# F5G OpenLab for Industry 4.0 Use Cases Demonstration

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# Digital Transformation of Industrial Automation
## Convergence of OT and IT

- **Field Level**

    - physical manufacturing equipment on the factory shop floor such as motors, actuators, video cameras and other sensors.

- **Control Level**

    - receives sensor and monitoring information from the devices in the Field Level. Based on that information, decisions are taken and control signals for the devices in the Field Level are generated, e.g. by using Programmable Logic Controllers (PLC).



- The current trend is towards <u>virtualization of control functions in the form of virtual PLCs (vPLC)</u> running in **edge cloud environments**.

- vPLCs alleviates the need for costly and often proprietary solutions for local PLCs on the shop floor, where cooling, power consumption, space and environmental effects are critical issues.

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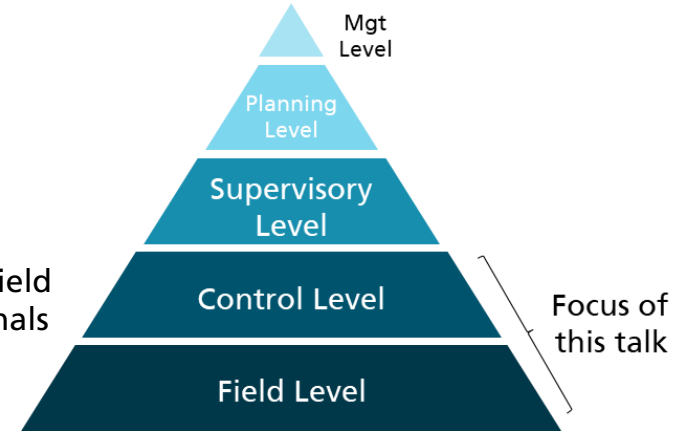
# Edge/Cloud for Industrial Applications

On-premise Edge

- **Private On-Premise Edge Clouds** are becoming increasingly important for real-time, secure, robust and low-latency communication in production sites.

  - a proven means for larger manufacturing companies

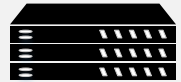  - SMEs cannot afford such infrastructures due to the high acquisition costs

Production Site 1

Production Site 2
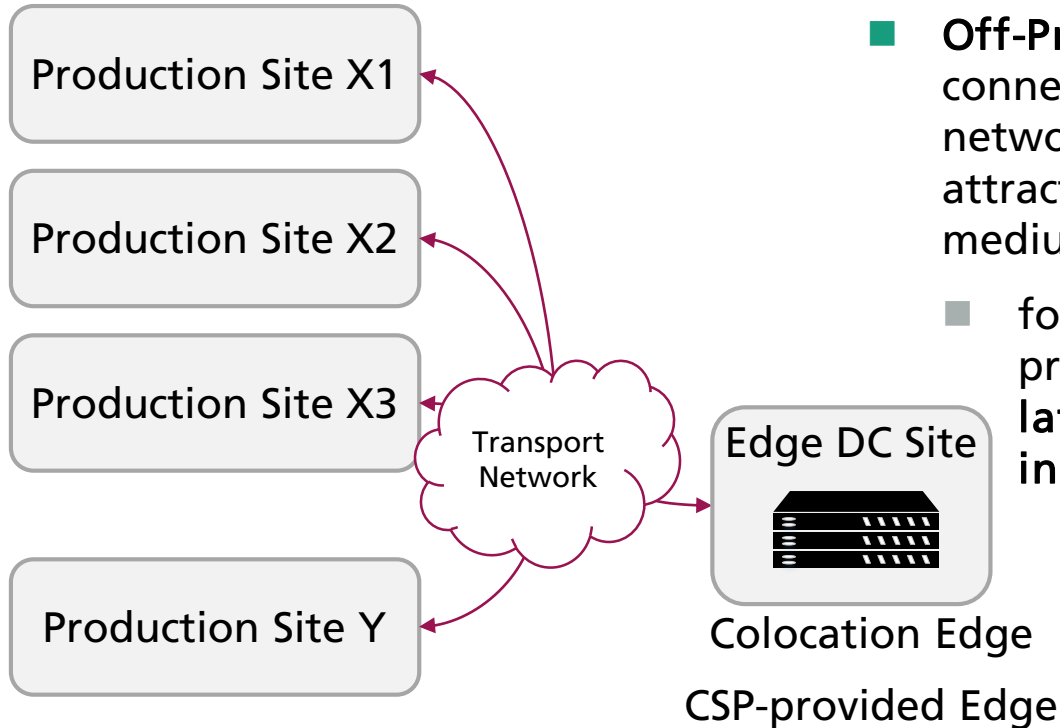
Production Site N

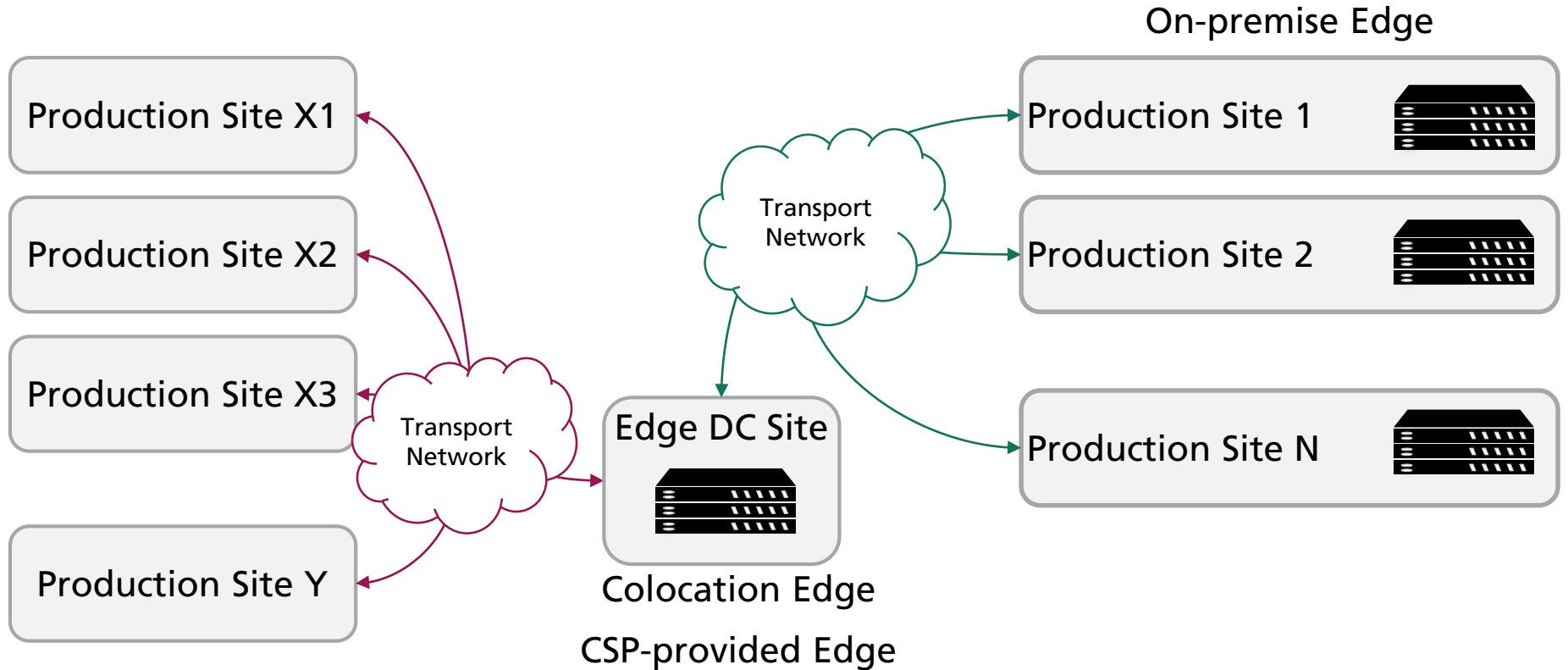behnam.shariati@hhi.fraunhofer.de

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# Edge/Cloud for Industrial Applications

Production Site X1

Production Site X2

Production Site X3

Transport Network

Production Site Y

Edge DC Site

Colocation Edge

CSP-provided Edge

- **Off-Premise Private/Public Edge Cloud** connected via a real-time communication network offers new, economically highly attractive possibilities, especially for small and medium-sized manufacturing companies.

  - for real-time support of distributed, urban production sites, **a real-time, low-latency, broadband fibre optic infrastructure is required.**

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# Edge/Cloud-based Control of Automated Guided Vehicles

- AGVs perform transportation of goods to and between robotic production cells.

- AGVs and robotic cells provide individual sets of micros services, which are hosted on an edge cloud.

- The navigation of the AGVs is performed on the edge cloud by a guidance control system.

- The end-to-end roundtrip latency between AGV → edge data centre → AGV needs to be less than 30 ms including processing.

- The data rate for control messages is about 400 kbit/s per AGV, while transmission of video from the AGV to the cloud may require 10 Mbit/s or greater.

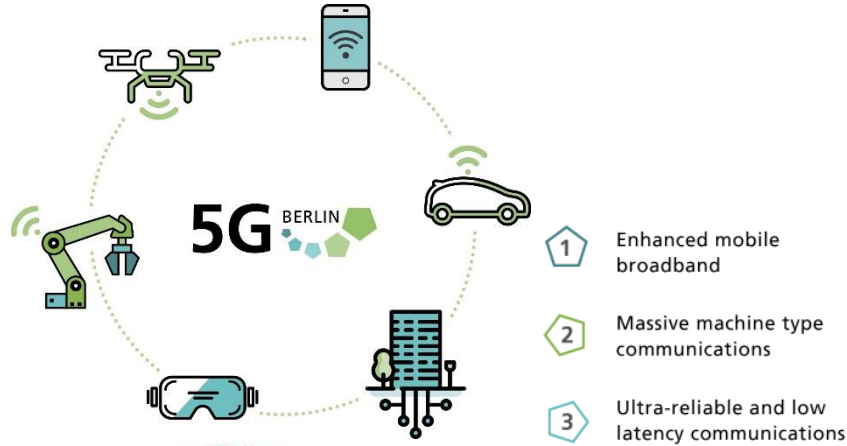behnam.shariati@hhi.fraunhofer.de

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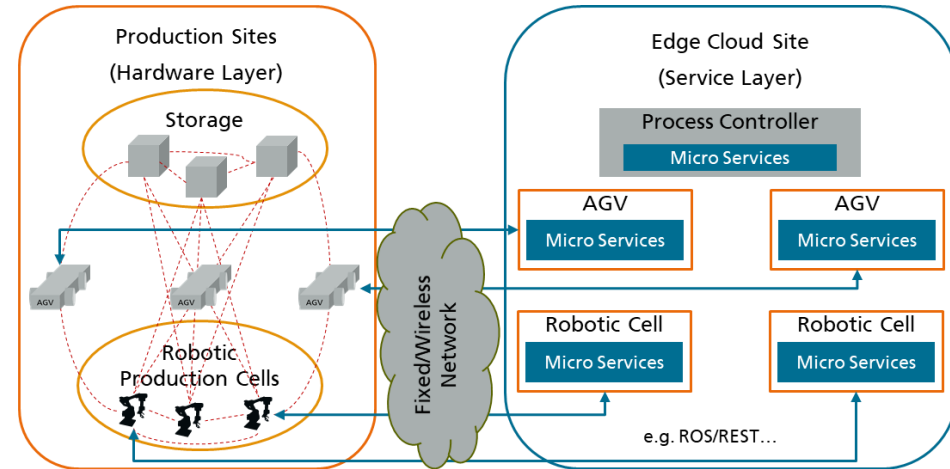
# Edge/Cloud-based Visual Inspection for Quality Assessment of Products

- Industrial-grade video cameras monitor produced objects and video streams are processed by AI-assisted video analytics on edge cloud to assess their quality.

- Automatic quality control measures are taken on the factory shop floor, such as e.g. controlling robotic actors to handle defect parts.

- The number of cameras per vision inspection station ranges from one to four.

- The upstream aggregated data rate per vision inspection station ranges from1 Gb/s to 20 Gb/s.

- The data rates are asymmetric, since the downstream control signals have a comparably negligible data rate.
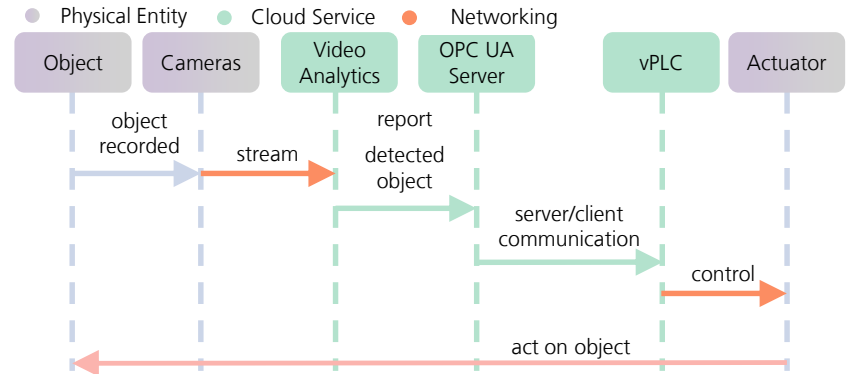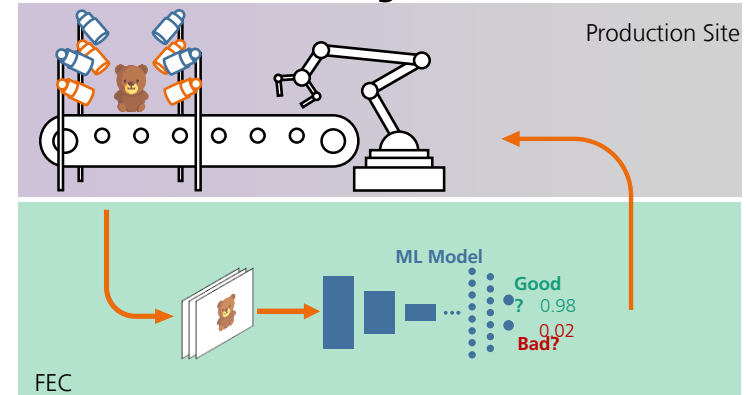


[ref] P. Safari, et al., "Edge Cloud based Visual Inspection for Automatic Quality Assurance in Production," in Proc. CSNDSP 2022.

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# Berlin-based Real-time Communication Infra. for Industry 4.0



5G BERLIN

1. Enhanced mobile broadband
2. Massive machine type communications
3. Ultra-reliable and low latency communications

Berlin Center for Digital Transformation

**Metro Optical Network**

**Time Sensitive Networking**

**5G Network**

**Enable Twin Transition through Ubiquitous Fiber Connectivity**

F5G OpenLab

**F5G Optical Access Network**

**Fraunhofer Edge Cloud (FEC)**

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# F5G OpenLab

Enable Twin Transition through Ubiquitous Fiber Connectivity.

## Vision

- Contribute to a green and sustainable ICT industry
  by promoting Fiber to Everything

- Accelerate digital transformation by highly reliable and trustworthy autonomous networking

## Mission

- Provide an ecosystem for validating networking solutions for twin transition

- Offer a vendor agnostic facility to verticals for evaluating their use cases

- Empower the development of fiber-based solutions

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# F5G OpenLab

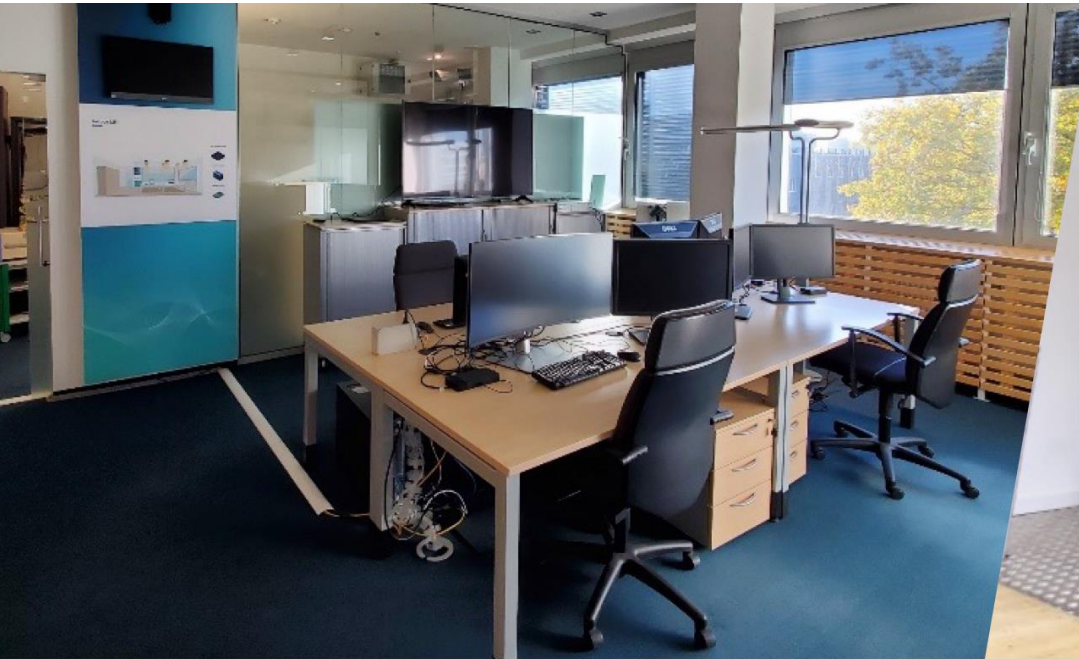## Environment for a Green and Digital Transition
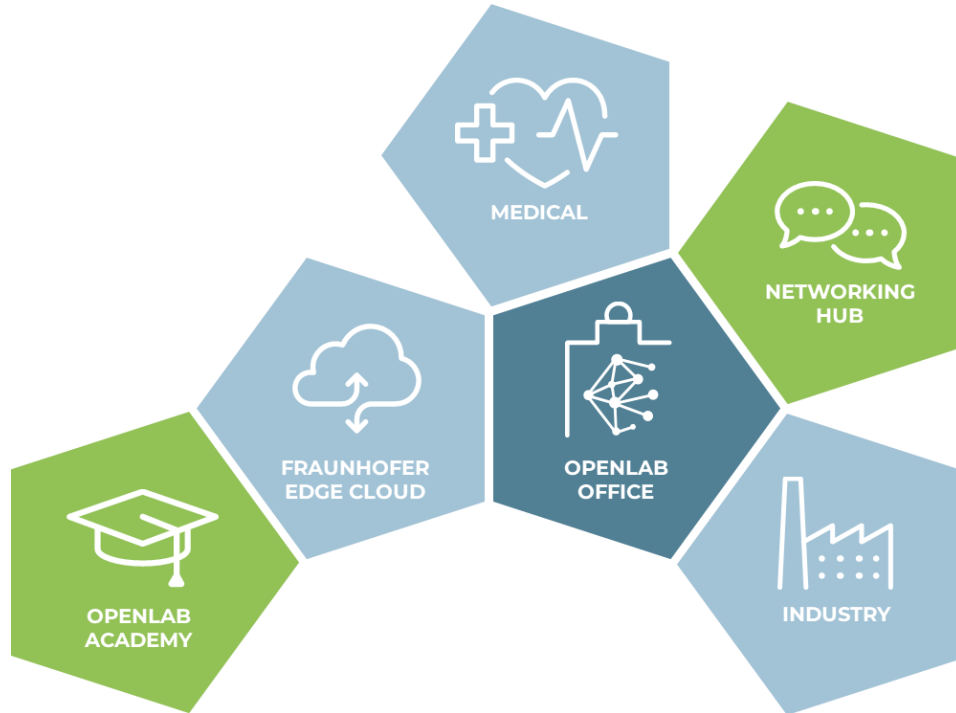


- Collaboration with complementing stakeholders
- Learning and understanding of evolution of networks
- Access to large scale and forward-looking infrastructure
- Identify novel business models and revenue streams
- Impact and contribute to F5G standards and specifications

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# F5G OpenLab Infrastructure at Fraunhofer HHI



**LAB AND OFFICE SPACE**

**FRAUNHOFER EDGE CLOUD**

FRAUNHOFER EDGE CLOUD

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# Infrastructure for Industrial and Medical Verticals

**INDUSTRIAL TEST FIELD / FRAUNHOFER IPK**

**MEDICAL ENVIRONMENT / CARL-THIEM-KLINIKUM (CTK)**

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# Testbed for the Proof-of-Concepts
## F5G OpenLab, IPK Test Field, and Fraunhofer Edge Cloud

- Dark fiber connectivity between F5G Open Lab and the factory shop floor at Fraunhofer IPK

- PON/WiFi networking of the factory shop floor

- Enabler for industrial use case demonstrations and field trials at F5G Open Lab

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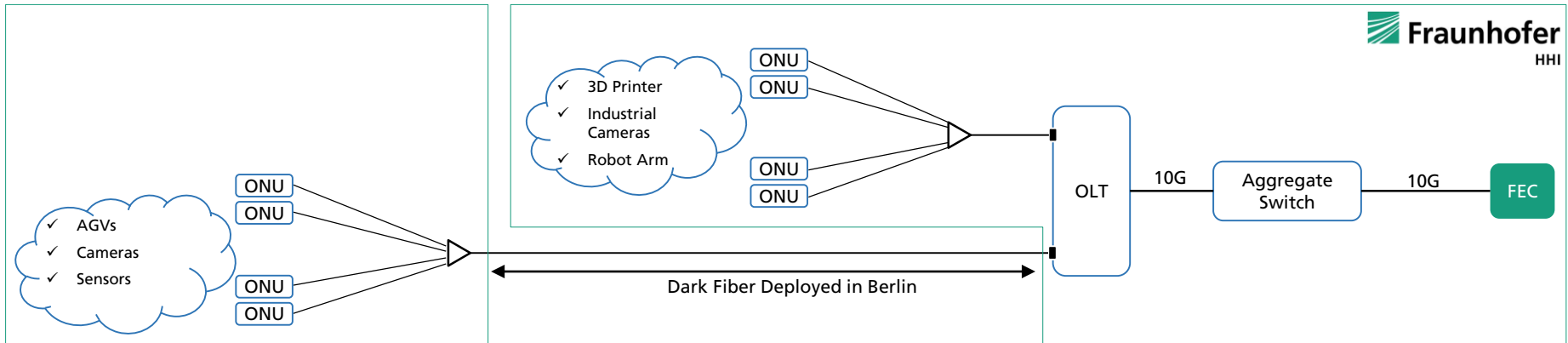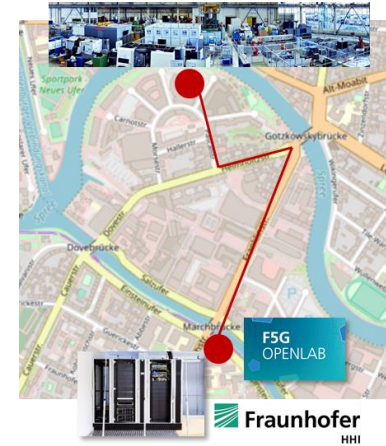
# Conclusions and Outlook

- Use cases for industrial automation pose very challenging requirements on the communication infrastructure

  - Time sensitive, cyclic communication with low latency and jitter

  - Potentially high bandwidth, data privacy, security and reliability

- F5G OpenLab offers a unique opportunity to operators, vendors, and technology developers to test and validate their solutions.

- We are carrying out several PoC demonstrations together with our partners.

  - Edge/Cloud-based visual inspection for quality assessment of products

  - Edge/Cloud-based control of automated guided vehicles

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# Become a Member of the

**F5G OpenLab**

Impact and contribute to F5G standards and specifications

**JOIN NOW**

Access to large scale and forward-looking infrastructure

Collaboration with complementing stakeholders

Identify novel business models and revenue streams

Learning and understanding the evolution of networks

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