CREATING THE
5G-MANUFACTURING
ECOSYSTEM

5G INDUSTRY CAMPUS EUROPE

5G for Digital Twins and Shadows
PLM Road Map & PDT 2020

17-18 November 2020

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Agenda

| 1 | **Motivation for 5G in Production** |

| 2 | **Selected 5G use cases** |

| 3 | **5G-Industry Campus Europe** |

| 4 | **Conclusion** |

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5G will be for industries the way 4G was for the Smart Phone

Foundation of Mobile Telephony

Mobile Telephony for Everyone

Foundation of Mobile Broadband

Future of Mobile Broadband

Industries beyond Smartphones

1G
AMPS TACS
NMT

2G
GSM D-AMPS
PDC IS-95

3G
WCDMA/HSPA
cdma2000

4G
LTE

5G
NR (New Radio)
Network Slices
Distributed Cloud
Machine Intelligence
Massive IoT
Security

~1980 ~1990 ~2000 ~2010 ~2020

Source: Ericsson

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5G technology offers great potential for the production

Communication systems as the basis for the factory of the future

To realize the vision of a highly flexible and networked manufacturing system, communication systems require the following characteristics:

Real-time data transfer

High reliability

Scalability

Dezentra-lisation

High datarates

High device density
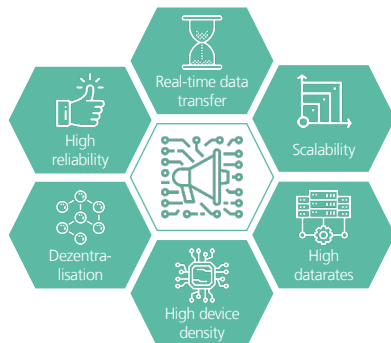
5G as future communication standard for production

| Enhanced mobile broadband	Ultra-reliable and low latency communication	Massive machine type communication
20 Gb/s Downlink max.	<1ms Latency	100x Connected devices
10 Gb/s Uplink max.	99,999% Reliability	~ 15 Jahre Battery run-time
10 Tbps pro km² Capacity	500 km/h Mobility	1.000.000/km² Device density

5G technology offers enormous potential for the production

5G is the first mobile standard that meets the requirements of future industry

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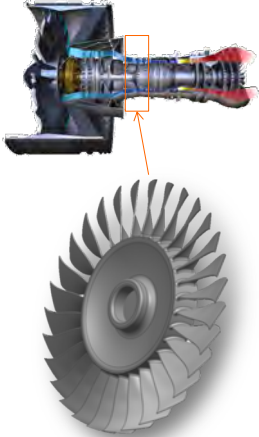
Production research from the cutting edge to 5G
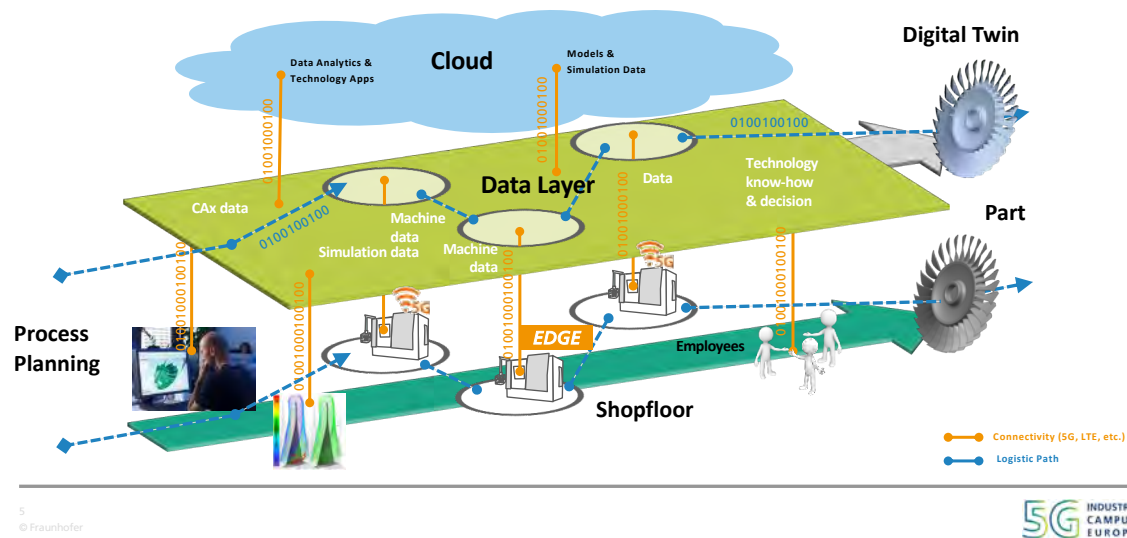
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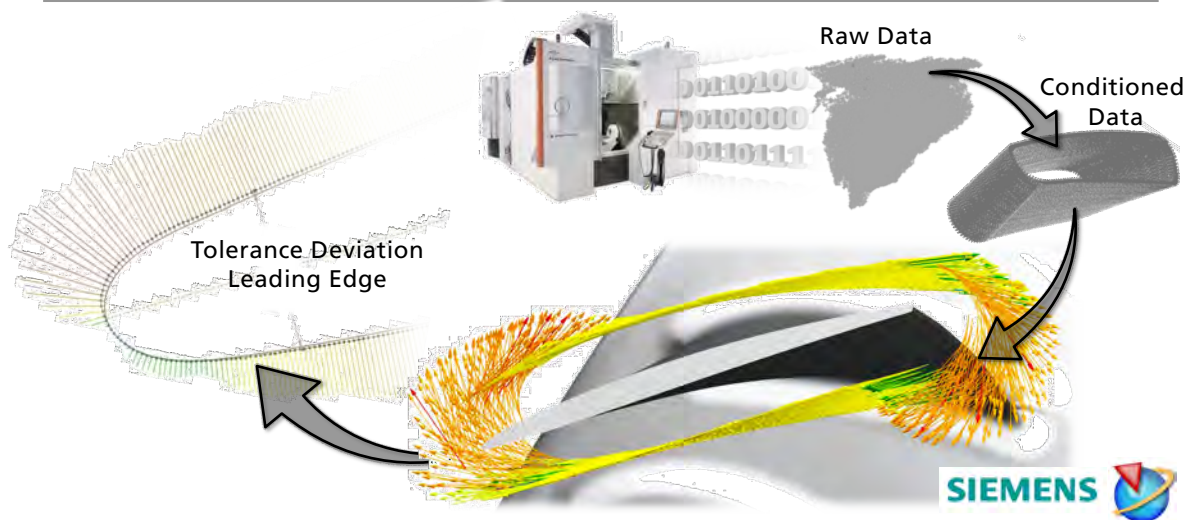
4 **Conclusion**

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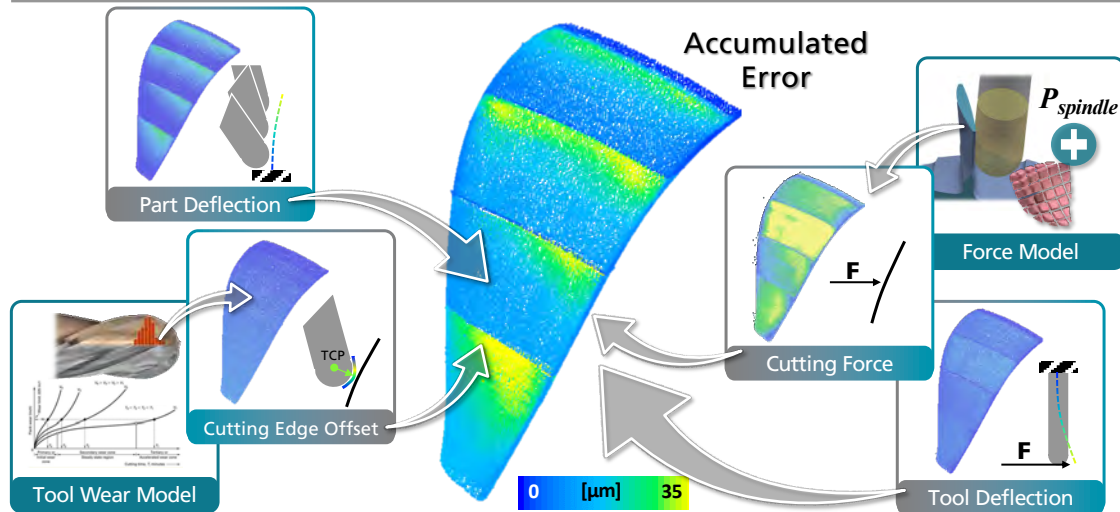**5-axis milling of BLISKs**

Pratt & Whitney PW1100G Engine

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The Most Obvious Use of a Digital Production Environment
Documentation of Quality Relevant Data via "Digital Twins"

Raw Data

Conditioned Data

Tolerance Deviation Leading Edge

SIEMENS

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Working with Raw Data from a Manufacturing Environment
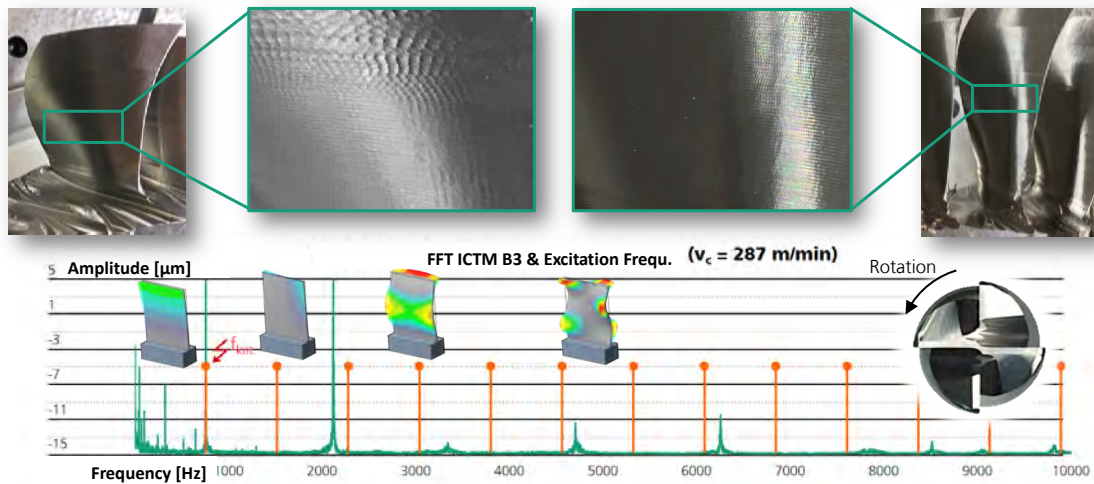**Data Conditioning, Filtering, Synchronization and Merging**

Accumulated Error

Part Deflection

Tool Wear Model

Cutting Edge Offset

TCP

$P_{spindle}$

Force Model

F

Cutting Force

Tool Deflection

F

0 [µm] 35

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Stability Indication from FFT

Amplitude [µm]

FFT ICTM B3 & Excitation Frequ. (v_c = 287 m/min)

Rotation

f_{knt}

Frequency [Hz] 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

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5G System Architecture for Closed-Loop Manufacturing
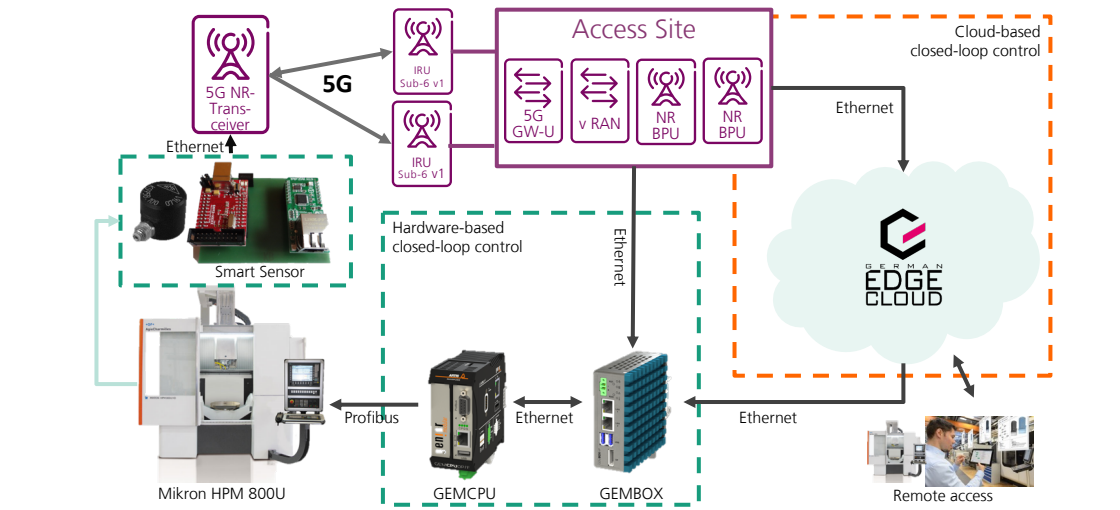
The Fraunhofer IPT & Ericsson Blisk Use-Case
Visualization of Critical Vibrations – *Real* Surface Finish
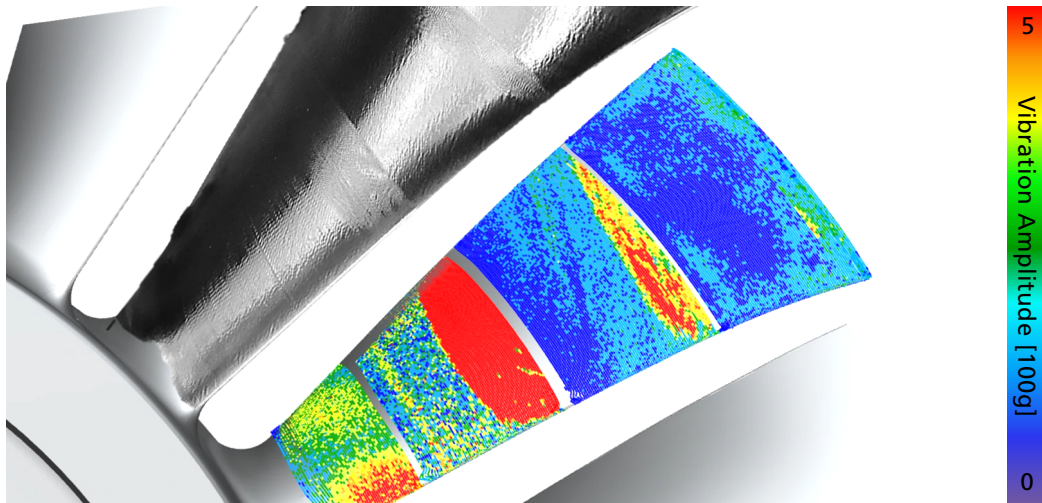
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5G-Industry Campus Europe will be the largest industrial 5G testbed
- 5G indoor networks on 4 different shopfloors fully equipped with machines and robots
- 5G outdoor network if 1 km² at the RWTH Aachen Campus
- 5G-NSA running on industry spectrum @3.7 – 3.8 GHz
- Simultaneous 4G network running @2.3 GHz as anchor band

5G network supplier: ERICSSON

5G-Industry Campus Europe
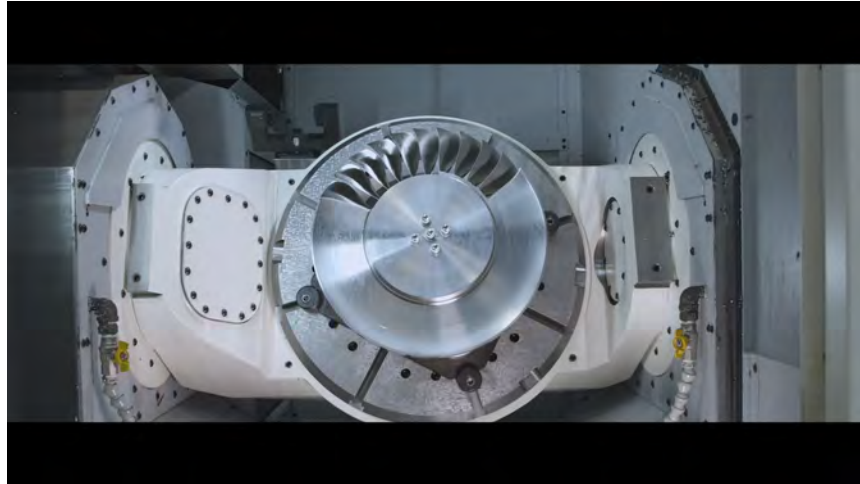
https://www.youtube.com/watch?v=sXbCWWNztuQ&feature=emb_logo

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Implementation projects 5G-Industry Campus Europe

MOBILE ROBOTICS

LOGISTICS

DATA ECONOMY

PROCESS MONITORING

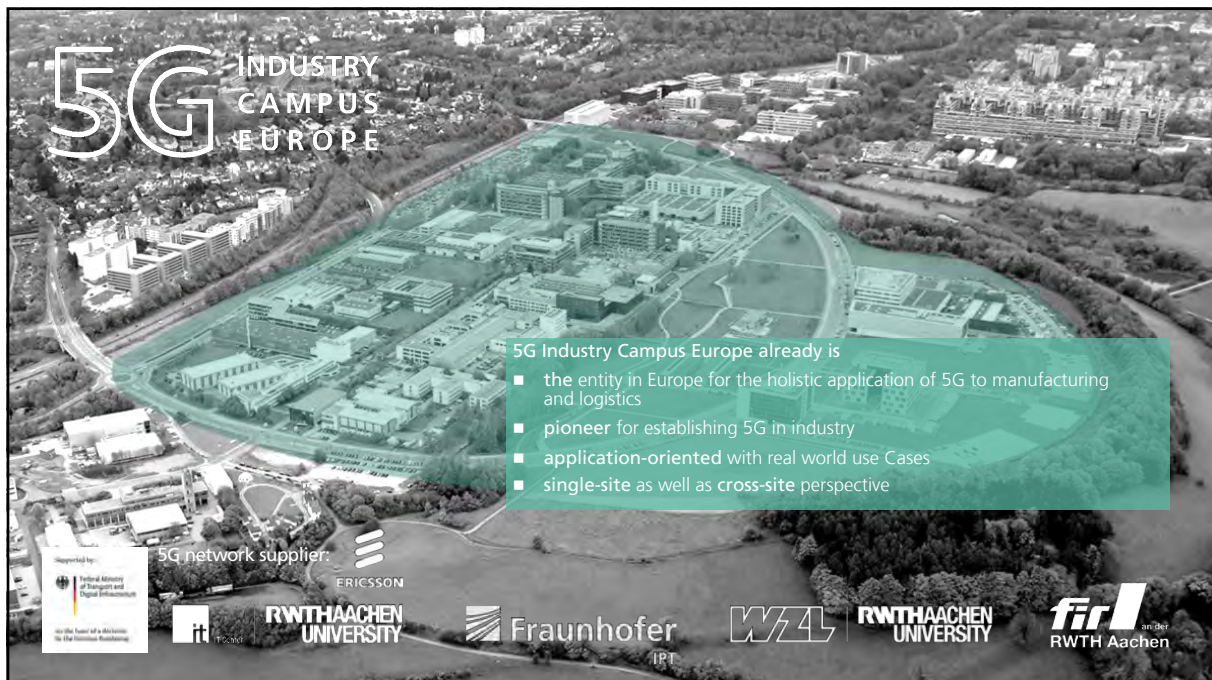CROSS-SITE PROCESSING

SMART SENSORS

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Implementation projects 5G-Industry Campus Europe

5G-AE Sensor	5G-Logistics	5G-Multisensor	5G-Blockchain
■ development of wireless acoustic emission (AE) sensor ■ detection of tool breakage and wear	■ AGV navigation ■ transition from indoor to outdoor network ■ remote navigation	■ multi-sensor platform ■ workpiece monitoring and localization ■ machine condition monitoring	■ data economy for multiple data streams ■ connected to blockchain operations
5G-Robotics	**5G-Cockpit**	**5G-3D**	**5G-Edge-Cloud**
■ mobile robotics ■ sensor guided operation with centralized data processing	■ production cockpit with 5G remote machine and sensor connectivity ■ digital twin visualization	■ wireless optical 3D laser scanner ■ seamless machine and robot integration and synchronization	■ integration of on-premise edge-cloud ■ low-latency data analytics for closed-loop operations

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5G Industry Campus Europe already 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

5G network supplier: ERICSSON

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Conclusion and outlook

Conclusion
- 5G offers large potential for production
- Industrial 5G campus networks can be realized today
- 5G-Industry Campus Europe is a collaborative platform to stimulate 5G innovations

Outlook
- 5G ecosystem requires joint efforts from IT and OT industry
- 5G development is ongoing and will enable future capabilities

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Thank you for your attention!
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