

F5G Proof-of-Concept Demonstrations for Industrial Applications

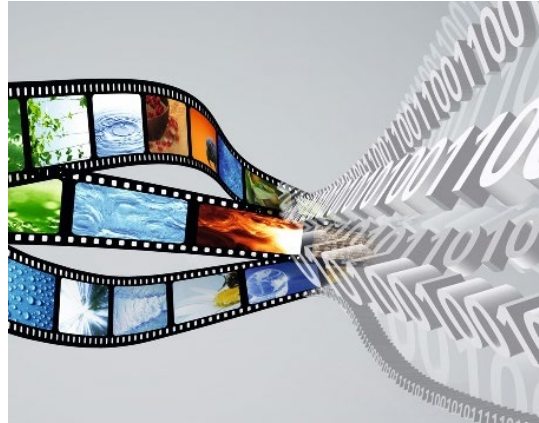
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Fraunhofer Heinrich Hertz Institute (HHI), Berlin, Germany



$10^0 - 10^2 - 10^4$ Tbps



H.264 – H.265 – H.266



3G – 4G – 5G – 6G

- Research: Photonic Networks / Systems / Components, Wireless and Video Coding
- Every second bit on the Internet touches Photonic or Video Technology invented or made by Fraunhofer HHI

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

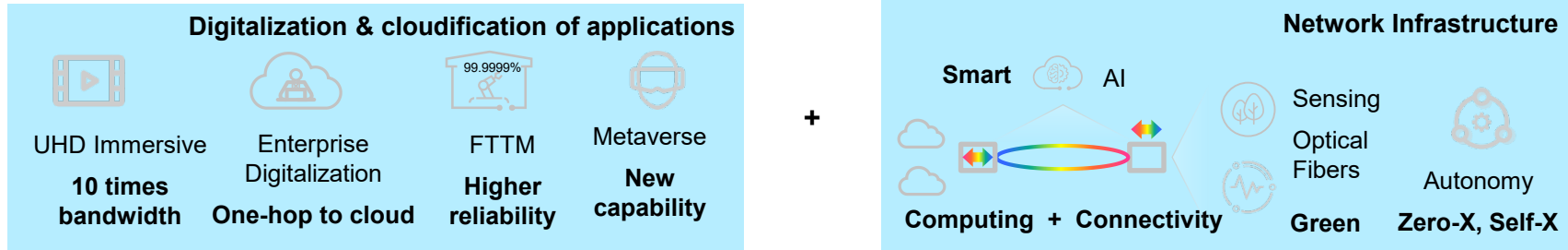


Mission

- 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

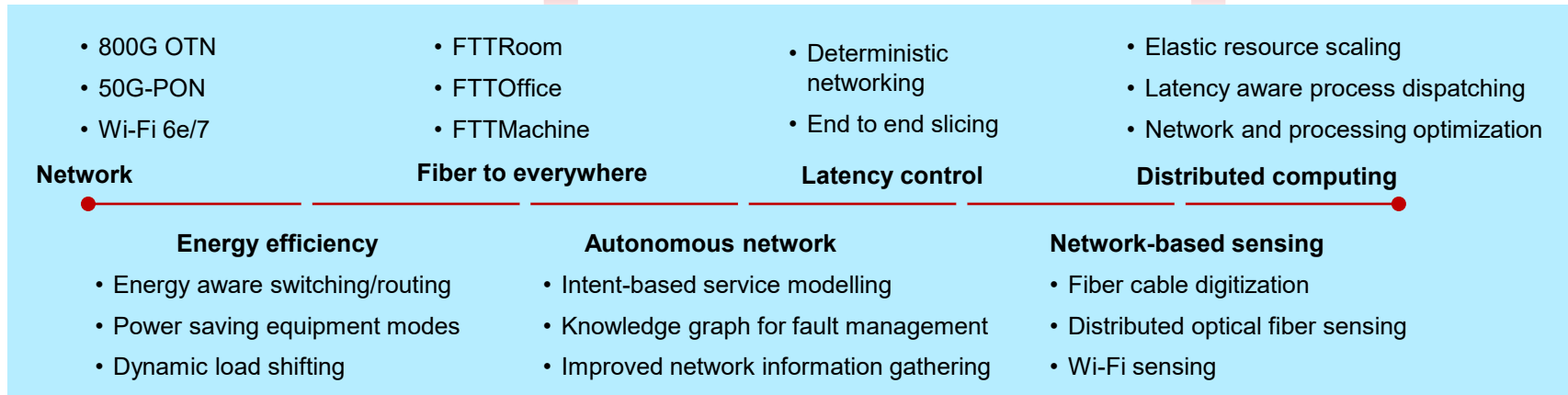
F5G Advanced Evolution, Key drivers and Enablers

Drivers



Enabling technologies

<https://www.etsi.org/media-library/white-papers>

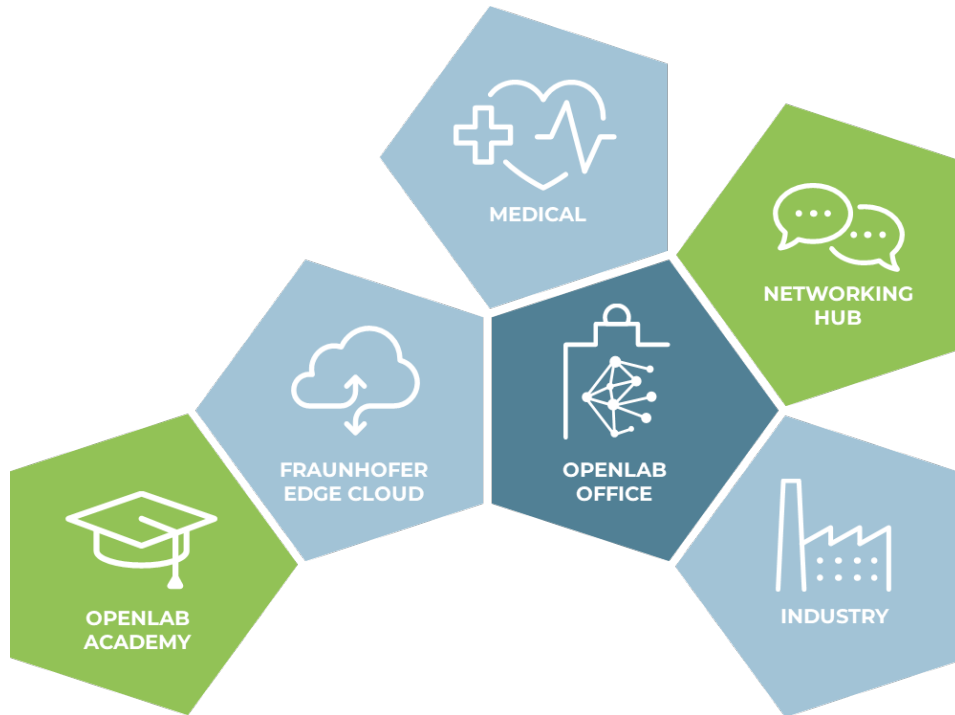


PON technological Characteristics

GPON	XG-PON	XGS-PON	50G PON
Gigabit PON	10G asymmetrical PON	10G symmetrical PON	50G symmetrical PON
Upstream: 1,25 Gb/s	Upstream: 2.5 Gb/s	Upstream: 2.5 or 10 Gb/s	Upstream : 12.5, 25 or 50 Gb/S
Downstream: 2.5 Gb/s	Downstream: 10 Gb/s	Downstream: 10 Gb/s	Downstream: 50 Gb/s
Enabler of Gigabit broadband	Asymmetrical bitrates. Co-exists with GPON. Same λ as XGS-PON	Dual rates: symmetrical or asymmetrical. Co-exists with GPON,	Dual rates: symmetrical or asymmetrical. Co-exists with GPON, XGS-PON
Deployments: Most widely deployed PON worldwide since 2007	Deployments ; worldwide, main China, Japan, US, South Korea	Deployments: Worldwide. Main PON flavor today.	In trials and pilot stage. Deployments expected to start after 2023

Source: ETSI F5G White Paper, „All-optical network facilitates the Carbon Shift“, Nov. 2023

F5G OpenLab: Environment for a Green and Digital Transition



- Access to infrastructure in relevant environments (industry, medical ...)
- Collaboration with complementing stakeholders
- Participation in proof-of-concepts and collaboration on standards

Services:

- Carbon footprint and lifecycle analysis for different verticals
- [FTTx network planning](#)
- Trainings and consultancies



**Enable twin transition –
green and digital,
through ubiquitous fiber
connectivity.**



Infrastructure at Fraunhofer HHI / IPK



INDUSTRIAL TEST FIELD / SHOP FLOOR

FRAUNHOFER EDGE CLOUD

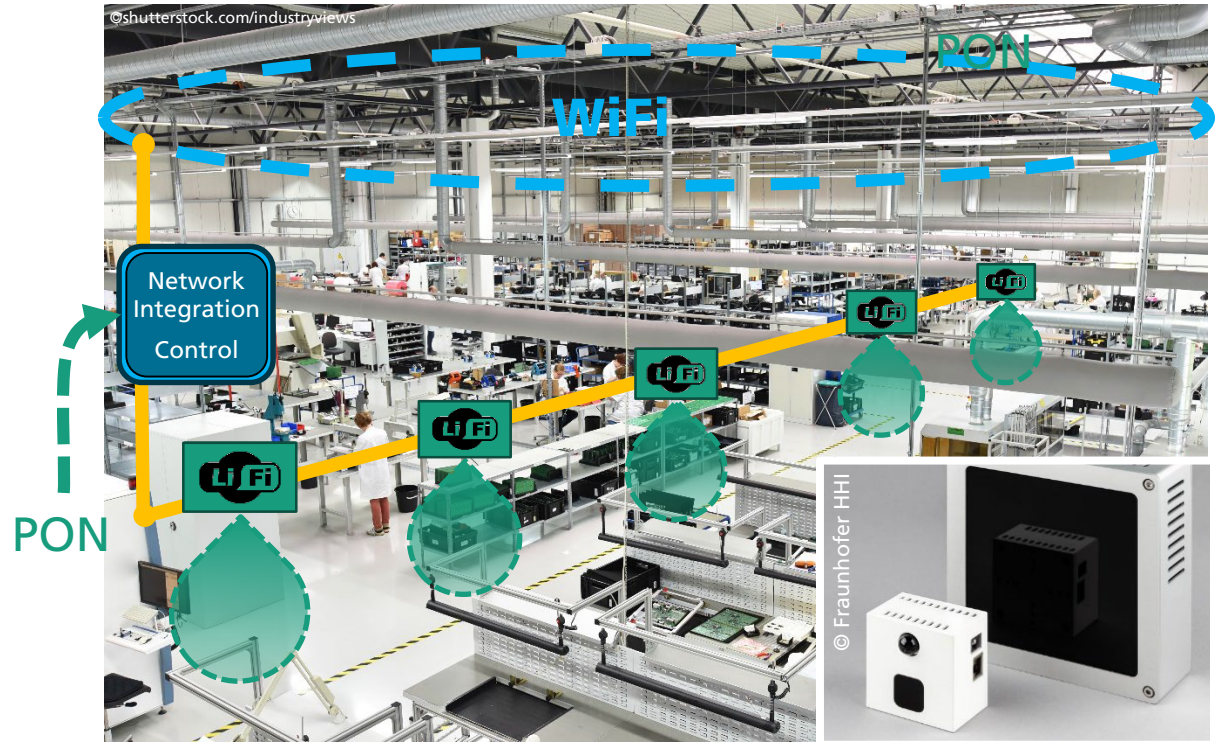


FRAUNHOFER
EDGE CLOUD

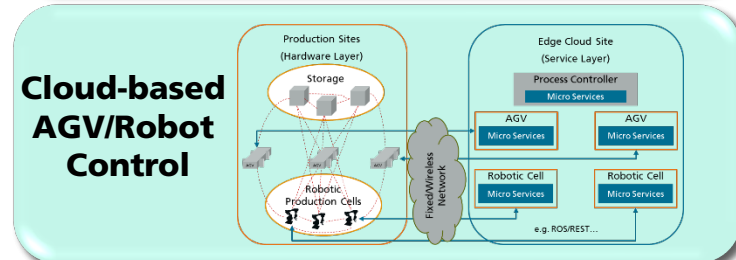
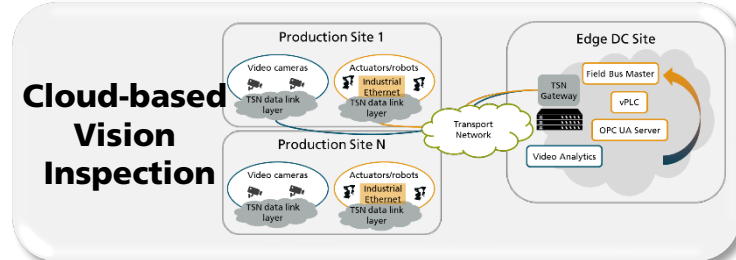
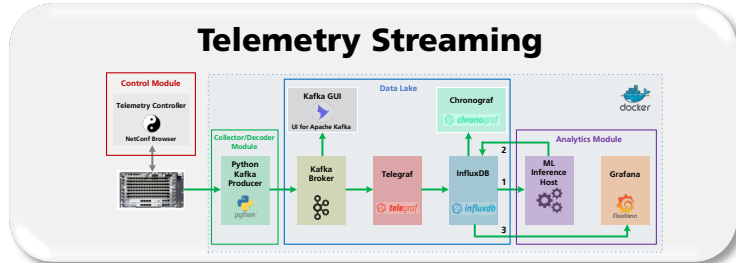


LiFi-enhanced Industrial Networks

- LiFi infrastructure in industrial production environment
 - Higher area capacity
 - Robust against EMI
 - Allows for secured communication positioning and navigation
- Remote control via PON



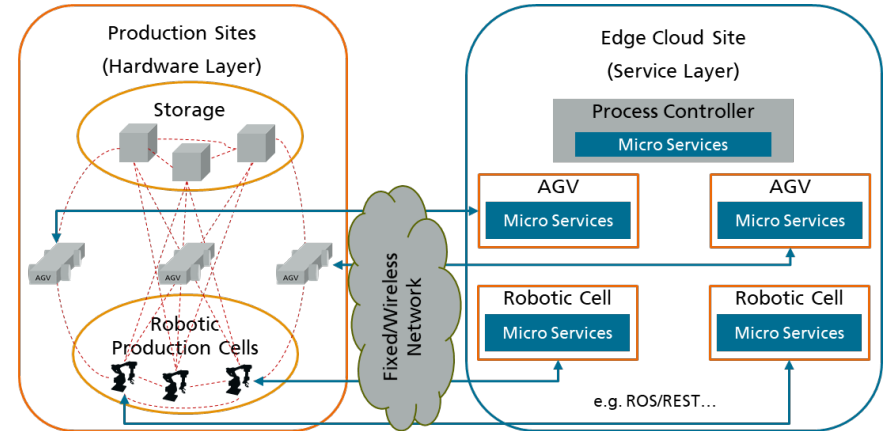
ETSI ISG F5G Proof-of-Concepts



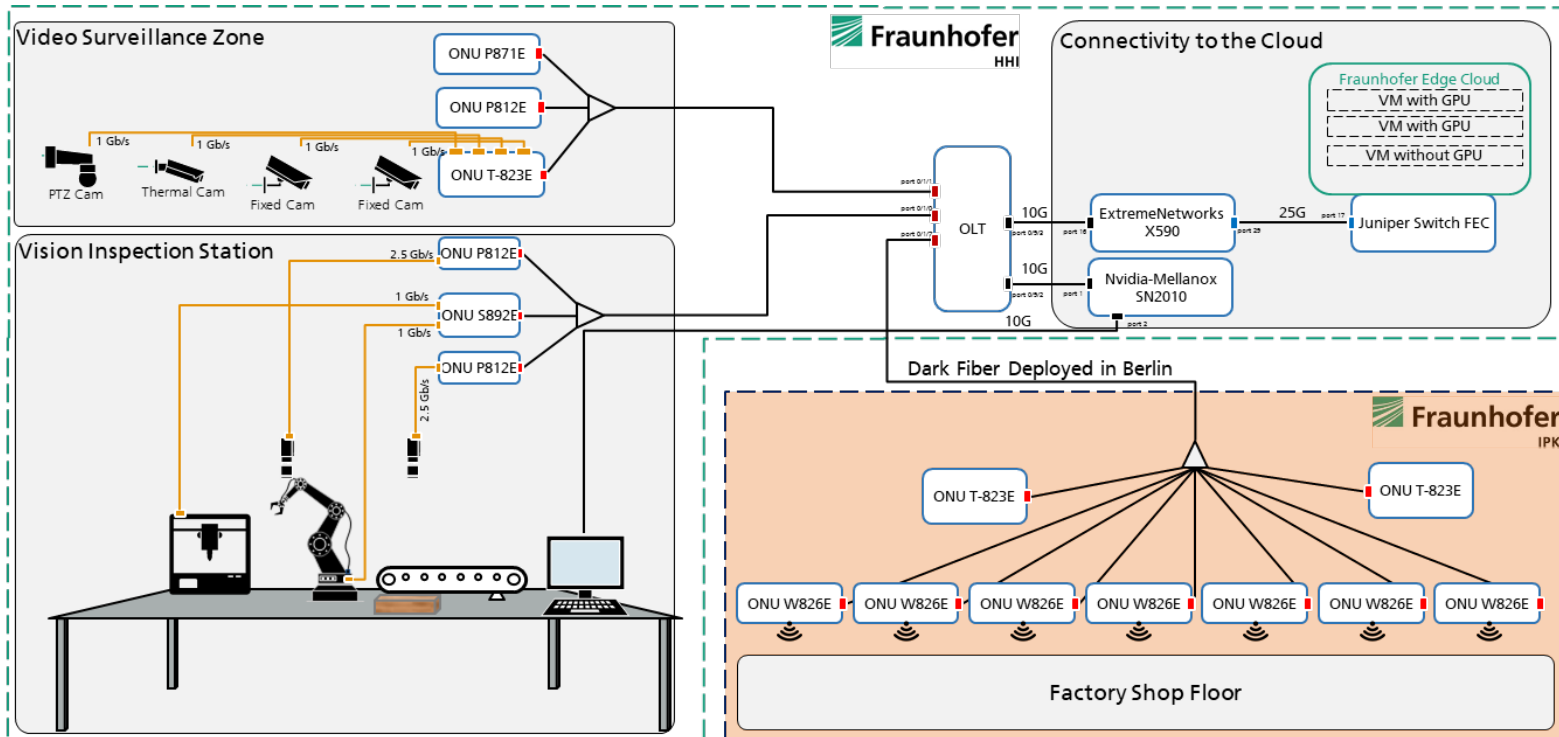
AI@TI Testbed Partner

Edge/Cloud-based Control of Automated Guided Vehicles

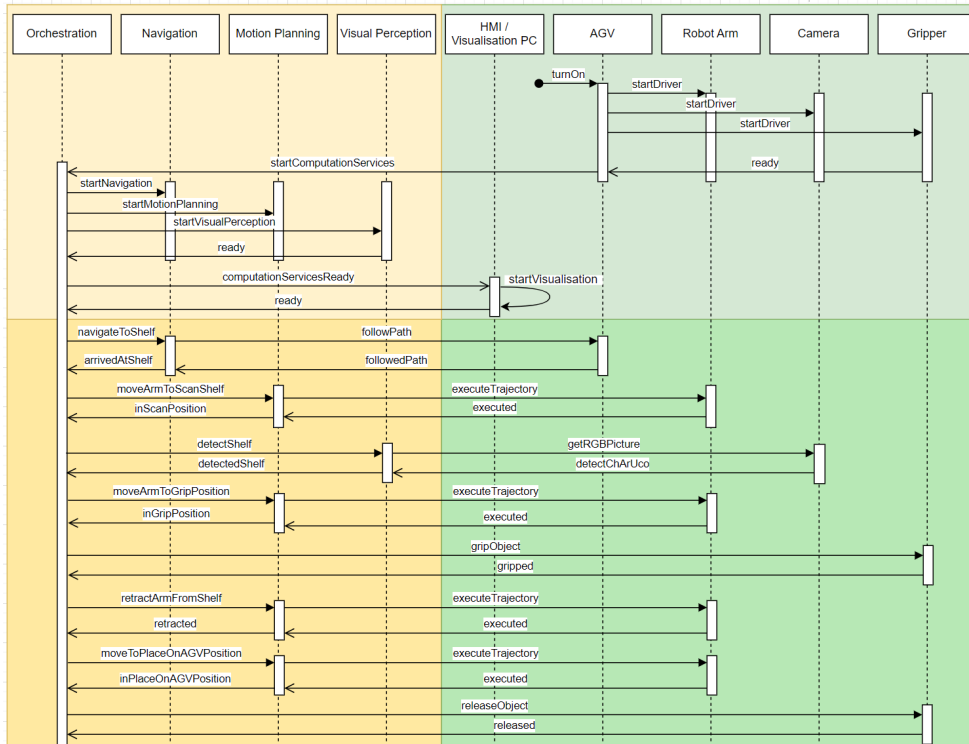
- AGVs perform **transportation of goods** to and between robotic production cells.
- AGVs and robotic cells provide individual sets of **microservices**, which are hosted **on an edge cloud**.
- The **navigation** of the AGVs is performed **on the edge cloud** by a guidance control system.
- The **end-to-end roundtrip latency** between AGV → edge data centre → AGV needs to be less than **30 ms** including processing.
- The **max data rate from the shop floor** to the cloud was around **80 Mb/s**, the max data rate from the cloud to the shop floor was around 30 Mb/s.



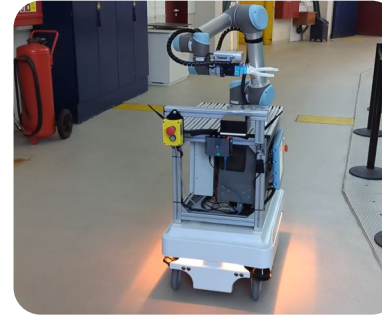
F5G OpenLab: Network Architecture



Cloud-based Control of AGVs and Robots: Process flow



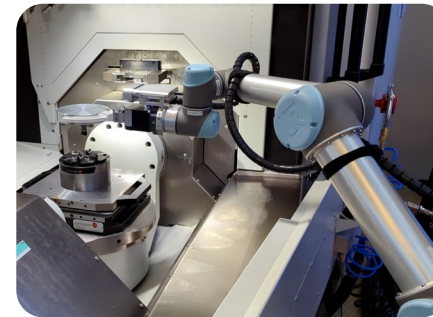
AGV Moving on the Shop Floor



Load Object into the Shelf

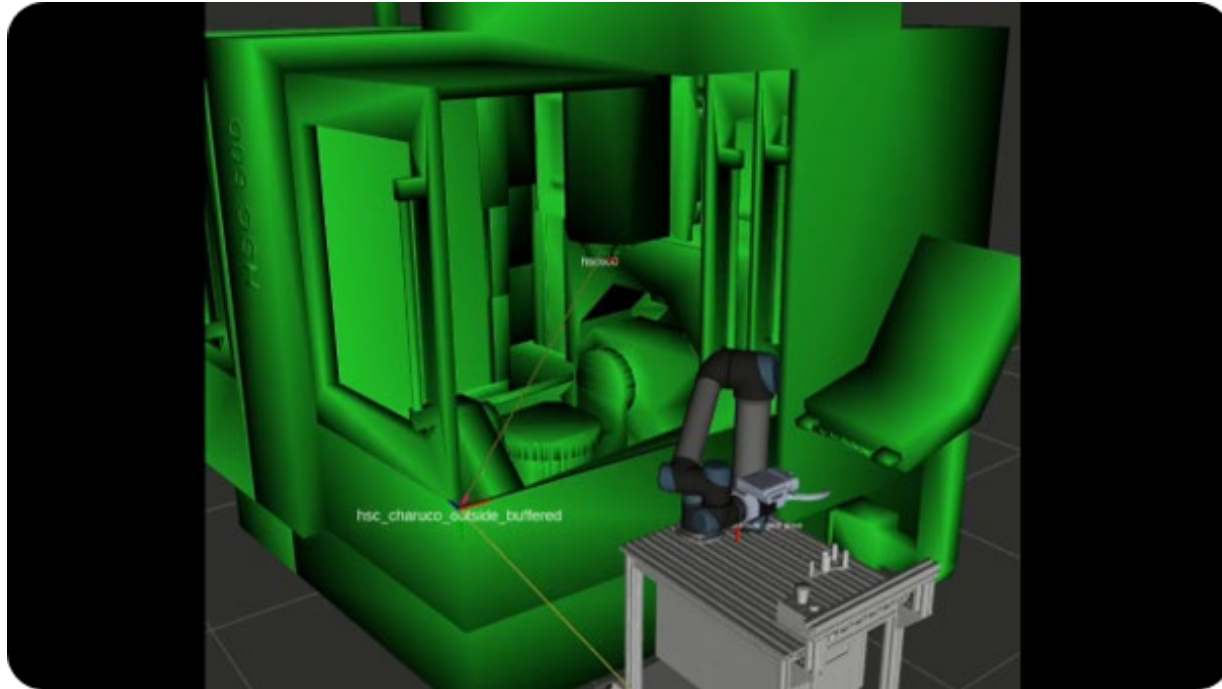


Load Object into the CNC Machine

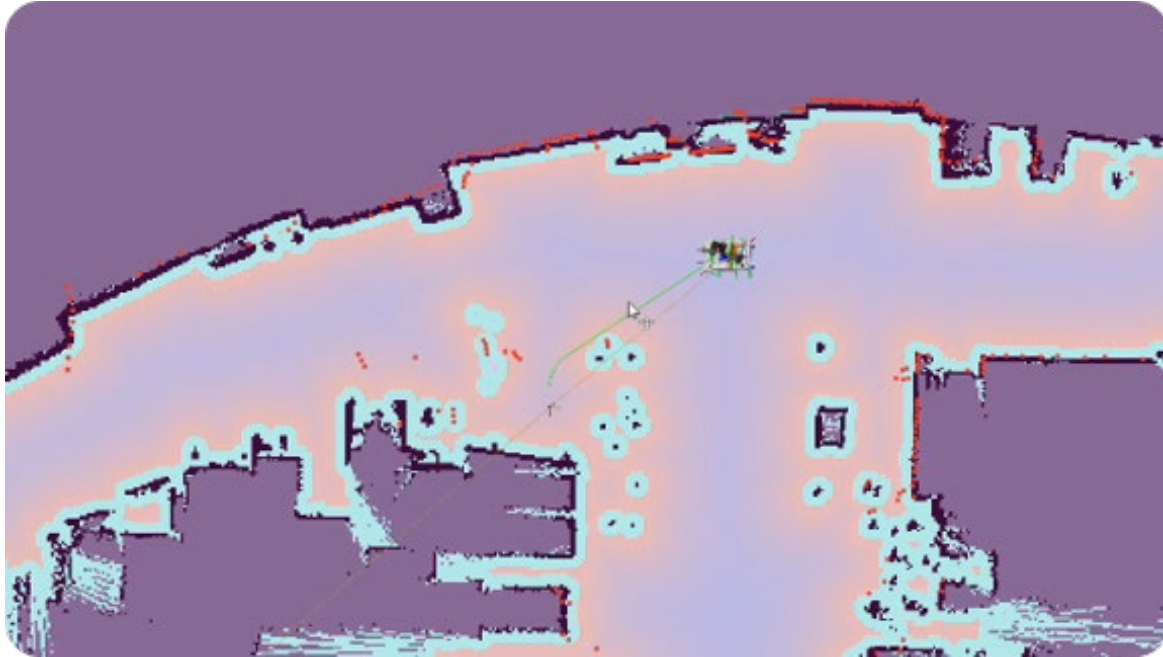


- Monitoring of traffic, energy consumption, latency in real-time for optimizations

Trajectory Planning of the Robot on the Digital Twin



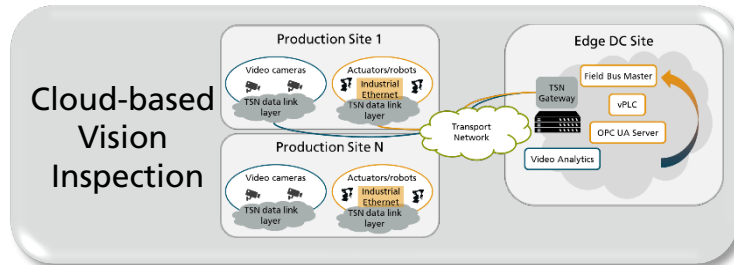
Route Planning of the AGV Using Lidar Data



ETSI ISG F5G Proof-of-Concept Cloud-based Vision Inspection



INDUSTRIAL TEST FIELD

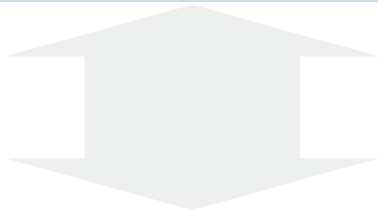


Factory Scenario

- Large manufacturing sites
- Requirement for >1000 fixed access points
- Min. 1GE per access point

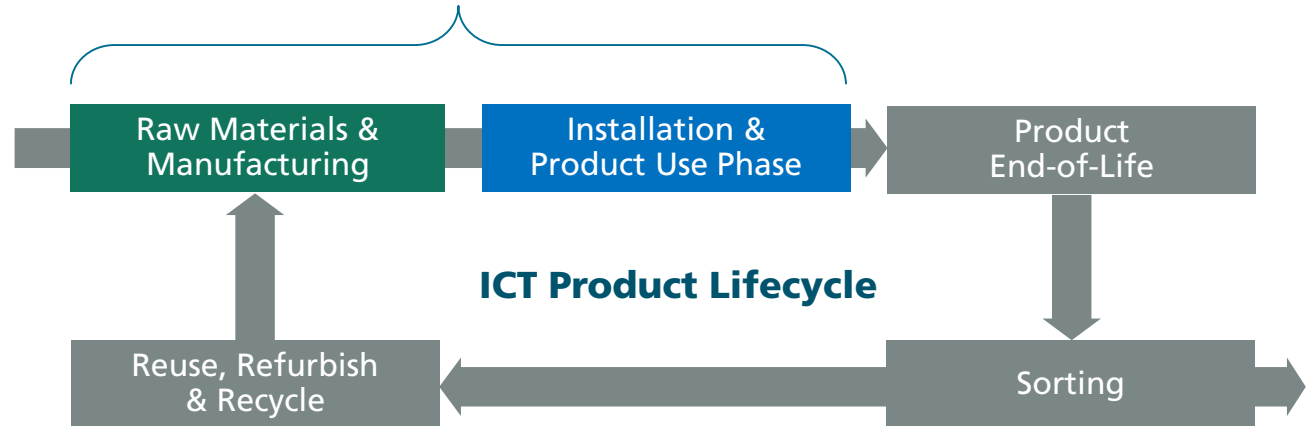
Objective: Modeling the carbon footprint of different system versions

System Version A
Baseline Technology
(conventional ICT)



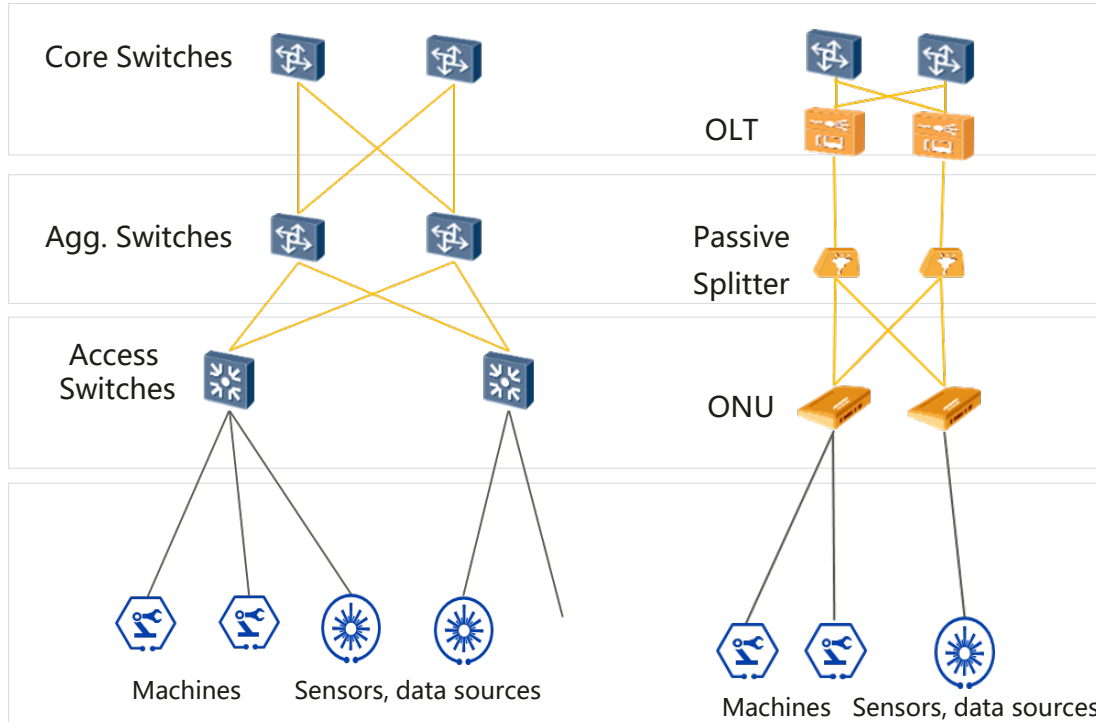
System Version B
Low Carbon
Footprint Technology
(Green ICT)

Creating the Lifecycle Inventory (LCI) requires selected technical data and precise measurements in testbeds



Industrial Fixed Network Architecture

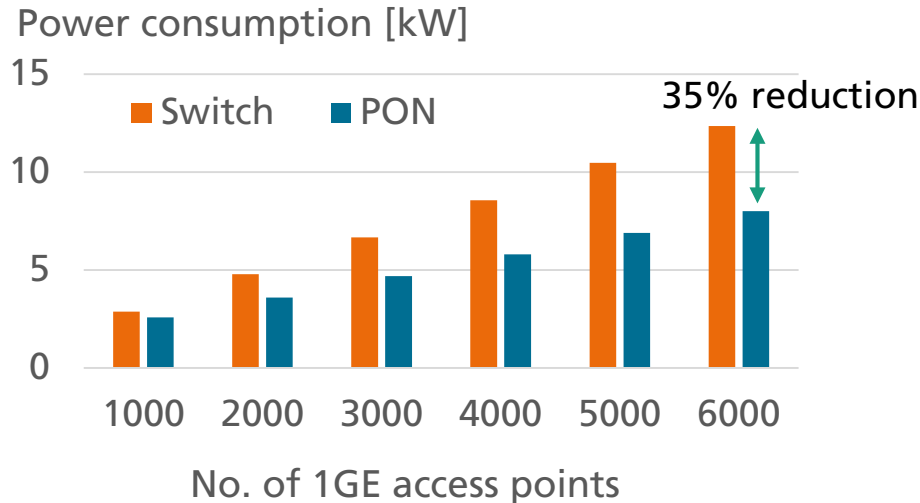
Traditional Switch Network  F5G Passive Optical Network



Optical Network Benefits

- Simplified architecture & cabling
- No electromagnetic interference
- Less power consumption

What is the power consumption improvement potential?



Assumptions

- 1 GE per access point
- Analysis based on typical power consumption values provided by vendor data sheets
- Operational technology (OT) can be considered

Summary

- Manufacturing industry is in the process of green and digital transformation
- Virtualized control functions running in edge cloud environments allow for highly flexible and efficient operation of production sites
- F5G provides networks solutions for industrial scenarios with reduced power consumption on a edge-cloud-based fiber infrastructure
- F5G OpenLab @ Fraunhofer HHI offers
 - Access to proof-of-concepts in relevant environments for different verticals (industry, medical , ...)
 - Support of standardisation
 - Services to partners and customers



Become a Member of the



F5G
OpenLab

Collaboration with
complementing
stakeholders



Learning and
understanding the
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



**JOIN
NOW**



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**WE PUT SCIENCE
INTO ACTION.**

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