CEC Continuing Education Center

DesignNews

5G Tech for Industrial Automation

DAY 5 : Future Directions

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Louis W. Giokas

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Course Overview

In this course we will analyze the impact of 5G technology on the industrial automation space. 5G has the ability to replace all of the wireless, and most of the wired, technologies in in the IIoT (Industrial Internet of Things), providing direct connection to the cellular infrastructure. This brings with it a simplified and more robust network architecture. It allows direct connection to remote computing resources including cloud computing. We will look at how this will roll out and what the near future will bring as 5G evolves rapidly.

Class Overview

5G is new and fast evolving technology. We will review enhancements for the IIoT which are already being proposed. We will also look at advancements in hardware and software expected in both the near term and long term. Having an insight into what is coming can be very useful in planning your implementation and rollout.

Agenda

- Overview
- Standards Development
- Devices
- Industry Applications

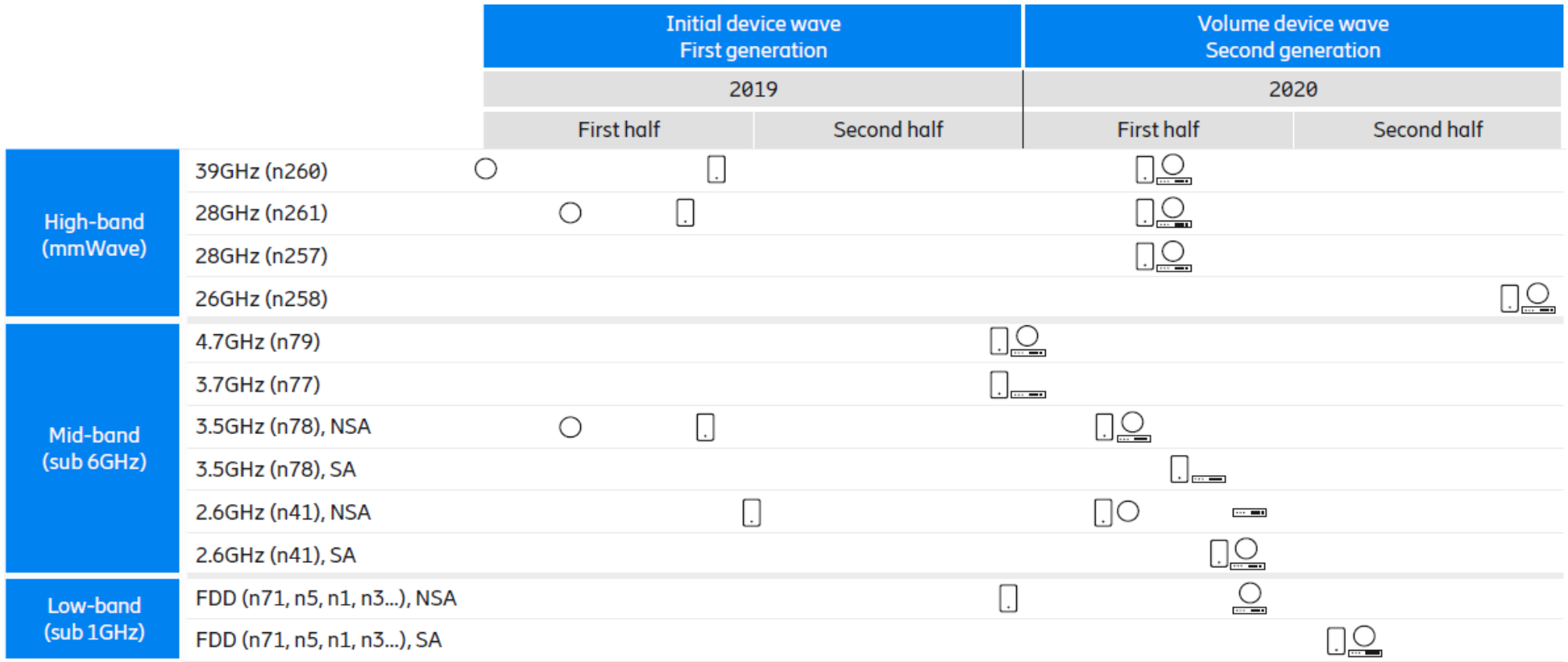
Overview

5G is a fast-moving technology at the beginning of its implementation. This affects everything from the standard itself, hardware, software and applications. Device availability drives applications which drives demand for more devices. Devices can divided into two areas. These are the 5G communication devices and the IIoT device which contains it. The trend will be smarter devices implementing more complex algorithms such as AI. We will discuss the trends along these dimensions and give a perspective on how this compares with past standards development.

Overview

- The dimensions along which we will consider the near future include:
  - The standard
  - Devices, concentrating on the communications, or radio, devices
  - Industry Application and their impact.
- It is the work of engineers developing IIoT devices, and their creativity, that will open up new applications and technologies.
- External factors, such as spectrum regulation, will also affect future directions.

Overview

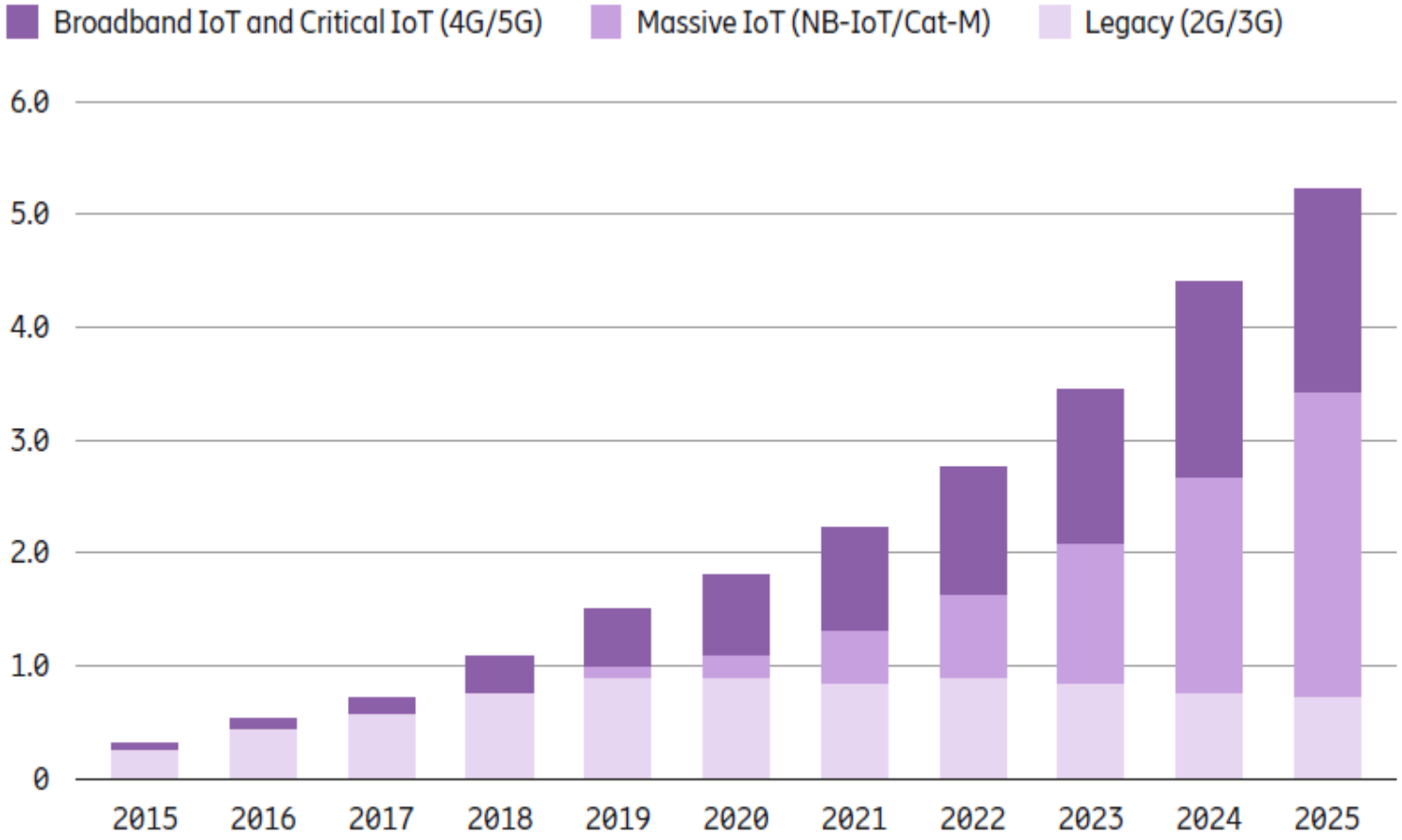


5G device availability (3GPP)

Pocket router Smartphone CPE/FWT

SA: Stand alone
NSA: non-stand alone
CPE: customer premises equipment
FWT: fixed wireless terminal

Overview



IoT	2019	2025	CAGR
Wide-area IoT	1.6	5.5	23%
Cellular IoT[3]	1.5	5.2	23%
Short-range IoT	9.1	19.1	13%
Total	**10.7**	**24.6**	**15%**

[1] Cat-M includes both Cat-M1 and Cat-M2. Only Cat-M1 is being supported today
[2] GSA (April 2020)

Standards Development

- The 3GPP has a definite roadmap for near term development of the 5G standards.
  - This currently goes out at least three releases.
- The engineer must be aware of the planned evolution and act accordingly.
- The communications industry has many good examples of this evolutionary path.
  - Ethernet (expansions in speed)
  - WiFi (expansions in speed and flexibility, including some cellular like features)
  - Cellular itself (2G, 3G, 4G, LTE)

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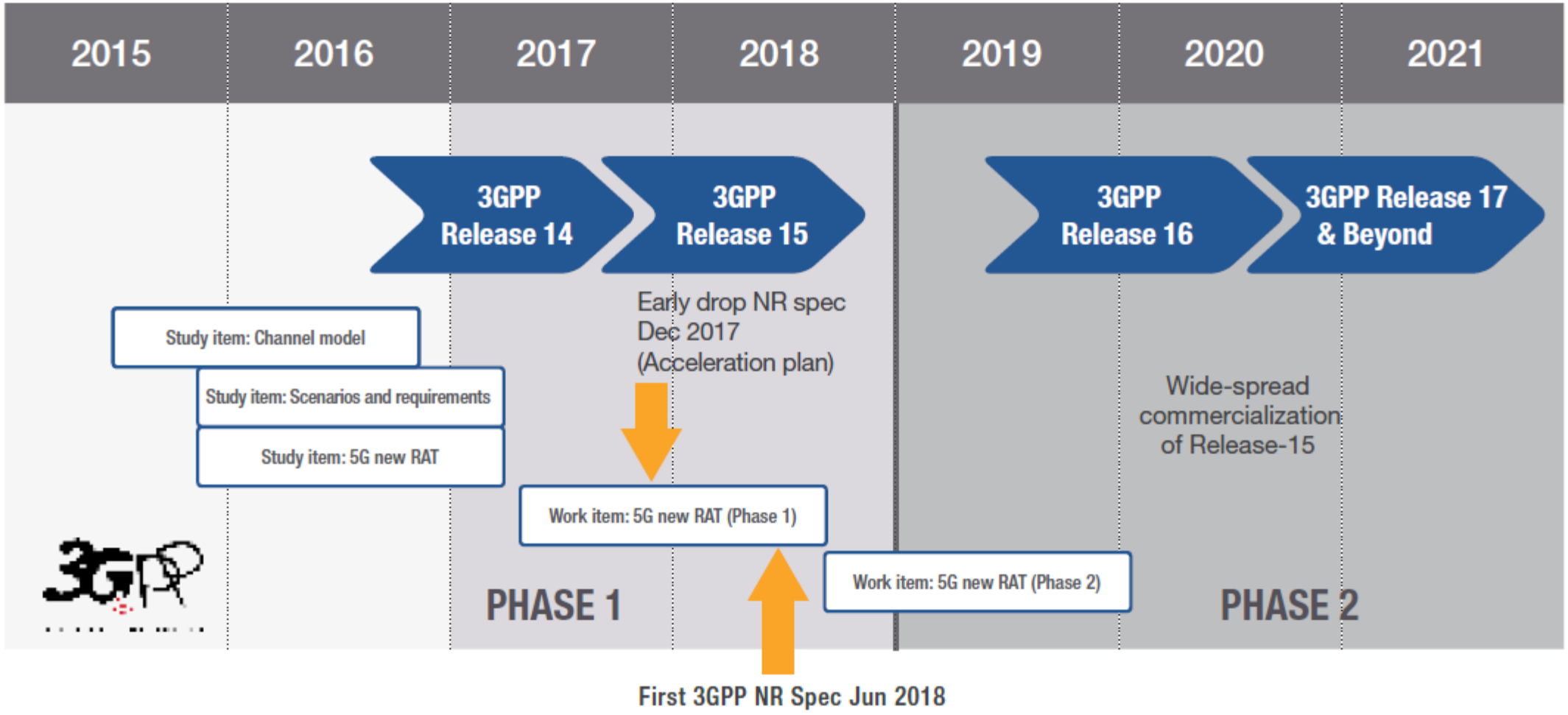
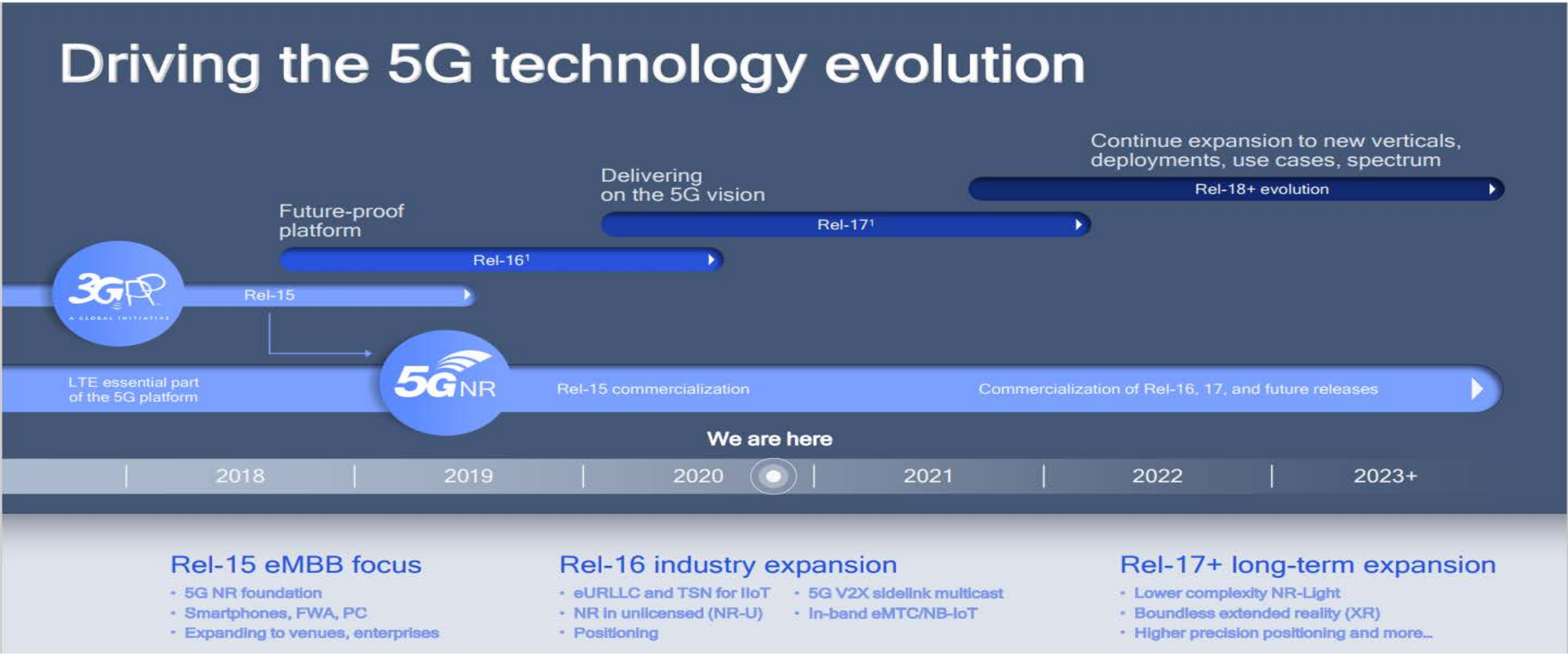
Standards


2015
2016
2017
2018
2019
2020
2021
3GPP Release 14
3GPP Release 15
3GPP Release 16
3GPP Release 17 & Beyond
Study item: Channel model
Study item: Scenarios and requirements
Study item: 5G new RAT
Early drop NR spec Dec 2017 (Acceleration plan)
Work item: 5G new RAT (Phase 1)
Work item: 5G new RAT (Phase 2)
Wide-spread commercialization of Release-15
PHASE 1
PHASE 2
First 3GPP NR Spec Jun 2018

Standards


Driving the 5G technology evolution
Continue expansion to new verticals, deployments, use cases, spectrum
Rel-18+ evolution
Delivering on the 5G vision
Rel-17¹
Future-proof platform
Rel-16¹
3GPP
Rel-15
LTE essential part of the 5G platform
5G NR
Rel-15 commercialization
Commercialization of Rel-16, 17, and future releases
We are here
2018
2019
2020
2021
2022
2023+
Rel-15 eMBB focus
• 5G NR foundation
• Smartphones, FWA, PC
• Expanding to venues, enterprises
Rel-16 industry expansion
• eURLLC and TSN for IIoT
• NR in unlicensed (NR-U)
• Positioning
• 5G V2X sidelink multicast
• In-band eMTC/NB-IoT
Rel-17+ long-term expansion
• Lower complexity NR-Light
• Boundless extended reality (XR)
• Higher precision positioning and more...

Devices

- Different 5G application areas will drive specialization in the communication device space.
  - It is not necessary to support eMBB for a temperature sensor.
- Devices will continue to be improved and will follow industry trends for better power utilization.
- Integration of powerful and diverse processing elements into an IIoT device will improve communication capabilities as well as device functionality.

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Devices

- Spectrum Issues
  - Two types
    - Licensed (service provider controlled)
    - Unlicensed (similar to WiFi)
      - Different considerations in different countries
  - Over time more spectrum will be added.
  - Working with a service provider takes these considerations away from the IIoT device developer.
    - This comes at a cost.

Devices

Can also use 2.4 GHz and 5 GHz currently used by WiFi

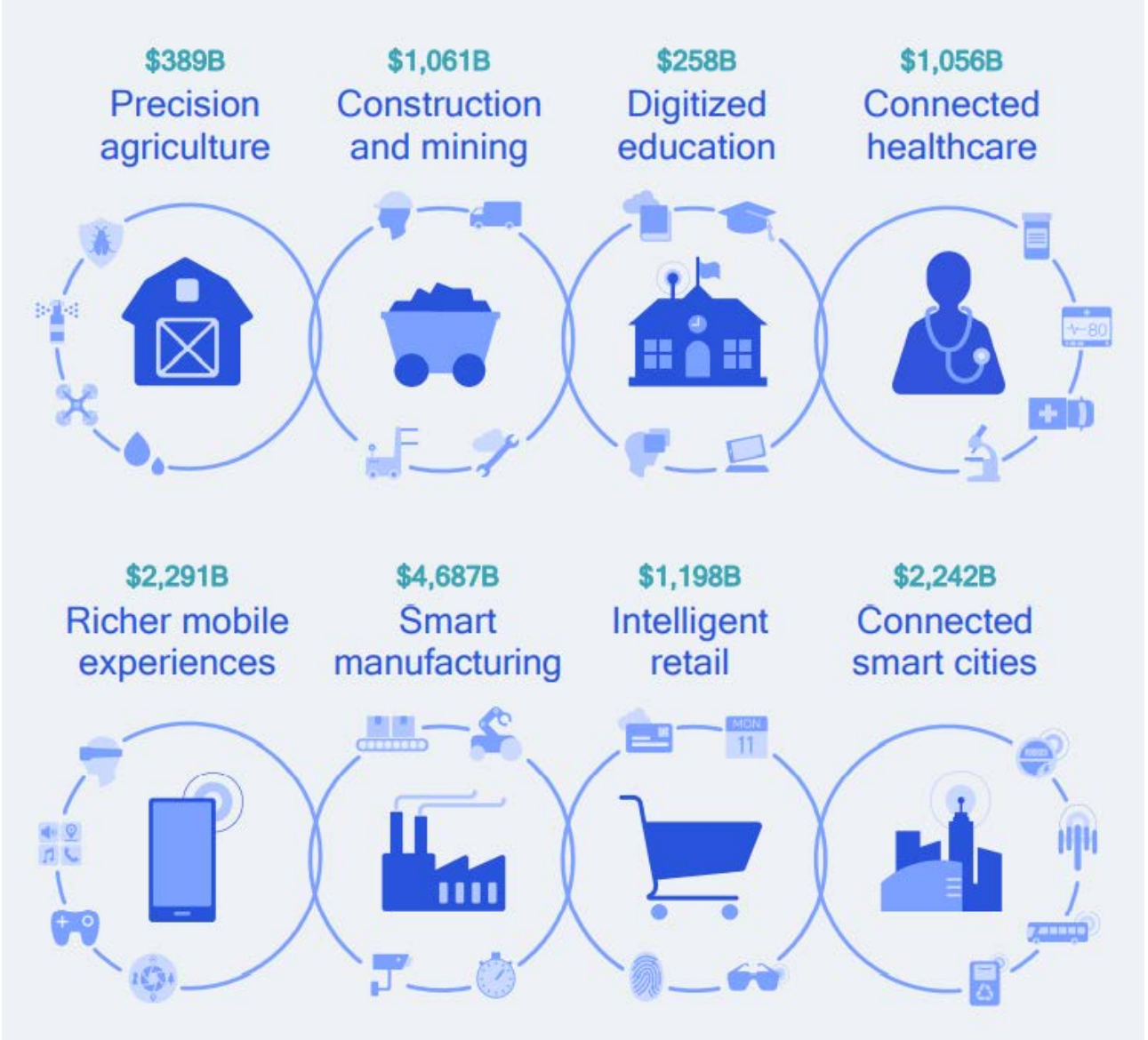
Band	Freq Range	Max Power
U-NII Low / U-NII-1 / U-NII Indoor	5.150–5.250	50 mW
U-NII Mid / U-NII-2A	5.250–5.350	250 mW
U-NII-2B	5.350–5.470	—
U-NII Worldwide / U-NII-2C / U-NII-2-Extended / U-NII-2e	5.470–5.725	250 mW
U-NII Upper / U-NII-3	5.725-5.850	1 W
DSRC/ITS / U-NII-4	5.850–5.925	—
U-NII-5	5.925 – 6.425	1 W
U-NII-6	6.425 – 6.525	250 mW
U-NII-7	6.525 – 6.875	1 W
U-NII-8	6.875 – 7.125	250 mW

Industry Applications

- A driver of 5G adoption is the extension into industrial applications (as widely understood).
  - This is the reason for the URLLC and mMTM features.
  - Some utilization of 4G, through commercial providers, is in use, but this was limited to remote monitoring (e.g., utilities)
  - We call 5G an enabling technology Industry 4.0
    - The fully connected industrial enterprise.

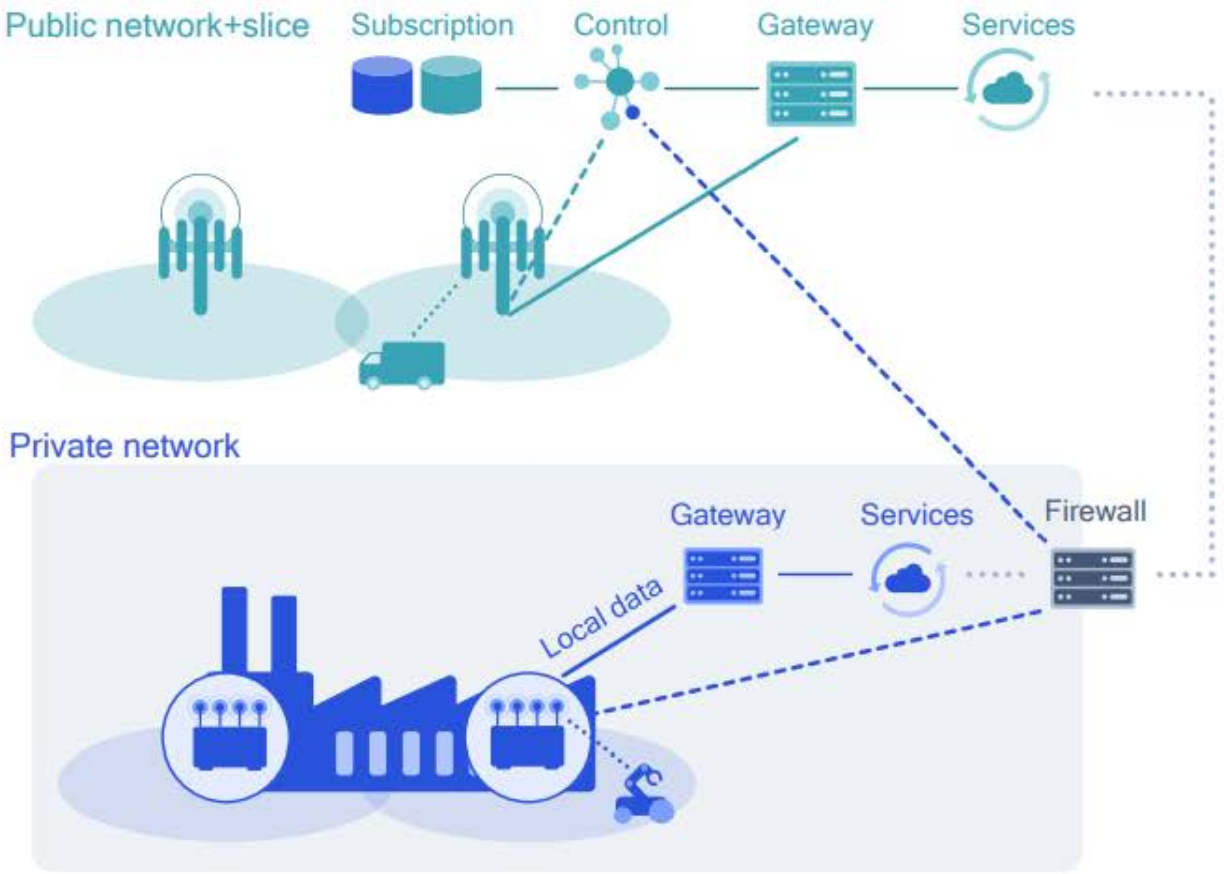
Industry Applications

Projections by application area in 2035.

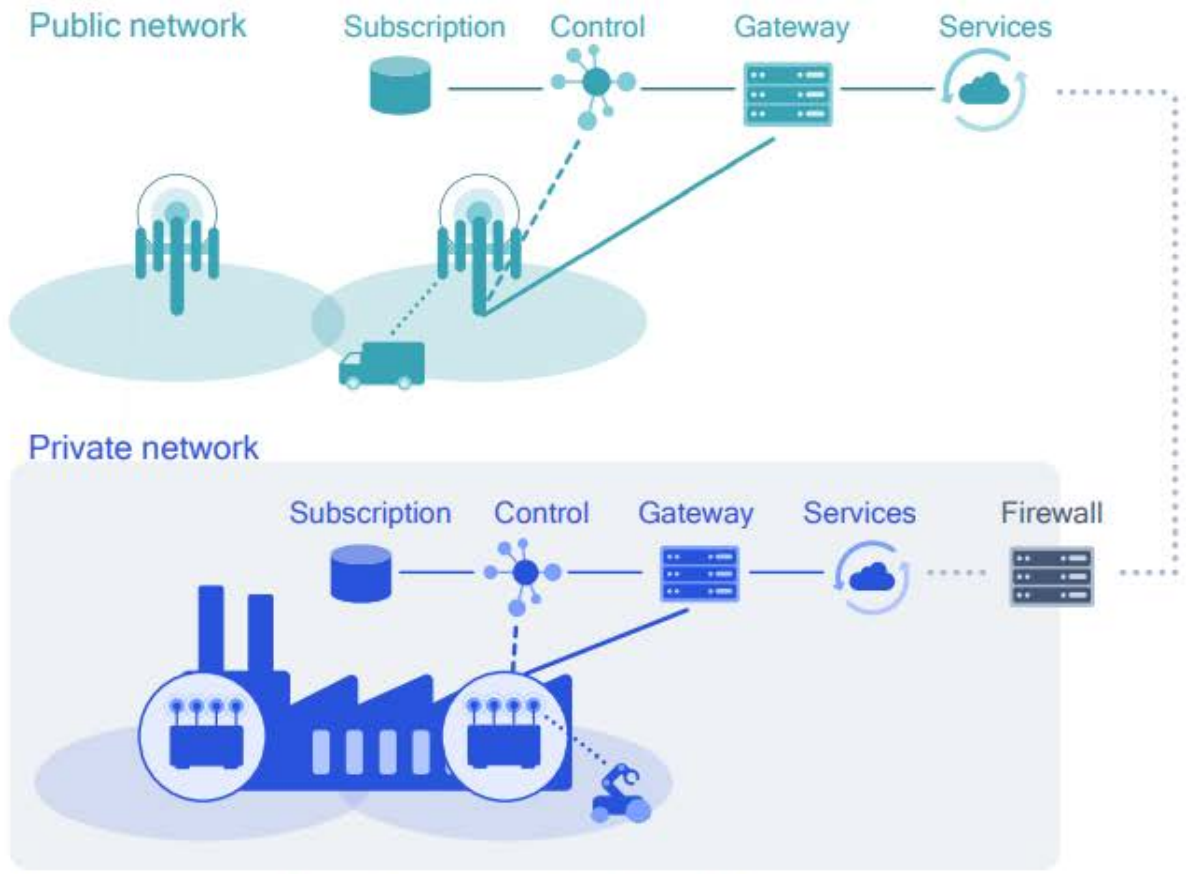


Industry Applications: Types of Network Implementations

Integrated private network



Independent private network[1]

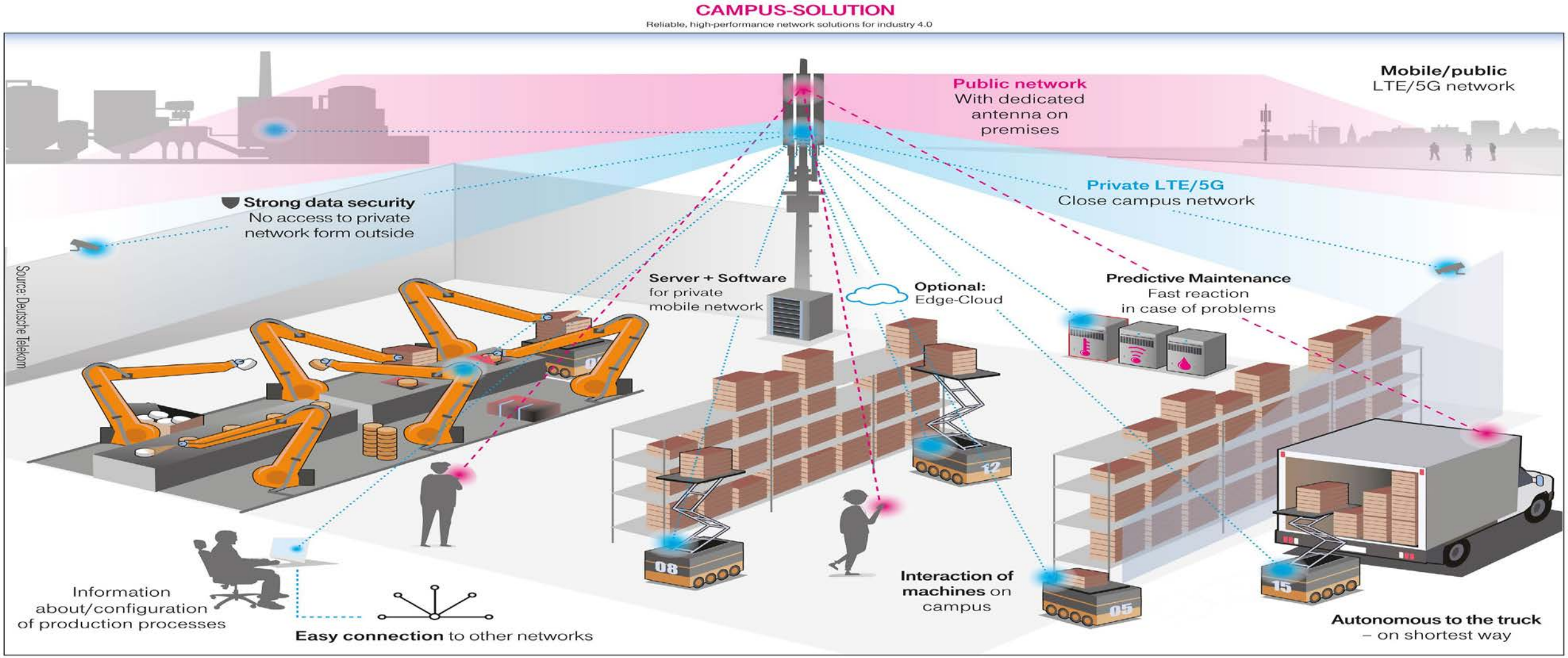


1) Mobility between private and public networks can still be supported via dual subscriptions

Industry Applications

Industry Applications

Industry Applications



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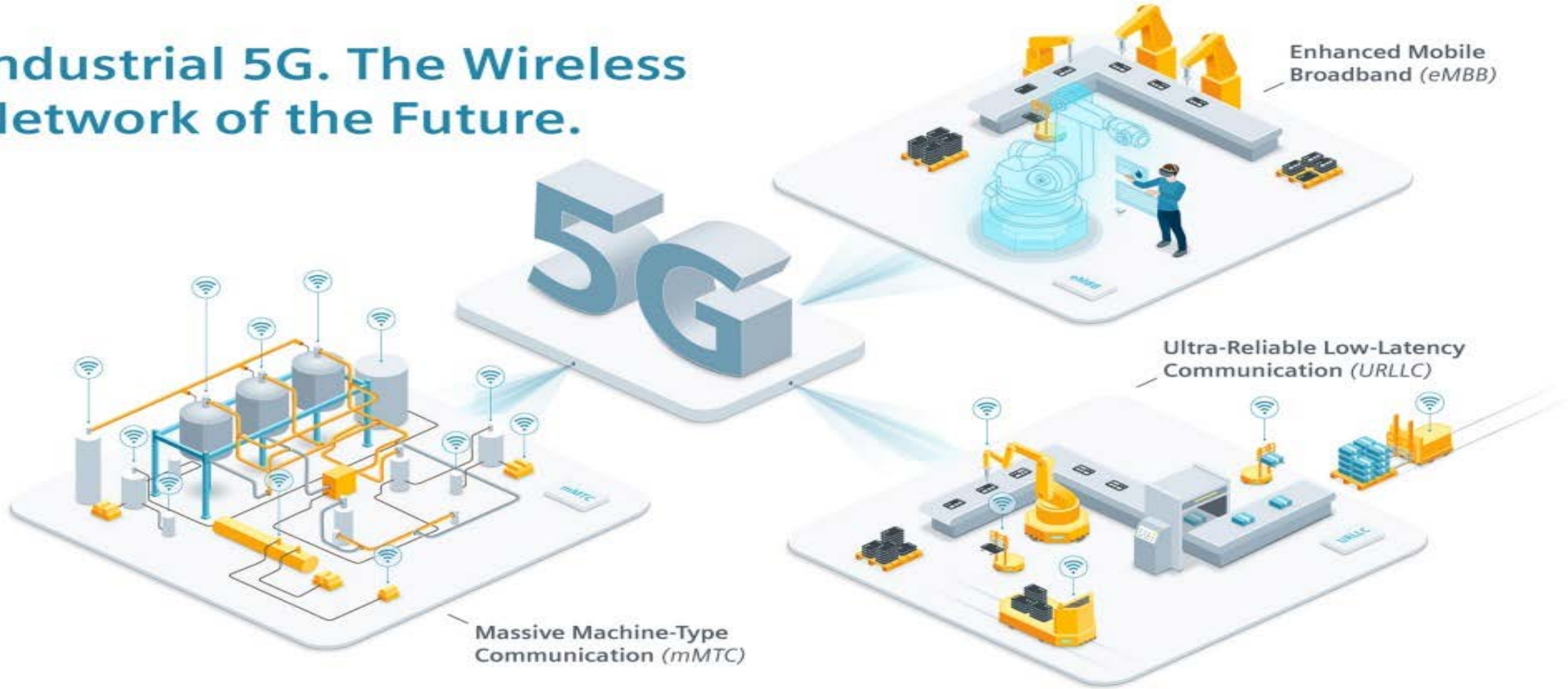
Industry Applications



Thank you for attending

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- I can be reached in the following ways:
  - Email: lgiokas@ieee.org
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