



INDUSTRY
CAMPUS
EUROPE

5G in der Produktion – Überblick und Best Practice

5G in production - overview and best practice

2. 5G Industrie Summit, 8th September 2021

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Advantages of 5G for production

Review 2020

1

Ultra-reliable low latency communication (URLLC)

- <1 ms end-to-end latency, <20 μ s jitter
- 99,999% reliability

2

Enhanced mobile broadband (eMBB)

- < 10 Gbit/s bandwidth

3

Massive machine-type communication (mMTC)

- 100x connected devices (comp. to 4G)
- ~10-15 years battery life time

4

Localization

- < 1 m position resolution

5

Cross-site end-to-end communication

- Site-to-site communication
- Enterprise cloud communication

6

Slicing

- Combine use cases with different criticality levels
- Combine public and private networks

Outline for today



Source:
Discovery Communications, LLC

- More than 140 licenses granted by Bundesnetzagentur for local spectrum, many of them in industry
- No 5G network in operative production use in industry! Why?

Outline:

1. Reality check of 5G marketing claims
2. Discussion about what is essential for 5G in production
3. Provide insights into experimental implementations

Agenda

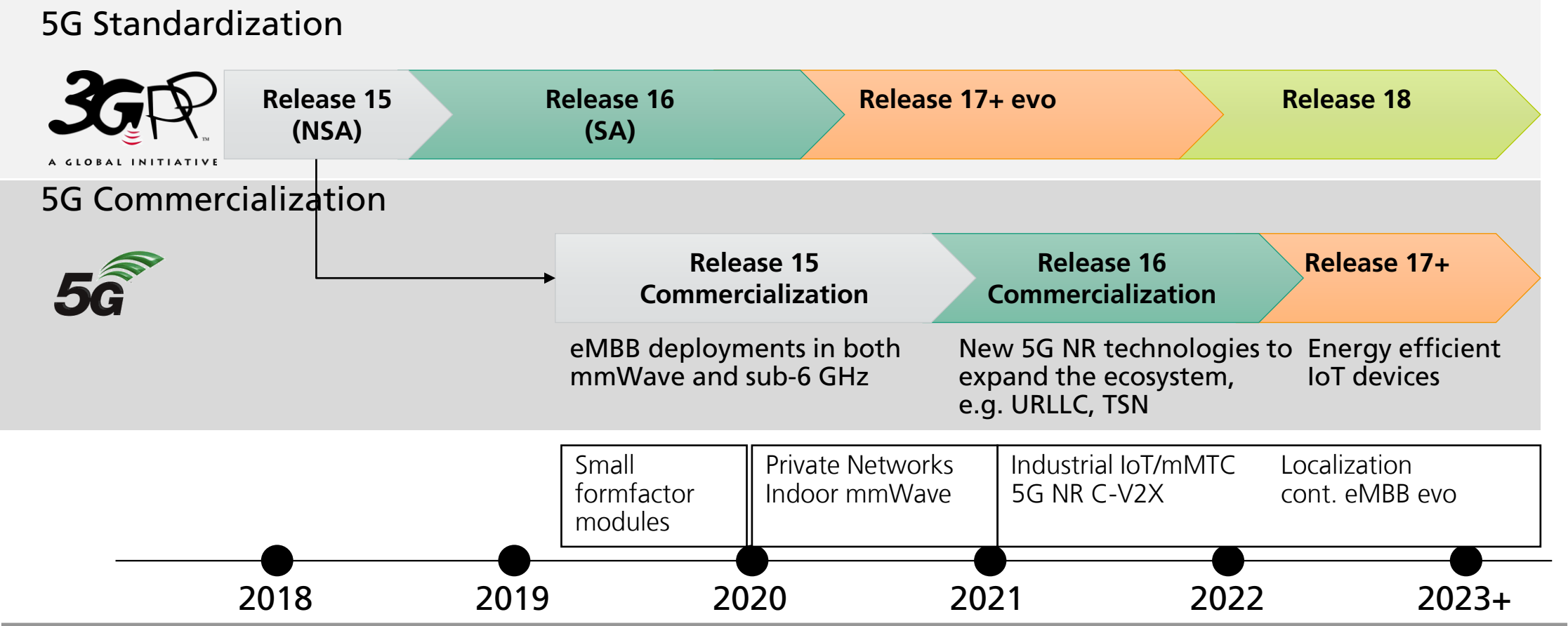
1 Relevance of 5G for Smart Manufacturing

2 5G-Industry Campus Europe

3 5G Use Cases

4 Conclusion

3GPP roadmap on 5G evolution



Reality check: Ultra-reliable low-latency communication (URLLC)

Claim#1: End-to-end latency of 5G is below 1 ms

- not available with standard 5G gear today
- URLLC features are part of 3GPP Rel. 16 → no commercial Rel. 16 compliant 5G systems and devices are available

But: many industrial applications do not rely on latency < 1 ms

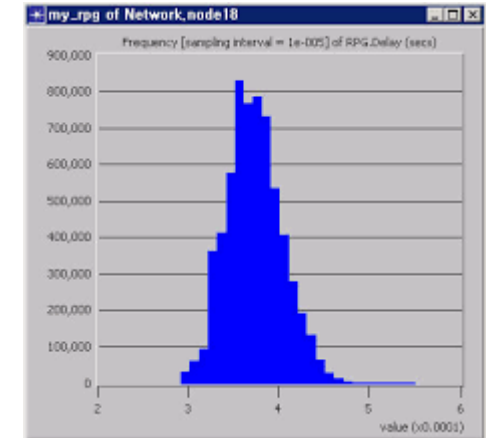
- wireless sensors in manufacturing < 10 ms
- mobile robot control < 10 -100 ms
- augmented reality < 10 ms
- can be achieved with most of today's devices

Claim#2: Reliability up to 99,999%

- 99,999% means service inavailability of 5 min. per year
- testing 99,999% reliability requires additional testing hardware
- for comparison: process capability c_p of 1,33 in production means 66 ppm failure probability

Outlook

- synchronization will have a higher impact than latency, e.g., for wireless fieldbus communication



delay histogram

Source:
leee802.org

Reality check: enhanced mobile broadband (eMBB) communication

Claim#3: data rates can go up to 10 Gbit/s

- data rates are usually limited per device, not by radio infrastructure
- communication modules are specified for ~2-4 Gbit/s (DL), ~900 Mbit/s (UL)
- additional limitations by data interface (e.g., Gbit-Ethernet)

But: most industrial applications do not require > 1 Gbit/s

- wireless sensors in manufacturing < 10 Mbit/s
- mobile robot control < 10 Mbit/s
- augmented reality < 5 Mbit/s
- can be achieved with all devices today



M.2 format
communication module



WNC Industrial 5G router

Source:
tekmodul.de, Fraunhofer IPT

Reality check: massive machine-type communication (mMTC)

Claim#4: >100x more connected devices compared to 4G

- not available with standard 5G gear today
- mMTC features are part of 3GPP Rel. 17 → no commercial Rel. 17 compliant 5G systems and devices are available

But: does industry need high device density?

- mMTC may enable up to 1 mio. devices per km² (=1 device per m²)

Claim#5: battery lifetime up to 15 years

- not available with standard 5G gear today
- mMTC features are part of 3GPP Rel. 17 → no commercial Rel. 17 compliant 5G systems and devices are available
- power consumption of today's 5G device still significant (>2 W)



Source:
Pixabay

Reality check: localization

Claim#5: accuracy of device localization < 1 m

- not available with standard 5G gear today
- mMTC features are part of 3GPP Rel. 17 → no commercial Rel. 17 compliant 5G systems and devices are available
- localization services probably will need part of the spectrum

But: does industry need localization with ~ 1 m accuracy?

- outdoor: tracking of assets in public/on-premise space (competes with GNSS)
- indoor: supplemental to existing localization options



Indoor GPS for drone localization and navigation

Source:
WZL | RWTH Aachen University

Interim conclusion



- Many marketing claims are not (yet) met today
- Expectation regarding 5G are often exaggerated

Chance:

- 5G is capable to do many things already with Rel. 15
- Make use of testbeds in the meantime
- Collect your own experience

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5G INDUSTRY CAMPUS EUROPE

5G-Industry Campus Europe is the largest industrial 5G testbed

- 5G indoor networks on 3 different shopfloors fully equipped with machines and robots
- 5G outdoor network of 1 km² at the RWTH Aachen Campus
- 5G-NSA and 5G-SA running on industry spectrum @3.7 – 3.8 GHz
- Simultaneous 4G network running @2.3 GHz as anchor band

Supported by:



Federal Ministry
of Transport and
Digital Infrastructure

on the basis of a decision
by the German Bundestag

5G network supplier:



ERICSSON



RWTH AACHEN
UNIVERSITY



Fraunhofer
IPT



RWTH AACHEN
UNIVERSITY

fir
an der
RWTH Aachen

5G INDUSTRY CAMPUS EUROPE

5G-Industry Campus Europe is

- the entity in Europe for the holistic application of 5G to manufacturing and logistics
- pioneer for establishing 5G in industry
- application-oriented with real world use Cases
- single-site as well as cross-site perspective

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Implementation projects 5G-Industry Campus Europe



MOBILE ROBOTICS



LOGISTICS



DATA ECONOMY



PROCESS MONITORING



CROSS-SITE PROCESSING



SMART SENSORS

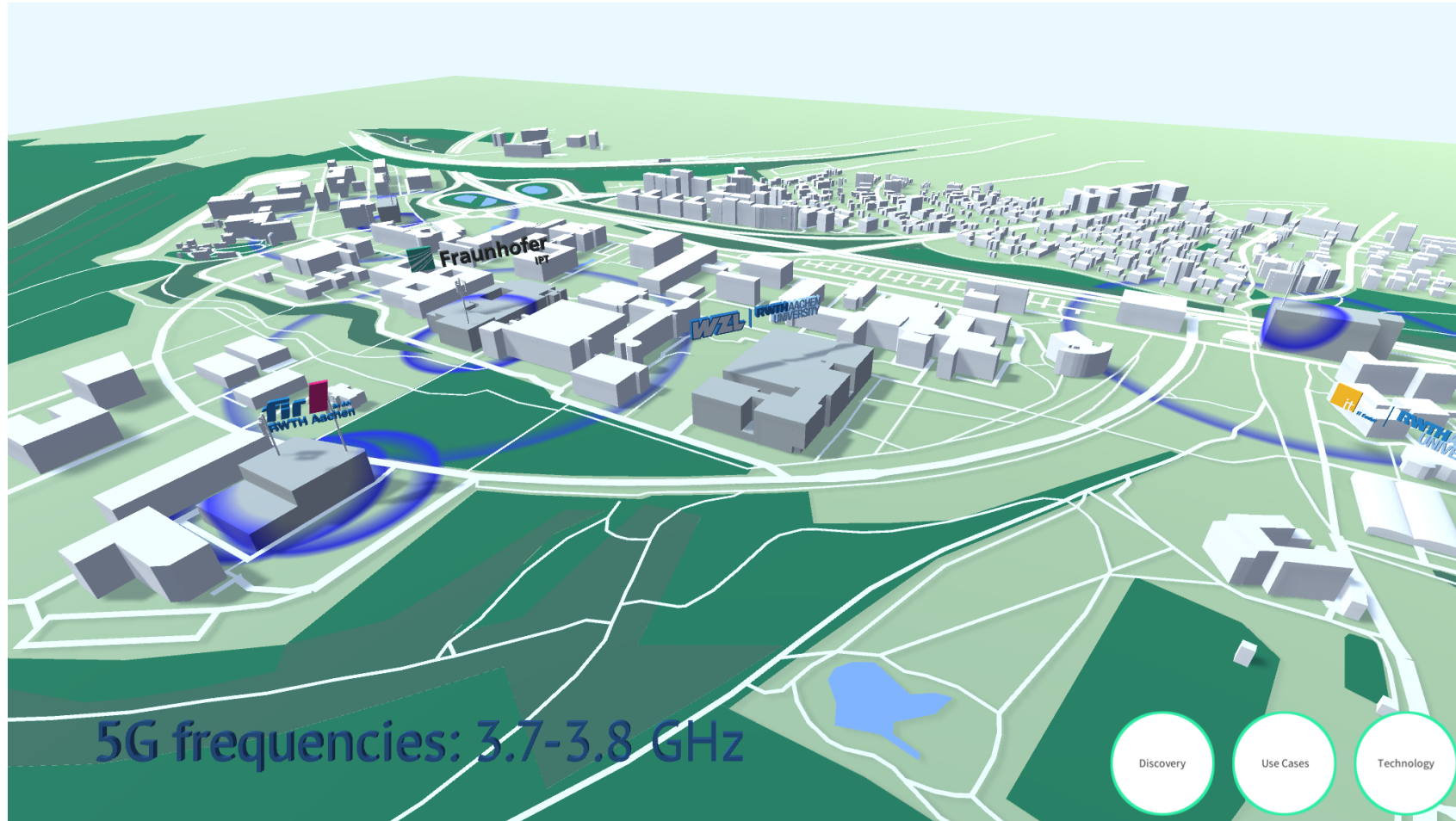


5G-Industry Campus Europe



https://www.youtube.com/watch?v=sXbCWWNztuQ&feature=emb_logo

5G-Industry Campus Europe – Interactive 3D-Modell



<https://5g-industry-campus.com/media-library/5g-area/>

News and Technical Developments – Stay Tuned



ABOUT ▾

MEDIA LIBRARY

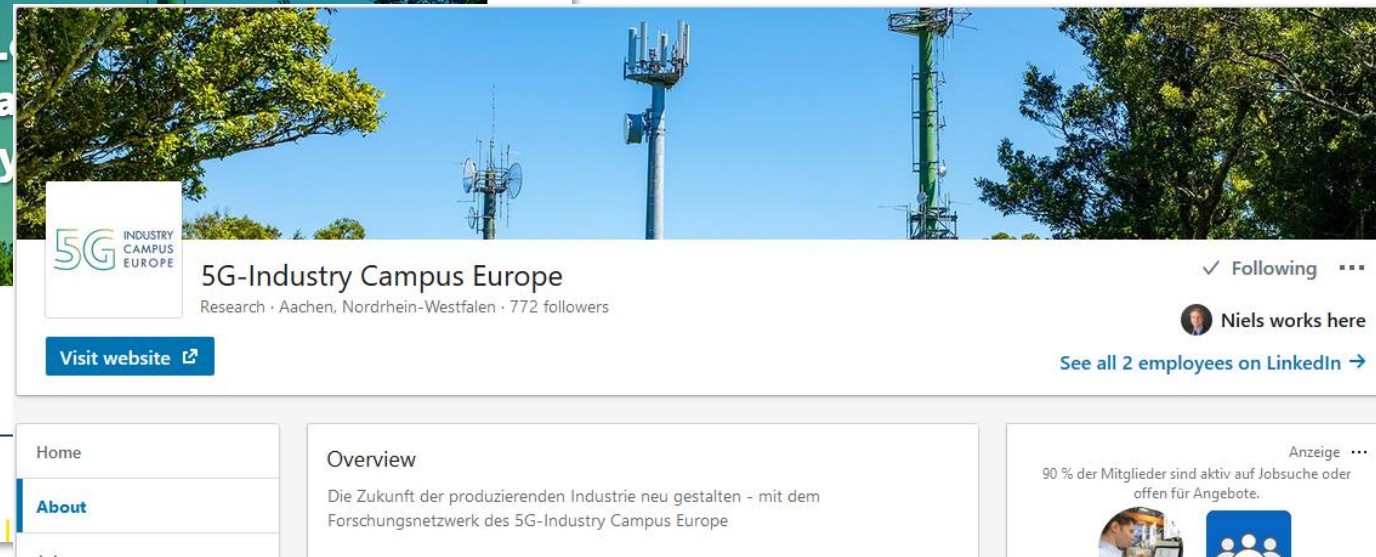
NEWS & EVENTS

CONTACT



Website

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MOTIVATION AND OBJECTIVES

The 5G-Industry Campus Europe will be the first site in Europe to have a comprehensive 5G network to

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3.1 5G-Multisensor

3.2 5G-AE Sensor

3.3 5G-Robotics

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GF Machining Solutions

+GF+

Use Case with Georg Fischer Machining Solutions

Real-time 5G-based smart manufacturing

 **Fraunhofer**
IPT

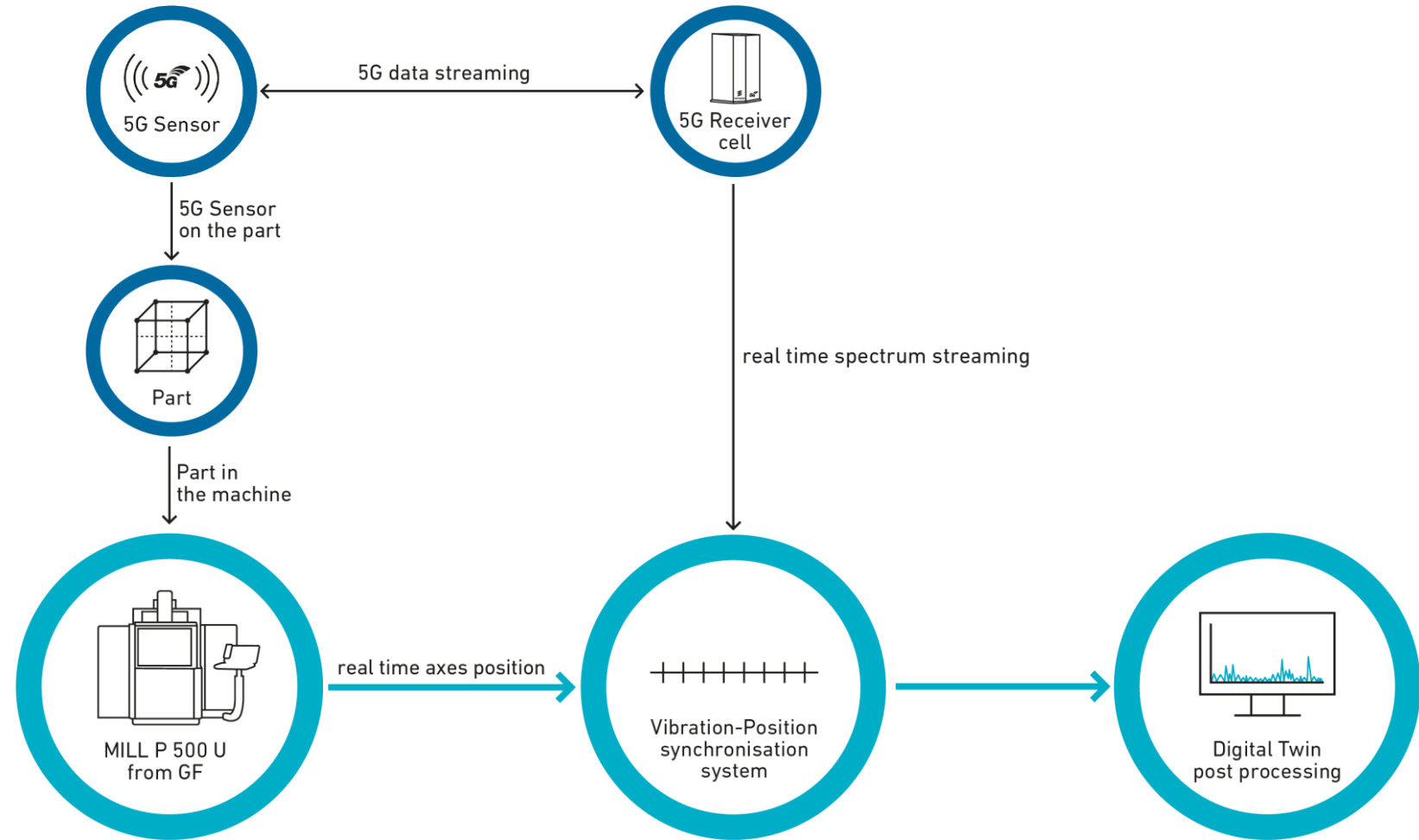
+GF+

The Task

Position-synchronized **vibration monitoring system** reconciliating the machining program and monitored data as a **digital twin**, thus enabling product integrity, process compliance, as well as equipment cost and efficiency optimization.



The Solution



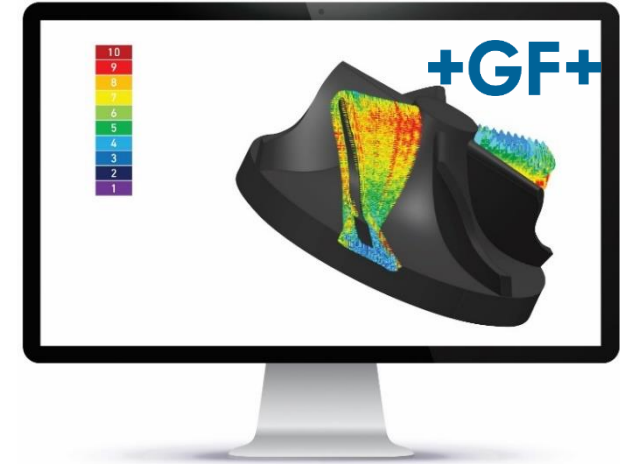
The Solution



5G multi-sensor platform by
Fraunhofer IPT & Marposs



measurement signals



position-synchronized
digital twin processing

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5G-acoustic emission sensor for in-Process tool wear & breakage detection

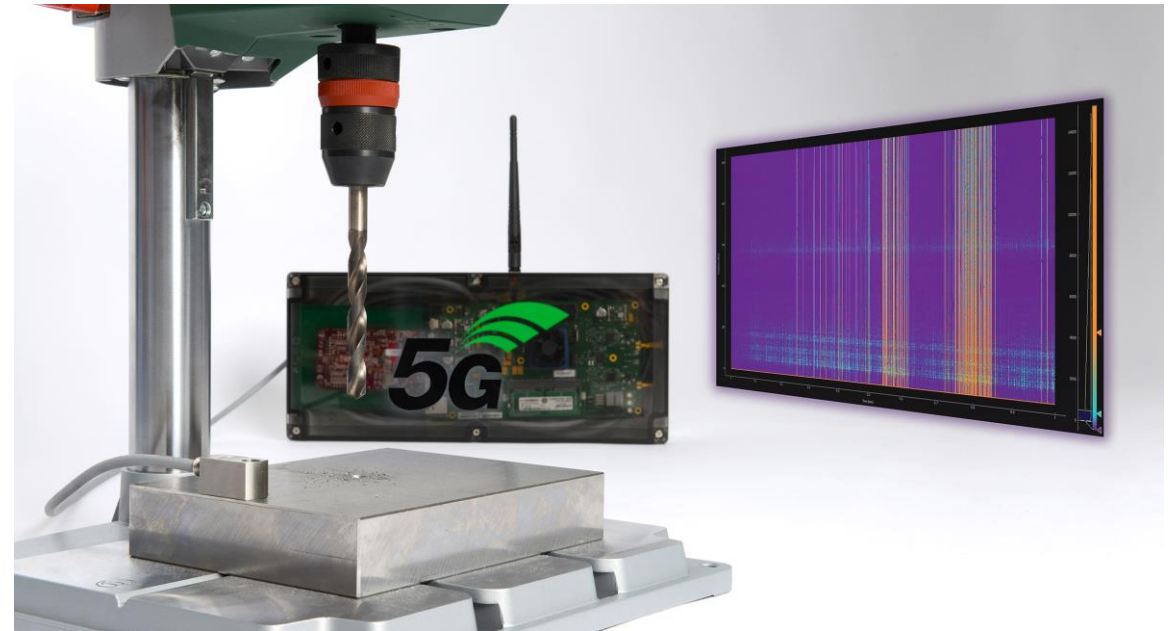


Use Cases 5G-Industry Campus Europe – Acoustic Emission

5G-AE Sensor

Features

- Standard AE sensing probe from Marposs
- Customized signal conditioning PCB
- 1 MHz sampling rate
- FPGA-based signal processing
- Integrated 5G transceiver
- Data transfer via 5G with 8 mBit/s
- Battery powered
- IP68 housing
- Custom application for PC based signal analysis and visualization



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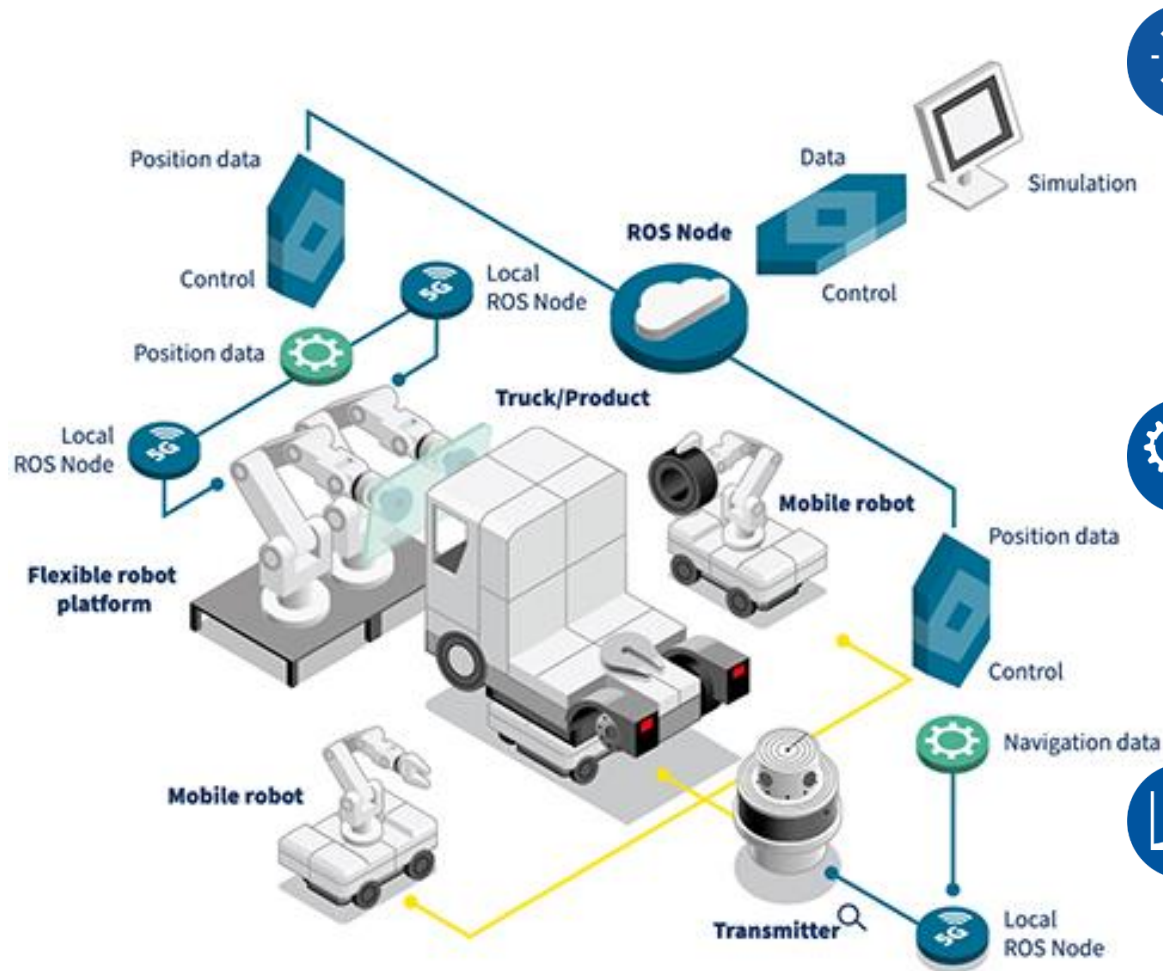
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Model-based Assembly Automation



Use Cases 5G-Industry Campus Europe – 5G-Robotics



Motivation

- Flexible assembly in **line-less mobile assembly** systems results in complex
- Complex assembly tasks need **handling** by **multiple robots**
- **Mobility** of resources and connectivity to sensors and control systems requires **wireless** connection
- High demands regarding **latency**



Technology

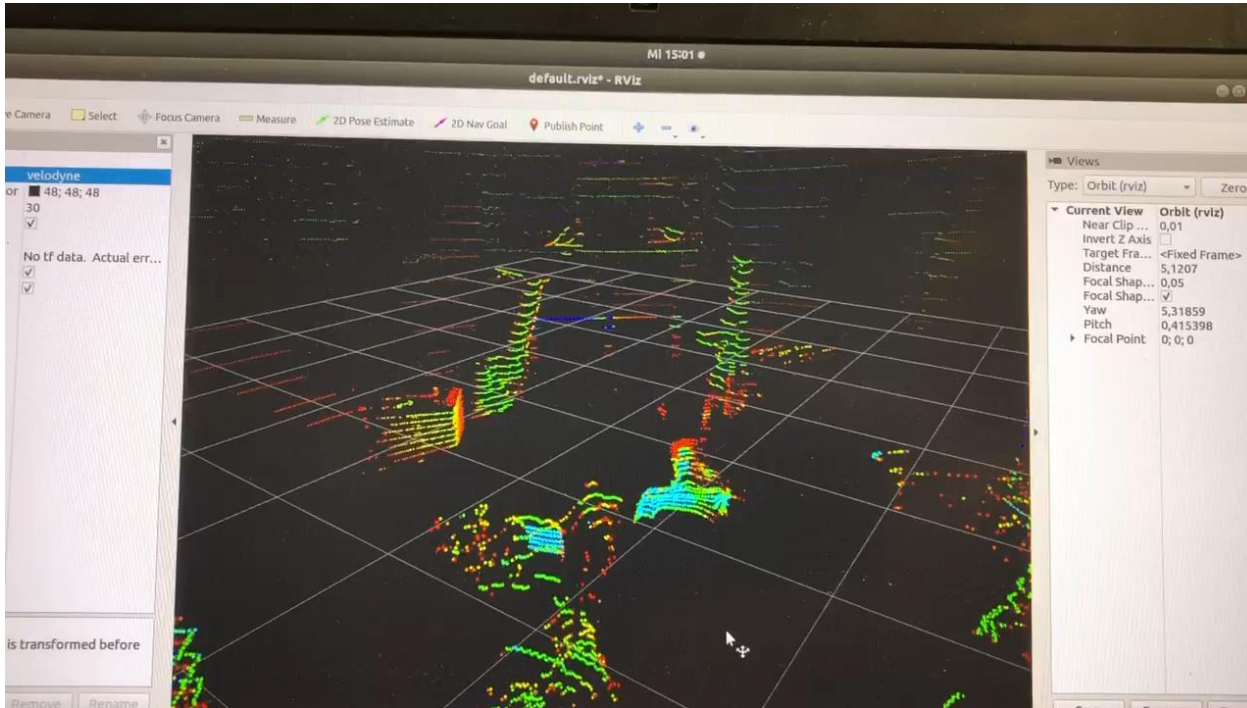
- Showcase **remote connection** of metrology systems and mobile robots
- Control general purpose **mobile robots** using **5G**
- Perform remote **AGV navigation**



Benefits

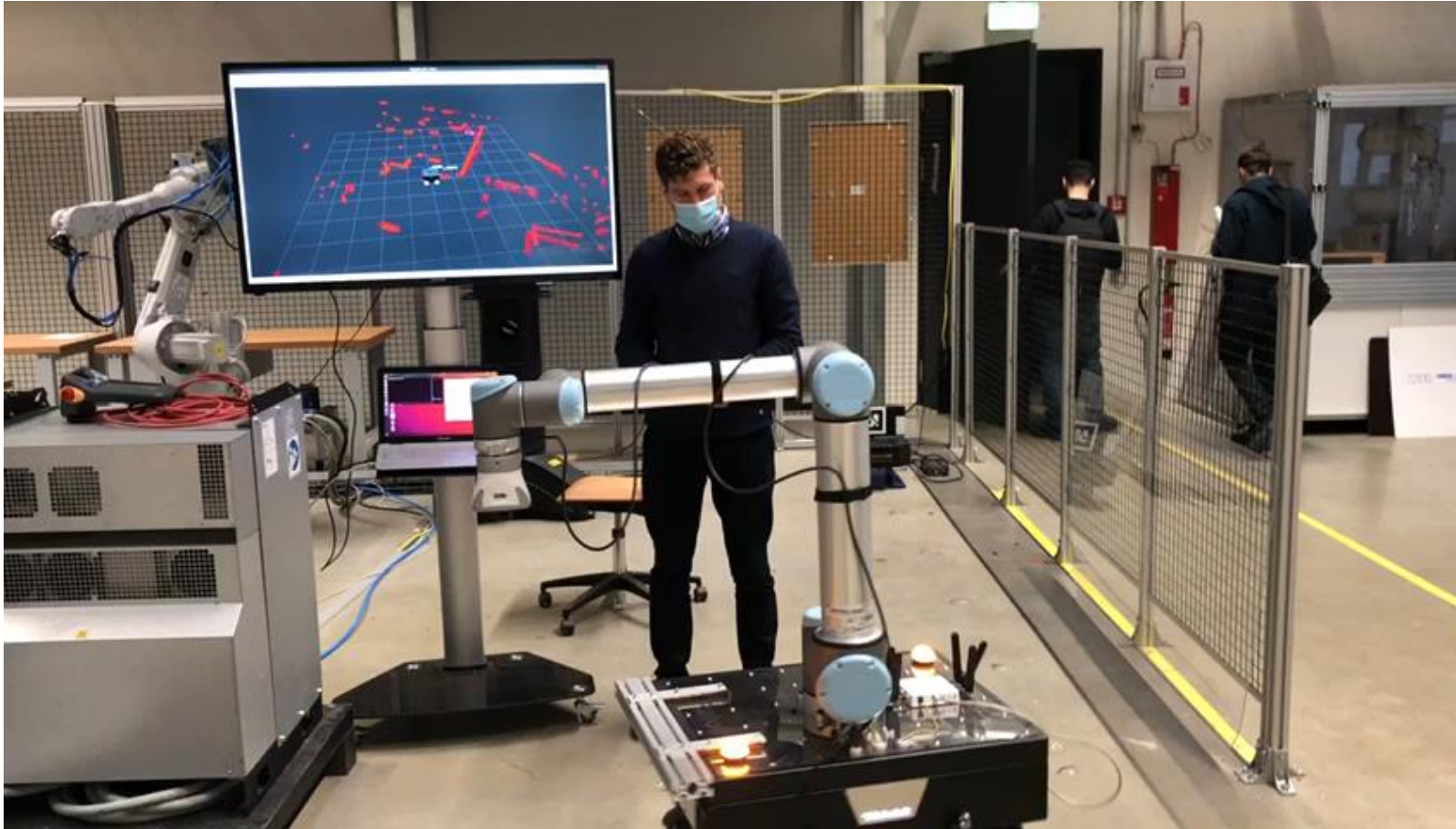
- Critical MTC – **ultra low latency**, very high availability
- Control two cooperating mobile robots linked by **metrology** and **wireless communication**

Use Cases 5G-Industry Campus Europe – 5G-Robotics



5G connected Wireless Velodyne Lidar System

Use Cases 5G-Industry Campus Europe – 5G-Robotics



<https://www.linkedin.com/feed/update/urn:li:activity:6725404043226714112>

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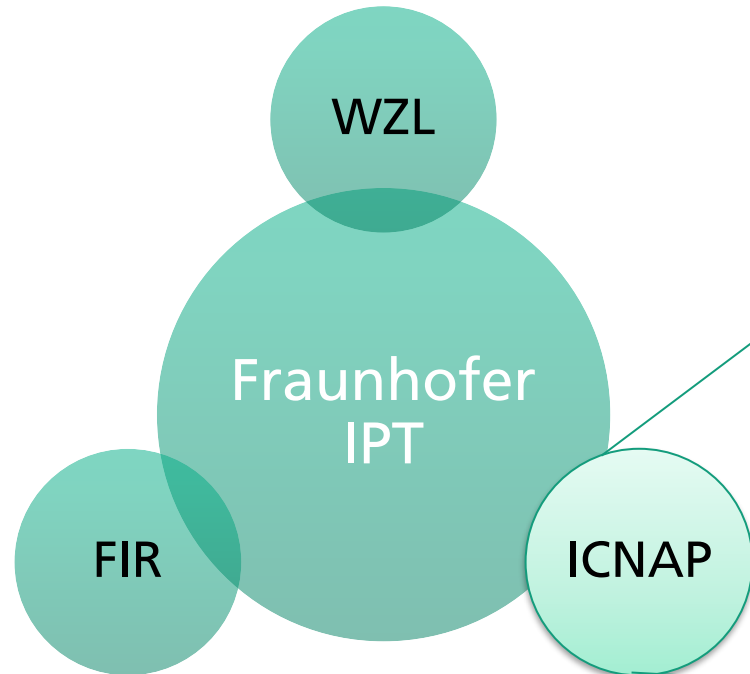
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Conclusion



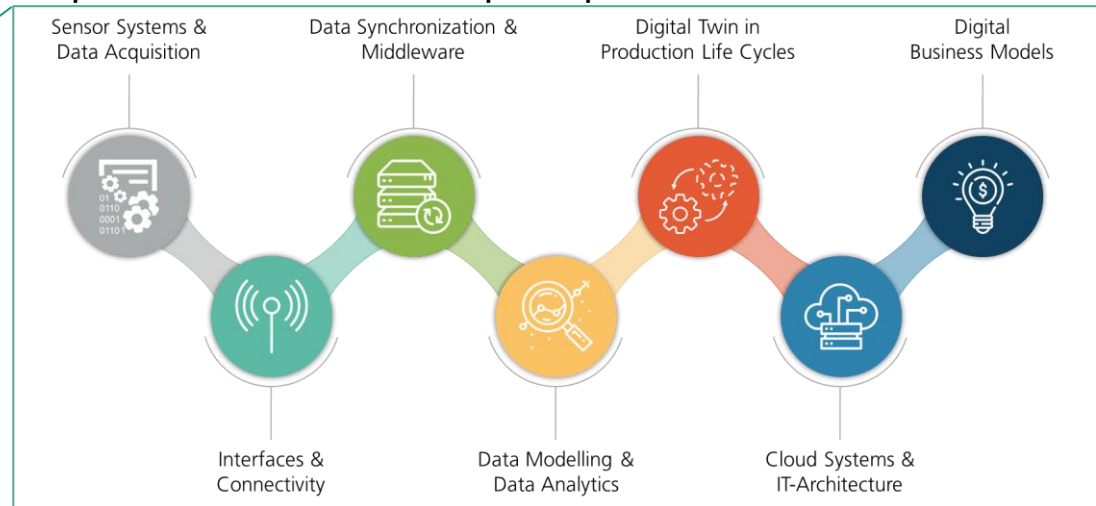
- Evolution of the 5G ecosystem is ongoing and many features are yet to come
- 5G is already mature enough for many industrial applications
- Germany has a lot of 5G testbeds
- 5G-Industry Campus Europe is an industrial testbed dedicated to production

Cooperation with the 5G-Industry Campus Europe



- Membership and pre-competitive collaboration in the International Center for Networked, Adaptive Production ICNAP

<https://www.vernetzte-adaptive-produktion.de/en.html>



- Bilateral cooperation with the 5G-ICE research partners IPT, WZL and FIR based on the ICNAP membership

Overview of the Current 25 ICNAP Community Members

Your Contact



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