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Joint research project „Bauen 4.0"
Overview, development status, demos and outlook

CMM online // December 2020

Outline

1. Overview

2. Demos

## 3. Development status

4. Outlook

Project partners and organizational framework

Facts and Figures:

- Funding BMBF – Project Management Agency Karlsruhe – INKOWE program
- Duration July 2019 – July 2022
- 20 industrial partners, 2 universities
- Accompanied by various associations
- Total costs 9 Mio. € / 4,8 Mio. € funding

Construction Site Problems

complex environment

No standards

Locally and temporally changing environment

uniqueness

No interfaces

Many, heterogeneous players

Lack of skilled workers
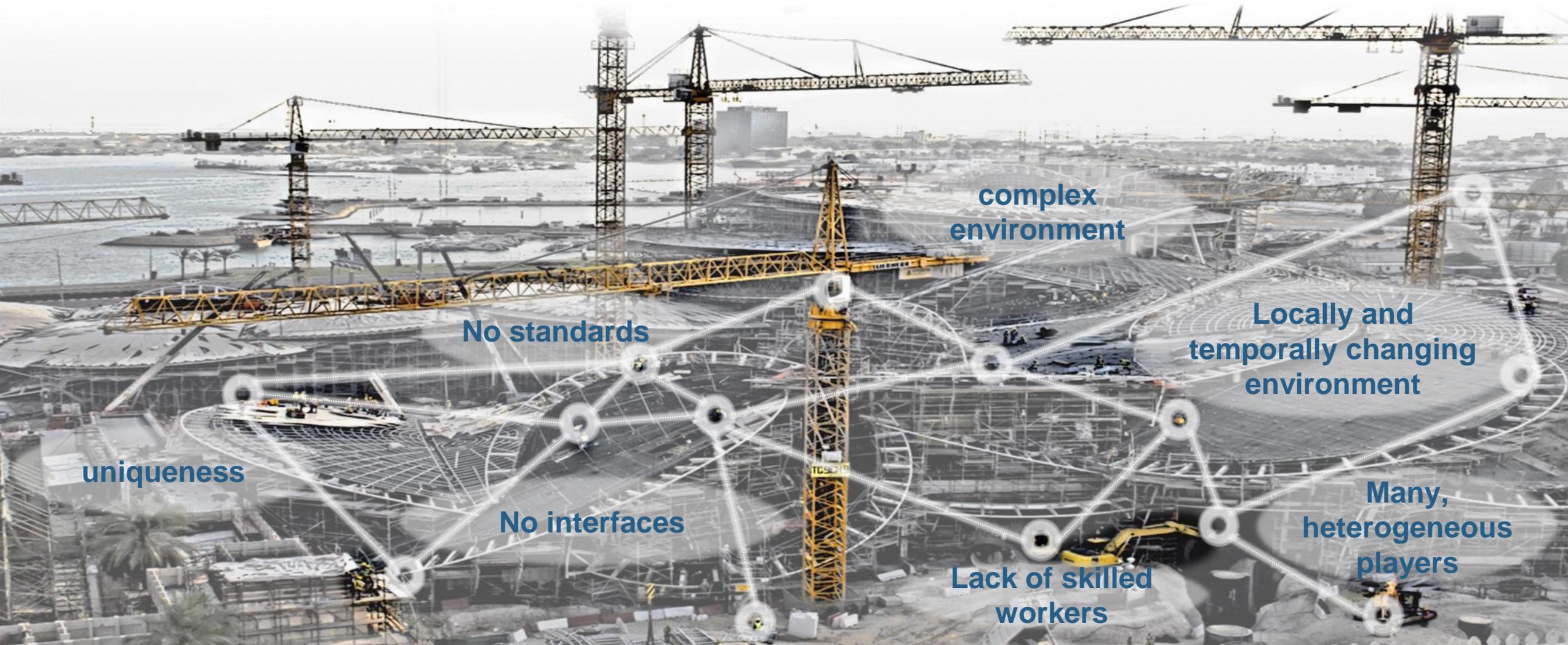
The main topics
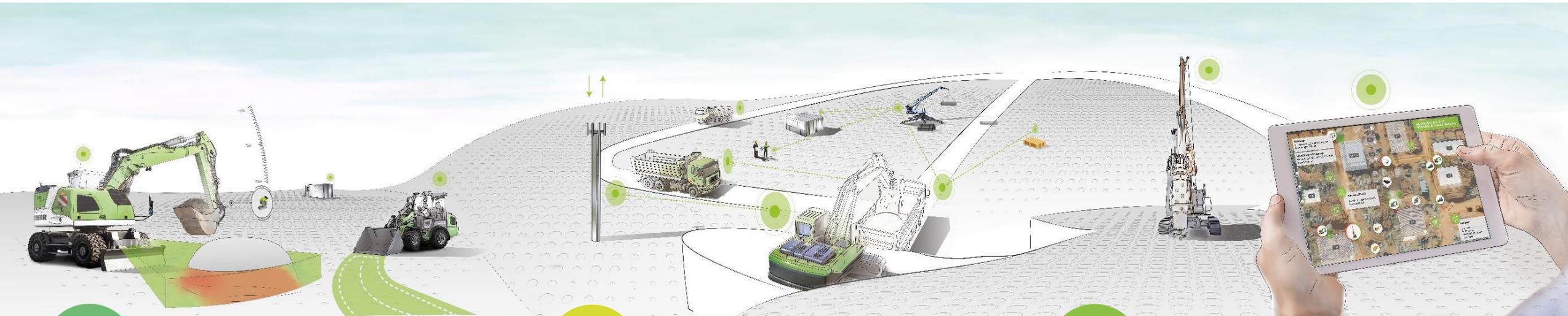
Automated, connected mobile machines

- **Automation**
- **Assistance functions**
- **Remote control**
- **Environment recognition**
- **Vertical Integration**

5G machine and construction site connectivity

- **Connectivity Solutions**
- **Cloud Technologies**
- **Reliable and secure data exchange**

Processes and solutions for the digital construction site

- **Tracking & Tracing**
- **Simulation of construction processes**
- **BIM to BIMsite**
- **Driver guidance system 4.0**

Sustainable demonstration & development platform for industry 4.0 solutions in construction site operations: Common Demo Scenario for 2022

2. Demos

Demos within the main topics

Automated, connected mobile machines

- ➢ Automated digging
- ➢ Automated tool change
- ➢ Detection "as built" condition

- ➢ Automated driving
- ➢ Environment recognition

- ➢ Automated processes
- ➢ Remote Control

Vertical Integration via OPC UA

## 5G machine and construction site connectivity

- ➢ Mulit-Connectivity modul: WiFi, 5G, 4G, BLE...

- ➢ Construction Site Networks: WiFi, 5G Campus

- ➢ Distributed Cloud Services

Processes and solutions for the digital construction site
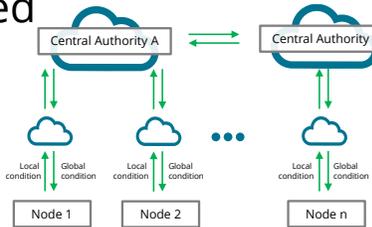
- ➢ Tracking & Tracing of Material via LPWAN
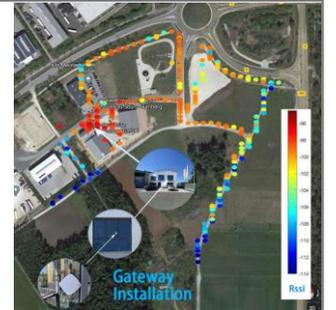
- ➢ Process optimization and progress prediction using simulation and machine data (e.g. with ISO 15143-3 data via OPC UA)

- ➢ AR-based driver assistance: Visualization via HoloLens
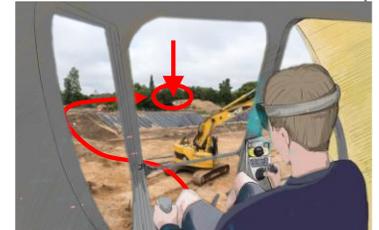
Demo Scenario at project end in 2022
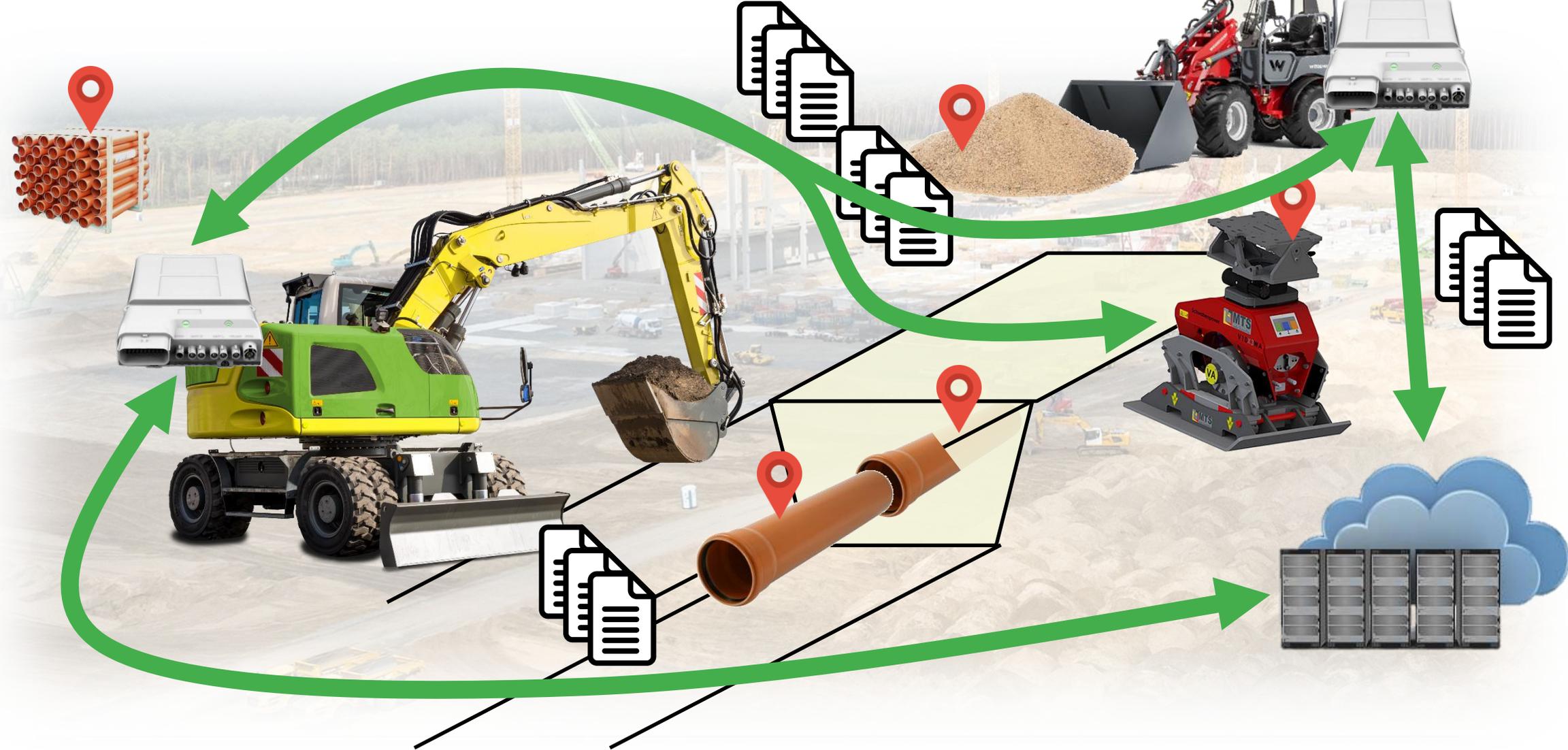
3. Development Status

Use Cases and data exchange requirements

➤ Accompanying process simulation during construction with a rotary drilling rig

➤ Model-based, automated earthworks and acquisition of actual condition / surface model by excavator

➤ Order transmission and automation of the movement of a loading crane

➤ Automated driving with a wheel loader

➤ Digital twin of the excavator for anomaly detection based on operational data

➤ Flexible site networks (5G, campus networks, mesh network, MEC)

➤ Tracking and tracing of attachments, material, bulk materials, auxiliary equipment

data throughput requirements

high
- as-built reports
- site management
- remote control incl. camera

medium
- fleet management
- process monitoring
- collaboration M2M
- collision avoidance systems

low
- service & maintenance
- theft detection
- safety related & environmental monitoring
- tool attachment
- remote safety stops

low — medium — high → latency requirements
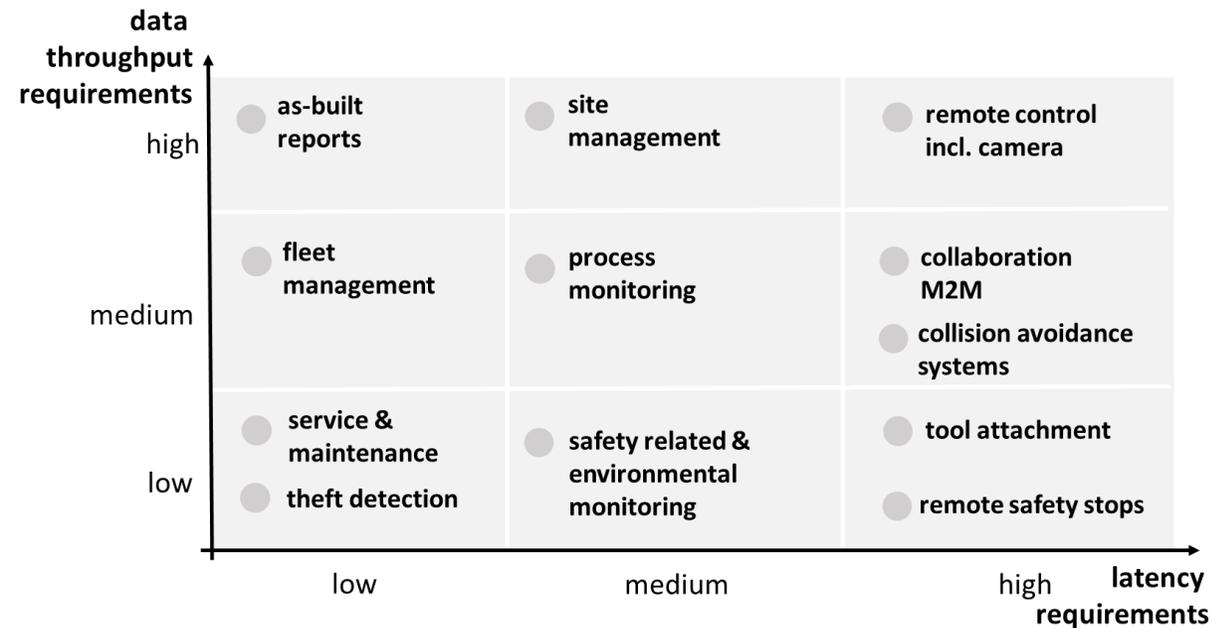
➤ Various latency and data rate requirements

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Connectivity Architecture
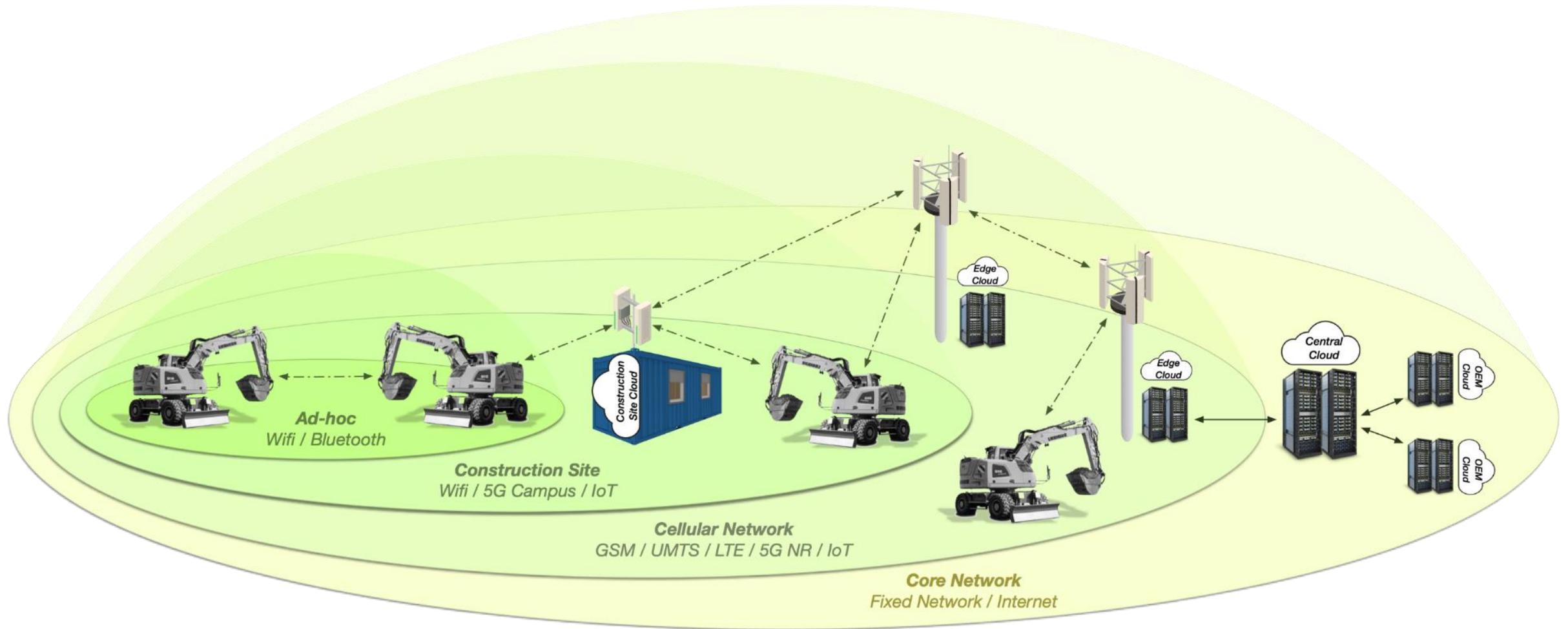
Focus on construction site layer – an independent local solution

Overall Architecture

Site Information System

OPC UA AGGREGATING SERVER

OPC UA CLIENT

UI

M2S

M2M

M2C

Storage

Simulation

Tracing

M2M
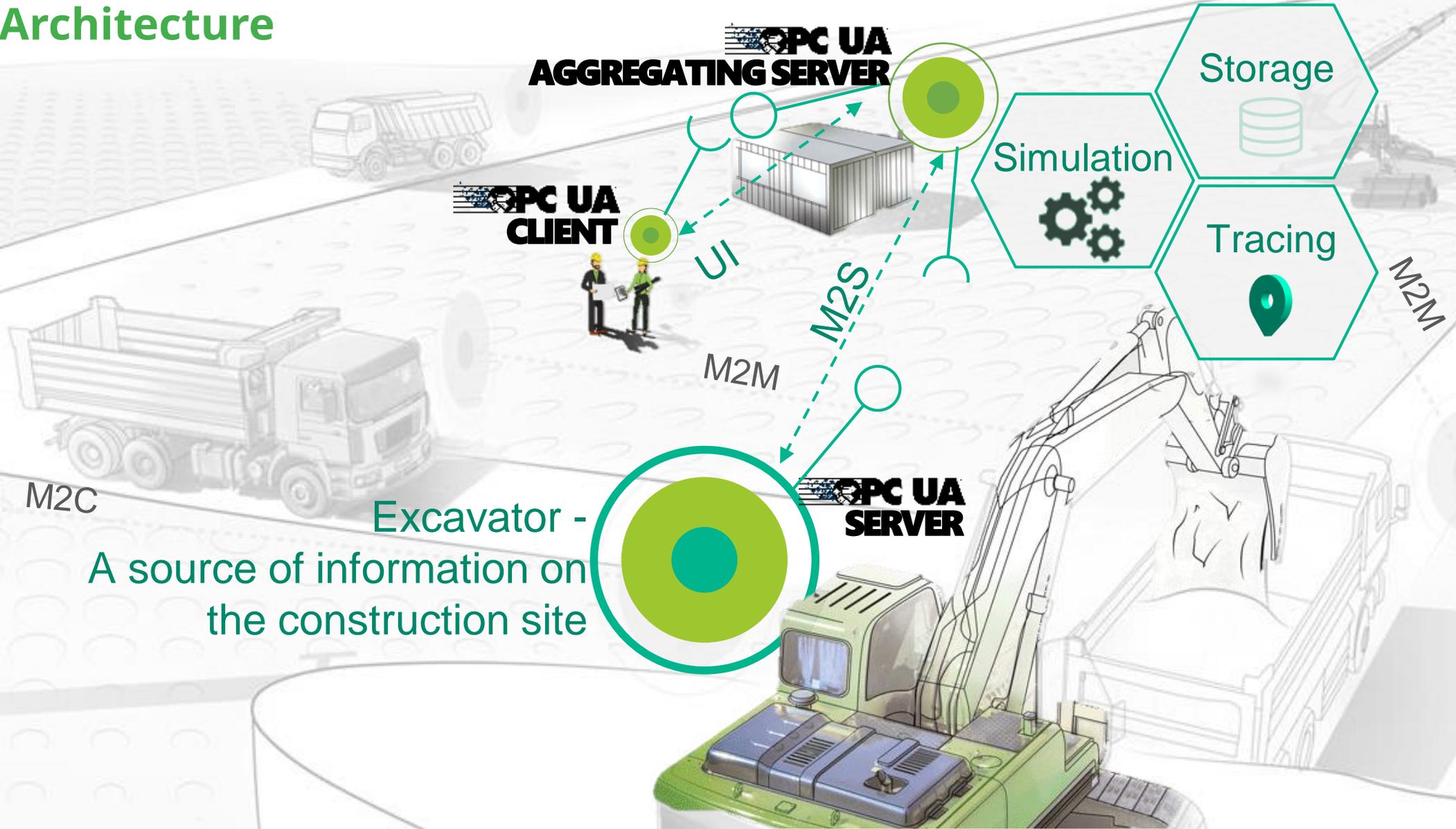
Excavator -
A source of information on
the construction site

OPC UA SERVER

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OPC-UA-architecture

Aggregating server on site

OPC UA Server
(Fleet information model)

OPC UA Client

Database

Custom application

Site management system

Fleet management

www

Custom application

Connectivity module

Connectivity module

Connectivity module

OPC UA Server
(construction equipment CS)

OPC UA Server
(construction equipment CS)

OPC UA Server
(construction equipment CS)

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OPC-UA data model for construction equipment

➢ Apply **basic building blocks for machinery** (finding machines on server and identification)

➢ Describe construction equipment as **Robotics:MotionDeviceType**

➢ Extending robotics CS for **full kinematic description** to enable forward kinematic calculation and visualization

➢ Equipment Telematics-interface to feature **telematics data** records from ISO 15143-3
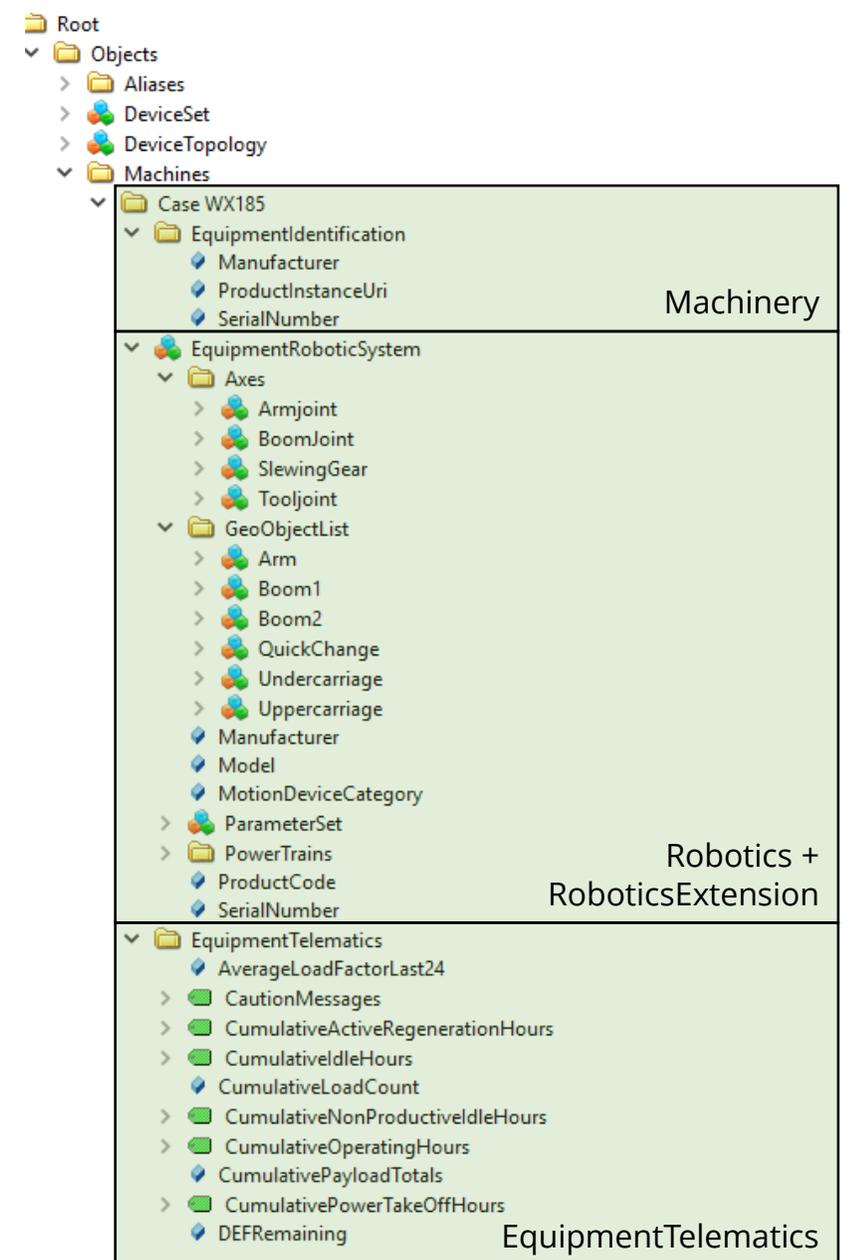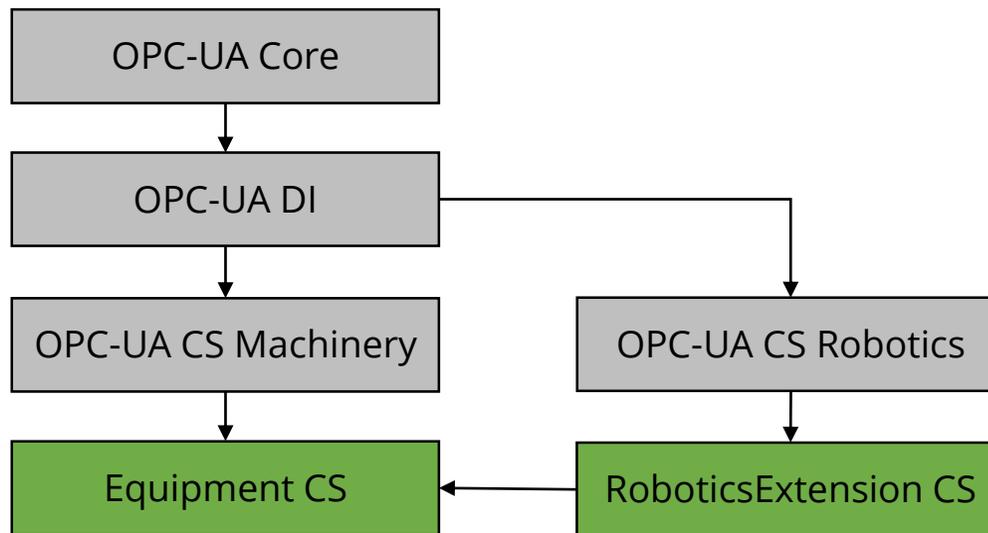
First Implementation tests: OPC-UA based Remote Diagnosis via ISO 15143-3 data
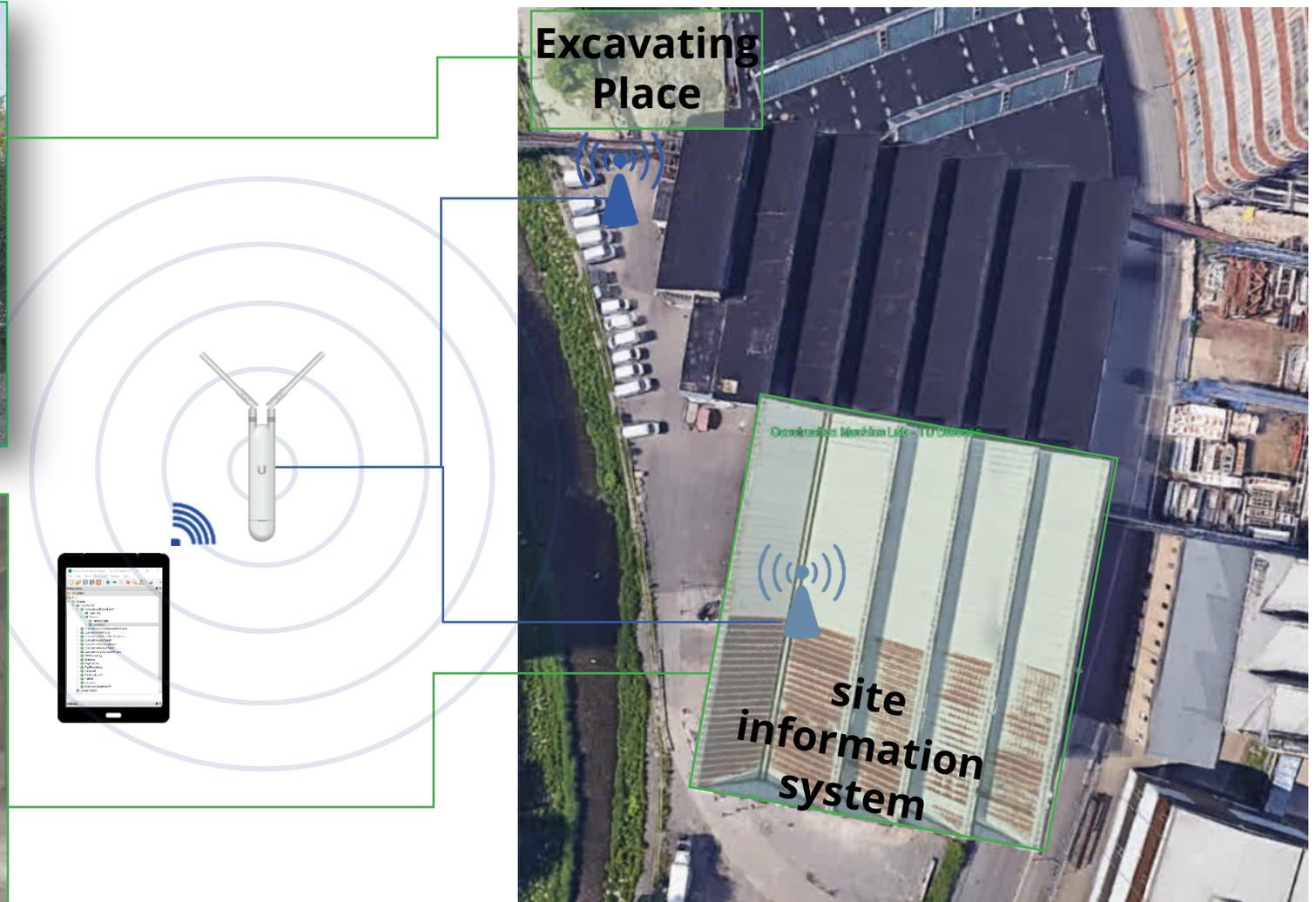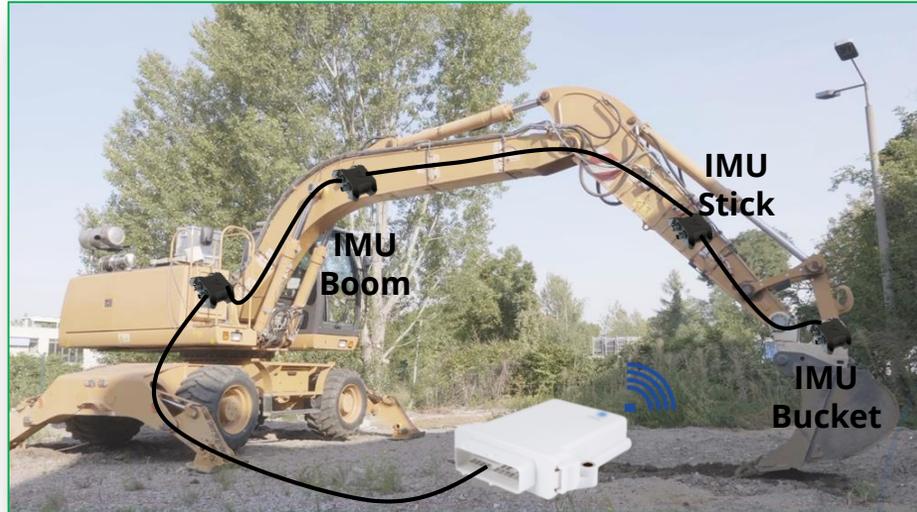
4. Outlook

Next Steps

➢ Scaling the Lab Demo: More Machines
➢ Setting Up Local Site Server
➢ Integration of Applications

📍 Fabrikstraße 48, Dresden

➢ WiFi to 5G Campus
➢ Setting up Remote Control Use Cases

📍 Industriegebiet Zeißig, Hoyerswerda

➢ Preparation Demo Scenario
➢ Development of infrastructure and organizational forms for use after project end

📍 Gewerbegebiet Klingewalde, Görlitz

Publications

- Fischer, A. et al.: Begleitende Prozesssimulation für das Kellybohrverfahren. In Proceedings of „8.Fachtagung Baumaschinentechnik", Dresden, 2020
- Köhler, S. et al.: Netzwerkschnittstellen für mobile Arbeitsmaschinen im Kontext der digitalisierten Baustelle. In Proceedings of „8.Fachtagung Baumaschinentechnik", Dresden, 2020
- Schöberl, M. et al.: The Process-oriented Digital Twin of Construction Machinery. In Proceedings of „8.Fachtagung Baumaschinentechnik", Dresden, 2020
- Zitterbart, T.: Anbauwerkzeug wird zum IoT-Device. In Proceedings of „8.Fachtagung Baumaschinentechnik", Dresden, 2020
- Beck, B. et al.: Connected Off-Highway Machines and Services – Large Scale Lab-Demonstrator Activities. Video Contribution to 5G++ Online Summit, Dresden, 2020
- Zhang, Jiajing; Kharabet, Ievgen: SENCE - Solution for Extended Network in Construction Environment. Video Contribution to 5G++ Online Summit, Dresden, 2020
- Waurich, V.; Will, F.: The Role of Construction Machinery on an Automated and Connected Construction Site. White Paper within 4th International VDI Conference "Smart Construction Equipment", München, 2020

Abstracts/presentations accepted for Mobile Machines April 2021; ISIC-Webinar September 2021; CECE Digitalisation Task Force Meeting January 2021; European Conference on Computing in Construction EC³ July 2021

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┌─ **contact** ─────────────────────────────┐

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