The Role Of 5G In Industry 4.0

August 27th, 2019

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Our speaker

Ludger Boeggering

Areas of expertise

- More than 15 years of experience in energy and industrial automation market

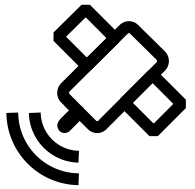
Experience

- Senior Application Marketing Manager for the energy, automation and industry 4.0 sectors at u-blox
- Product Marketing and Sales Director at Sagemcom Dr. Neuhaus GmbH for Smart Metering and remote maintenance
- Engineering degree in telecommunications (Dipl. Ing. Nachrichtentechnik) at the University of Applied Science in Aachen

Innovation for your competitive advantage

Our major R&D themes

Autonomous driving



GNSS & Wireless core technology

Connectivity

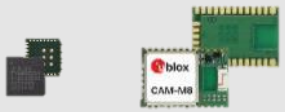
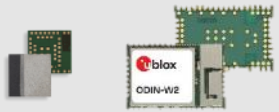
Security

Robustness

Size and cost reduction

We make wireless and location easy

Access the best available solutions for the IoT with our hardware and services

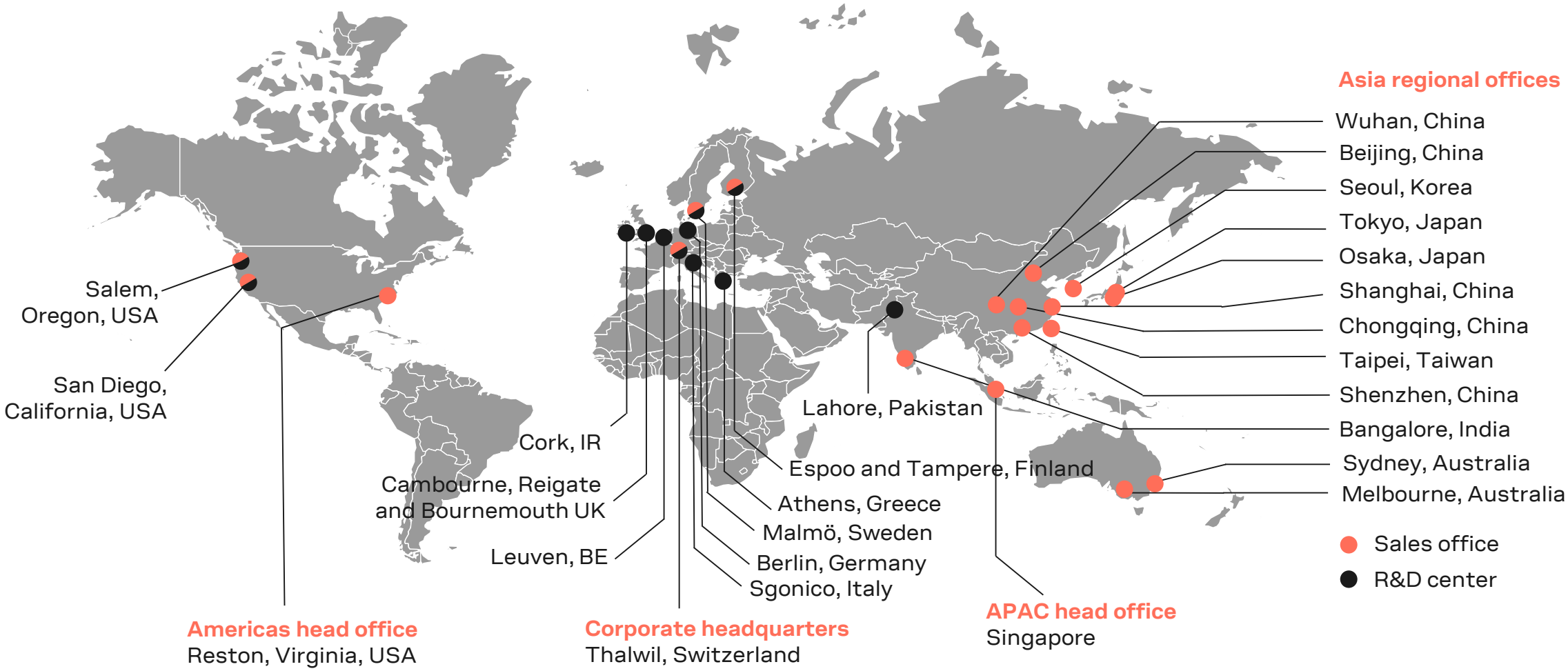
	P Positioning	C Cellular Communication	S Short Range Communication
Integrated Circuits			
Modules			
Services	IoT Communication-as-a-service IoT Security-as-a-service IoT Location-as-a-service		

The **combination of our three core technologies** offered in the form of **chips and modules** provides essential benefits to our customers

- Complete solutions
- Full ownership of technology
- Maximum competence
- Solid product roadmaps
- **Services** on top of HW
  - Improved functionality
  - Secure connectivity
  - Lifetime support

Global presence

29 locations

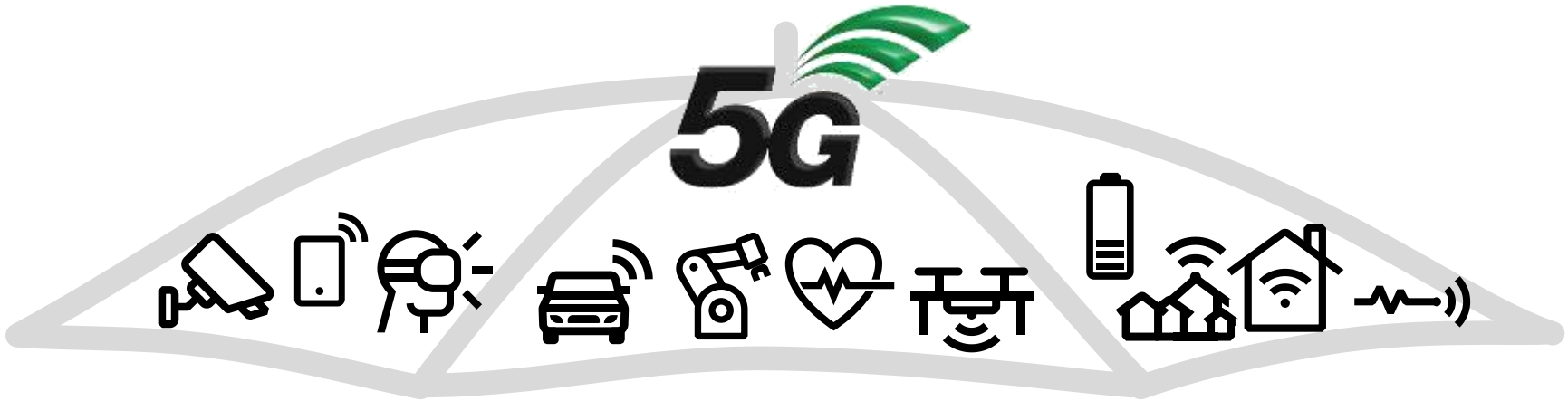


5G

Way To Go

Cellular technology enhanced towards 5G

5G – an umbrella for different use cases



eMBB	URLLC	mMTC
enhanced Mobile BroadBand	Ultra Reliable Low Latency Communications	massive Machine Type Communications
Capacity	**Mission Critical**	**Density**
• Up to 10's of Gbps • 100 Mbps for every user • Spectrum efficiency • 4ms user plane latency • Mobility up to 500km/h	• 1ms user plane latency • High reliability (99.999%) • High availability and resilient	• Energy optimized • Reduced signaling • Higher connection density, I M devices per km^2

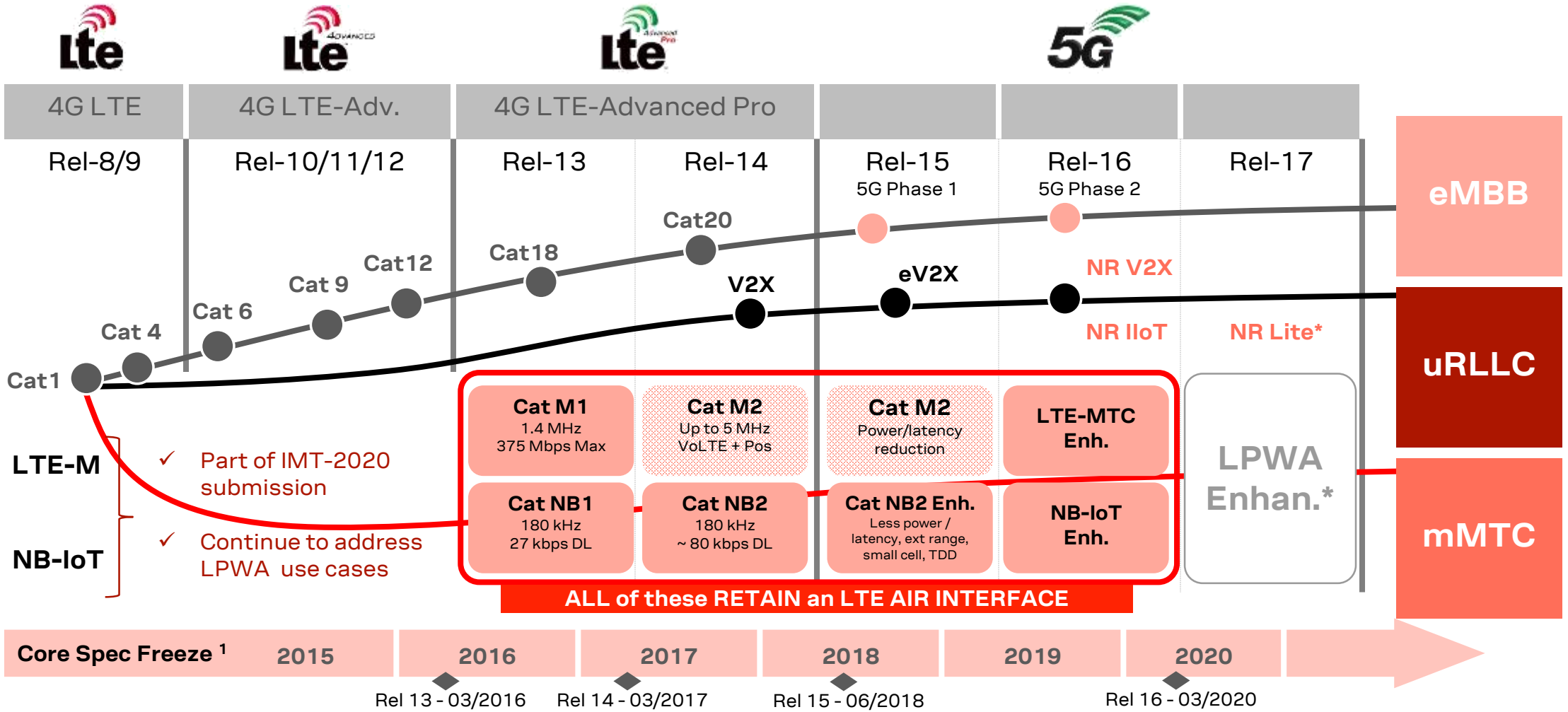
5G is/does many things

- Multiple evolutions in 3GPP Rel 15, 16, 17…, which also evolve LTE, LTE-M and NB-IoT
- Is complementary to, and underpinned by, 4G
- Enhances 4G use cases (MBB, IoT, V2X)
- Adds new use cases (URLLC)
- Enables new spectrum
- Adds a new radio / air interface
- Introduces a new core network
- Introduces new network innovations (slicing, edge compute, virtualization)

eMBB enhanced Mobile BroadBand
URLLC ultra Reliable Low Latency Communications
mMTC massive Machine Type Communications

Evolution from 4G LTE to 5G LTE and 5G NR

NB-IoT and LTE-M to address LPWA use cases in the 5G era



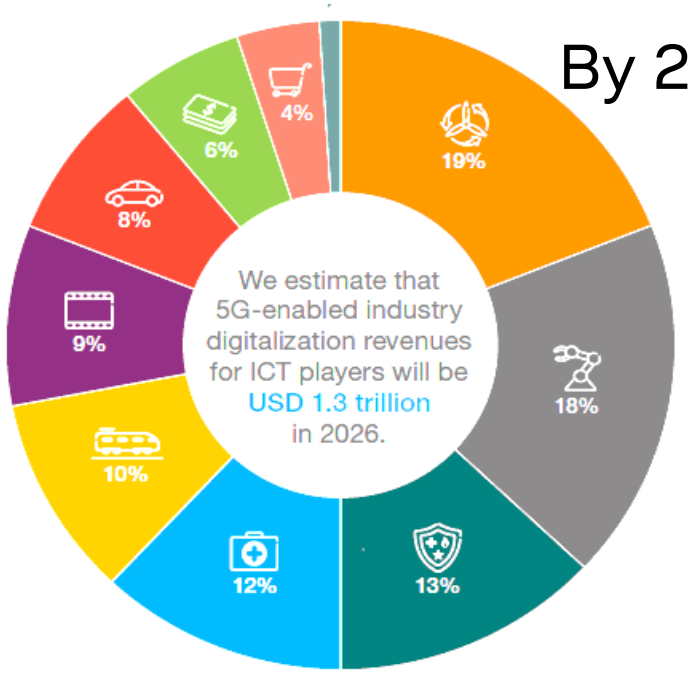
[1]ASN.1 freeze 3 month after that,
Chipset availability expected ~1.5yrs after ASN.1 freeze

* Subject to change pending future 3GPP meeting outcomes

5G-enabled industry digitalization revenues for ICT

Billions of things waiting to be connected

By 2026

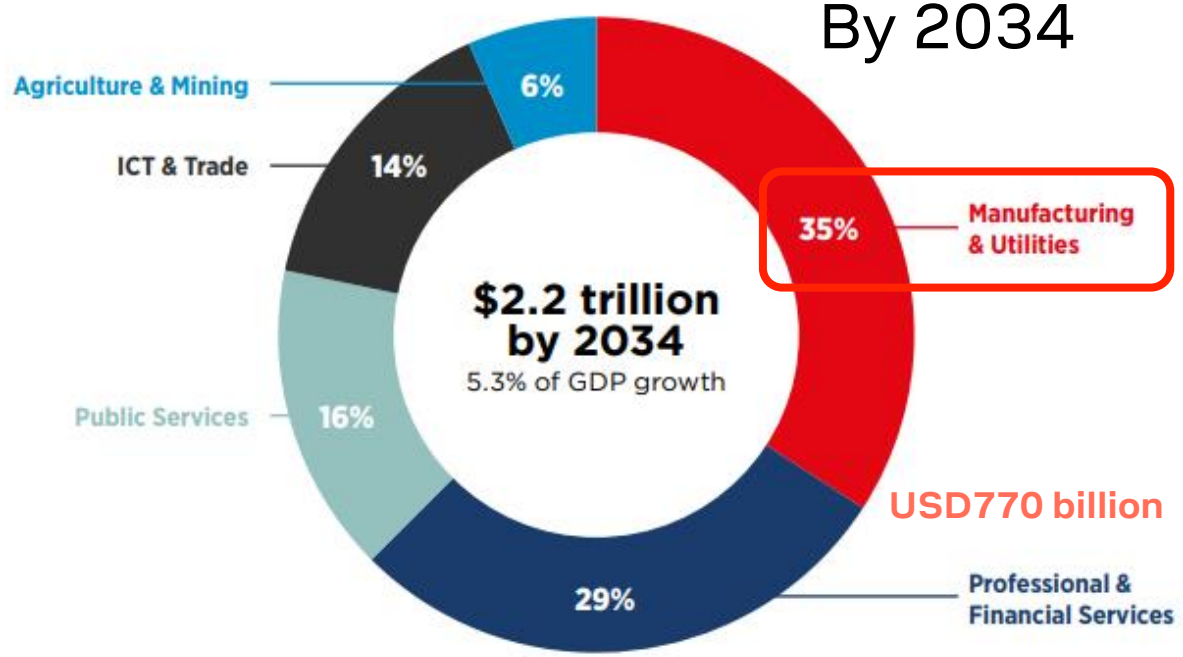


Source: Ericsson

Top 3 (Global)

1. **Energy and utilities** USD247 billion
2. **Manufacturing** USD234 billion
3. **Public safety** USD169 billion

By 2034

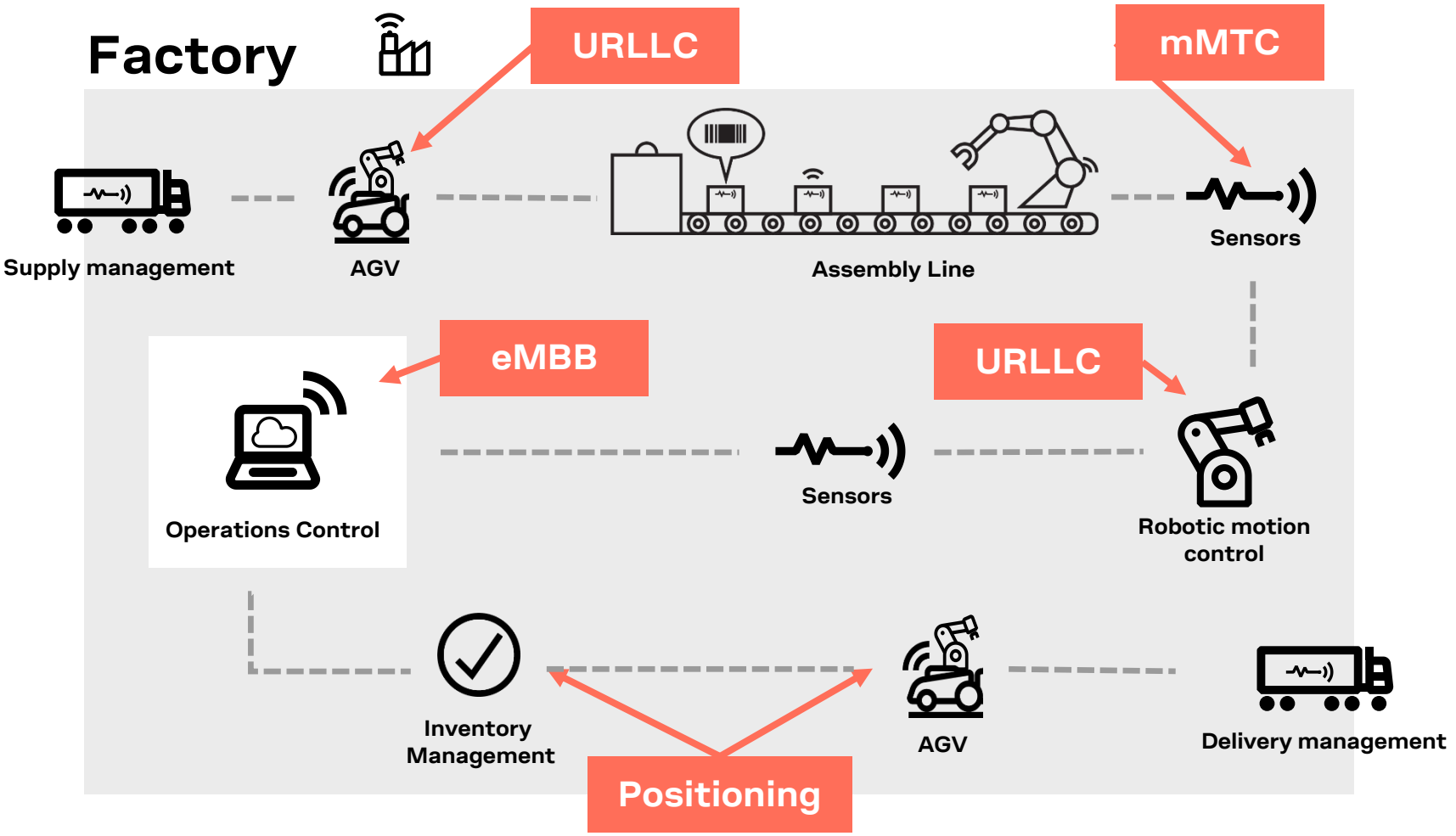


Source: GSMA

GSMA: 5G will contribute $2.2 trillion to the global economy over the next 15 years

Industrial IoT relevant use cases

Automation and manufacturing



Use cases

- Mobile & portable Asset monitoring
- Moving & Rotating Parts
- Sensors & actuators
- AR / VR HMI interaction
- (Intra-) logistics
- Modular & Retrofit Solutions

Ref: 5G-ACIA White Paper

Transformation is not just about new things,

it’s about how to do things differently

Industry 4.0

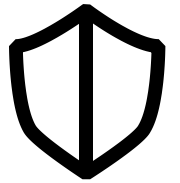
Motivation for transformation and investment

Higher productivity and versatility

Shorter time to market

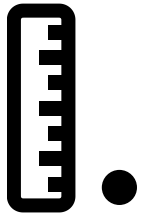
Optimized production process and increased flexibility

Prevent unplanned shutdowns

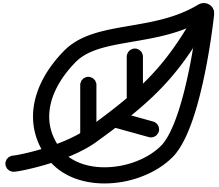


Increase revenue and profitability

Scale individual customization



Optimize resource efficiency and usability



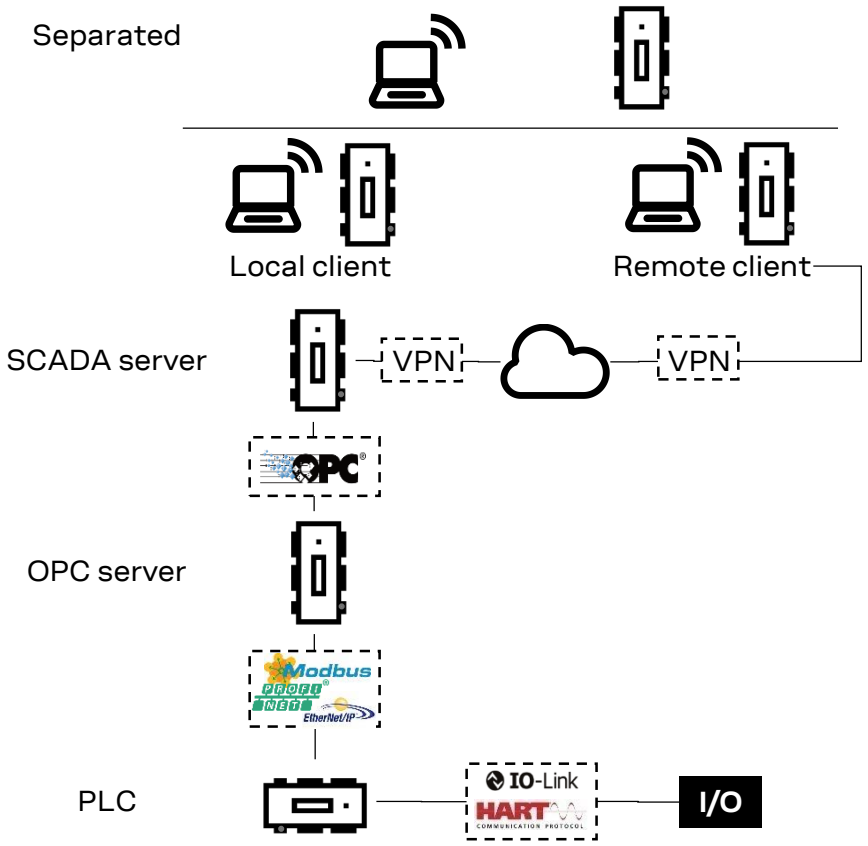
Increase competitiveness

Industry 4.0

Architecture and business model transition

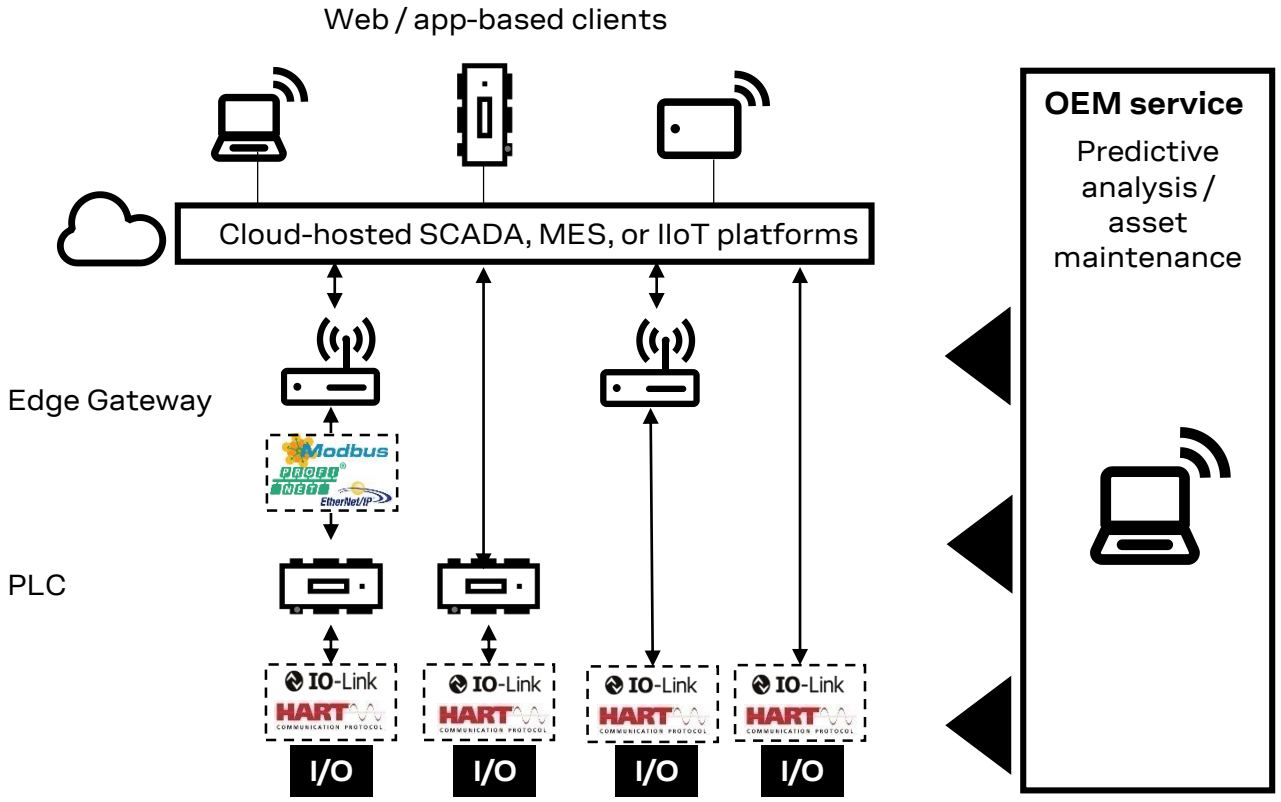
Traditional architecture

Site business planning and logistics



New architecture and new business models

Factory-owner operated

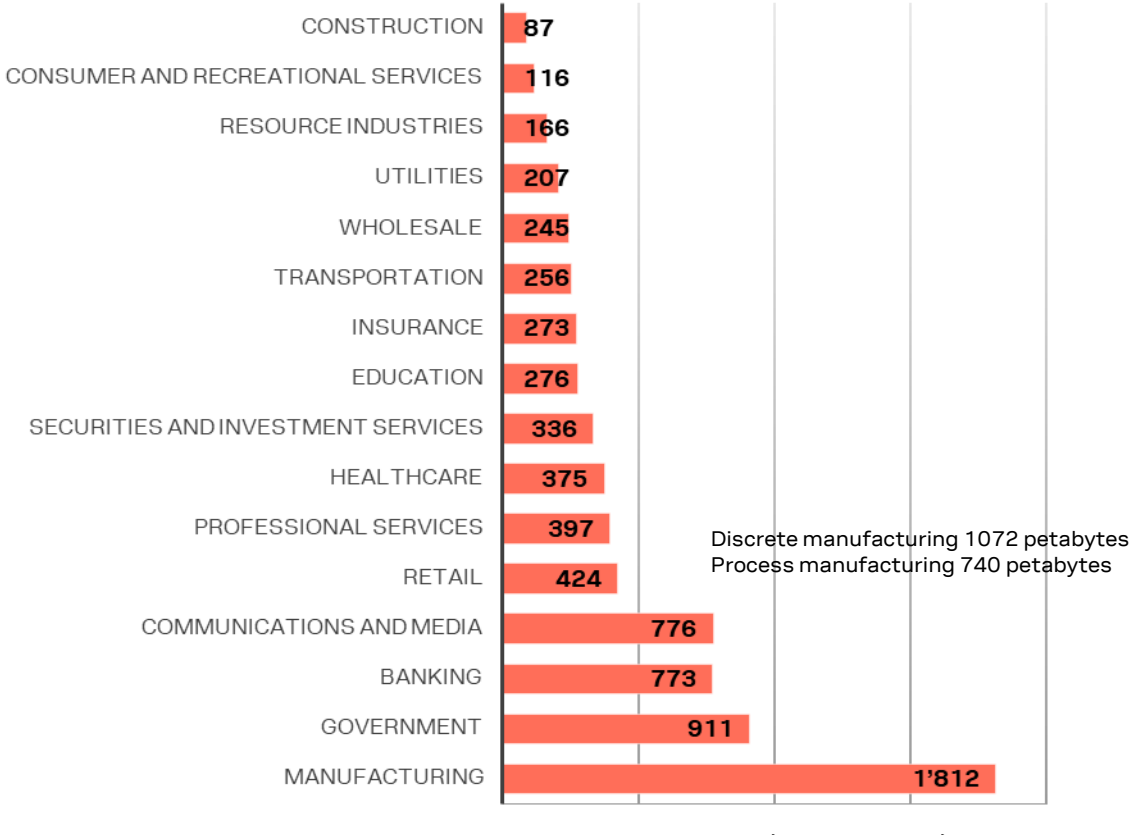


Communication protocols

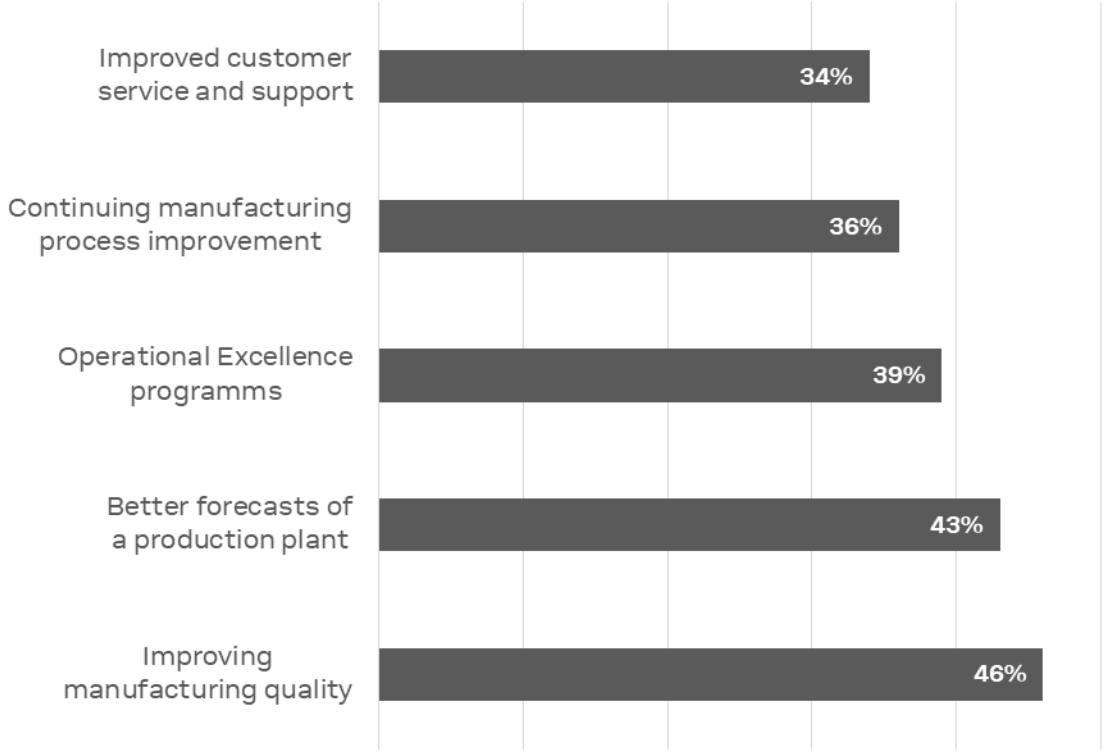
The value of data

Manufacturing already generates more data than any other sector

Annual new data stored by sector



Top 5 uses of analytics in the manufacturing enterprise



Source: © LNS Research, 2018

Focus Only On Using Technology

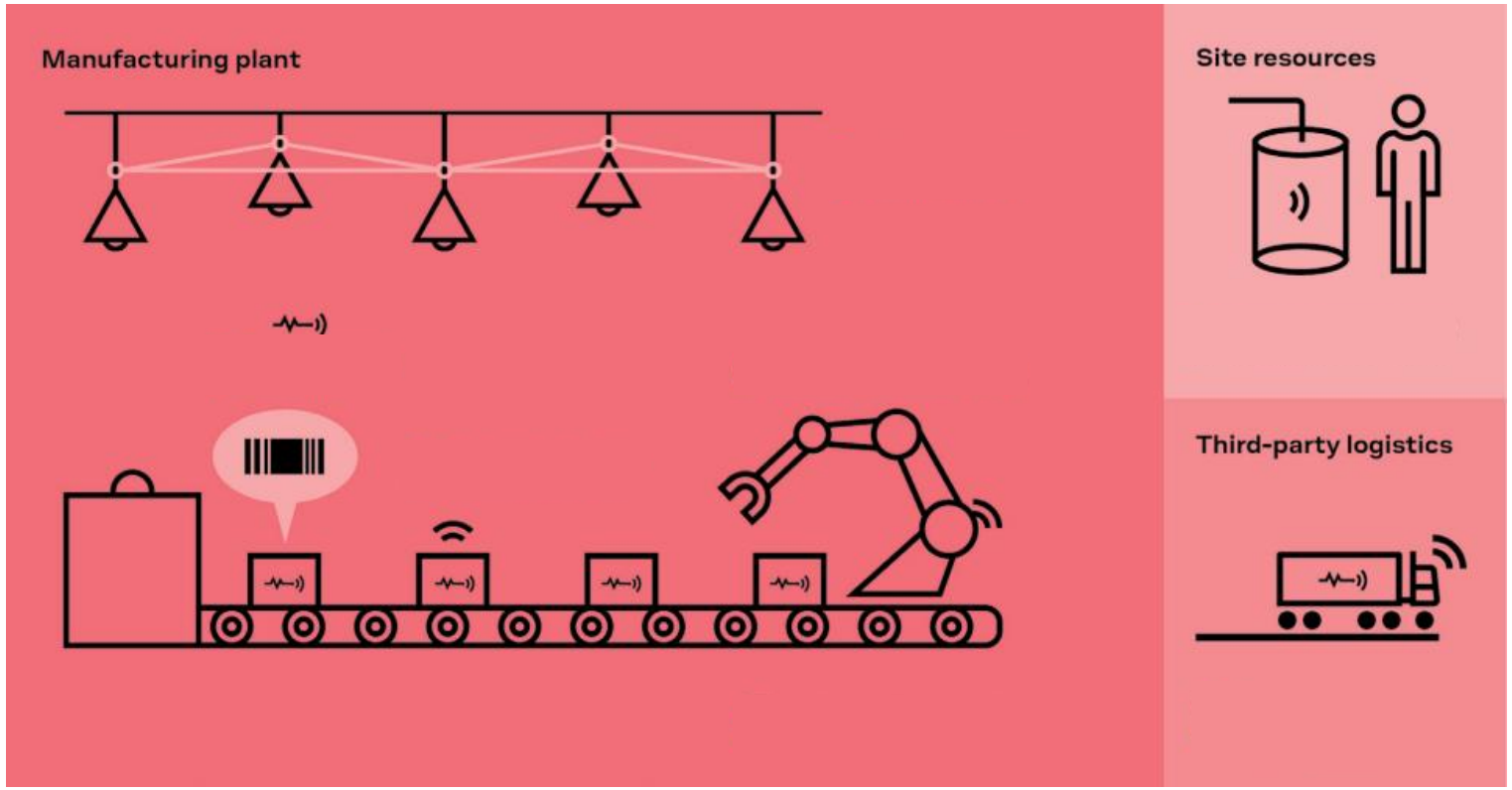
That Helps Create Value

Main Application Areas OT focus onto

For the vertical "Factories of the Future”

Factories of the Future

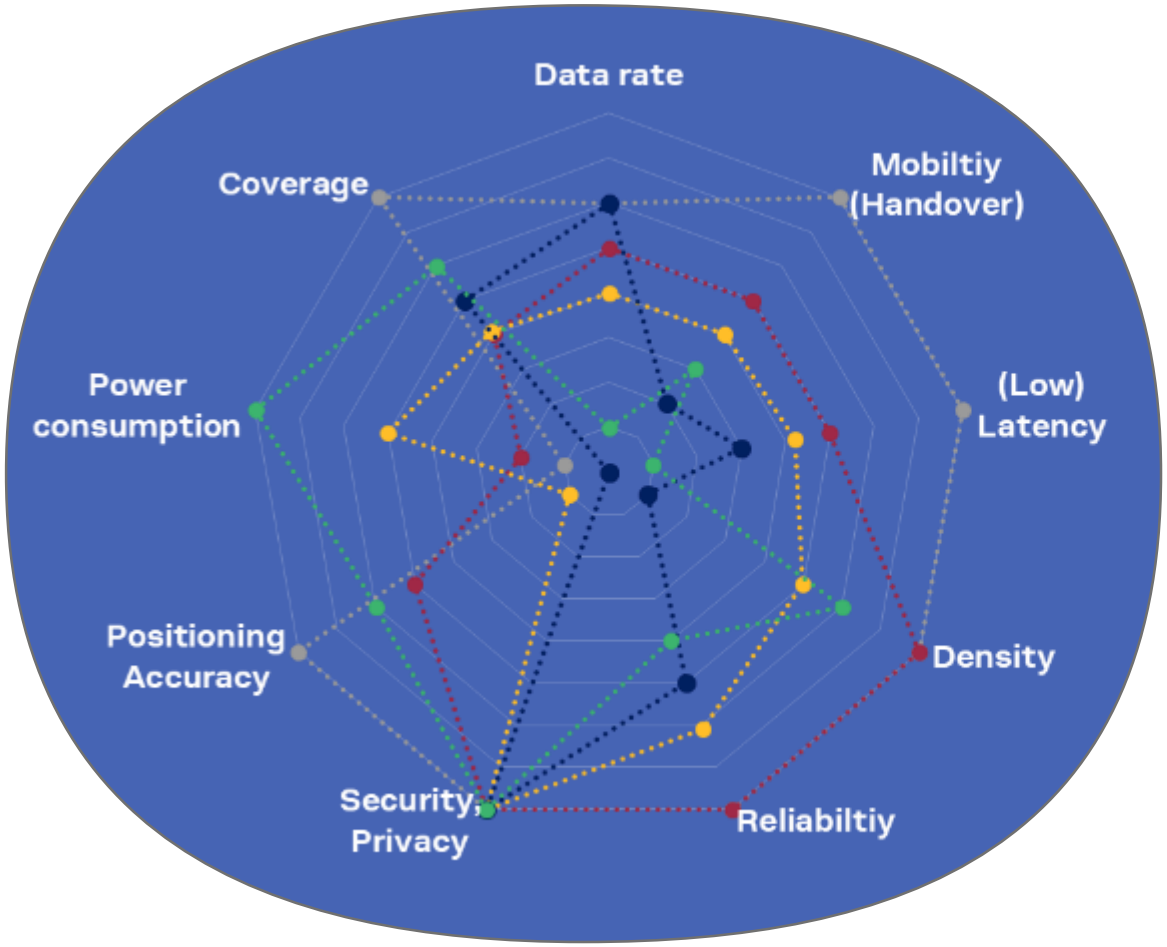
- Factory Automation
- Process Automation
- HMIs and Production IT
- Logistics and Warehousing
- Monitoring and Maintenance



u-blox AG, For internal use only

5G key capabilities and KPIs

Technical requirements: Factories



- Time-critical Process Control
- non time critical factory automation
- Remote monitoring
- Intra/inter enterprise communication
- connected goods

- Availability of the industrial automation process is a critical component.
- The cycle time is the critical requirement for network availability.

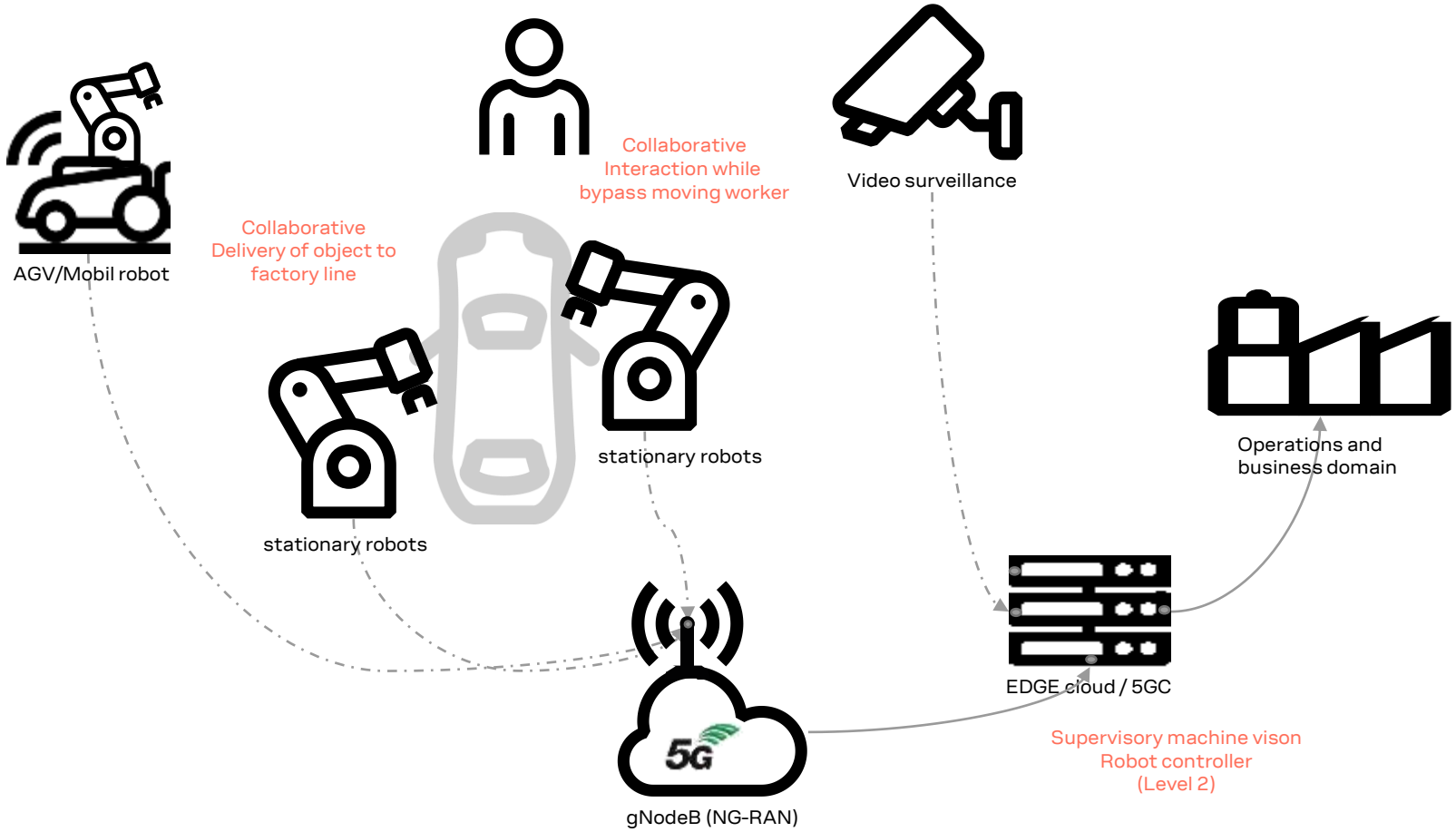
a view of target network convergence times

Requirement Class	Target Cycle Time	Target RPI	Target Network Convergence
Information/Process (e.g. HMI)	< 1 s	100 … 250 ms	< 1 sec
Time critical processes (e.g., I/O)	30 - 50 ms	20 ms	< 100 ms
Safety	10 - 30 ms	10 ms	< 24 ms
Motion	500 µs - 5ms	50 µs - 1 ms	< 1ms

RPI Requested Packet Interval, repetition interval in both directions

5G use cases – mobile robots

Remotely supported collaboration of connected robots and Machine vision assisted real-time human robot interaction



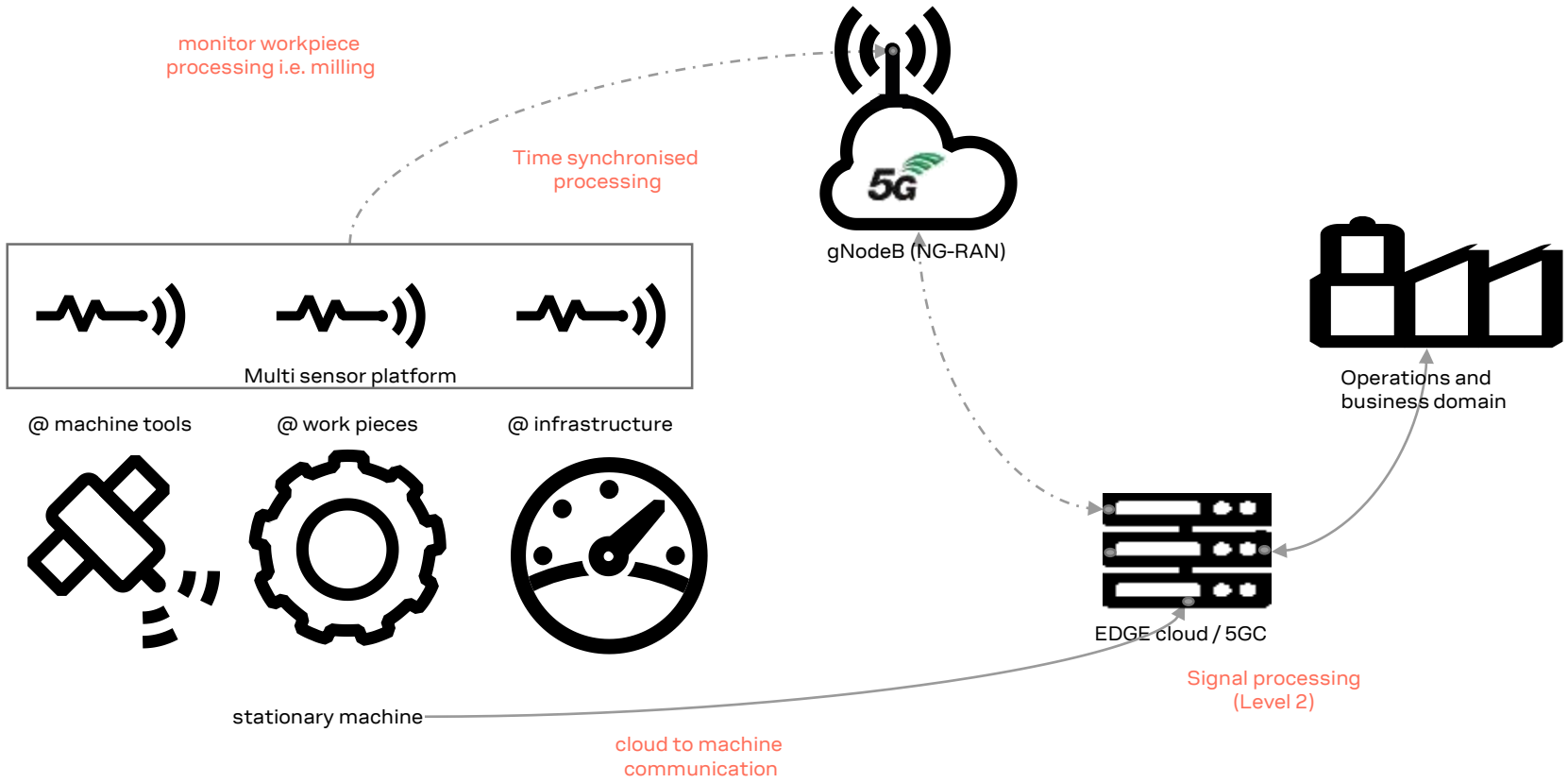
- **Description:**
  Collaboration of mobile robots and stationary robots.
  Bypass worker moving around the shop floor.
- **Challenges:**
  Major control functionalities move to the edge cloud
  - Motion planning
  - Robot localization
  - Collision avoidance
  - Human interaction
- **5G services:**
  URLLC, eMBB

AGV Automatic Guided Vehicle

NG-RAN Next Generation Radio Access Network
gNodeB 5G New Radio (NR) Base station
5GC 5G packet Core network

5G use cases – Production Automation

Multi-sensor platform for digital twin

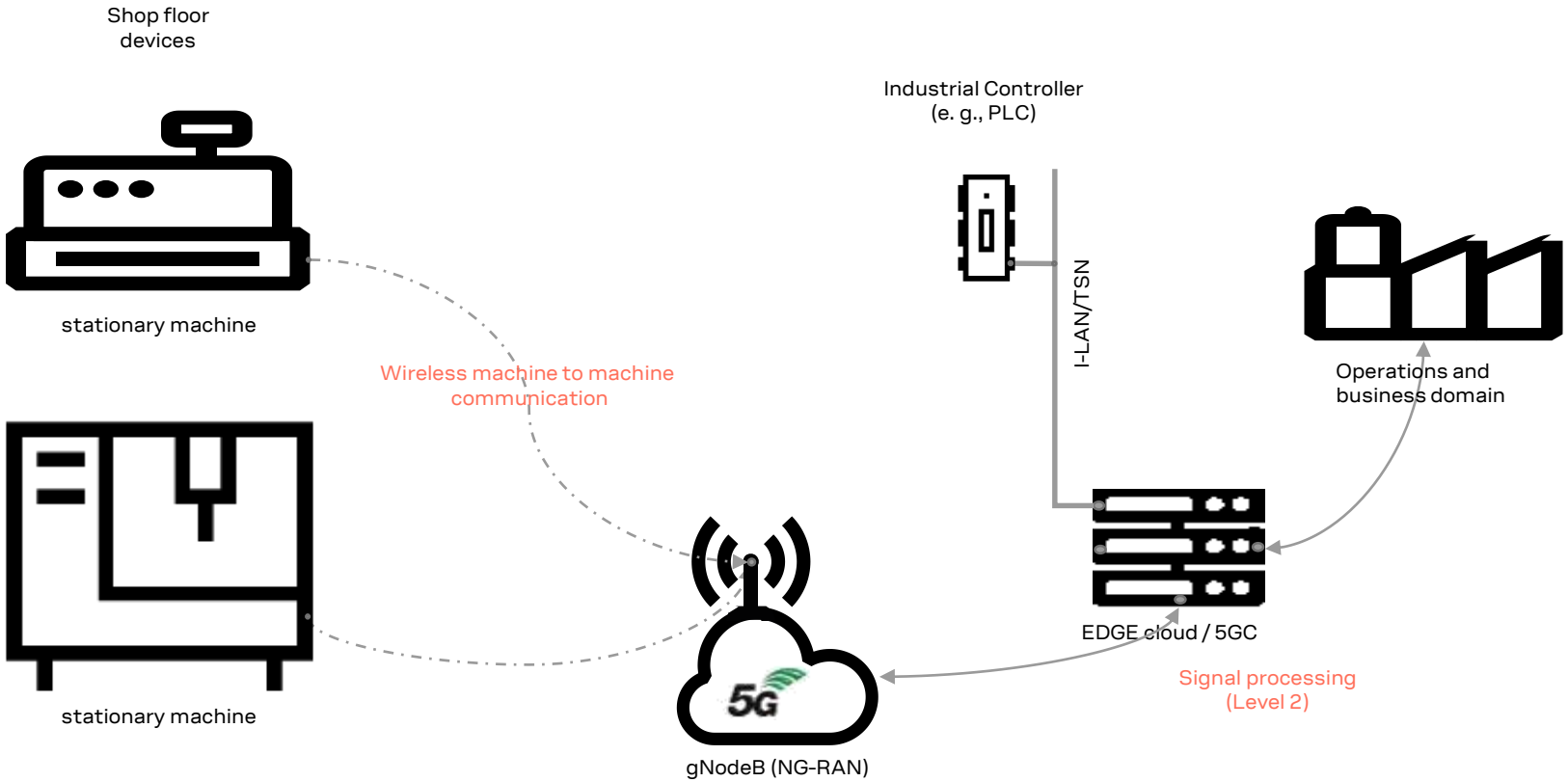


- **Description:**
  Wirelessly connected Multi-Sensor Platform (MSP) integrated into multiple machines and connected to multiple work pieces
- **Challenges:**
  Time synchronised signal processing performed in the edge and cloud
- **5G services:**
  mMTC, eMBB

NG-RAN Next Generation Radio Access Network
gNodeB 5G New Radio (NR) Base station
5GC 5G packet Core network

5G use cases – Production Automation

Time Synchronized Networking (TSN)/Industrial LAN over 5G



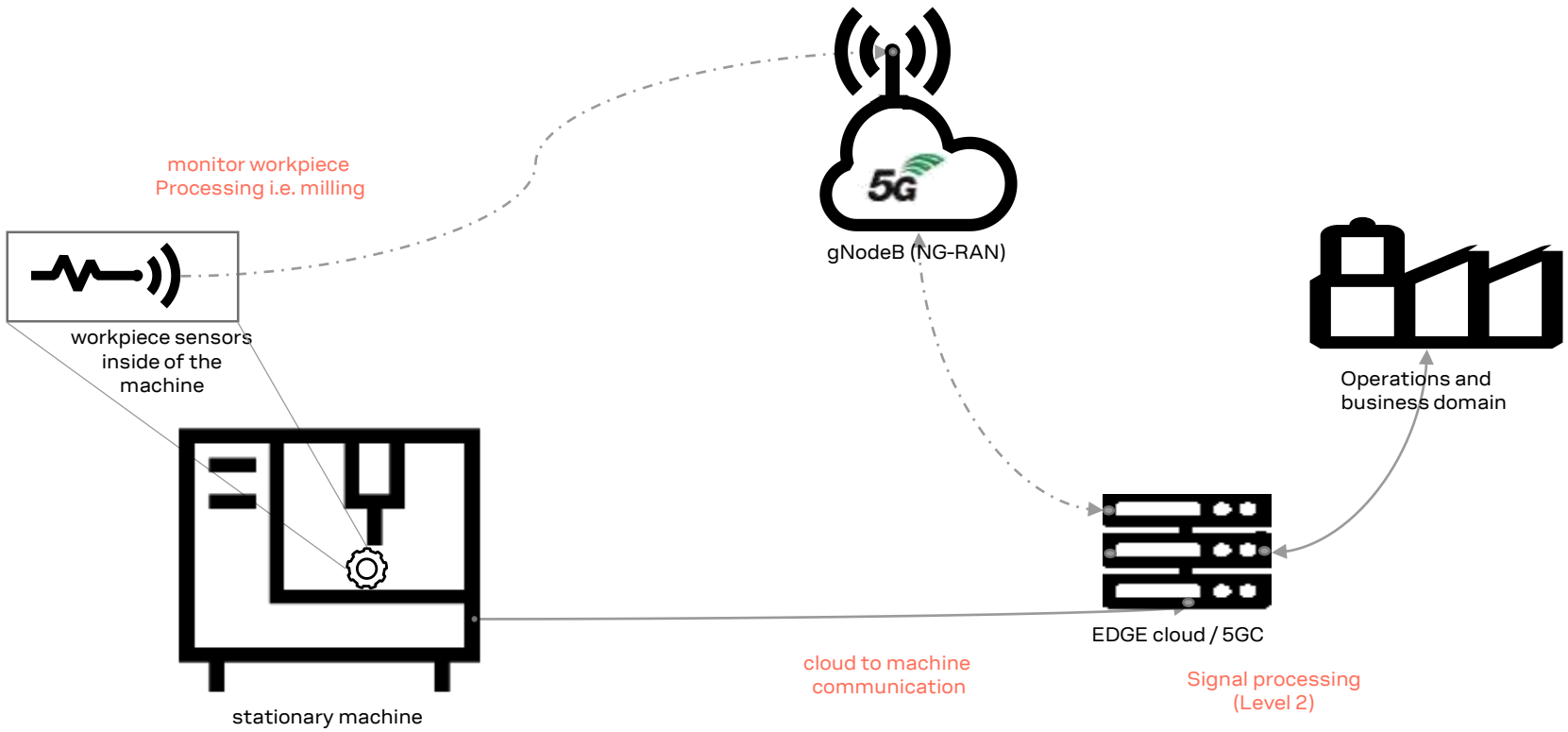
- **Description:**
  Cable-based controller-to-controller communication replaced with 5G communications
- **Challenges:**
  Strict QoS guarantees, time-synchronization between domains
- **5G services:**
  URLLC, eMBB

I-LAN	Industrial Local Area Network
TSN	Time Synchronized Networking
PLC	Programmable Logic Controller
QoS	Quality of Service

NG-RAN	Next Generation Radio Access Network
gNodeB	5G New Radio (NR) Base station
5GC	5G packet Core network

5G use cases – Production Automation

Wireless workpiece monitoring



- **Description:**

  Wirelessly connected acoustic emission (AE) sensor integrated into a machine

  Used to monitor the process e.g. tool break and its detection.

- **Challenges:**

  Major control functionalities move to the edge cloud e.g.

  - Milling process
  - Tool break detection

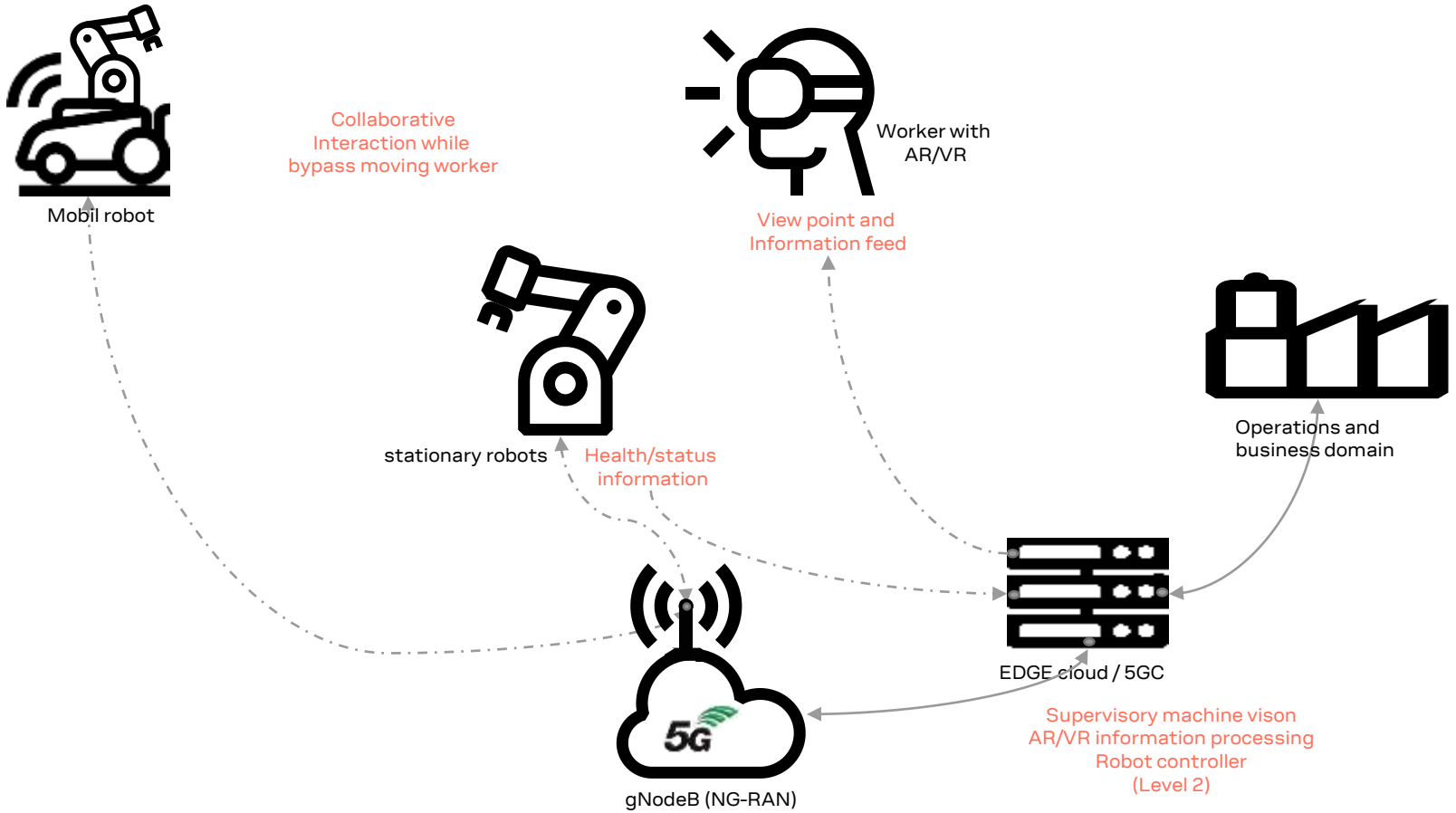
- **5G services:**

  URLLC, eMBB

NG-RAN Next Generation Radio Access Network
gNodeB 5G New Radio (NR) Base station
5GC 5G packet Core network

5G use cases – Human Machine Interaction (HMI)

Aided visualization of the factory floor



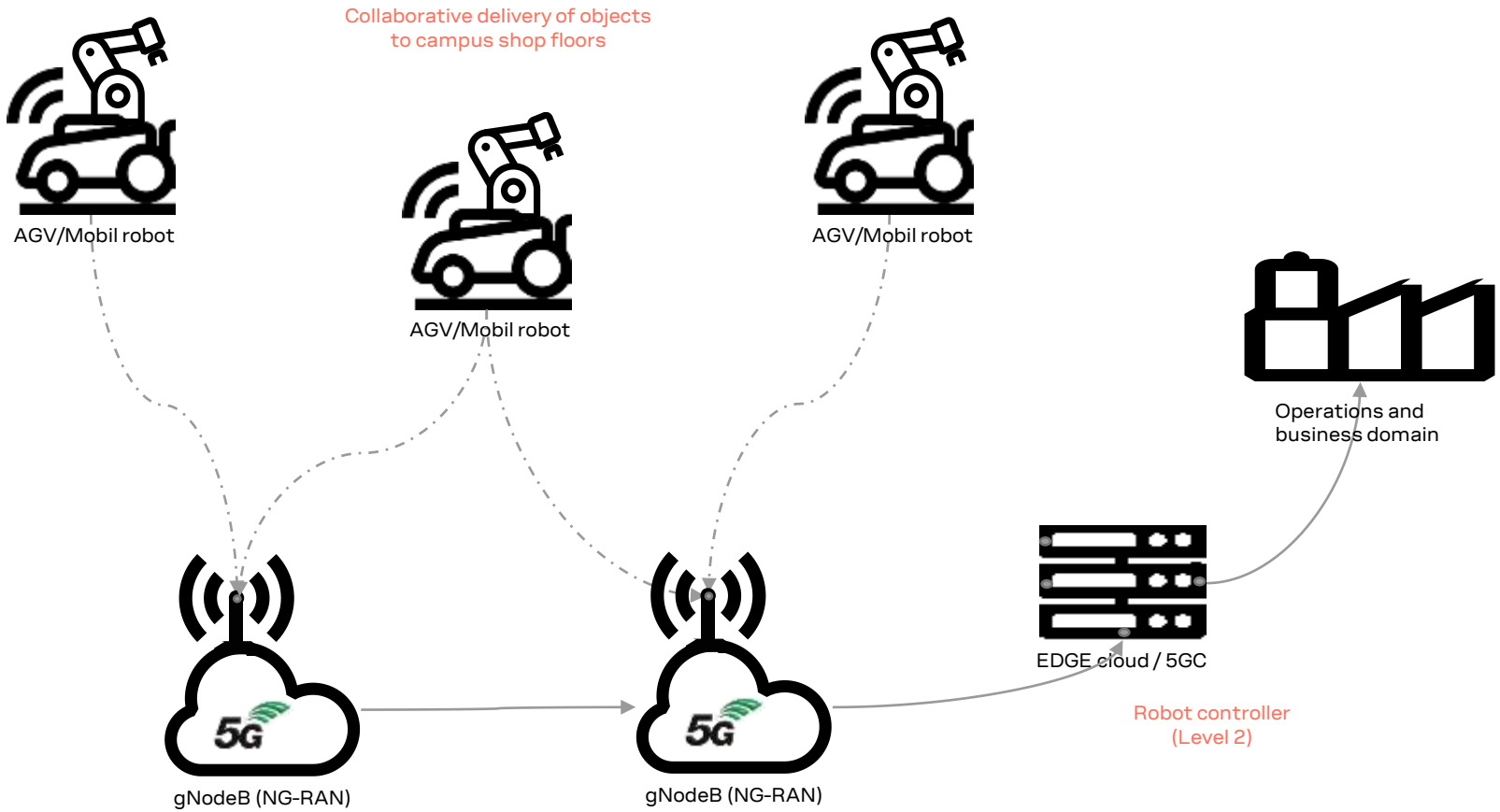
- **Description:**
  Collaboration of mobile robots and stationary robots.
  Provides worker with shop floor information via AR.
- **Challenges:**
  Major control functionalities move to the edge cloud
  - Motion planning
  - Robot localization
  - Human interaction
  - AR/VR processing
- **5G services:**
  URLLC, eMBB

AR Augmented Reality
VR Virtual Reality

NG-RAN Next Generation Radio Access Network
gNodeB 5G New Radio (NR) Base station
5GC 5G packet Core network

5G use cases – Logistics

Cloud-based mobile robots



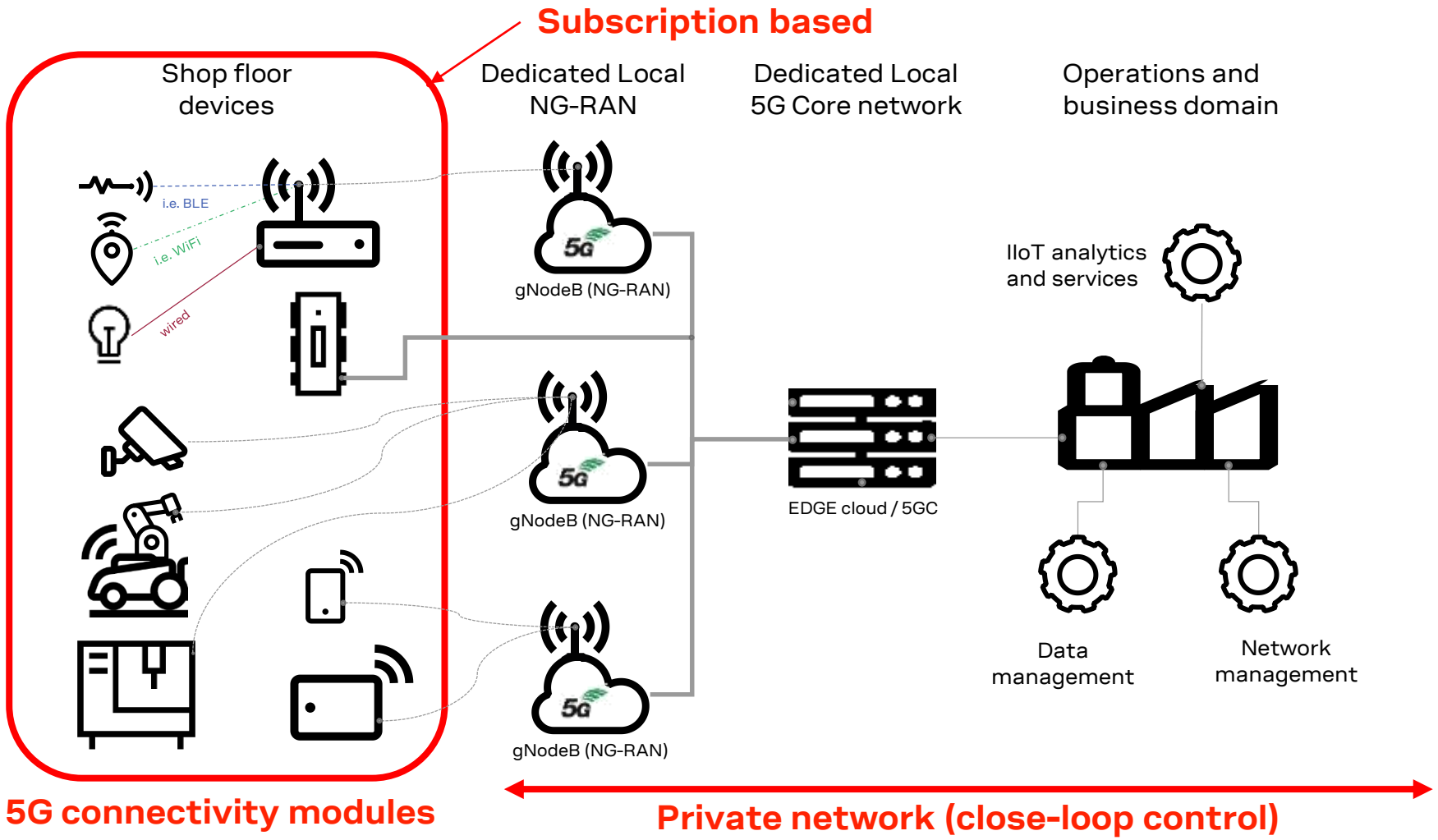
- **Description:**
  Collaboration of AGVs/mobile robots.
  Delivery to shop floor of objects across campus.
- **Challenges:**
  Reliable, low-latency communication between centralized intelligence and local intelligence and I/O devices
  - Motion planning
  - Robot localization
  - Collision avoidance
  - Human interaction
- **5G services:**
  URLLC

AGV Automatic Guided Vehicle
I/O Input/Output

NG-RAN Next Generation Radio Access Network
gNodeB 5G New Radio (NR) Base station
5GC 5G packet Core network

Connectivity for the factory floor

Non Public Network (NPN) for industrial automation



NG-RAN Next Generation Radio Access Network
gNodeB 5G New Radio (NR) Base station
5GC 5G packet Core network

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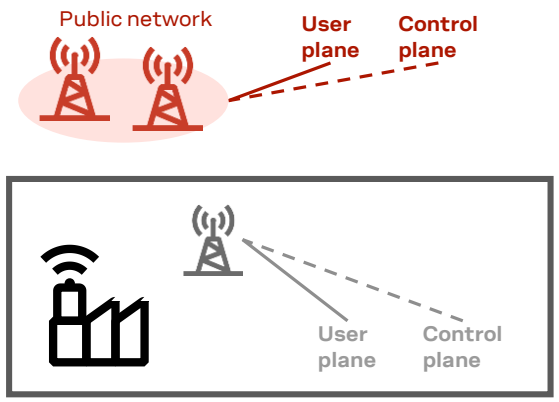
Non-public network (NPN) scenarios

Development scenarios x4 based on 3GPP specifications

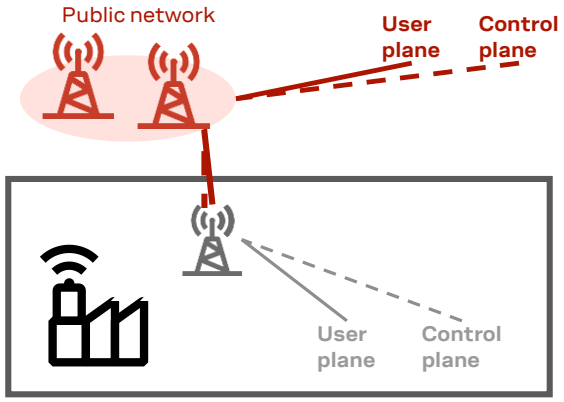
Private

Isolated

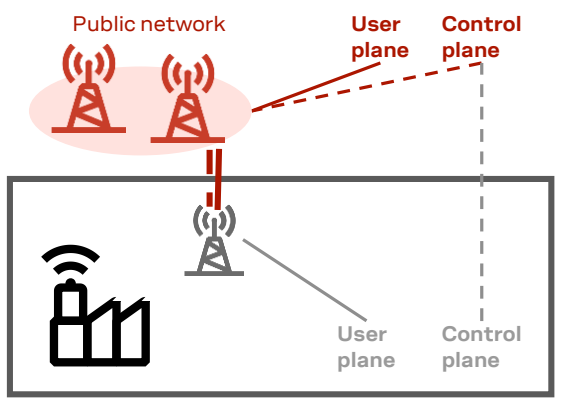


Hybrid

Shared RAN

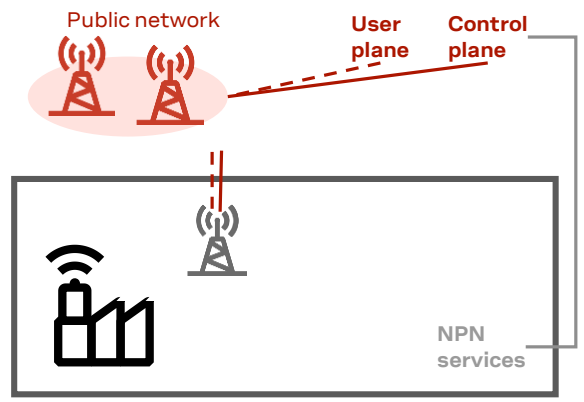


Shared RAN and control plane



Public

NPN within public network



Firewall as the only interface to the public network.

Network provides all services and capabilities required by the non-public network (NPN) at various levels with service-level agreements in place between NPN operator and public network operators.

NPN Non Public Network
RAN Radio Access Network

Non Public Network (NPN) - A New Enterprise Enabler

Primary reasons to deploy a private network

Coverage	guaranteed coverage at their facility or location by installing their own network indoors and at campus locations
Capacity	full and exclusive use of available capacity; ability to configure up-/downlink and set usage policy; engineer the network according to specific demands
Control	how resources are utilized and traffic is prioritized to optimize reliability and latency
Security & Privacy	to ensure that sensitive information does not leave the premises
end-2-end traceability	ability to trace in all components of a local network to promise reliability and SLA.

Advantages of NPN based on LTE

- Range / Link Budget
- Spectral Efficiency / Capacity
- Configurable QoS
- Mobility
- High to Low Rate Scaling
- Roadmap to 5G

SLA Service Level Agreement
NPN Non Public Network

Private in LTE and 5G

for the Enterprise

Licensed Spectrum

> 40 bands globally exclusive use

- Enterprises get their localized (campus) license
- Carriers sublicense their spectrum to enterprises

3GPP A GLOBAL INITIATIVE

Shared Spectrum

2.3 GHz EU/3.5GHz US use on priority level

- Enterprises can operate Private networks in spectrum that is owned
- shared via SAS

CBRS ALLIANCE

Unlicensed Spectrum

ISM 2.4 / 5 GHz, U-NII-3

- Operation in unlicensed spectrum, i.e. U-NII-3 (5.725 .. 5.825 GHz) band

Wi Fi™ MULTEFIRE LTE U LAA

CBRS Citizens Broadband Radio Service
3GPP 3rd Generation Partnership Project
SAS Spectrum Access System
LAA Licensed Assisted Access

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Spectrum for NPN access

Industry interest into unlicensed, private, local or regional 5G licenses

Germany (the German Federal Network Agency/BNetzA): 3.4-3.8 GHz band for 5G

- Band 3.7 - 3.8 GHz is to be used on a local basis by individual companies (Already 15 companies are interested in local or regional licenses for the use of 5G in factories, i.e. automotive, energy and automation, chemical and prof. audio.)

Sweden (PTS most likely to follow Germany in mid-band)

- 24.25 – 25.10 GHz in high-band

UK (announced during CWIC 2019 in July by Ofcom)

- Access to spectrum for local coverage; possibility of "private local networks" for applications such as Industry 4.0 in 1800 MHz, 2.39 GHz, 3.8 - 4.2 GHz and 24.25-26.5 GHz (in building)
- Licenses can be granted in blocks of 10 MHz and in principle up to 100 MHz

Japan

- 4.6 - 4.9 GHz (band n79) and 28.2 – 29.1 GHz (part of n257) for private use

US

- CBRS is technology agnostic and can be used by enterprises to create own private LTE networks in 3.5 GHz (B42/48)band with150 MHz spectrum.

China (via MNOs for industrial usage)

- 4.80 – 4.90 GHz

- Global harmonization of NPN spectrum is not likely to happen with various spectrum options considered globally
- Licenses in UK and DE to be granted on a "per location" basis following a "first come - first serve" principle at a handling cost level
- On request, the German Federal Network Agency will allocate frequencies for a limited period of up to 10 years based onto requested bandwith, duration of allocation and area to cover. Depending on the area, duration and bandwidth to be used, annual fees in the 4 to 5 EUR digit range are payable.
- U.S. government is making 150 MHz of spectrum available on a lightly-licensed, shared-access basis using a three-tiered model

CBRS Citizens Broadband Radio Service
Ofcom Office of Communications
UK's communications regulator.

NPN Non Public Network
PTS Post and Telecom Authority
BNetzA German Federal Network Agency

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5G

Challenges And Way To Go

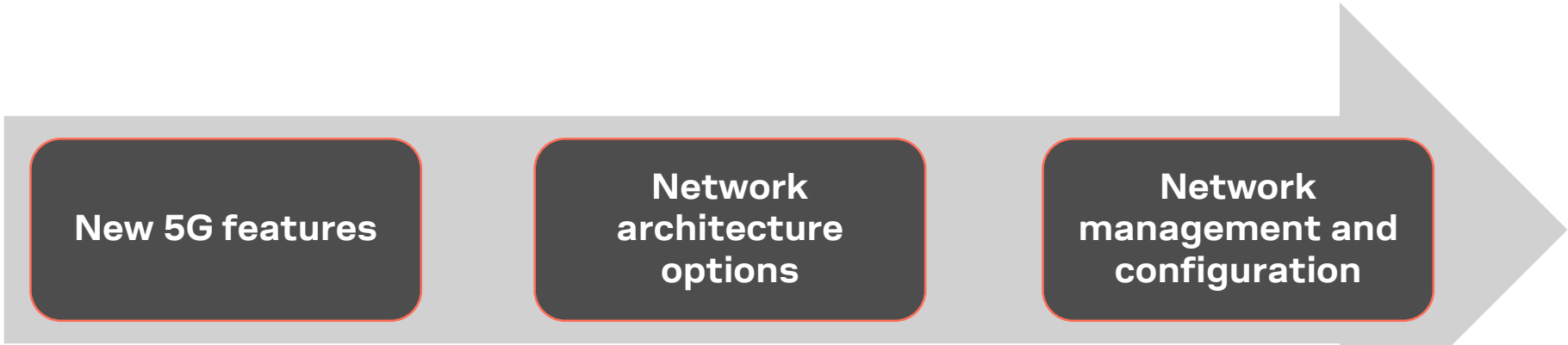
5G use case in industrial automation

Transition

	4G LTE	5G
Branch high availability	Critical application failover	Built in wireless failback
Industrial operations	Wireless monitoring	Wireless autonomous operation
Workforce collaboration	Video collaboration	Augmented reality collaboration
Transportation	Tracking & telemetry applications	Autonomous applications

5G in IIoT

Challenges and way to go



optimization and design for manufacturing

new 5G features beyond the trials, e. g.

- Time-Sensitive Networking (TSN) and industrial LAN
- Positioning and time synchronization
- Low-latency across network
- Industrial grade QoS

New deployment architecture options, e. g.

- Seamless integration of cloud and 5G into existing infrastructure
- Deployment of wireless networking in factories
- Redundancy, anomaly detection, self healing

industrial-centric framework, e. g.

- network management and configuration
- implementation of the network slice manager
- Long lifetime (>20 years)
- Radio propagation environment

Overall picture of u-blox 5G IIoT activities

3GPP, 5G-ACIA, 5G-SMART

(SyLu)

3GPP A GLOBAL INITIATIVE

Use cases, requirements

NB-IoT & LTE-M

C-V2X, Sidelink

NR-Positioning

NR-IIoT, uRLLC

LTE Advanced Pro

5G

(SyLu/LuBo)

5G ACIA 5G Alliance for Connected Industries and Automation

Industrial forum to fill gaps in use cases, requirements, biz cases, technical recommendations

WG 1	WG 2	WG 3	WG 4	WG 5
Use Cases & Requirements	Spectrum & Operator Models	Architecture & Technology	Liaisons & Dissemination	Validation & Tests

u-blox

(SyLu/LuBo)

European Commission

5G smart

EU H2020 project within ICT-19 call: "Advanced 5G validation trials across multiple vertical industries"

Business models	Concept work	Industry field trials for evaluation and validation of 5G capabilities		
Understand the "5G eco system" Explore Regulatory and spectrum aspects	Contribute to future 5G releases TSN/Industrial LAN, Time synchronization, Positioning	Trial 1: WP2 5G-Enhanced Industrial Robots Kista	Trial 2: WP3 5G for Manufac-turing Processes Aachen	Trial 3: WP4 Validation of 5G in Semicon. Factory Reutlingen

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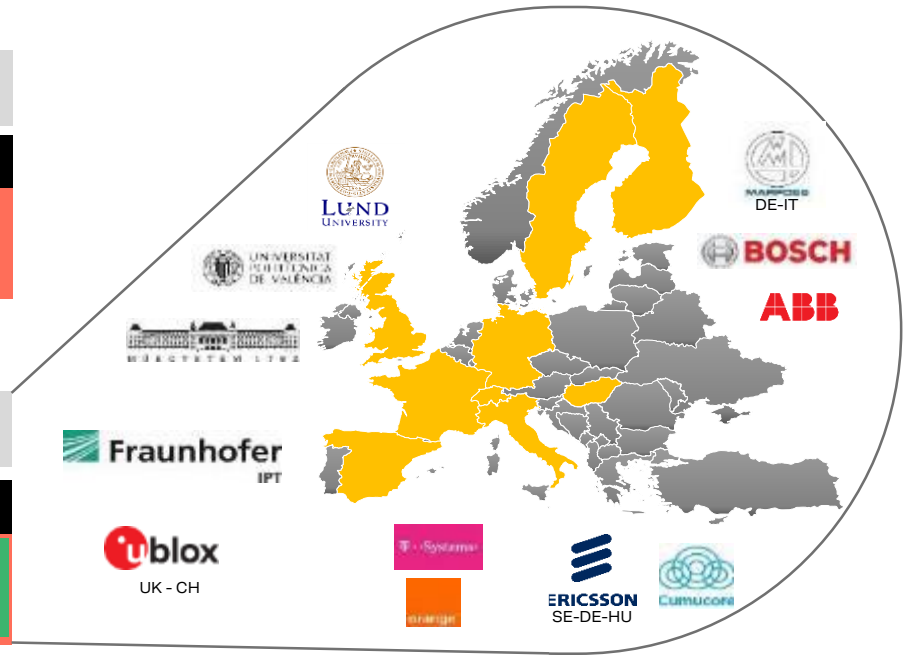
2019 2020 2021



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Thank you for your attention

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Questions?

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