
  - 5G DCI/UCI (Polar) encoder and decoder
  - 5G Shared Channel (LDPC) encoder and decoder

Enclosure Dimensions in inches(15.394 x 10.236 x 1.75) inches
1U Dimensions requirement (in): 16.92in x 11.81in x 1.75in

Solution Features	
Standard	3GPP R.15
BBU Platform	NXP BonnyRigg LX2160 + LA12xx DU reference design
Fronthaul interface	Option 7-2x: eCPRI over 10GE or 25GE
Frequency band	<6 GHz
System bandwidth	Up to 100 MHz, multiple CCs
Duplexing	TDD and FDD
Subcarrier spacing	15kHz, 30kHz, 60kHz, 120KHz
MIMO	4x4 spatial multiplexing
System throughput	Multi-Gbps
Modulation	Up to 256QAM
Layers	Multi-Layers
Sync	GPS, IEEE1588, SyncE
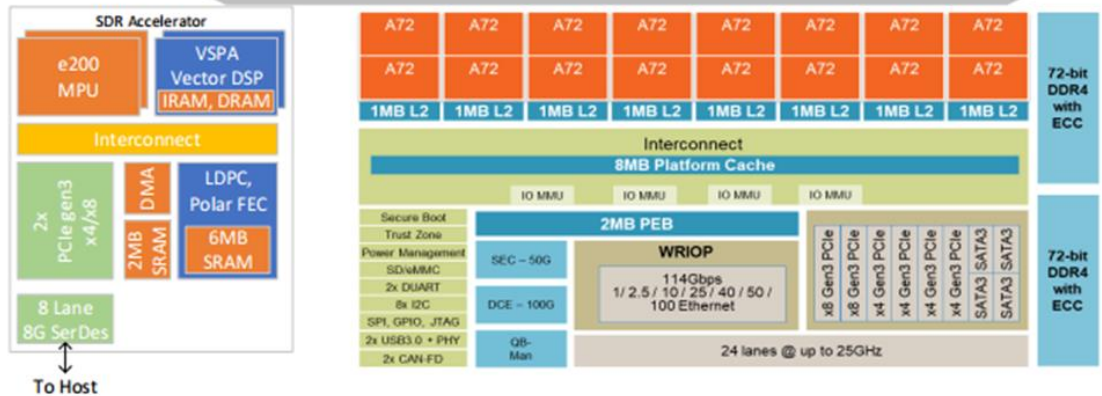
LA12XX 系列高性能基带处理器

Programmable
- Faster updates R15 → R16 features vs. FPGA or ASICs
- Value added features: example: digital front end
- Custom modulation

Flexible
- mmWave or Sub 6GHz configurations
- CPE, RU, DU, Integrated Small Cell use cases
- Modem or offload accelerator

Scalable
- 2T2R → 16T16R
- Indoor femto to O-RAN infrastructure
- Core complex
- 2-4x e200@ <640MHz (equivalent to ARM M7)
- Real time management/control
- 4-8x VSPA3-16@ up to 640MHz (=1.3TFLOP)

Connectivity and I/O
- Zero IF Radio interface
- PCIe gen3
- 2T2R High Speed ADC/DAC complex
- 4T4R Low Speed ADC/DAC complex

Acceleration
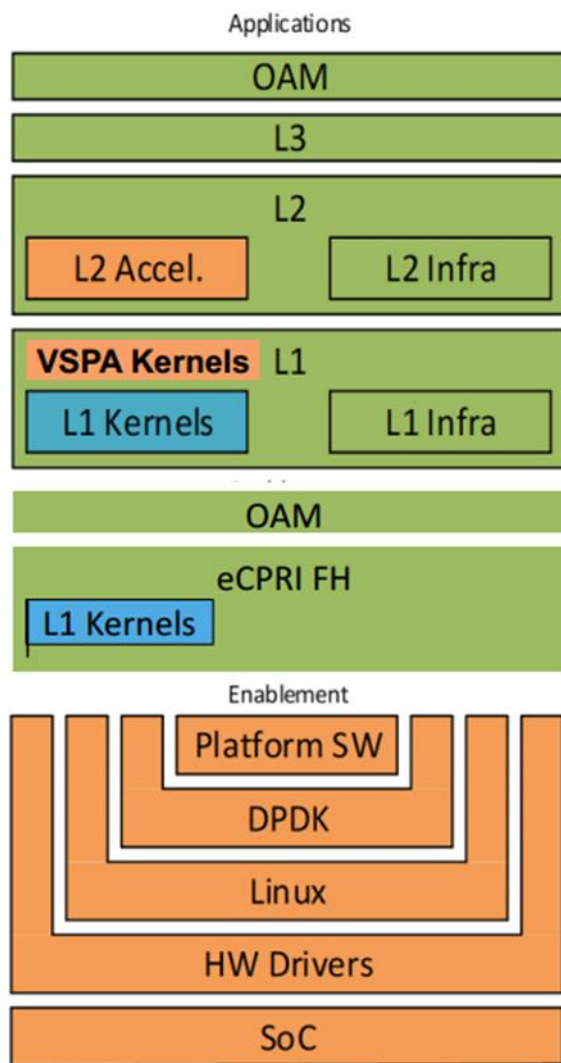- Forward Error Correction: LDPC & Polar en/decode
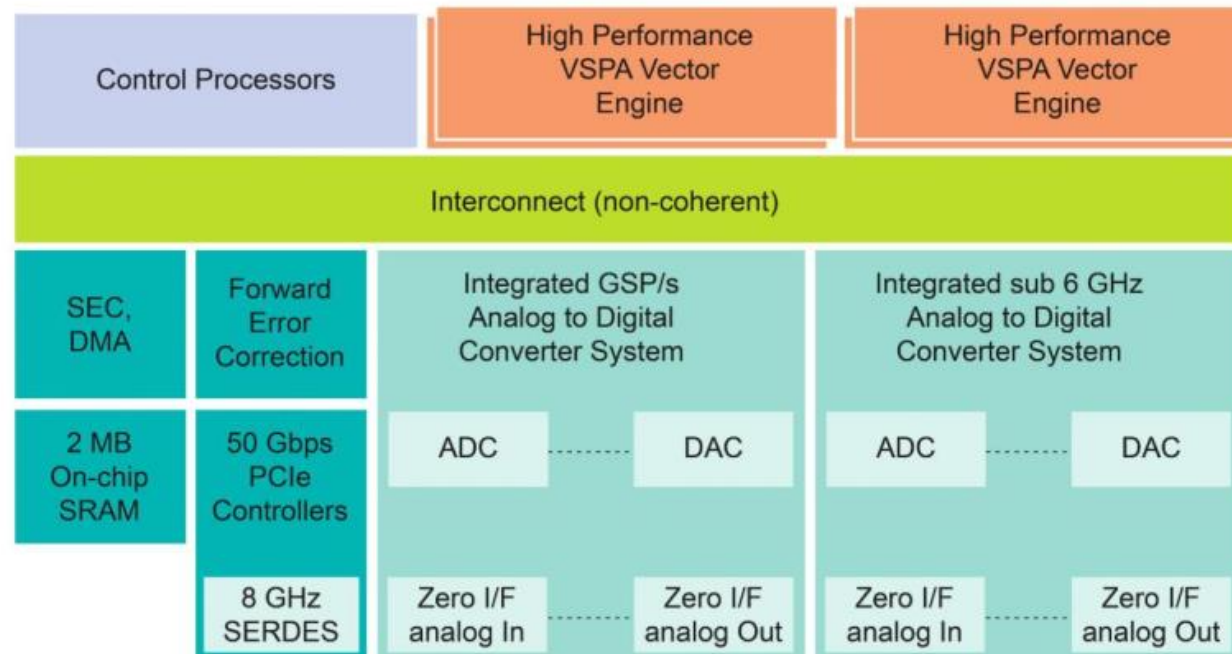
mmWave and Sub-6 GHz Baseband Processor

Ideal, software defined, open baseband processor for:
- <6GHz or mmWave 5G *Small Cell*
- <6GHz or mmWave 5G *FWA CPE / Mesh*
- <6GHz or mmWave 5G *RU*
- O-RAN CU/DU L1 / Error Correction *offload co-processor*
- General compute, aerospace/defense, civilian safety SDR
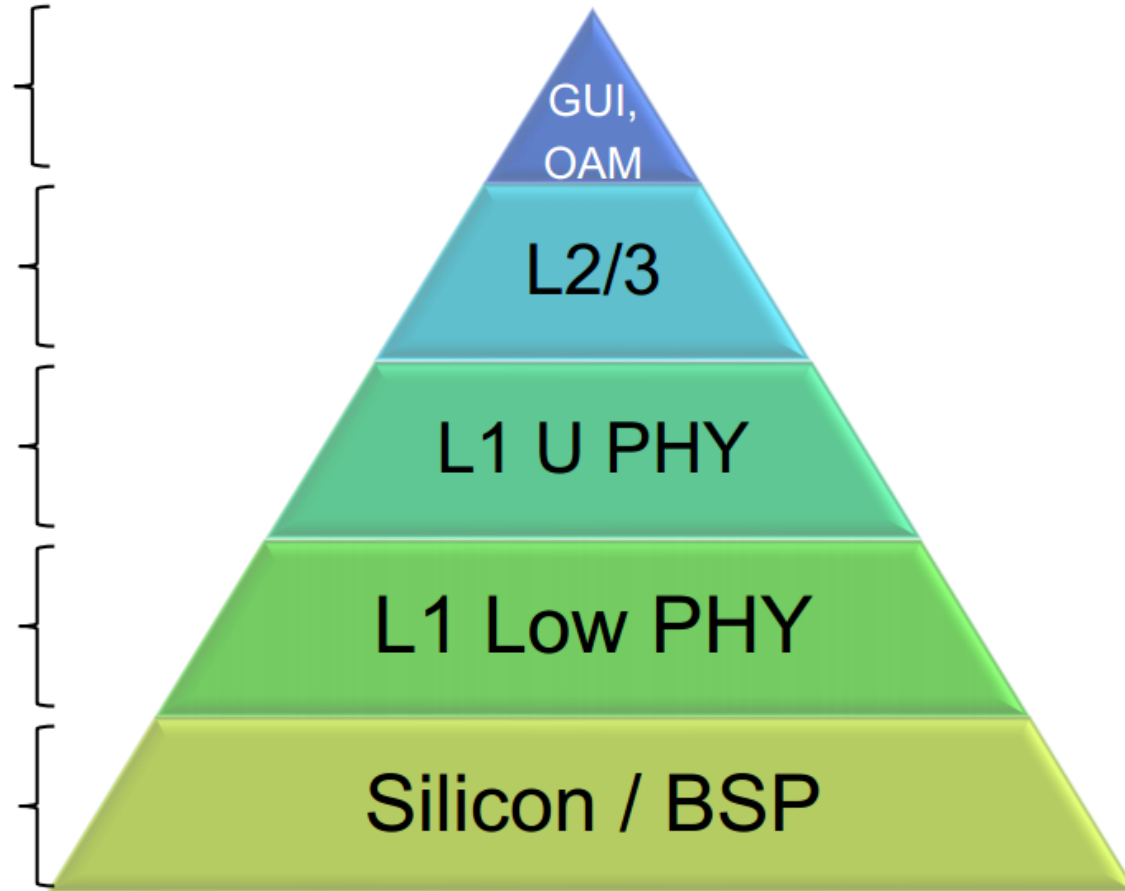
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软件定义 O-DU 以及 O-RU
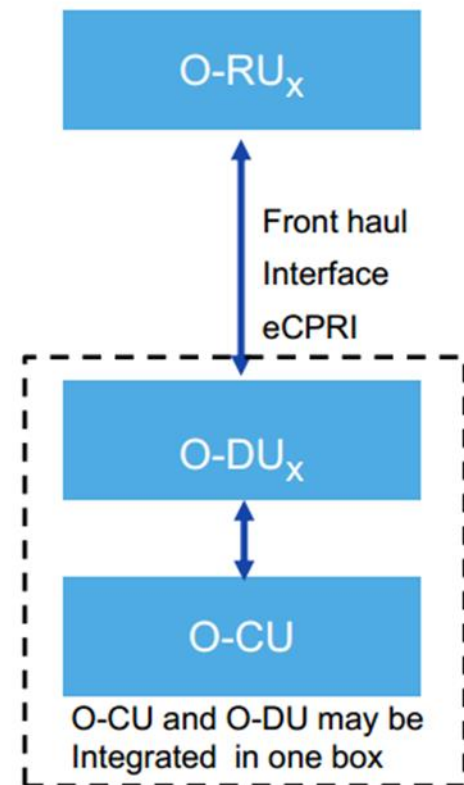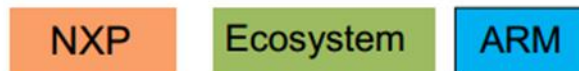
ISC (INTEGRATED SMALL CELL) 软件体系

- NXP has a strong ecosystem with several high-quality options

ODM, L2/3 Vendor

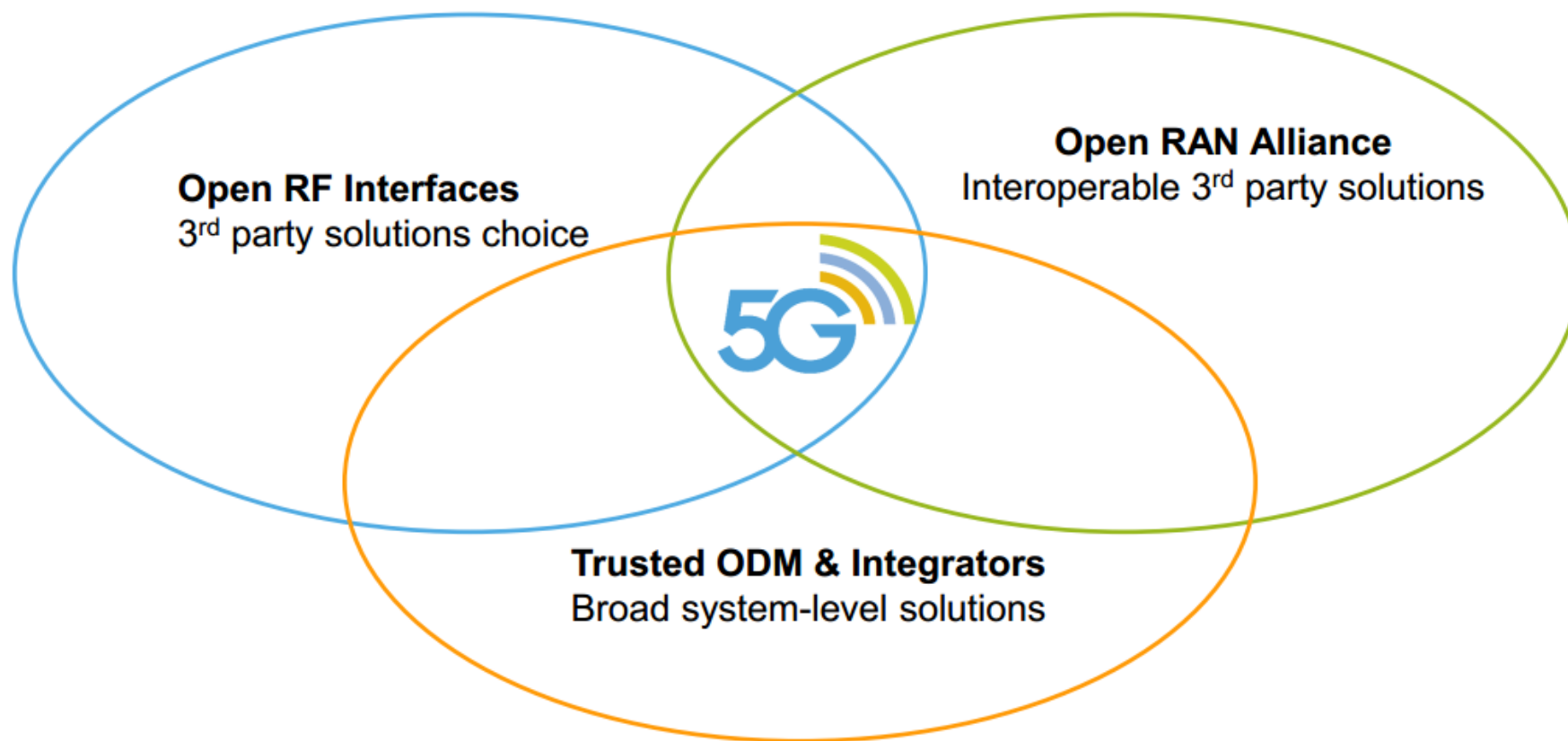- 3rd party vendors to supply L1 upper PHY and integration with upper stacks

Altran, Radisys

ASTRI, ArrayComm CommAgility Synergy

- NXP delivers lower PHY, BSP and libraries

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- ODM and 3rd party software conduct IOT and performance testing

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GUI, OAM

L2/3

L1 U PHY

L1 Low PHY

Silicon / BSP

NXP开放的生态体系

Open RF Interfaces
3rd party solutions choice

Open RAN Alliance
Interoperable 3rd party solutions

Trusted ODM & Integrators
Broad system-level solutions

NXP开放的生态体系

Layerscape Processors

Layerscape Access Baseband Processors LA12XX

- LA120X – DU coprocessor
- LA121X – RU FR1, FR2
- LA122X – CPE FR1, FR2
- LA123X – Small Cell FR1, FR2

- >1Tflop vector engines
- 50Gbps I/O
- 8-10W
- Integrated ADC/DACs
- Integrated FEC

Layerscape Communication SoCs:

- LX2160 – CU/DU
- LS10XX – Integrated Small Cell, RU, CPE

- 2-16 Arm v8 CPUs
- 2.5-100 GbE I/O
- 1-16 PCIe lanes
- 4-30W
- eCPRI offload
- Integrated Security & Virtualization

Ecosystem Partners

Software

ALTRAN
Radisys
ASTRI
ArrayComm
CommAgility

Hardware

movandi
SIVERSIMA

Systems

Multiple ODM and OEM partners

Reference & Development Designs

Reference Design: LA1224-RDB Development system

Orderable today as part of Access Program

Reference Design: LA12XX CPE Development system

Proof of Concept and IODT test System

Reference Design: LA93XX RU Development system

Orderable Q1 2020 as part of Early Access Program

Reference Design: LX2160 PCIe iNIC CU Reference system

ODM solutions

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工业和物联网场景
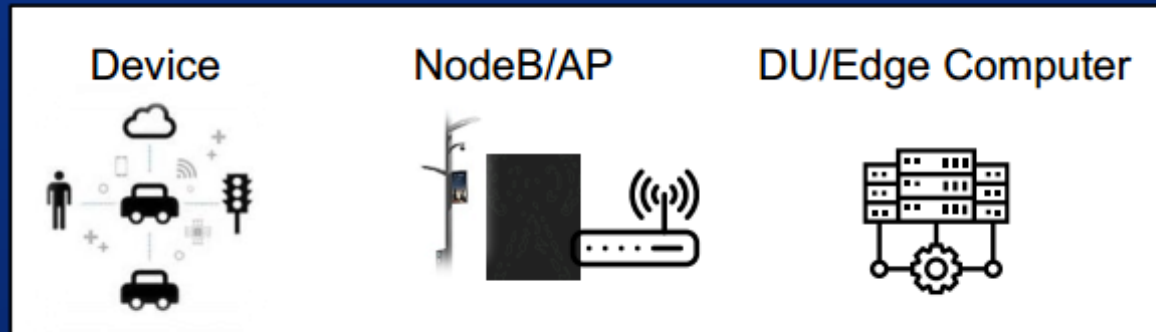
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5G用于工业场景 – 从公用网络到垂直应用

Example: Automated Guided Vehicle (AGV)

- **Today Layerscape has adoption in AGV solutions for path planning & motion control – e.g. LS1043, LS1046**
- **Next generation: Smart & Adaptive AGV**
  - *Smart* AGV acquires real-time environment information via computer vision technology
  - 5G small cell on site - link to the cloud, training via environment data
  - Inference on the intelligent AGV to achieves autonomous obstacle avoidance   increased efficiency & more adaptive AGV solutions

Outdoor / Indoor Case

Indoor Case

End-to-End latency required at ~5ms
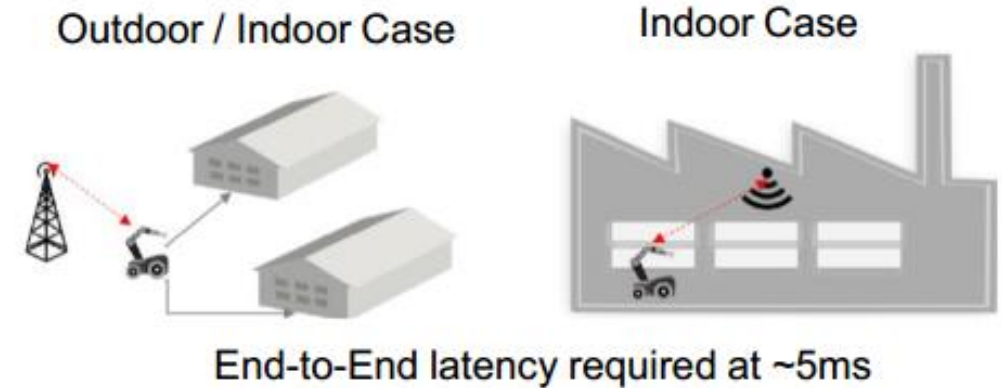
The Generalized 5G Access Edge & Edge Compute Case

5G

Device   NodeB/AP   DU/Edge Computer

→ Reduced latency & packet loss

→ Improved efficiency through locality

→ Data privacy

Overall 1-10ms Round Trip Delay

1-5 ms
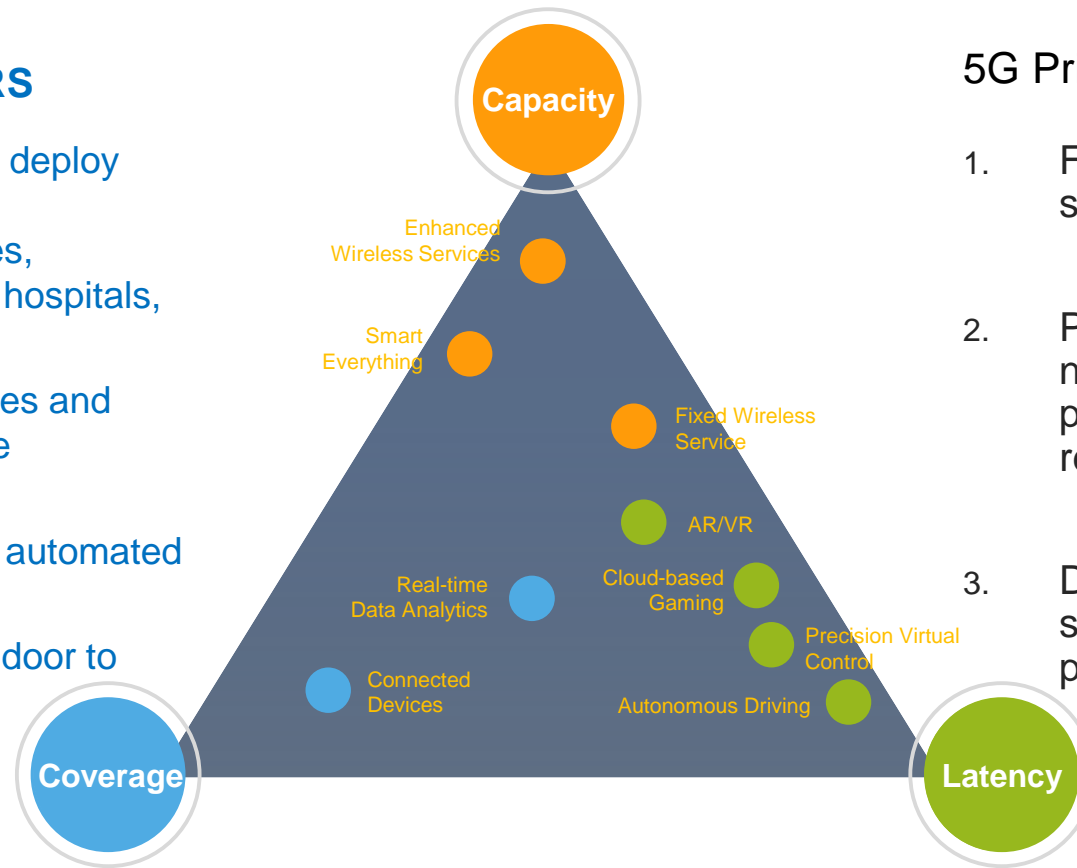
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5G专用网络扩展了TSN解决方案的覆盖范围
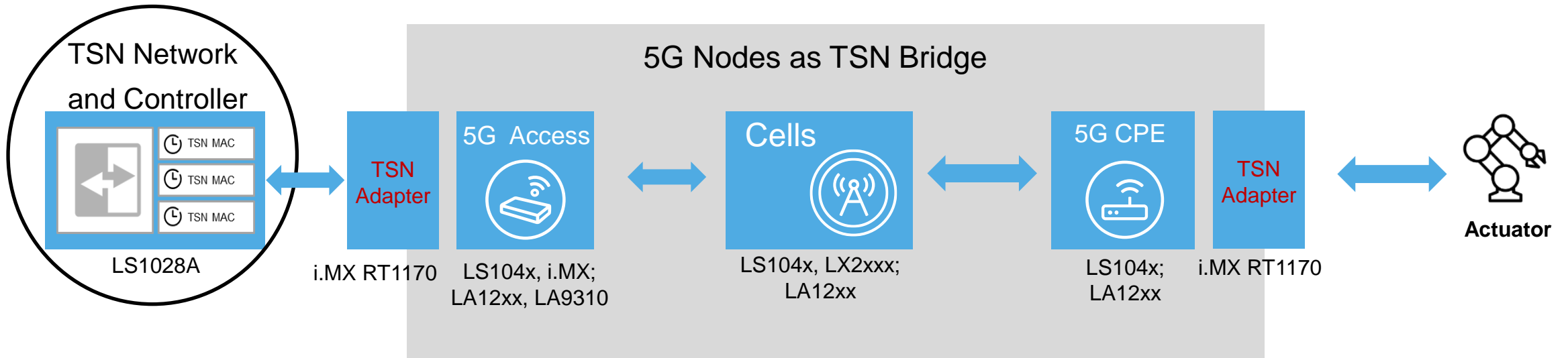
- Combining 5G and TSN for deterministic connectivity end-to-end between end points (e.g. Actuator above) and controller residing in an edge cloud
- NXP enables the necessary hardware and software platforms for the 5G-TSN integration
- Thus providing the key technology components for combined deployment in private networks

5G特性之平衡三角形

5G DEPLOYMENT DRIVERS

- 100s of thousands of companies to deploy private 5G networks this decade: manufacturing facilities, warehouses, seaports, and mining operations to hospitals, and utilities.

- 100s of millions of connected devices and sensors with massive machine-type communication

- Low latency and wide coverage for automated guided vehicles

- 3GPP provisions for Wi-Fi to 5G, indoor to outdoor hand-off

Capacity

Enhanced Wireless Services

Smart Everything

Fixed Wireless Service

AR/VR

Real-time Data Analytics

Cloud-based Gaming

Precision Virtual Control

Connected Devices

Autonomous Driving

Coverage

Latency

2019+

Enhanced mobile broadband

2021+

Ultra-reliable and low latency communications

2023+

Massive machine type communications

5G Private Networks → efficient edge compute

1. Flexibility and integration options: flexible / scalable system implementations

2. Performance and Reliability: the growing number of devices requires high performance networks; Industry 4.0 requires reliable connectivity

3. Dense Networks, Coverage, and Control: support growing number of devices and in parallel control data processing and storage

Sources: Jefferies, NXP

边缘计算需求量激增
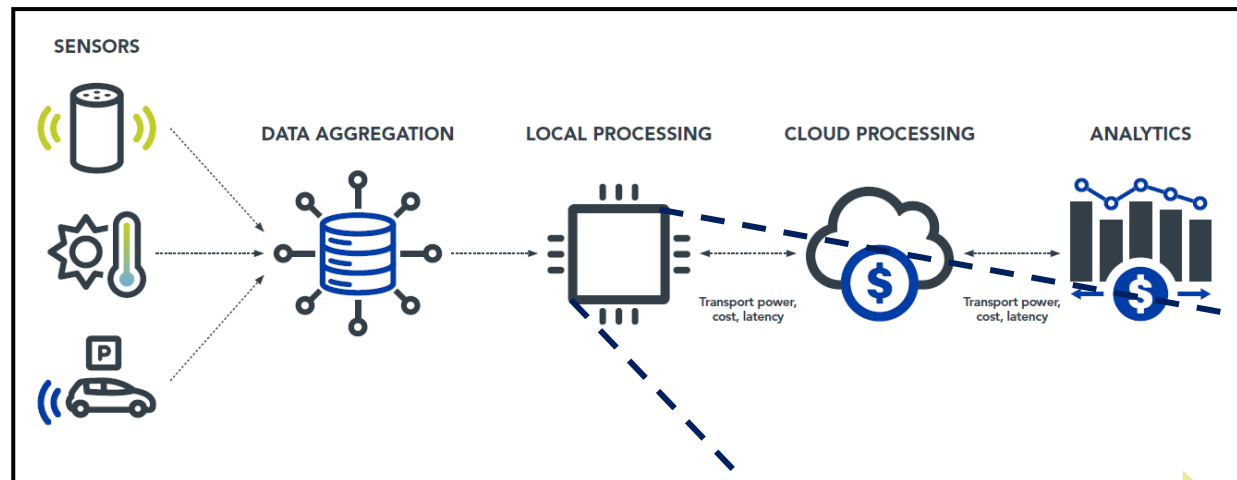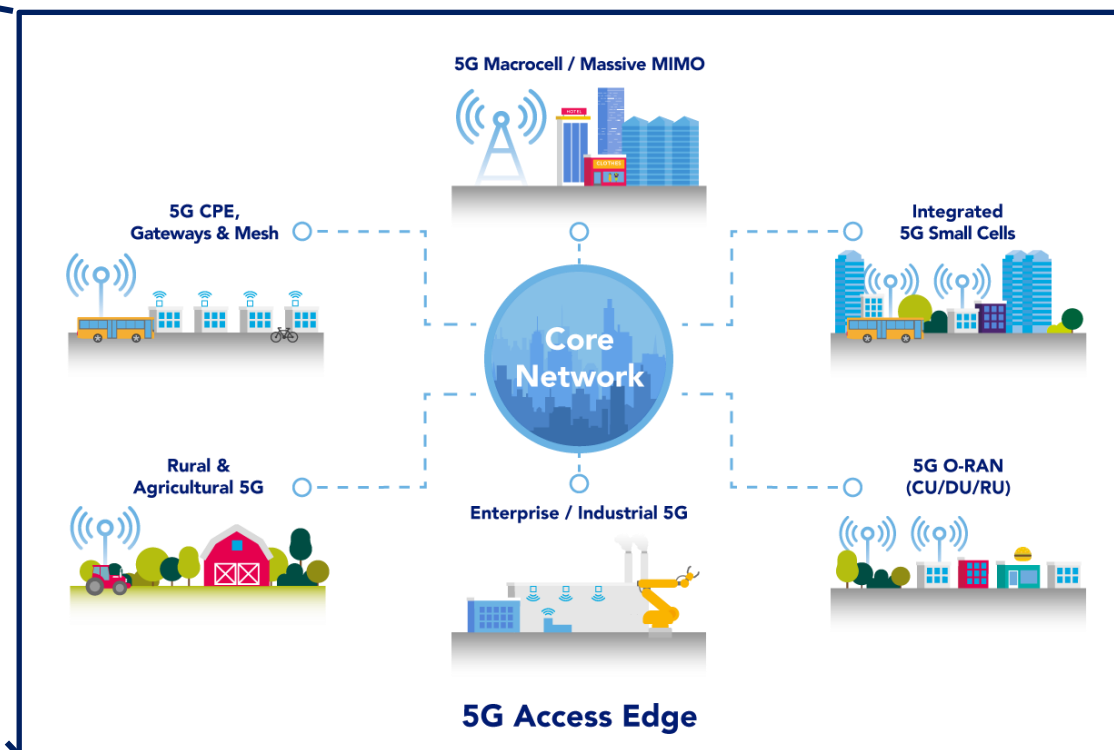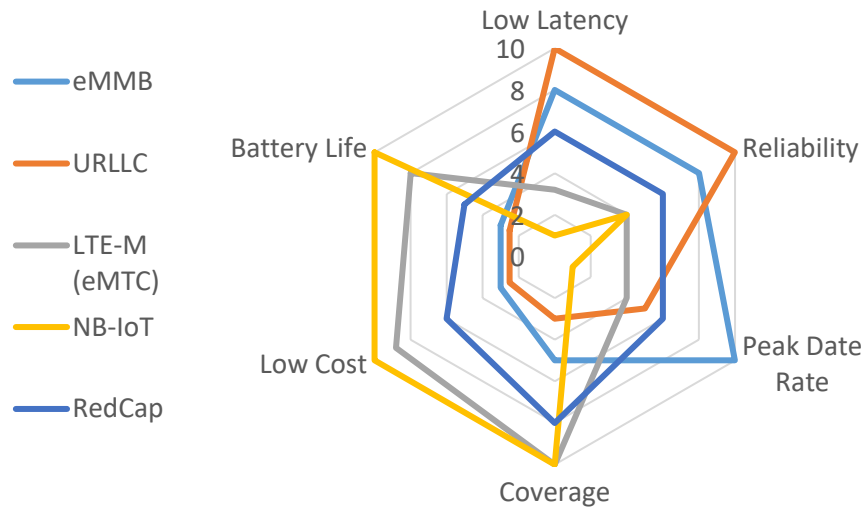

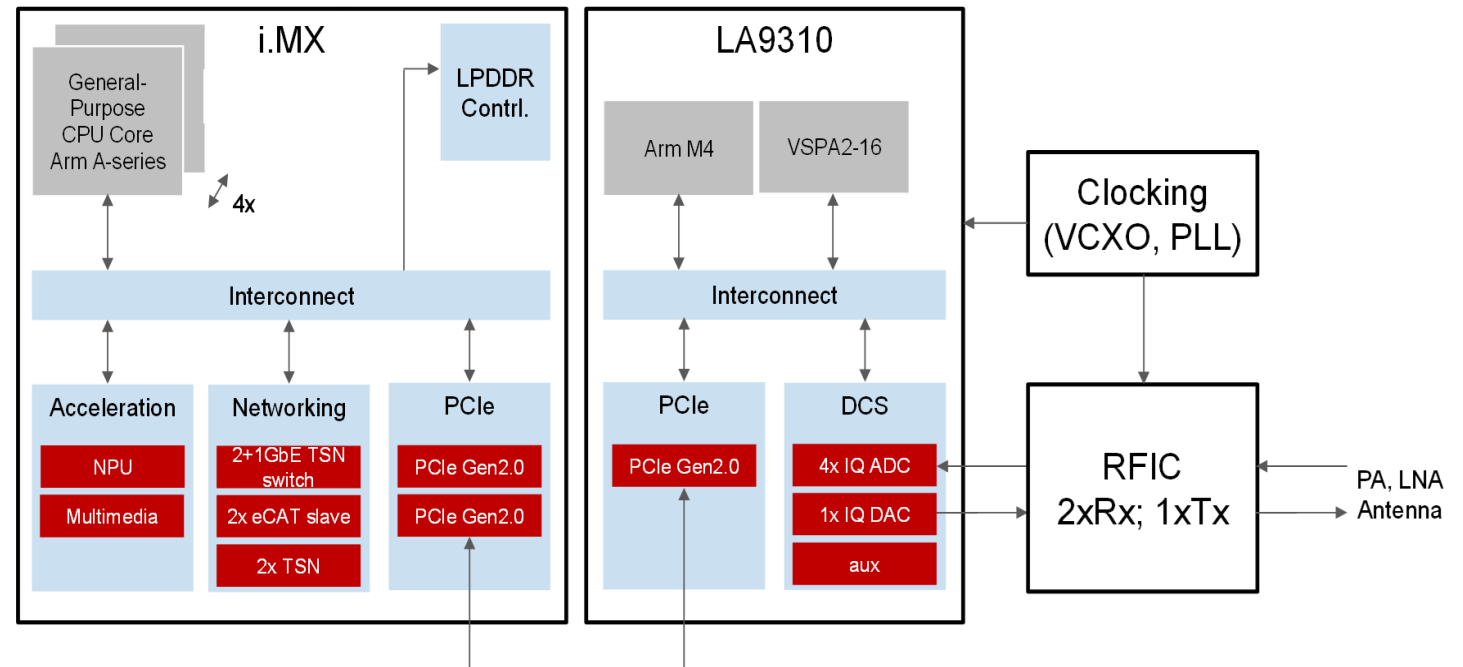Power, Processing Cost, Latency

Edge Compute Considerations

- Energy/bit
- Connectivity including WiFi and 5G
- Edge to Cloud Infrastructure
- Security and Lifecycle Management
- Intelligence: ML and AI at the edge

5G RedCap 方案 (Reduced Capability, in 3GPP R17)

RedCap is a balanced solution for edge

- Application/host processor = NXP i.MX processor. Responsible both for the Industrial/IoT processing as well as implementing the upper-Phy and L2+ stack components of the 5G RedCap modem

- Low-Phy modem = LA9310; Responsible for the low-Phy processing of the RedCap UE, including ADC/DAC data conversion to analog baseband IQ

- RFIC (3rd party) converts analog baseband IQ to RF signals that are fed to/from discrete PA, LNA and antenna pieces of the system