5G-enabled technologies on Smart Ports: new opportunities and business challenges

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5G LOGINNOV – Facts & Figures

5GLOGINNOV

Start 10 oct 2020, duration 36 months

7,9 million €

Consortium with 15 members from 7 countries (BE, FR, IT, RO, GR, SL, DE)

Members represent stakeholders from Logistics, Automotive and Telecom Industry working closely with Infrastructure operators and Research Institutes.

SMEs and Start-Ups will be integrated for future 5G market uptake across Europe

Project members

- ERTICO
- AKKA
- CIRCLE
- Continental
- ICCS
- ICOOR
- ININ
- Luka Koper
- PCT
- SWARCO
- tec4U
- Telekom Slovenije
- T-Systems
- VICOM
- VODAFONE

Per type of partner:

- Logistics 13%
- 5G 22%
- SMEs 9%
- Research 19%
- Industry 13%
- Services 9%
- Other 15%
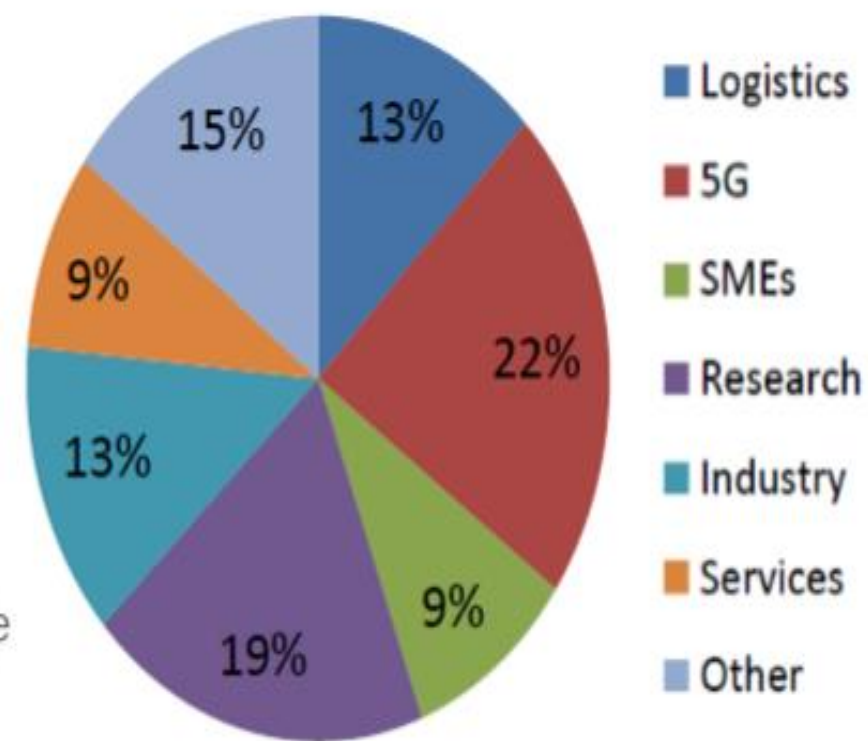
Project partners

Vertical: logistics industry

AN OPEN PROBLEM

- **Supply chain efficiency largely depends upon data and information** – how it is collected, processed, stored, updated, interpreted, understood, and exploited.
- **On operational level,** actors need real- time information, to be able to make effective decisions.
- **On tactical and strategic levels**, transportation systems need increased connectivity.
- **Existing systems are currently not linked to each other,** thus missing the opportunity to optimize the performance of their cooperation.
- There is the need of **new solutions for connecting logistics** information systems with different characteristics, intra- and cross-company, for immediate (real-time) exchange of information.

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Vertical: logistics services

Data exchange

Data posting

Risk prediction

E-CMR

Visibility services

CO_2 monitoring

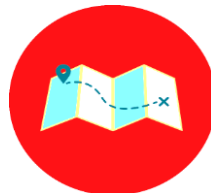Port services

Data sharing

Data collection

Marketplace

Custom services

Control Tower

Estimated Time of Arrival

Route planning

Data management

What else?

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How are deployed new CAD & Logistics

- Ports have a huge potential for job creation and investment: **74% of extra-EU goods** are shipped through ports & **37% of the intra-EU** freight traffic and 385 million passengers pass by ports every year

- 5G-LOGINNOV aims to support the **new generation of 5G-CAD terminals**, **new type of IoT-5G connectivity devices** through **technical solutions, business models and priority scenarios** by deploying new **CAD and Logistics as a Service in real-life port-city areas (Hamburg, Athens, Luka-Koper=intelligent hubs & network optimisation-**multi/ synchromodal transport &optimise the logistics network**)**.

- 5G-LOGINNOV's central innovation is to build a first-class European industrial supply side for **5G core technologies and new IoT-5G devices** (e.g. slicing, eMBB, uRLLC, mMTC, MEC, 5G-NR) with global market footprints.

- The project will have a strong impact in the **logistics industry**, as the innovative use cases deployed in the three Living Labs will test and evaluate **5G-enabled services during the project**.

- The project has a strong interest in the emergence of new market players, such as SMEs and start-ups, taking advantage of the growing adoption of distributed cloud computing technologies in 5G networks and making possible open innovation at service level in the logistics and Industry 4.0 sectors.

- 5G-LOGINNOV contributes to the emergence of global standards and **globally harmonised frequency bands for 5G** in the context of related developments at the level of global bodies like **3GPP, ITU and 5G standards (Rel. 16/17**).

- Being part of the third 5G PPP phase implies supporting the development of a "lead" market involving cooperation models with key vertical sectors contributing to the wider policy objectives of industry digitisation in the Digital Single Market.

5G LOGINNOV – Project overview

Deployment of 5G enabled Connected and Automated Logistics

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Project goal

Design an innovative framework of 5G enabled Connected and Automated Mobility technologies inside and outside modern ports (Hamburg, Athens, Koper)

- Development of 5G enabled ports and logistics hub operation
- 5G integrated predictive maintenance to anticipate breakdowns
- CAM truck platooning from hinterland to port
- GLOSA for truck platooning and sustainable traffic management

Use cases

Benefits

- Significant reduction of CO2 and NOx caused by hub logistics
- Boost CCAM based on 5G technology and hub-centric use cases
- Establish new business models and 5G CCAM based Go-to-Market strategies in ports according to the Green Deal policy requirement

Hamburg port:
5G Floating truck and emission data for automated truck platoons using GLOSA

Athens port:
Remote automation, 5G communication in ports and predictive maintenance

Koper port:
5G based V2X data exchange of surveillance data for yard truck logistics

PROJECT FRAMEWORK

- Offer a vision for 6G innovation in ports to improve their sustainability, their security, optimizing the activities that have become more complex in a post-pandemic

- Use cases based on the future 6G candidate technologies: test the potentiality of the 6G innovations to increase safety, sustainability and optimization in ports, two Living Labs are presented.

**Athens Living Lab-Port of Piraeus**   **Hamburg Living Lab**

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Athens Living Lab-Port of Piraeus

- Use cases and platforms which communicate over the 5G NSA network with different types of end devices (5G-Trucks, 5G-Cranes, 5G-IoT, 5G UEs).

- 5G technology drives the use case innovations exploiting the eMBB service and low latency transmissions of 5G, including NFV-MANO based applications and service orchestration, pioneering extreme-edge computing solutions, computer vision and AI-enabled video analytics.

- Deployed 5G radio access network (based on the RRU 5639w) at Piraeus Port, operating in band n78 at 3.7GHz with 100 MHz bandwidth, providing 5G connectivity to a subset of the port Piers.

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Experimentation Platform

- IoT node:
    - (i) 5G interface: Teltonika's RUTX50 industrial 5G router that facilitates the cellular connectivity
    - (ii) aNVIDIA Jetson AGX Xavier (JAX) device for GPU based processing connected to the 5G modem via a gigabit Ethernet connection
    - (iii) 4K camera also connected via gigabit Ethernet to the cellular interface.
    - Cloud server is deployed at the back-end system of PCT (residing beyond the NSA core), equipped with a GPU NVIDIA RTX 3090
    - Virtual platform managed via a k8s system (based on Microk8s), where the extreme-edge and Cloud infrastructure nodes are added as k8s worker nodes that host the workload of containerized AI services.
    - Exploited the YOLOv5 convolutional neural network (CNN) family augmented with data from daily port operations. The various object detection models are prepared as docker images (i.e., container network functions, CNFs).

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The use case architecture and all relevant service components
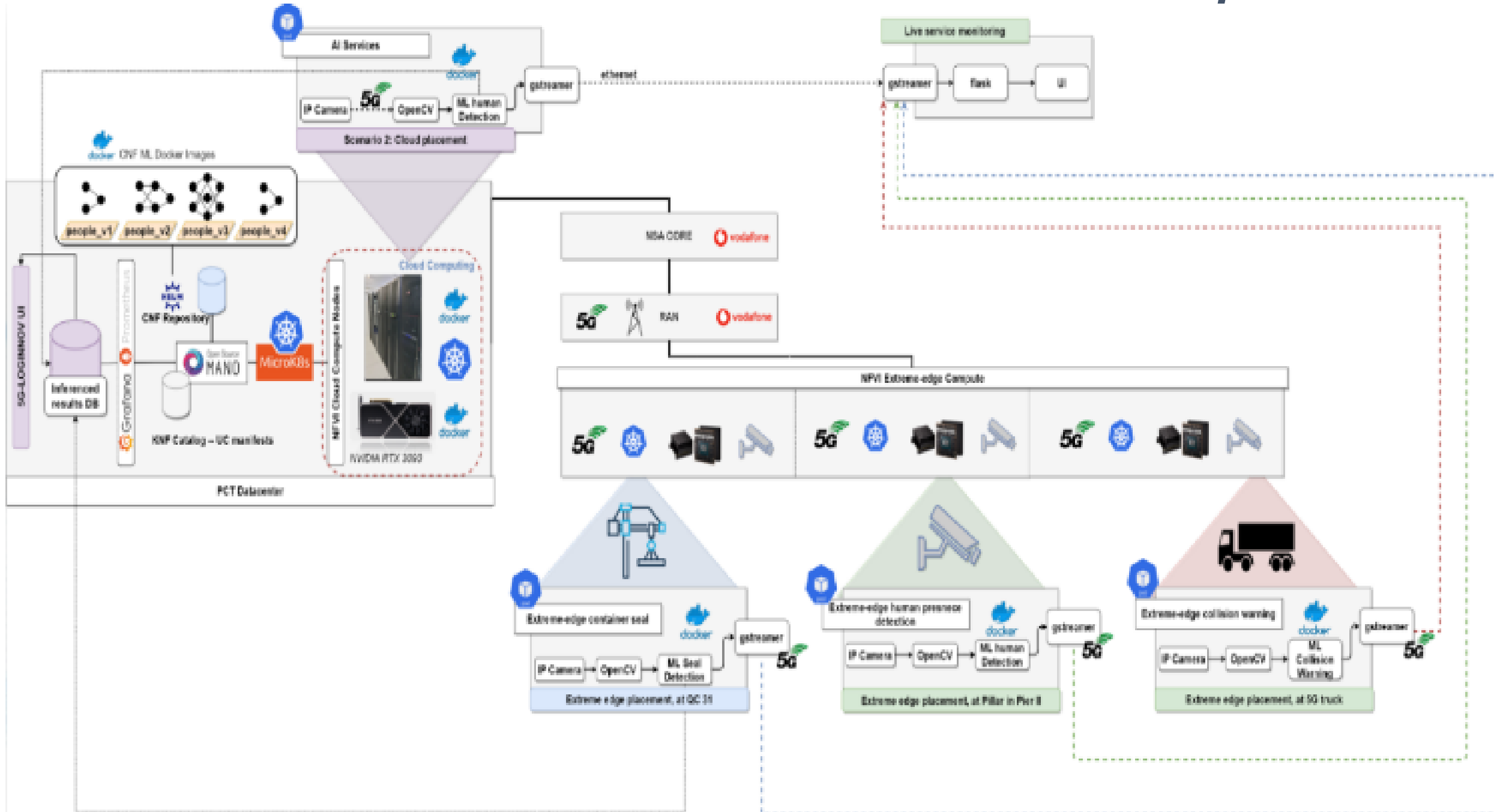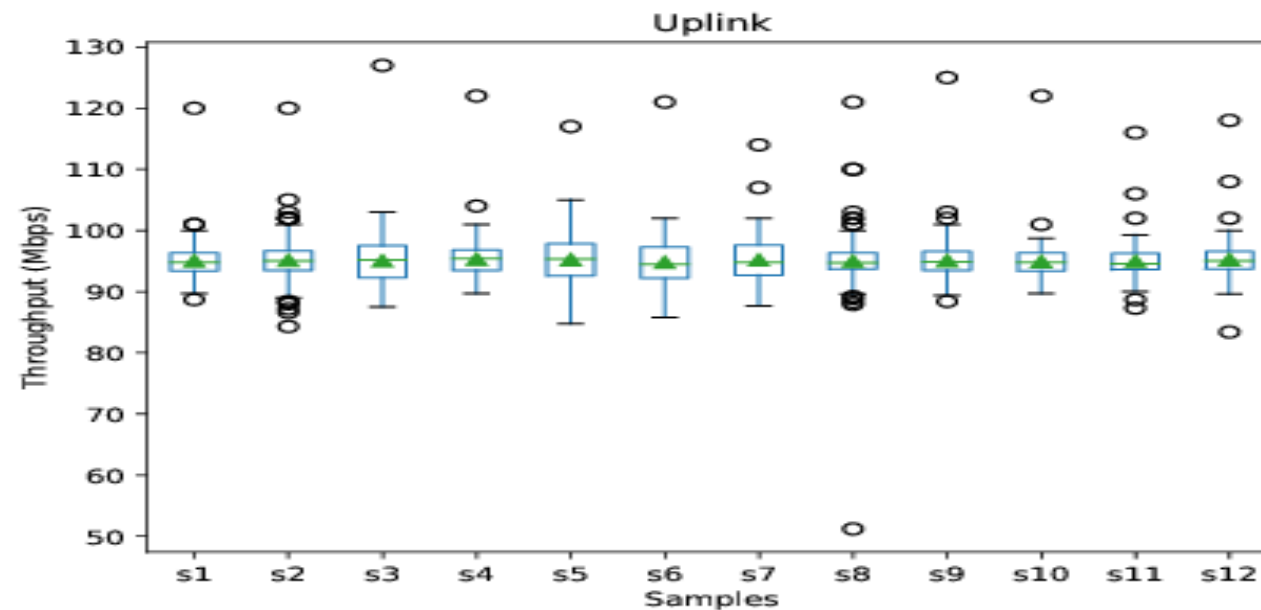
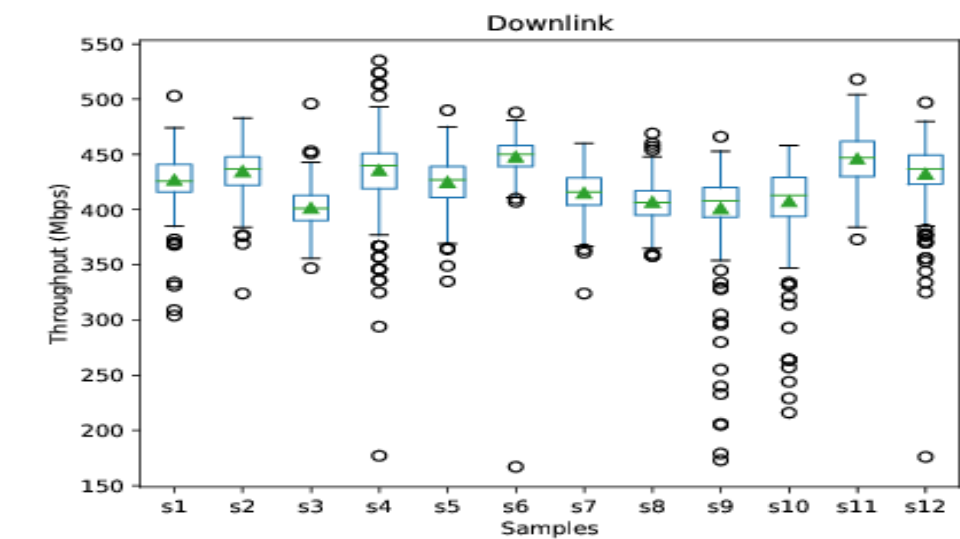# 5G Network Evaluation

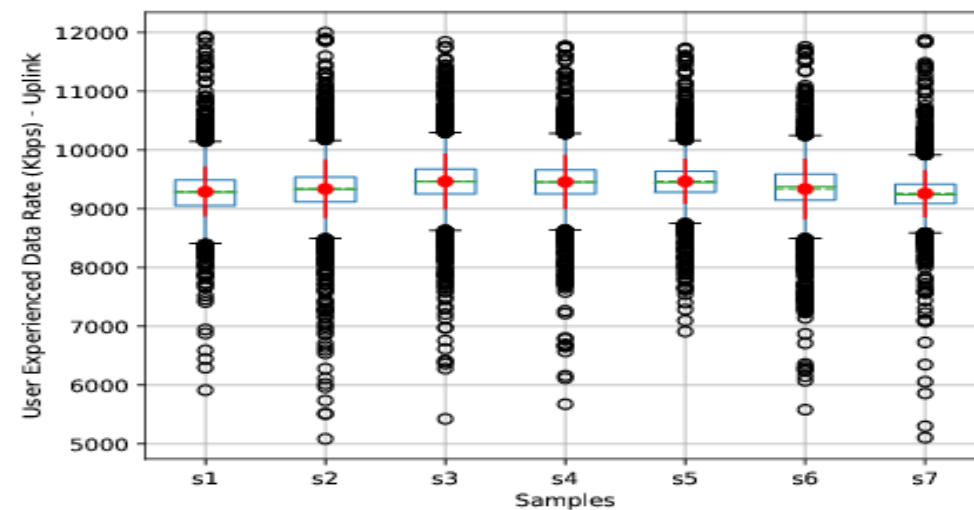## Latency (ping) measurements
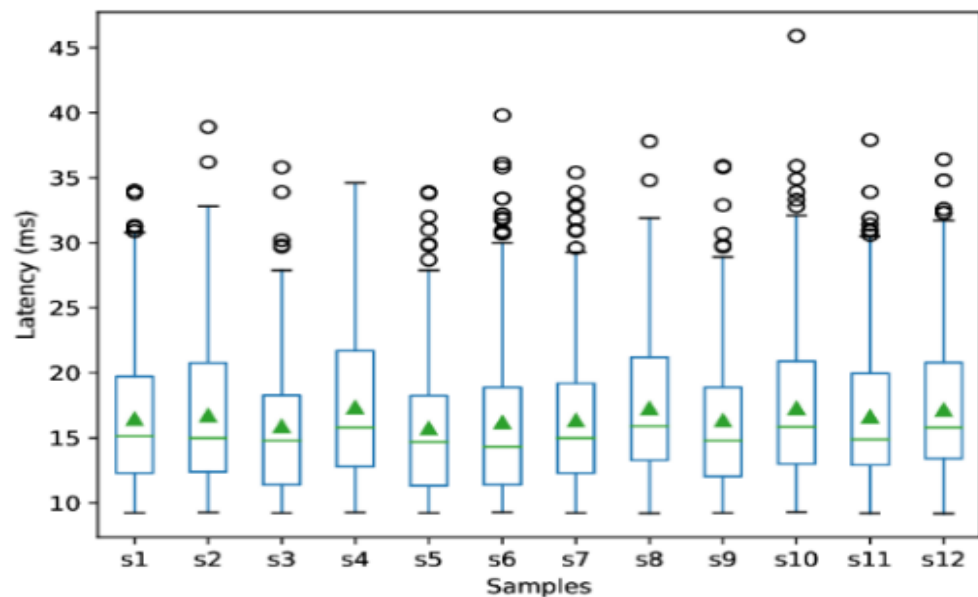
Throughput Uplink (iperf)

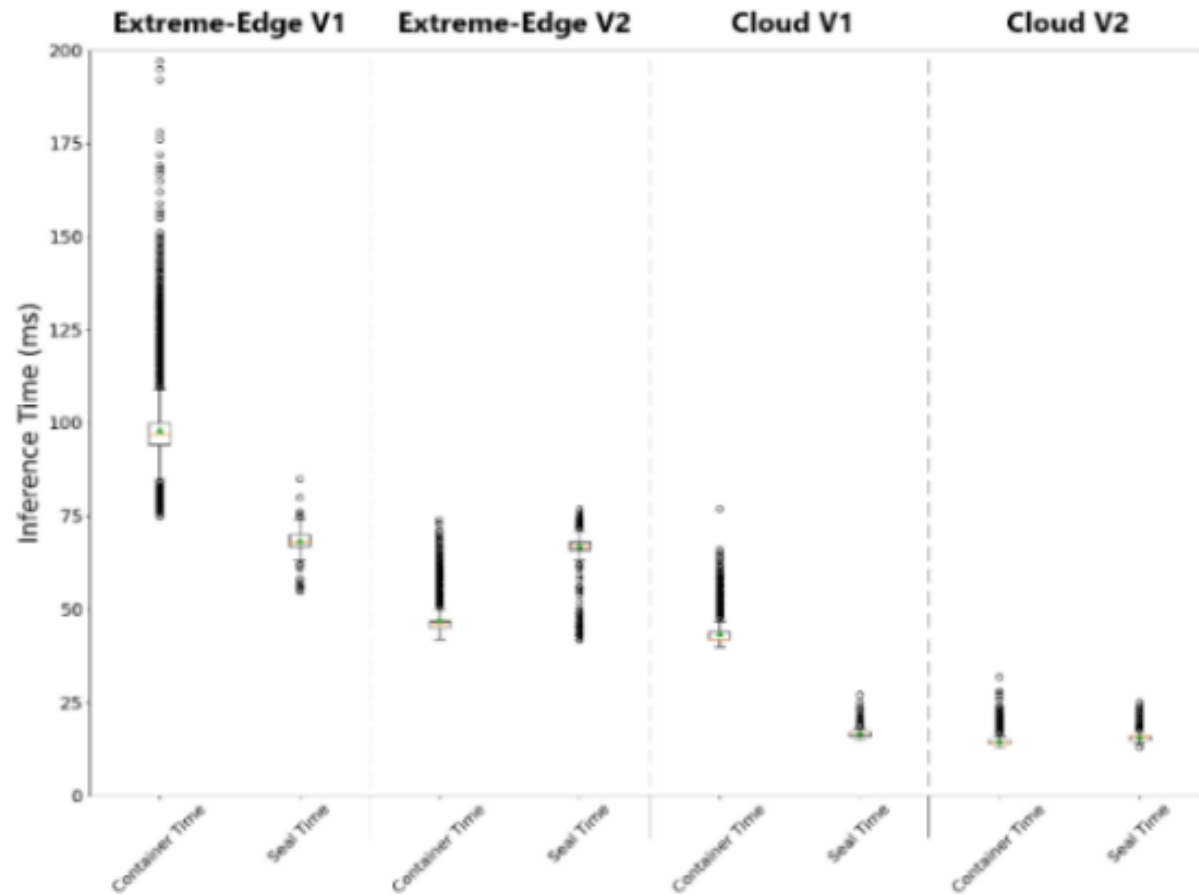

Throughput Downlink (iperf)

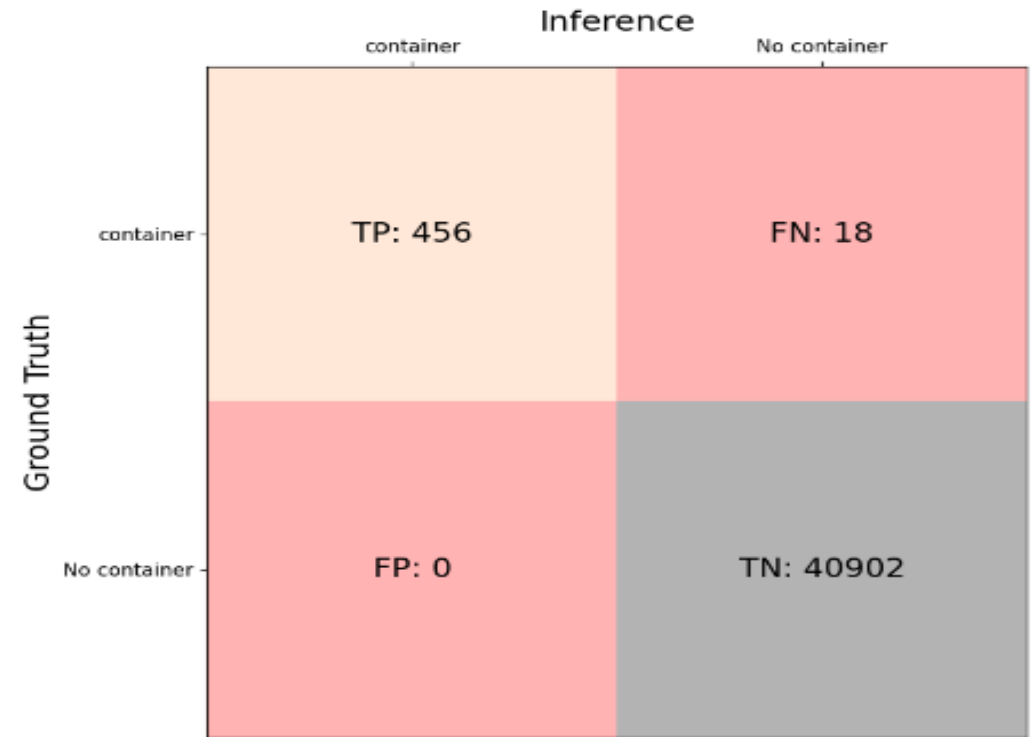## 4K Uplink video streaming data rate

5G&AI enabled container seal detection evaluation

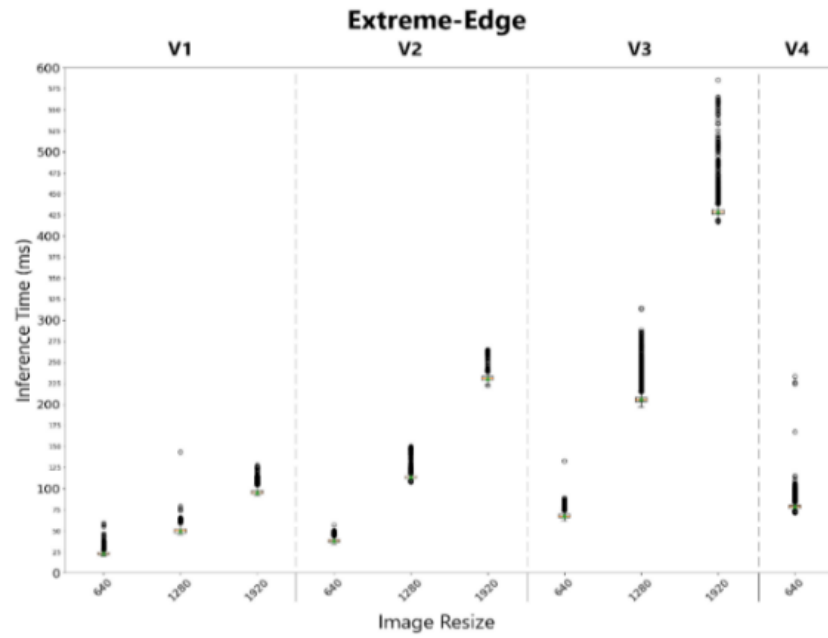**Inference time for container seal detection -- extreme edge and cloud placement**

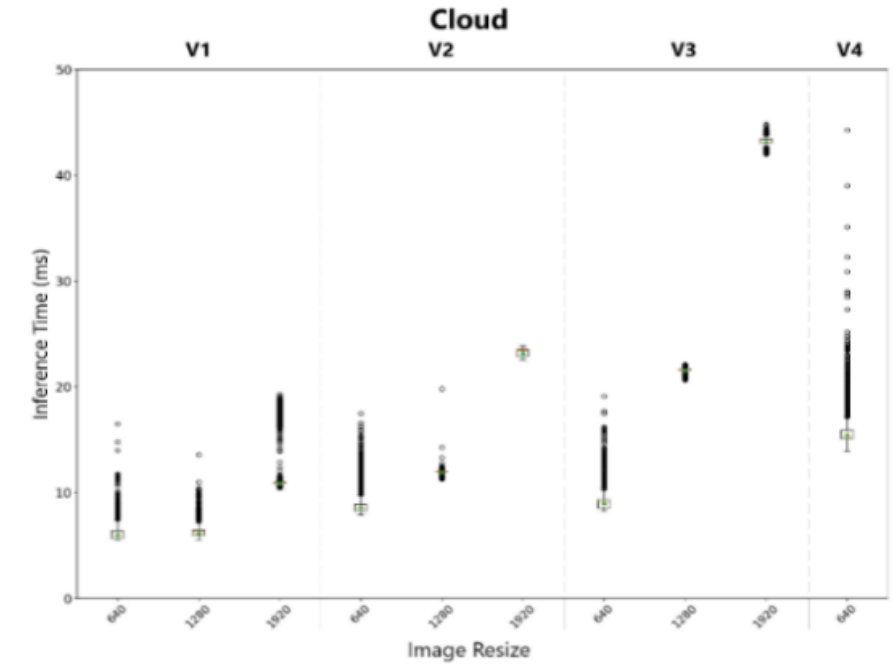
Seal Detection (True/False Positives/Negatives)

5G LOGINNOV

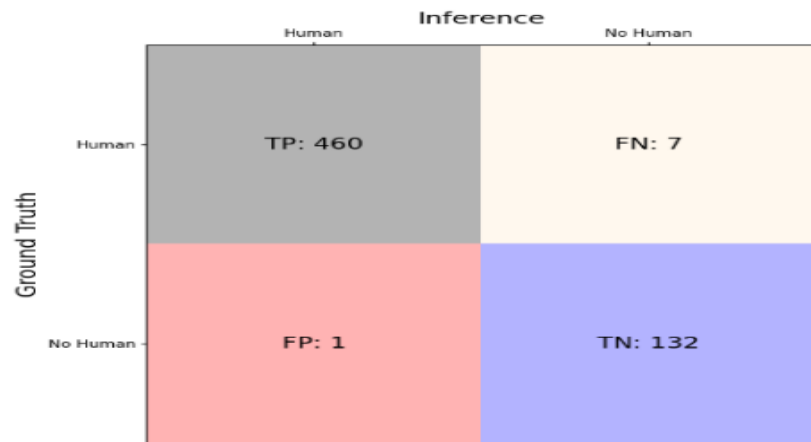# 5G&AI-enabled human presence detection evaluation

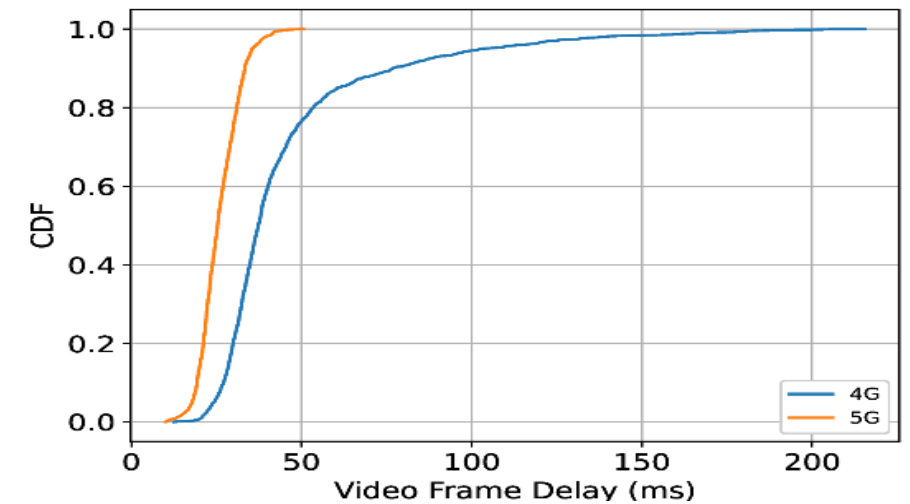## Inference time for human presence detection

Inference time for human presence detection

People Detection (True/False Positives/Negatives)

## 4K frame network transmission delay (ms)

Hamburg Living Lab

- Mobile Edge Computing, low latency communication (uRLLC) and advanced IoT, including massive Machine Type Communication (mMTC)
- Hamburg Port Authority (HPA) already traffic lights operated in the ferry port and cruise terminal area to guarantee a seamless traffic flow within the heart of Hamburg's tourist zone near "Landungsbrücken"

- **Connectivity in Hamburg.** Deutsche Telekom operates the public 5G network which covers the designated testfield for connected and automated driving (TAVF).

- **6G-enabled Teleoperated Driving and Multi-Modal Platooning:** uRLLC + eMBB + and mMTC+. The ISAC systemin the E-Band (71-73.4GHz) together with Multi-access Edge Computing (MEC) to support the GLOSA+ in city ATP(Automated Truck Platooning) use case.

- **Multi-sensorial collision alerts and VRU Assistance beyond 5G:** optimizes the control of traffic signaling systems and detects vulnerable road users thanks to multi-sensorial traffic data, including anonymous video data. The deployment of sensing capabilities from the infrastructure uses an Integrated Sensing and Communication (ISAC) system in the E-Band (71-73.4GHz) to enhance the perception of vehicles

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First platooning tests using ISO/DIS-23795 Carbon Monitoring

Communication scenario		Payload (Bytes)	Tx rate (messages per second)	E2E latency (ms)	Reliability (%)	Data rate (Mbps)	Min range (m)
Scenario	Degree						
Cooperative driving for vehicle platooning	Lowest degree of automation	300–400	30	25	90		
Information exchange between a group of UEs supporting V2X application.	Low degree of automation	6500	50	20			350
	Highest degree of automation	50–1200	30	10	99.99		80
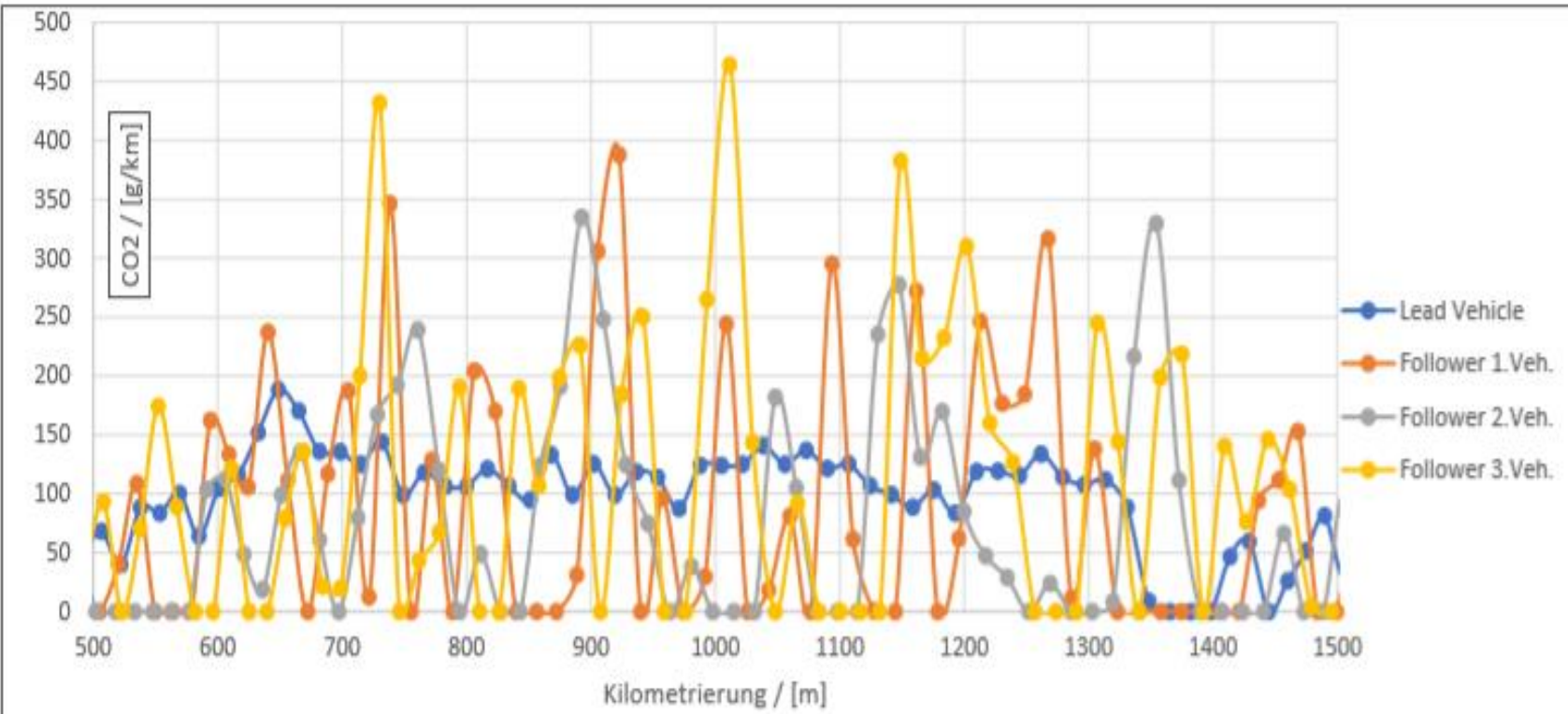
LCMM – Impact Assessment

tec4U
Ingenieurgesellschaft mbH

WLTP Low compared to Eco-drive Mode

EPI for different speed cycles and profiles: Golf 7

	Avg. Speed/[km/h]	Dist./[km]	EPI / [Centilitre/tkm]	STS/[sec]
WLTP	18,9	3,09	4,17	150
REAL	28,5	4,66	4,79	69
36kph	29,9	4,89	2,19	65

	Avg. Speed/[km/h]	Dist./[km]	EPI / [Centilitre/tkm]	STS/[sec]
WLTP	18,9	3,09	4,17	150
REAL	28,5	4,66	115%	46%
36kph	29,9	4,89	52%	43%

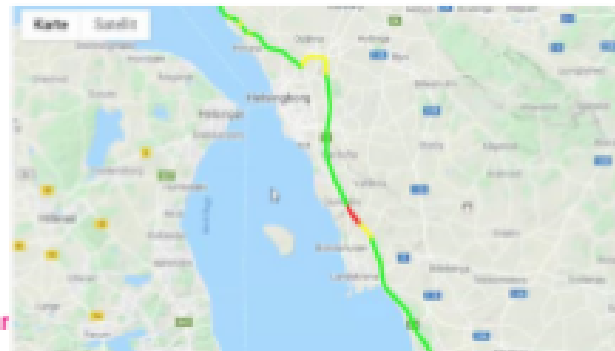**EPI for different speed cycles and profiles: half-loaded truck**

	Avg. Speed/[km/h]	Dist./[km]	EPI / [Centilitre/tkm]	STS/[sec]
WLTP	18,9	3,09	3,15	150
REAL	28,5	4,66	125%	46%
36kph	29,9	4,89	34%	43%

Deutsches Zentrum
DLR für Luft- und Raumfahrt

T··Systems·   Let's power higher performar
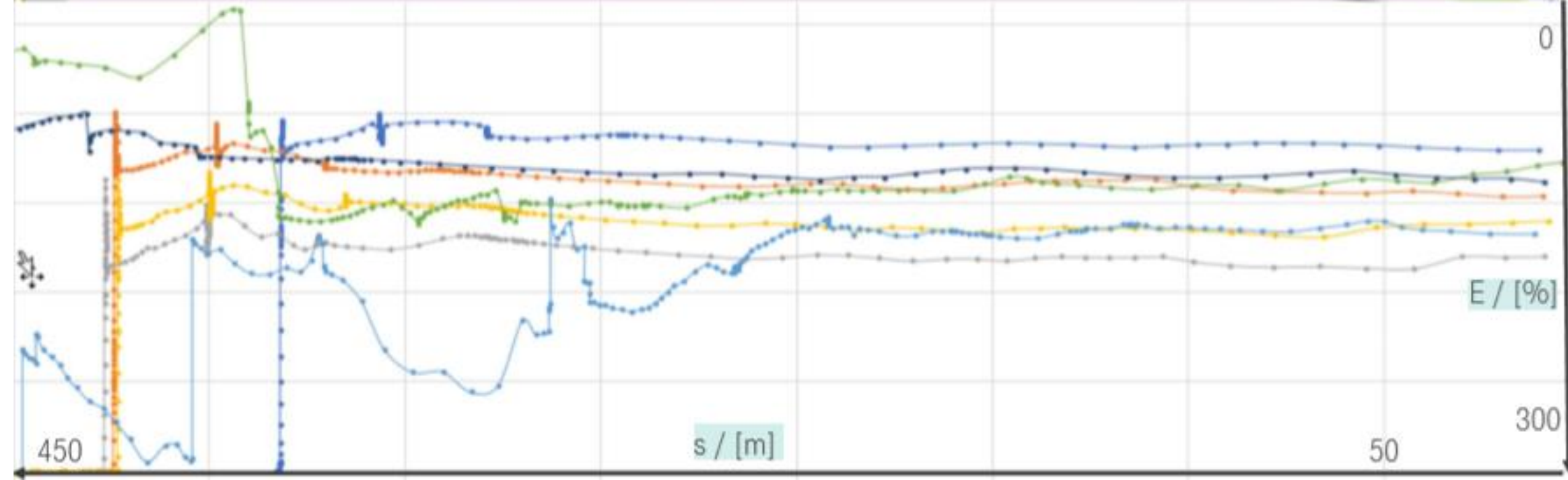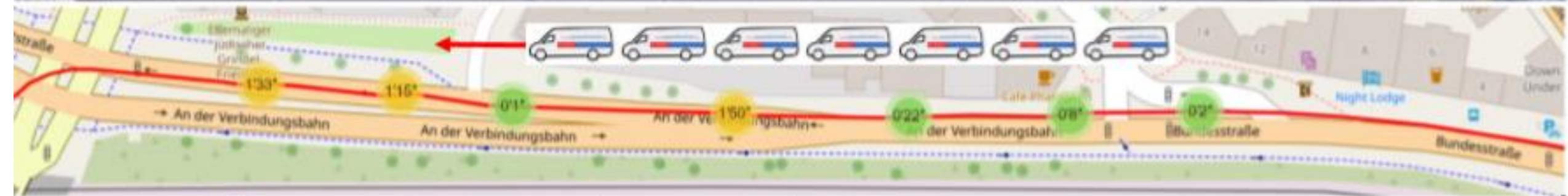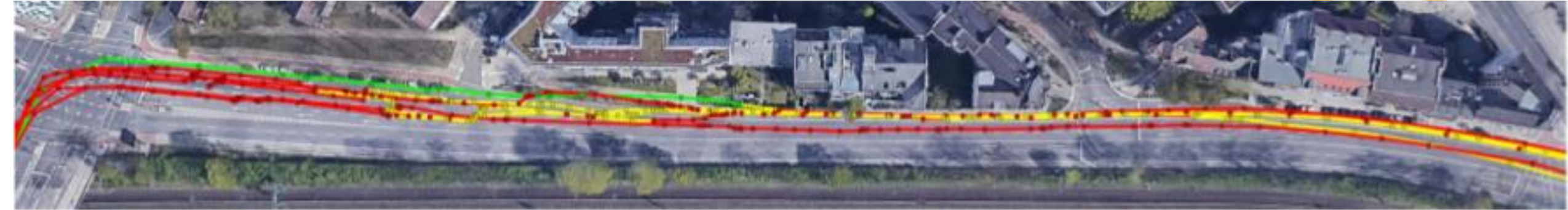
Hamburg Living Lab-preliminary results

KPI	Vehicle Mode	Results
Increase average truck speed	Single	> 5 %
Reduction of average acceleration activities		> 5 %
Reduction of stillstand time		> 5 %
Increase average truck speed	Platoon	Plus > 4 %
Reduction of average acceleration activities		Plus > 4 %
Reduction of stillstand time		Plus > 4 %
Reduction of fuel consumption	Single	12 %
Reduction of CO_2 emission		12 %
Reduction of fuel consumption	Platoon	Plus 10 %
Reduction of CO_2 emission		Plus 10 %
Increase energy performance index 'EPI – cl per ton and km'	Overall	10 – 20 %
Increase acceleration performance index 'API – KWh per ton and km'		10 – 20 %
Extended cellular bandwidth on urban roads by 5G network		Max. 800 Mbit/s
Positioning quality on urban road networks with 5G by 10 cm		< 1 m
signal latency in the 5G environment		avg. 20 ms
Average rate of packed errors during 5G data transmission		5 - 15 %

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AI-Enabled Networks: it's expected to integrate also artificial intelligence (AI) and machine learning (ML) into network operations, enabling more efficient and intelligent network management

Massive MIMO: it's also expected to use massive MIMO (Multiple Input Multiple Output) technology, which uses a large number of antennas to transmit and receive data simultaneously.

Dynamic Spectrum Access: in the near future it's expected to support dynamic spectrum access, which enables flexible and efficient use of available spectrum resources.

Network Slicing: it's expected to support network slicing, which allows multiple virtual networks to be created within a single physical network infrastructure..

Edge Computing: it's expected to support edge computing, which involves processing data and running applications at the network edge, closer to where the data is generated.

Integrated Satellite-Terrestrial Networks: it's important to support seamless integration between satellite and terrestrial networks, which could enable global coverage and connectivity for a wide range of applications, including autonomous vehicles, remote sensing, and disaster response.

Massive IoT connectivity: if would like to connect seamless millions of IoT devices, enabling a range of applications in smart ports, autonomous vehicles, autonomous drones, vehicle robots and precision positioning.
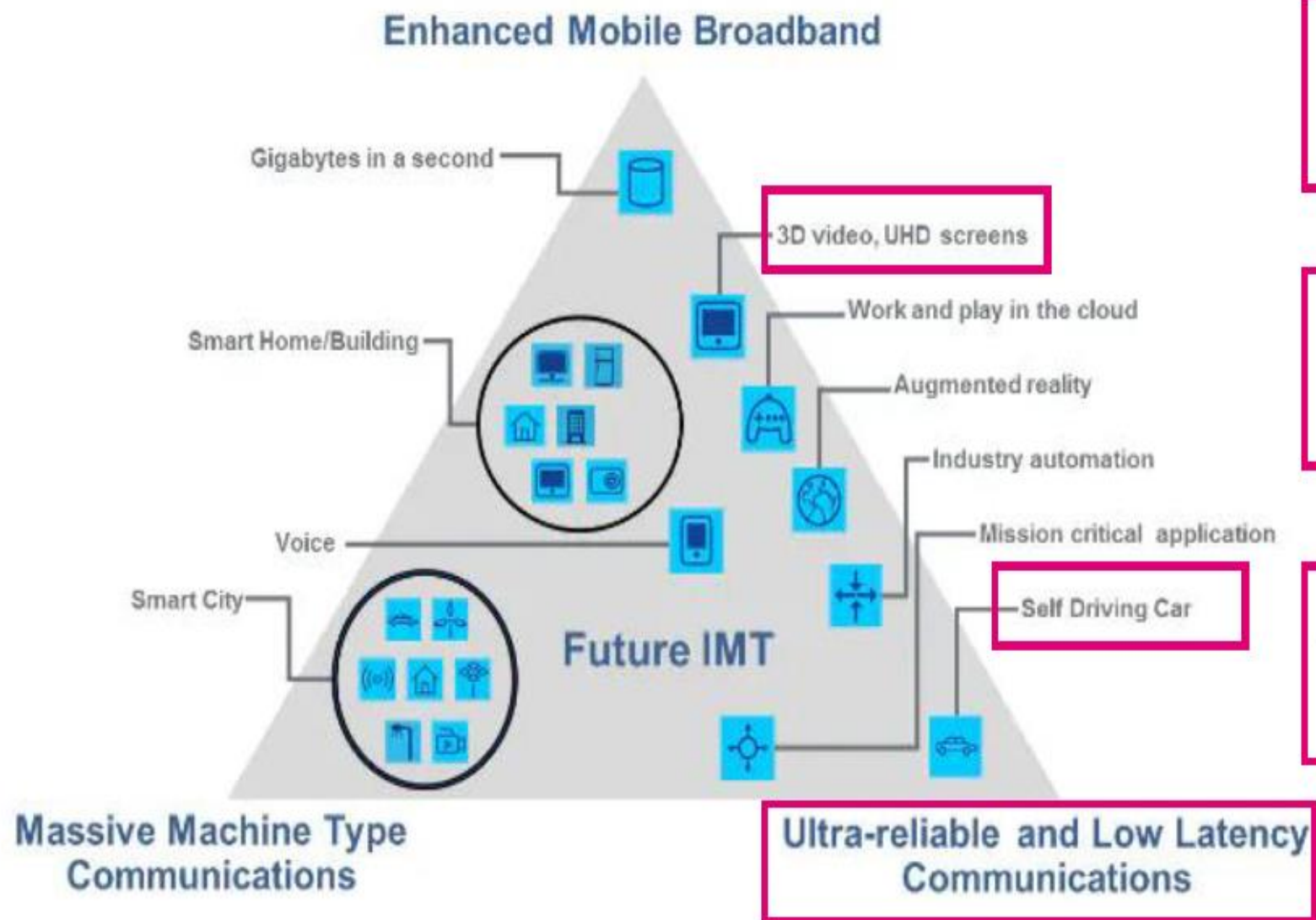
Augmented reality (AR) and virtual reality (VR): B5G/6G could enable high-speed and low-latency communication, which could enhance the experience of AR and VR applications for seals & containers.

Energy-Efficient Communication: it's needed in order to support much higher data rates and more connected devices than 5G, which could lead to increased energy consumption and carbon emissions.

Environmental monitoring: B5G/6G networks could be used to monitor the environment in real-time, providing insights into climate change, air quality, and other environmental factors using vehicles as IoT sensors on the road network

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5G ASPECTS COVERED IN 5G-LOGINNOV

Enhanced Mobile Broadband

Gigabytes in a second

3D video, UHD screens

Work and play in the cloud

Smart Home/Building

Augmented reality

Industry automation

Voice

Mission critical application

Smart City

Self Driving Car

Future IMT

Massive Machine Type Communications

Ultra-reliable and Low Latency Communications

5G enabled Precise Positioning, MEC

Real-time tracking & enhanced visibility

Automated Truck Platooning: <25ms cellular V2X /V2V

5G-LOGINNOV➔Future of Logistics

- *TRUST*: Trust is the basis of the 5G-LOGINNOV. To use the data, the data consumer must fully accept the data owner's usage policy.

- *NEW BUSINESS ECOSYSTEM*: new innovative solutions for port operations and logistics, Identify real market opportunities especially in target niches for SMEs

- *STANDARDIZED INTEROPERABILITY*: is implemented in different variants and can be acquired from different vendors.

- *VALUE ADDING APPS*: includes also services for data processing, data format alignment, and data exchange protocols.

- *DATA MARKETS*: 5G-LOGINNOV enables the creation of novel, data-driven services that make use of data apps, cross-sectorial nature of the 5G core technologies and innovative services.

- *PI*: 5G-LOGINNOV enables the creation of new ICT infrastructure to support operations in future PI logistics networks

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5G**LOGINNOV** Thank you for your attention!

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