5GLOGINNOV

D3.2

Living Labs trials preparation report

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Work Package	WP3 Trials and Evaluation
Tasks 3.2, 3.3 and 3.4	T3.2 Specify LL test scenarios and test cases for the LL Athens and process test cases T3.3 Specify LL test scenarios and test cases for the LL Hamburg and process test cases T3.4 Specify LL test scenarios and test cases for the LL Koper and process test cases
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List of abbreviations and acronyms

Abbreviation	Meaning
3G	Third Generation Wireless System
3GPP	3G Infrastructure Partnership Project
4G/5G	4th/5th Generation (of cellular networks)
5G	5th Generation Wireless System
5G MOBIX	5G for cooperative & connected automated MOBIility on X-border corridors
5G-PPP	5G Infrastructure Public Private Partnership
ADAS	Advanced Driver Assistance System
AEOLIX	Architecture for EurOpean Logistics Information eXchange
AI	Artificial Intelligence
API	Application Programming Interface
ATP	Automated Truck Platooning
CAD	Connected and Automated Driving
CAM	Connected and Automated Mobility
CAN	Controller Area Network
CCAM	Cooperative, Connected and Automated Mobility
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CNF	Cloud Native Functions
CONTI	CONTINENTAL AUTOMOTIVE ROMANIA SRL
COREALIS	Capacity with a pOsitive enviRonmEntal and societAL footprInt: portS in the future era
CSF	Critical Success Factor
DoA	Description of the Action
E2E	End-to-End
EC	European Commission
eMBB	Enhanced Mobile BroadBand
EPI	Energy Performance Index
EU	European Union
EAMS	Enterprise Asset Management System
FTED	Floating Truck & Emission Data

GLOSA	Green Light Optimal Speed Advisory
GNSS	Global Navigation Satellite System
HMI	Human-Machine Interface
IoT	Internet of Things
IT	Information Technology
ITS	Intelligent Transport Systems
KPI	Key Performance Indicator
LCMM	Low Carbon Mobility Management
LL	Living Lab
MANO	MAnagement and Network Orchestration
MCA	Multi Criteria Analysis
MEC	Mobile Edge Computing
ML	Machine Learning
MNO	Mobile Network Operator
NFV	Network Functions Virtualization
NSA	Non-Standalone (5G network operation)
OEM	Original Equipment Manufacturer
ORDP	Open Research Data Project
ORDP	Open Research Data Pilot
PCT	Piraeus Container Terminal
SA	Standalone (5G network operation)
SDK	Software Development Kit
SME	Small and Medium Enterprises
STS	Ship to Shore
TEC4U	tec4U Ingenieurgesellschaft mbH
TEU	Twenty-foot Equivalent Unit
TOS	Terminal Operating System
TSYS	T-SYSTEMS INTERNATIONAL GMBH
TMS	Truck Monitoring System
UC	Use Case
UHD	Ultra-High Definition

VNF	Virtual Network Function
WLTP	Worldwide-harmonized Light vehicles Test Procedure
WP	Work Package

1 EXECUTIVE SUMMARY

The deliverable D3.2 ‘Living Labs trials preparation report’ is based on the tasks T3.2, T3.3 and T3.4 were the LL specified there LL test scenarios and test cases and processed the test cases for a first time to state the level of

- Technical readiness of the definded technical components (Hardware, services or software)
- Operational readiness for demonstration the defined use cases within the defined infrastructure
- Readiness to process the trials for collecting the data for evaluation
- Readiness for evaluation in the tasks T3.4 and T3.5.

The basic framework and the scenario specification therefore have been defined in deliverable D3.1 ‘Trial methodology, planning and coordination’. D3.2 will complement aspects for technical test cases to the storyboards to have a clear procedual understanding for each component needed for the use cases.

The following table shows an overview of all WP3 realted tasks.

Task #	Task description
T3.1	Specify a framework for the operation of LL trials and evaluation
T3.2	Specify LL test scenarios and test cases for the LL Athens and process test cases
T3.3	Specify LL test scenarios and test cases for the LL Hamburg and process test cases
T3.4	Specify LL test scenarios and test cases for the LL Koper and process test cases
T3.5	Evaluate and assess the LL trial data for operation optimization
T3.6	Evaluate and assess the social and economic impacts

Table 1: Tasks of WP3: Overview

The basic methodology set up in D3.1 will be complemented in D3.2 by specifying the test cases and the test processing to be ready for the submission of the data for evaluation and the overall coordination to monitor the trials demonstrated in the context of 5G-LOGINNOV.

Deliverable D3.1 has standardized the aspects on a

1. common trial methodology per each LL base on storyboards to detail and describe the demonstration and all relevant information to setup and perform the LL UCs.

2. LL planning the 'LL trial plans' have been initiated by setting up a common template for the related aspects of planning and monitoring.

The following chapters of D3.2 are structured with an introduction (Chapter 2) to the 5G-LOGINNOV project, the objectives of the deliverable and the intended audience. Chapter 3 focuses on the overall methodology approach and by the LL for test cases and the related aspects of the deliverables D3.1, D1.4 and D2.2. Within Chapter 4 the LL have defined and presented for the LL the test strategy, the test planning and the test results in preparation of the trials. Within the Annex test protocols and time planning sheets are added.

The summary of the test results states the overall readiness of the LL setups for the trials:

LL	Test Case / Test Scenario / UCDescription	Results
Athens	5G NSA network testing by Vodafone (local MNO)	Testing and evaluation of 5G network at PCT premises illustrate normal operation. *Ready for the trial phase.*
Athens	NFV-MANO service orchestration of AI-enabled services with 5G network support for lifecycle management operations	NFV-MANO platform and kubernetes cluster ready to orchestrate AI services (UC3, UC4, UC5) at the port premises. *Ready for the trial phase.*
Athens	5G&AI enabled rapid alert system in yard truck operations for collision avoidance (UC3)	People succesfully detected in truck proximity based on live 4K streams from on-truck camera. *Ready for the trial phase.*
Athens	5G&AI enabled video analytics for human presence detection in high risk areas (UC4)	People successfully detected based on live video input from 4K cameras. *Ready for the trial phase.*
Athens	5G&AI enabled container seal detection at the loading/unloading process of vessels (UC5)	Container seals succesfully detected based on live video feed from 4K cameras installed on quay side cranes. *Ready for the trial phase.*
Athens	Predictive Maintenance (UC7)	Necessary data from predictive maintenance algotithm are transmitted from 5G truck to EAMS. *Ready for trial phase.*
Athens	Device management platform ecosystem (UC2)	Truck driver succesfully manuvers with support of external video feed *Ready for the trial phase*
Hamburg	Use of LCMM by running vehicle trips, collection of position data, feedback to driver and result overview at the LCMM portal.	*LCMM ready for trials. LCMM data for **KPIs 1-12** available.*
Hamburg	Use of LCMM by running vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Parallel use of GLOSA for traffic light forecast during trip.	*LCMM ready for trials. LCMM data for **KPIs 1-12** available GLOSA ready for trials. GLOSA data available for **KPIs 1-12**.*

Hamburg	Use of LCMM @ Skylark device, collection of position data by Skylark (precise position service), result overview at the LCMM portal.	*LCMM data via skylark device ready for trials.* *Data especially for **KPI 14** available.*
Hamburg	Collection of position data, including vehicle speed, acceleration, altitude with Conti IoT Device.	*Conti IoT device ready for the trialse.* *Conti IoT device data available for **KPIs 1-10**.*
Hamburg	Use of LCMM by running vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Parallel use of GLOSA platoon for traffic light forecast during trip.	*LCMM ready for trials.* *LCMM data for **KPIs 1-12** available* *GLOSA ready for trials. GLOSA data available for **KPIs 1-12** within platoon mode for KPIs 5,6,9,10.*
Hamburg	Use of Mobileum to measure 5G Bandwidth and Latency during vehicle trips at TAVF	*Mobileum tool setup ready for trials.* *Cellular data available for **KPIs 13,15,16**.*
Hamburg	Use of Entruck during vehicle trip, collection of position data, overview of results on Entruck Online	Entruck and Skylark ready for trials. Data available for KPIs **1-12** and **14**
Koper	Initial 5G IoT System Deployment Automation (collector, Reference server)	5G IoT system successfully deployed in lab environment and ready for the pre-test in LL environment.
Koper	Initial Private 5G System Deployment Automation	Private 5G System deployed and ready for the trial phase
Koper	Initial 5G Drive test (n7 5G NR, Macro CN)	Initial drive test performed, results expected, setup ready for the trial phase.
Koper	5G Drive test (n7 and n78 5G NR, local CN)	This is trial phase test only – continuation of pre-test UC1-S3-1.
Koper	Continuous 5G NSA testing (n7 5G NR, Macro CN)	Pre-test procedure and results do not show any significant anomalies. Ready for the trial phase.
Koper	Continuous 5G NSA testing (n7 and n78 5G NR, Macro CN)	This is trial phase test only – continuation of pre-test UC1-S4-1.
Koper	Continuous 5G SA testing (n78 5G NR, Local 5G CN)	Pre-test procedure and results do not show any significant anomalies. Ready for the trial phase.
Koper	Collection of position data, including vehicle speed, acceleration, altitude	Pre-test procedure and results allow for the trial phase to start.
Koper	Optical Character Recognition of container markings and Container Damage Detection	Objects (incl. text and IMDG label) successfully recognized, ready for the trial phase
Koper	Drone based video streaming	Ready for the trial phase.
Koper	Body worn camera-based video streaming	Ready for the trial phase.
Koper	People and vehicle detection in the controlled area	Objects successfully detected, ready for the trial phase.

Table 2: Summary test results test phase

2 INTRODUCTIONS

2.1 PROJECT INTRODUCTION

5G-LOGINNOV's main aim is to design an innovative framework addressing integration and validation of CAD/CAM technologies related to the industry 4.0 and ports domains by creating new opportunities for LOGistics value chain INNOVation. 5G-LOGINNOV will focus on seven 5G-PPP Thematics and support to the emergence of a European offer for new 5G core technologies in 11 families of Use cases.

5G-LOGINNOV is supported by 5G technological blocks, including new generation of 5G terminals notably for future Connected and Automated Mobility, new types of Internet of Things 5G devices, data analytics, next generation traffic management and emerging 5G networks, for city ports to handle upcoming and future capacity, traffic, efficiency and environmental challenges. 5G-LOGINNOV will deploy and trail 11 families of Use cases beyond TRL7 including a GREEN TRUCK INNITIAVE using CAD/CAM and automatic trucks platooning based on 5G technological blocks. Thanks to the new advanced capabilities of 5G relating to wireless connectivity and Core Network agility, 5G-LOGINNOV ports will not only significantly optimize their operations but also minimize their environmental footprint to the city and the disturbance to the local population.

5G-LOGINNOV will be a catalyst for market opportunities build on 5G Core Technologies in the Logistics domains, thus being a pillar of economic development and business innovation and promoting local innovative high-tech SME and Start-Ups. 5G-LOGINNOV will open SMEs' and Start-Ups' door to these new markets using its three Living Labs as facilitators and ambassadors for innovation on ports. 5G-LOGINNOV promising innovations are key for the major deep sea European ports in view of the mega-vessel era (Hamburg, Athens), and are also relevant for medium sized ports with limited investment funds (Koper) for 5G.

2.2 PURPOSE OF THE DELIVERABLE

The purpose of deliverable D3.2 'Living Labs trials preparation report' is to report the technical readiness of the defined components to demonstrate and execute the LL use cases. Based on the tasks T3.2, T3.3 and T3.4 where the LL specified there LL test scenarios and test cases and processed the test cases for a first time to state the level of readiness.

The detailed objectives are:

- Technical readiness of the definded technical components (Hardware, services or software)
- Operational readiness for demonstration the defined use cases within the defined infrastructure

- Readiness to process the trials for collecting the data for evaluation
- Readiness for evaluation in the tasks T3.4 and T3.5.

The basic framework and the scenario specification therefore have been defined in deliverable D3.1 ‘Trial methodology, planning and coordination’. D3.2 will complement the basic framework of D3.1 by aspects for technical test cases to the storyboards.

2.3 INTENDED AUDIENCE

The dissemination level of D3.2 is a ‘public’ (PU) deliverable and available to members of the consortium, the Commission Services and those external to the project. It is specifically aimed at providing the 5G-LOGINNOV consortium members to get a clear understanding of the final step before operating the trials to collect relevant data for KPI evaluation.

3 METHODOLOGIES

The deliverable D3.2 ‘Living Labs trials preparation report’ is to report the technical readiness of the defined components to demonstrate and execute the LL use cases. Based on the tasks T3.2, T3.3 and T3.4 where the LL specified there LL test scenarios and test cases and processed the test cases for a first time to state the level of readiness.

The detailed objectives are:

- Technical readiness of the definded technical components (Hardware, services or software)
- Operational readiness for demonstration the defined use cases within the defined infrastructure
- Readiness to process the trials for collecting the data for evaluation
- Readiness for evaluation in the tasks T3.4 and T3.5.

The basic methodology has been set up in D3.1 and will now be complemented in D3.2 by specifying the test scenario, test cases cases and the technical test processing to be ready for the submission of the data for evaluation and the overall coordination to monitor the trials demonstrated in the context of 5G-LOGINNOV.

The following chapters of D3.2 will remember the storyboard approach, the trial planning and the evalauation aspects to be covered.

3.1 ‘STORYBOARDS’

In order to have a very clear view on the course of the demonstrations deployed in each LL, the LL leaders will define storyboards. The objective of the storyboards is to detail and describe all relevant information to setup and perform a single UC.

The storyboards describe in simple words what is needed to perform the UC deployed by the LL and how it will be processed. It starts e.g. when the user arrives at the location of the demonstration, describes the whole process he/she is following and ends with the last action completing. Pictures/cartoons have been added to illustrate the story. Most of the LL have several storyboards, usually one for each UC and related KPIs because the experience for each UC is different.

The exercise of detailing step by step is very helpful for the related tasks T3.2, T.3.3 and T3.4 in the LL. It is helpful in the sense that it allows highlighting all actions needed for a smooth execution of the demonstration. The storyboards also aim at integrating the rather technical demonstrations into a comprehensive, user and business-oriented context.

To increase transparency and comparability the template for the storyboards covers the following aspects:

Object	Description
Storyboard ID	Numeric identifier for each Living Lab for the storyboard
Title	Name of the storyboard
UC	List of relevant use cases for the storyboard
KPI	List of the relevant KPIs for the storyboard
Baseline Data	Description of the approach to collect baseline data (Level KPI)
Operational data	Description of the approach to collect operational data (Level KPI)
Evaluation Data	Description of the approach to provide data for evaluation (Level KPI)
Action/sub UC / step …	All needed information on: • The organizational 'setup': e.g. Vehicles, infrastructure, participants etc. • The technical setup to process the storyboard with regards to WP2 architecture and the overall technical bracket related to 5G technologies • Optional information about 'story' and 'setup' e.g. diagrams, maps, pictures etc.

Table 3: Storyboard Objects

Based on this structure of the storyboards the initial storyboards per LL are defined in chapter 4.

Within this deliverable the LL will provide their initial specification of each LL storyboard which will be used for the tasks T3.2, T.3.3 and T3.4 and updated in deliverable D3.2 'Report on the Living Labs preparation and readiness of the trials'.

3.2 TRIAL PLANS'

The 5GLOGINNOCV LL trial plans are defined by each LL per storyboard and related KPIs. The template for the 'LL trial plan' has been initiated by setting up a common template for the related aspects. Aspects are defined by items like:

Object	Description
Name of the LL	Name of the LL
Date	Date of the version edited
Version	Version of the planning
Storyboard Number	ID of the storyboard defined for the storyboard
KPI and name of KPI	ID and name of the related KPI
Number of iterations	Number of planned iterations
Baseline Data collected	Date to confirm baseline data for the Storyboard/KPI are collected
Baseline KPI calculated	Date to confirm baseline data are finally calculated
Baseline data pushed for evaluation	Data to confirm baseline data are transferred to central data storage
Status UC deployment	Date to confirm deployment has been finalized for the storyboard
Test setup ready	Date to confirm test/trial setup has been finalized for the storyboard
Operational data collected	Date to confirm operational data for the Storyboard/KPI are collected
Operational KPI calculated	Date to confirm operational data are finally calculated
Operational data pushed for evaluation	Data to confirm operational data are transferred to central data storage

Table 4: LL trial planning objects: Overview

Within an iterative process all objects of the planning are the result of the contributions by the LL.

The template therefore has been agreed by all LL leaders and will be initially setup for each LL within this deliverable (see Annex). The trial planning sheet covers the status overview on trial preparation per storyboard and the execution. Within deliverable D3.1 there is one initial LL trial plan per LL and this initial trial plan is added as annex to this deliverable.

Date of planning	Version
yyyy/mm/dd	V0.1

Athens	UC Name / storybook	#KPI & KPI Name	Baseline data collected and calculated	Status deployment	Test setup ready (SW, HW, Services)	#KPI data collected - operational data	Data assessed	#Iterations	M13 September 35	36	37	38	39	M14 October 40	41	42	43	M15 November 44	45	46	47
#UC ID	x	A	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd								#1	#1			#2		
		B	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		C	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		D	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd									#1					
		E	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		F	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		G	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		H	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		I	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
#UC ID	y	A	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		B	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		C	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		D	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
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		I	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
#UC ID	z	A	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		B	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		C	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		D	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		E	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		F	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		G	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		H	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														
		I	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd	yyyy/mm/dd														

# 1	#Test Iteration planned
# 1	#Test Iteration excecuted (sucessful)
	planned
	under construction
	done

Figure 1: WP3 illustration LL trial plan

During the performance of the trails in the LL the planning will also feed the deliverable D3.2 'Report on the Living Labs preparation and readiness of the trials'. In this sense the matrix is foreseen as monitoring basis for the readiness and the execution of the trials. The structure and the related items are also based on contributions by the LL. For the structure and the frame of monitoring see also Table 4: LL trial planning objects: Overview During the processing of the tasks 3.2, 3.3 and 3.4 this 'LL trial plan' will be updated by needs of the task progress. To discuss the plans with the LL frequently bi-weekly calls with the LL leaders will be organized to update the 'LL trial plan' if replanning is needed and to monitor the progress concerning performance and data collection. The final outcome of the updated 'LL trial plans' will be reported in deliverable D3.2 by each LL. To assess the execution, the progress and the collection of data for the KPIs, finally to monitor and to assess the success of stories defined by the LL the 'LL trial plans' will offer the overview of the operation by each LL during processing the tasks 3.2, 3.3 and 3.4.

The outcome of the assessment will also be documented in deliverable D3.2. During processing the tasks 3.2, 3.3 and 3.4 the 'Progress matrix' will be analyzed by the WP3 core trial team (LL leaders and WP3 task leader) on necessary refinements for the execution of the trials.

3.3 EVALUATION AND CENTRAL DATA COLLECTION

The evaluation aims to assess the impact of 5G-LOGINNOV on port operations (T3.5) and on the society, economy, and environment (T3.6), based on the data collected by the tools developed in the context of the project (T2.2). In the end, 5G-LOGINNOV will demonstrate a set of use cases (UC) within the three Living Labs (LLs) and the evaluation will assess the impact.

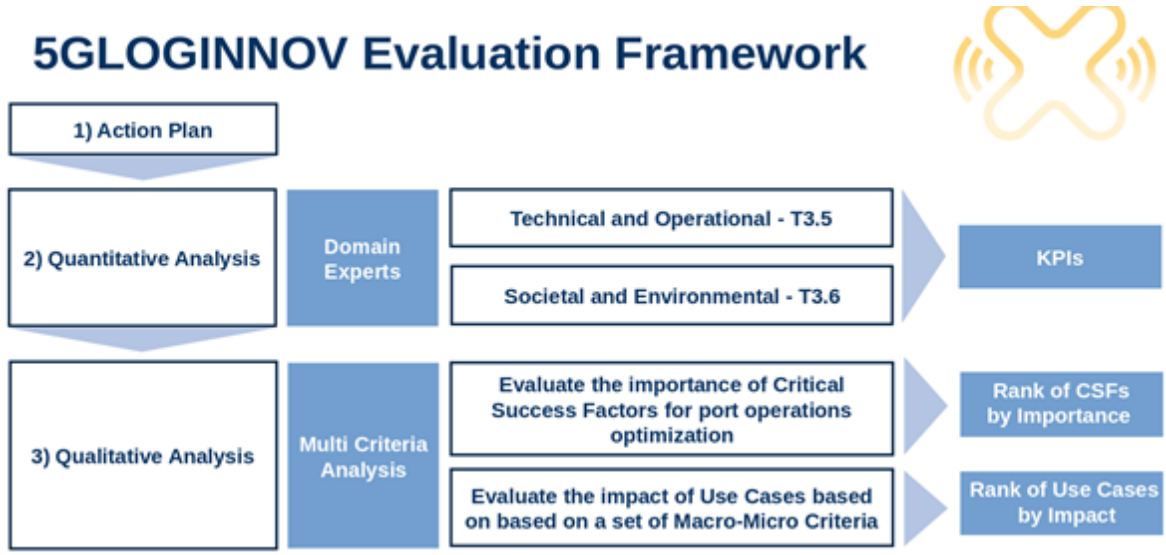


Figure 2 5G LOGINNOV evaluation framework, authors' elaboration

In general, the evaluation methodology of 5G-LOGINNOV consists of the following components:

1. An Action Plan to assist step by step the LL leaders and the project partners in the evaluation process.
2. A quantitative analysis, which consists of a set of KPIs that are measured based on data collected during the UCs demonstration. The objective of the indicators is to measure the impact of the UCs on:
    - Technical and operational aspects (T3.5).
    - Societal and environmental aspects (T3.6).
3. A qualitative analysis that aims to:
    - Evaluate the most important Critical Success Factors (CSF) for port operations optimization (T1.4).
    - Evaluate the impact of 5G-LOGINNOV UC according to a set of Macro and Micro-Criteria (T1.4).

The KPIs selected and specified in D1.4 by each LL rely on the capability of measuring the impact of each UC and the possibility to calculate them.
Within the storyboards the relation to the relevant KPIs and the data to be collected during the performance for the evaluation is described.

With reference to the data collection, the requirements of the tool for the data collection had to be defined. It was agreed that some data needs to be collected prior to the implementation of the 5G-LOGINNOV UC to assess the baseline scenario and to quantify the “before” situation.
The data collection process is based on the data management for 5G-LOGINNOV.

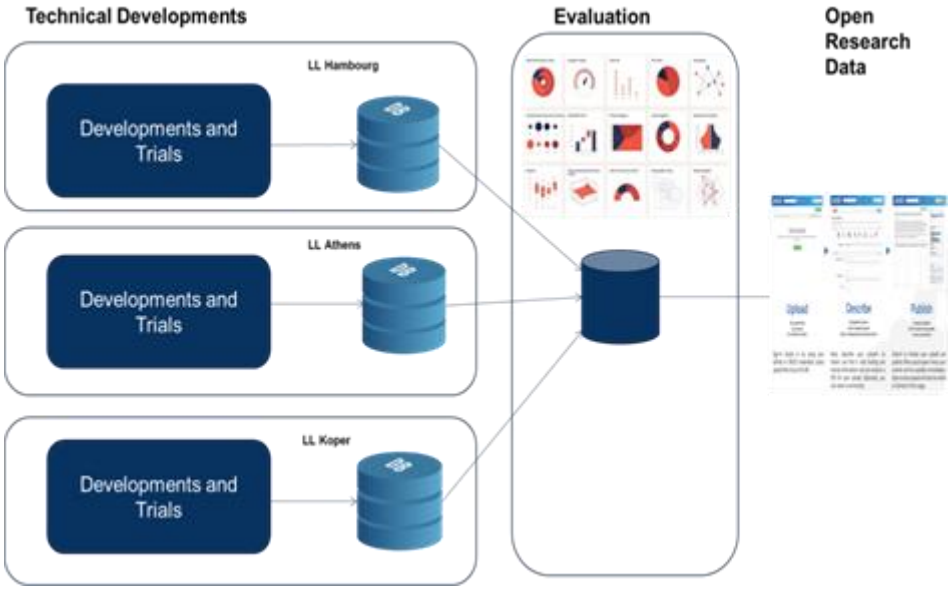


Figure 3 5G LOGINNOV data management process

The overall approach of D2.2 ‘Data collection and evaluation procedures’ is still under development during the time of writing the present deliverable, but the data collection principles are already defined. These principles focus on:

1. The LL are responsible for collecting KPI relevant data.
2. The LL will decide whether a preliminary calculation of data by the LL is needed.
3. The LL will provide all relevant data to the central data collection tool.
4. The LL will add meta data within agreed data schemes to the collected/calculated LL data (Figure 4).
5. All data are foreseen for the evaluation processes within 5G-LOGINNOV and ORDP.

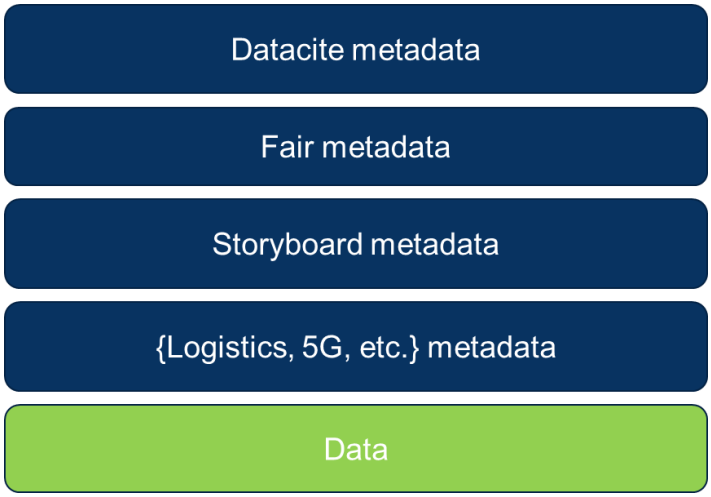


Figure 4 5G LOGINNOV common evaluation data model

Below the most relevant scenario on data provisioning is visualized.

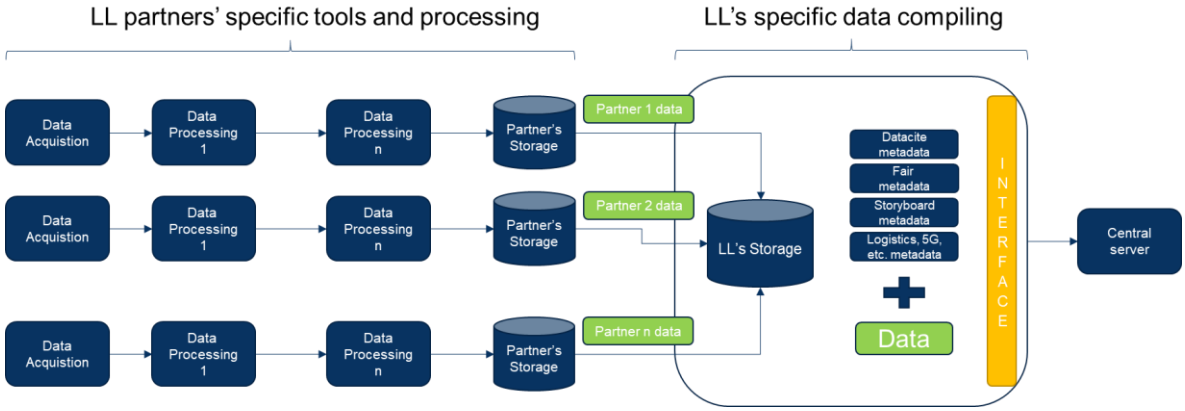


Figure 5 5G LOGINNOV data provisioning process to the central data collection tool

The central data collection tools or central server will primarily make the collected evaluation data available to the 5G-LOGINNOV tasks that will conduct the evaluation (T3.5 and T3.6). Additionally, the tool will help in publishing some of the collected datasets under the frame of ORDP1 in which 5G-LOGINNOV is participating.

[1] https://data.europa.eu/data/datasets/open-research-data-the-uptake-of-the-pilot-in-the-first-calls-of-horizon-2020?locale=en

4 LL TEST & RESULTS

4.1 LL ATHENS

In 5G-LOGINNOV project, the Athens LL developed a set of 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 will enable the use case innovations exploiting the eMBB service and low latency transmissions of 5G, including NFV-MANO based applications and service orchestration, pioneering far edge computing solutions, 5G truck telematics, computer vision and AI/ML-based video analytics.

Particularly, the portfolio of application innovations includes live tracking of 5G (yard and external) truck operations for collision avoidance (UC3); coordination with external truck operations (UC2); and predictive maintenance services (UC7) by exploiting telemetry and video data (from various on-truck sensors) aggregated over the fleet of 5G connected trucks in (near-)real time; 4K transmissions of voluminous uplink (and/or downlink) inferenced video streams from deployed AI-enabled 5G-IoT devices (UC3, UC4, UC5) for safety/security applications and port operations monitoring; remote, automated management and orchestration of end-to-end computer vision analytics services targeting safety/security and logistics applications, orchestrated as NFV-MANO services with 5G network support for lifecycle management of various service components.

Table 5 lists the storyboards for trials as described initially in D3.1. It includes 5G KPI measurements as enablers for port operations and 5G LOGINNOV use cases, as well as logistics KPIs to measure the impact and need of 5G technology on the identified use cases and daily port operations.

As mentioned in previous deliverables and the amendment, *UC3: optimal container job allocation*, will not exploit 5G localization services (hence we also remove LL_Athens_Story_#3 as described in D3.1). Instead, a 5G&AI enabled rapid alert delivery system is designed and developed for collision avoidance between trucks and personnel, exploiting the eMBB service of 5G and low latency transmissions, tailored to personnel safety. To this end the new storyboard (LL_Athens_Story_#8 in Table 5 will be explained in Annex 1, and relevant test case #3) is tailored to the new augmented use case scenario. For more details in UC3 changes, please refer to D2.3.

In summary the project's trials are focused on measuring the performance of the private 5G NSA network as use case enabler, the impact of NFV-MANO enabled video analytics services targeting security, safety and logistics applications, as well as 5G truck telematics services for improving the efficiency of yard truck operations and coordination with external tucks, as well as reducing the environmental footprint in the nearby area.

The following subsections describe the pre-test conducted to facilitate the Athens LL readiness for trials, as well as the distinct steps to be followed for the actual LL trials of the use cases, bind to a timeline per use case and storyboard.

LL_Athens_Story_#1 (cross collaboration with Koper LL, using ININs qMON monitoring platform for measuring 5G network KPI's)
5G-LOGINNOV 5G-NSA network (Release 15) at Piraeus Container Terminal (PCT) # UC2, UC3, UC4, UC5, UC7
LL_Athens_Story_#2
5G-LOGINNOV Device Management Platform Ecosystem # UC2
LL_Athens_Story_#4
5G-LOGINNOV NFV-MANO enabled video analytics platform. # UC3, UC4, UC5
LL_Athens_Story_#5
5G-LOGINNIOV optimal surveillance cameras and video analytics (human presence detection) # UC4

LL_Athens_Story_#6
5G-LOGINNOV Automation for Ports: Port Control, Logistics and Remote Automation (Container Seal Detection) # UC5
LL_Athens_Story_#7
5G-LOGINNOV Predictive Maintenance # UC7
LL_Athens_Story_#8
5G-LOGINNOV 5G&AI Enabled Rapid Alert System for Collision Avoidance # UC3

Table 5: LL_Athens_Storyboards Overview

The LL Athens has defined the following KPIs which will be measured during the trials. These KPIs are aligned with the above listed storyboards and testcase scenarios that will follow. For more details in the KPIs please refer to D1.4.

KPI ID	A-KPI1
Measurable objectives and indicators	Novel surveillance technologies and mechanisms (pioneering portable 5G-IoT device, AI/ML based video analytics) with MANO orchestration Support
KPI	Model Inference Time
Description	The time required for the machine learning model to process the input of video stream(s) and infer the presence/absence of people
Data Needed	Time dedicated for analysing each of the video/images of the risk area(s)
Owner	ICCS, PCT

KPI ID	A-KPI2
Measurable objectives and indicators	Novel surveillance technologies and mechanisms (pioneering portable 5G-IoT device, AI/ML based video analytics) with MANO orchestration Support
KPI	Model Accuracy/Reliability
Description	The accuracy (ratio of success) of the developed machine learning model for detecting the presence/absence of people. Based on the resulting confusion matrix and the derived true/false positive/negatives relevant ratios of the classifier, precision (fraction of correctly classified instances containing humans among the entirety of instances classified as such) and recall (fraction of correctly classified instances containing humans among the entirety of instances actually containing humans) for each of the two classes (i.e., human present or not) will be calculated
Data Needed	Live video feed from deployed 4K camera.
Owner	ICCS, PCT

KPI ID	A-KPI3
Measurable objectives and indicators	Novel surveillance technologies and mechanisms (pioneering portable 5G-IoT device, AI/ML based video analytics) with MANO orchestration Support.
KPI	Deployment Time.
Description	Elapsed time from the moment the deployment is started via the MANO orchestrator until the system is ready to use.
Data Needed	Time of service instantiation request, Time that the service activated.
Owner	ICCS

KPI ID	A-KPI4
Measurable objectives and indicators	Reduce percentage of empty container runs by 15%
KPI	Percent of Empty Containers Runs
Description	By counting the number of non-full arrivals (20ft) at PCT
Data Needed	Location of containers, pick up/drop-off locations, real time localization
Owner	PCT, Vodafone

KPI ID	A-KPI5
Measurable objectives and indicators	Traffic redistribution in port operations based on real-time truck localization data
KPI	Mean time of container job
Description	Based on the real time ETA (estimated times of arrival) of external trucks, reassign Straddle Carriers (SCs) to either external or internal container jobs. This KPI will capture the reduction in time spent by external trucks at the port premises
Data Needed	Number of yard equipment available for external trucks, real time localization of external trucks, time spent by external truck in port premises
Owner	PCT, Vodafone

KPI ID	A-KPI6

Measurable objectives and indicators	Reduced time for a device to connect to the network in comparison to existing 3G/4G based devices
KPI	Time needed for the device to open a network connection
Description	When the device wakes up from hibernation, it takes an amount of time for the modem to connect and post data; the project investigates the reduction of this time
Data Needed	Device-network connection data
Owner	Vodafone

KPI ID	A-KPI7
Measurable objectives and indicators	Extrapolation of the potential CO_2/NO_X savings based on the real traffic volume to the port terminals.
KPI	CO_2 Emissions.
Description	Reduction in the CO_2/NO_X emissions of trucks (average) in port operations by minimizing truck waiting times, e.g., at port gates, at container handover operations.
Data Needed	Truck travel distance, travel duration
Owner	Vodafone Innovus

KPI ID	A-KPI8
Measurable objectives and indicators	Reduce emissions produced by trucks delivering/picking up containers at least 15%
KPI	Fuel Consumption
Description	Reduction in the fuel consumption of trucks (average) in port operations by minimizing truck waiting times, e.g., at port gates, at container handover operations.
Data Needed	Truck travel distance, travel duration
Owner	Vodafone Innovus

KPI ID	A-KPI9

Measurable objectives and indicators	Optimise the use of human resources in yard equipment port operations
KPI	Human resource optimization (person-hours)
Description	Computer vision assisted surveillance of high-risk areas for automatically detecting human presence. Physical staff (appointed safety/security personnel) will no longer be needed for the service at the specified area(s). High resolution video of the selected area(s) is additionally streamed at PCT backend system
Data Needed	Computer vision model inference (i.e., human presence detected), video stream of specified area(s)
Owner	PCT

KPI ID	A-KPI10
Measurable objectives and indicators	Reduce vessel operation completion times by at least 5%
KPI	Vessel Operation Completion Time
Description	The developed computer vision model will automatically detect the presence/absence of container seals at the unloading/loading phase of vessels, alleviating (or minimizing) human personnel intervention (which consumes a considerable amount of time), hence, significantly accelerating the vessel operation completion time
Data Needed	Reduction in time for vessel operation completion time after the deployment of the use case
Owner	ICCS, PCT

KPI ID	A-KPI11
Measurable objectives and indicators	Novel surveillance technologies and mechanisms (pioneering portable 5G-IoT device, AI/ML based video analytics) with MANO orchestration Support
KPI	Model Inference Time
Description	The time required for the computer vision model to process the input of video stream(s) and infer the presence/absence of container seals
Data Needed	Time dedicated for analysing each of the video/images of containers at the loading/unloading phase of vessels
Owner	ICCS, PCT

KPI ID	A-KPI12

Measurable objectives and indicators	Novel surveillance technologies and mechanisms (pioneering portable 5G-IoT device, AI/ML based video analytics) with MANO orchestration Support
KPI	Model Accuracy/Reliability
Description	The accuracy (ratio of success) of the developed algorithm for detecting the presence/absence of container seals Based on the resulting confusion matrix and the derived true/false positive/negatives relevant ratios of the classifier, precision (fraction of correctly classified instances containing seals among the entirety of instances classified as such) and recall (fraction of correctly classified instances containing seals among the entirety of instances actually containing seals) for each of the two classes (i.e. container seal present or not) will be calculated
Data Needed	Video feed from PCT's vessel loading/unloading operations, focusing on the seal area and on the field training of the computer vision technique hosted at the 5G-IoT device. Annotated data made available from PCT, containing positive/negative examples of sealed/unsealed containers, respectively
Owner	ICCS, PCT

KPI ID	**A-KPI13**
Measurable objectives and indicators	Reduce total cost of spare parts and tyres annually by at least 10%.
KPI	Parts in Stock.
Description	Number of items per part of yard trucks functional components. The accumulated telemetry data from sensors installed on yard trucks transmitted via the 5G network will be used by the AI/ML model that predicts possible malfunctions of functional parts of yard trucks, hence, optimizing the number of necessary parts in stock at PCT warehouse for maintenance.
Data Needed	CAN-Bus, data from sensors installed on yard trucks, AI model inference, Enterprise asset system management data (EAM).
Owner	PCT

KPI ID	**A-KPI14**

Measurable objectives and indicators	Enhanced monitoring and predictive maintenance of port assets by collecting telemetry data from different sensors equipped on yard trucks in port Operations.
KPI	Vehicle Breakdowns.
Description	Reduce the number of yard truck breakdowns. 5G connected trucks transmit telemetry data from sensors installed on yard trucks. The transmitted data will be used by the AI/ML algorithm in order to anticipate possible malfunctions of yard truck functional components, hence providing insights and intervention indications to prevent potential breakdowns of yard vehicles.
Data Needed	CAN-Bus, data from sensors installed on yard trucks, AI model inference, Enterprise asset system management data (EAM).
Owner	PCT

KPI ID	**A-KPI15**
Measurable objectives and indicators	Enhanced monitoring and predictive maintenance of port assets by collecting telemetry data from different sensors equipped on yard trucks in port Operations.
KPI	Vehicles Under Maintenance.
Description	Reduce downtime for repairs. The accumulated sensor data from the fleet of 5G connected trucks will be used by the AI\ML algorithm to anticipate potential breakdown of vehicle components, and hence, pro-actively purchase/stock relevant assets/parts at PCT warehouse. This insight will minimize vehicles downtime for repairs, as relevant replacement parts will be in stock (available) at PCT premises.
Data Needed	CAN-Bus data, data from sensors installed on yard trucks, AI model inference, Enterprise asset system management data (EAM).
Owner	PCT

KPI ID	**A-KPI16**

Measurable objectives and indicators	Enhanced monitoring and predictive maintenance of port assets by collecting telemetry data from different sensors equipped on yard trucks in port Operations.
KPI	Vehicles Unexpected Breakdown.
Description	Reduce the number of unexpected yard truck breakdowns (Unscheduled maintenance). 5G connected trucks transmit telemetry data from on-board sensors. The transmitted data will be used by the AI/ML algorithm in order to anticipate eventual/potential breakdowns, and thus minimize events of corrective maintenance that take place after the occurrence of a breakdown.
Data Needed	CAN-Bus data, data from sensors installed on yard trucks, AI model inference, Enterprise asset system management data (EAM).
Owner	PCT

KPI ID	**A-KPI17**
Measurable objectives and indicators	Enhanced monitoring and predictive maintenance of port assets by collecting telemetry data from different sensors equipped on yard trucks in port Operations.
KPI	Maintenance Costs of Vehicles.
Description	Reduce maintenance costs of yard trucks. 5G connected trucks transmit telemetry data from sensors installed on yard trucks. The transmitted data will be used by the AI/ML algorithm in order to anticipate eventual breakdowns that lead to higher costs when handled with corrective maintenance or routine maintenance.
Data Needed	CAN-Bus data, data from sensors installed on yard trucks, AI model inference, Enterprise asset system management data (EAM).
Owner	PCT

KPI ID	**A-KPI18**
Measurable objectives and indicators	Minimise percentage of yard equipment assets idling for more than one shift
KPI	Assets Idling
Description	Reduction in percent of yard trucks staying idle, i.e., not participating in port operations
Data Needed	Active/open container jobs, container presence sensor data (from on-truck sensors)
Owner	PCT

***KPI ID**	**A-KPI19**

Measurable objectives and indicators	Support the 5G next generation network architecture to deploy use case. 5G-based cellular communications system will be provided by the national Mobile Network Operator to meet the needs of port operations and address the use case requirements.
KPI	Area Traffic Capacity.
Description	The total traffic throughput served per geographic area (in bps/m^2).
Data Needed	Throughput Served per Geographic Area: Site density, Bandwidth, Spectrum Efficiency.
Owner	Vodafone

KPI ID	A-KPI20
Measurable objectives and indicators	Support the 5G next generation network architecture to deploy use case. 5G-based cellular communications system will be provided by the national Mobile Network Operator to meet the needs of port operations and address the use case requirements.
KPI	Bandwidth.
Description	Maximum TCP/IP uplink and downlink bandwidth measured from the end user device on 5G RAN to the reference server located in 5G core.
Data Needed	Total System Bandwidth (sys 1+ sys 2+ … + sys N).
Owner	Vodafone

KPI ID	A-KPI21
Measurable objectives and indicators	Support the 5G next generation network architecture to deploy use case. 5G-based cellular communications system will be provided by the national Mobile Network Operator to meet the needs of port operations and address the use case requirements.
KPI	Connection Density.
Description	The total number of connected and/or accessible devices per unit area (per km^2).
Data Needed	Number of Active Devices in the Area Considered: Active Devices, Area.
Owner	Vodafone

KPI ID	A-KPI22

Measurable objectives and indicators	Support the 5G next generation network architecture to deploy use case. 5G-based cellular communications system will be provided by the national Mobile Network Operator to meet the needs of port operations and address the use case requirements.
KPI	Reliability.
Description	The percentage (%) of the amount of sent network layer packets successfully delivered to a given system node (including the User Equipment) within the time constraint required by the targeted service, divided by the total number of sent network layer packets.
Data Needed	Packets Successfully Delivered, Total Number of Packets.
Owner	Vodafone

KPI ID	A-KPI23
Measurable objectives and indicators	Support the 5G next generation network architecture to deploy use case. 5G-based cellular communications system will be provided by the national Mobile Network Operator to meet the needs of port operations and address the use case requirements.
KPI	End-to-End Latency.
Description	Measured round trip time (RTT) from the moment the IP ICMP Echo Request packet leaves the source host until the IP ICMP Echo Reply is received from the destination host.
Data Needed	Time from Source to Target Device (i.e., measured at the communication interface).
Owner	Vodafone

KPI ID	A-KPI24
Measurable objectives and indicators	Support the 5G next generation network architecture to deploy use case. 5G-based cellular communications system will be provided by the national Mobile Network Operator to meet the needs of port operations and address the use case requirements.
KPI	One-way Latency.
Description	The one-way latency is the total time that is required for a packet to be generated at the communication unit at the transmitter's side, until it is received at the communication unit at the receiver's side.
Data Needed	Time from Source to Target Device (i.e., measured at the communication interface).
Owner	Vodafone

KPI ID	A-KPI25

Measurable objectives and indicators	Novel surveillance technologies and mechanisms (pioneering portable 5G-IoT device, AI/ML based video analytics) with MANO orchestration Support
KPI	User Experienced Data Rate
Description	The data rate that is experienced by the 5G device (e.g., truck, IoT, Crane) for delivering/receiving voluminous video streams to/from PCT's management platform or the edge processing device. Due to 5G technology higher data rates can be achieved to accommodate for high resolution video streaming (e.g. 4K, UHD) services in real time.
Data Needed	Experienced data rate (Mbps)
Owner	ICCS, PCT

4.1.1 TEST STRATEGY & TEST CASES

In Athens LL, the trials will take place at Pier 3, of Piraeus port as illustrated in Figure 6. In relation to the defined UCs and storyboards of LL Athens, here we describe the strategy to ensure the technical readiness of our LL, and trials roll-out. Details in the development phases across use cases can be found in D2.3.

Figure 6: Trials site Athens LL.

For measuring 5G related KPIs, additional to Vodafone's (local MNO) monitoring/testing system and conducted evaluation relevant to network performance activities at the port of Piraeus, a cross-collaboration between Koper and Athens LL exploiting ININ's *qMON* monitoring system (for more details on ININ's monitoring platform please see D2.3) will be performed. Via this procedure, we will have a common reference architecture and tool for measuring the 5G capabilities among the two LLs, performing similar trials for the evaluation of the 5G technology. *Annex 2 defines the scope and relevant shared test protocols across Koper and Athens LLs*.

In relation to the defined UCs and storyboards of Athens, a number of pre-tests have been performed with respect to the NFV-MANO platform, the 5G IoT system, edge processing nodes and AI services, as well as telemetry data collection and exploitation from yard and external trucks. Initially, the NFV-MANO platform and 5G IoT system have been fully tested at the ICCS 5G testbed (i.e., service orchestration and lifecycle management), along with the development (and testing) of the relevant AI-enabled services (UC3, UC4 and UC5). In the sequence the full system was established/migrated at the port premises including the deployment of 4K cameras at quay side cranes, on truck and fixed port locations; and the installation of the edge computing nodes to support relevant use cases tailored to safety/security and logistics applications. Next, OpenSourceMANO (rel 11) along with a Kubernetes cluster at PCT datacentre where deployed and tested, connected to the 5G nodes (edge/compute devices) through 5G NSA network for control (e.g., AI service orchestration) and data plane functions (e.g., 4K uplink inferenced/annotated video streaming). The

full system has been tested and is ready for trials to evaluate its operation and KPIs data collection under the established NSA network at PCT premises, in daily port operations.

For UC7 (predictive maintenance) telemetry data collection from the fleet of connected trucks is verified and operational, flowing over 5G to PCT's internal system and services. Internal systems include the traffic monitoring system (TMS) and Enterprise Asset Management System (EAMS) at PCT datacentre dedicated for collection of operational data from yard truck's daily port operations, e.g., hours of operation, number of jobs each truck completed, average speed and acceleration, CO_2 emissions and truck travel distance, breakdown events and duration, parts of the truck that were affected by a malfunction and the spare parts used for the repair etc. Such data will be exploited by the AI-based algorithm delivering the predictive maintenance service.

For UC2 (Device management platform ecosystem) truck data (video, location and GNSS) are transmitted via the 5G network towards PCT's internal infrastructure. During testing the drivers will use the mobile phone (via a window phone holder) and during manuvering will consult the application and view their truck from external sources (2 or 3 in line-of-sight trucks). While picking up or releasing a container the drivers will interact with the application and inform this, in order to collect information regarding container truck runs.

The following Annexes (Annex 1 and Annex 2) portray the completed pre-test and relevant planning activities for conducting the trials mapped to a corresponding timescope, all given in discrete steps to perform and conclude the trials which will trigger the evaluation procedures for selected KPIs (D1.4). A short overview is show in the following sub-sections.

4.1.2 TEST CASES PLANNING

The trials for Athens LL will be conducted at Pier III (Figure 6), where the 5G base station is deployed. Trucks operating within this area (UC2, UC3 and UC7) will be exploited for the trials. The installation of 4K cameras on quay side crane 31 and other points in Pier III are within range to the gNB, facilitating massive uplink video transmissions to the NFV-MANO platfrom and monitoring system. The edge computing nodes receive data over 5G (e.g., relevant video) whereas the orchestartion of the service components (control plane function, e.g., AI model orchestartion) also occurs over the 5G new radio. Each use case and relevant storyboards are detailed in discrete steps and timescope to facilitate the trials and evaluation of Athens LL in 5G LOGINNOV via the test protocols detailed in Annex 1. An example snapshot of the test protocols is show in Figure 7. Trials will mainly begin in July 2022 and are envisioned to be completed for all use cases and storyboards by the end of February 2023 (please see Annex 2).

	Step 2	Start Kubernetes cluster	Activate Kubernetes virtualized infrastructure manager (VIM)
	Step 3	Establish 5G communication between the 5G truck and the compute (GPU enabled) node used for the video analytics service	Compute node and 5G truck are connected and ready to activate the collision avoidance service.
	Step 4	Deploy Opensource MANO and Kubernetes manifests for Use Case 3	Activating 5G&AI-enabled rapid alert system components for yard trucks collision avoidance service
		Scenario	
	Step 5	5G truck performs a particular route, i.e., moves in a predefined and bounded port area (prioritizing safety of personnel involved in the trials)	The 5G truck follows the predefined route for the trial scenarios.
	Step 6	As the 5G truck is moving in the bounded area, the 4K video feed from the camera's field of view is transmitted to the edge processing node over 5G (uplink)	Send uplink 4K video stream at the GPU enabled compute node over the 5G network
	Step 7	The orchestrated AI model at the edge node processes the live video feed to infer in real time the presence (or absence) of people close to the truck.	Receive and process input video streams for the AI-enabled service at the edge computing node
	Step 8	**Scenario 1: No event detection.** For cases where no person is detected in the truck's vicinity based on the developed AI algorithm's inference, a black screen is illustrated at a tablet installed in the truck's cabin.	No alert, i.e., blank screen is illustrated at the tablet in the truck's cabin
	Step 9	**Scenario 2: Event creation.** Utilize PCT trained personnel, to move inside the trial area (camera's field of view from the truck) and create "fixed" events for the evaluation of the collision avoidance system.	Create fixed events to evaluate the service.
	Step 10	**Scenario 2: Event re-action**. The inference engine delivers over the 5G network (downlink) the 4K inferenced video stream to the tablet installed in the truck's cabin, alerting the driver for potential collision event.	Deliver rapid alerts/video to the yard truck driver for people in vicinity over 5G
	Step 11	Repeat scenarios of steps 8 to 10 in varying light conditions	Get statistical results for the operation of the service
Expected result	Evaluate the efficiency and feasibility of the collision avoidance service		

node receiving over 5G the live 4K stream captured by the truck's camera. In the truck's cabin, a tablet is also installed and will be exploited for the trials.

Figure 6: 4K camera and tablet installed on PCT's yard truck

The trials will demonstrate the AI enabled rapid alert system in two scenarios based on a fixed truck route. In scenario 1 the 5G truck will follow the predefined route where no person will be present. The edge node will receive the uplink 4K video stream in real time, and the developed inference engine will provide no alert, i.e., a black screen is illustrated to the tablet at the 5G truck's cabin, indicating that within the bounding box area, no person is detected according to the developed AI model (Figure 7, left). In scenario 2, to create a fixed "risk" event, a person will be positioned within the bounding box of the camera's field of view, along the truck's route. The AI model will process the live video feed, detect the person within the bounding box area at the truck's vicinity, and transmit the inferenced 4K video stream (alert) at the tablet in the truck's cabin (Figure 7, right) over 5G. For more details on the developed service and AI model tailored to the collision avoidance service please refer to D2.3. The model will be evaluated under varying light conditions to evaluate the efficiency and feasibility of the service.

Figure 7: 5G&AI enabled collision alert service

Error Description if test negative

Figure 7: Trial steps for 5G&AI rapid alert deivery system for collision avoidance

4.1.3 TEST RESULTS

Table 1 summarizes test cases and their preliminary results as achieved during the pre-test phase. The test protocol column refers to testcase ids as detailed in Annex 1. Mainly, the step wise approach followed for pre-testing use cases and use case components (including KPI data collection), are followed for the trial phase as well. For PCT, some commercial services are already available (before 5G LOGINNOV), e.g., the traffic monitoring system (TMS) and Enterprise Asset Management System (EAMS) dedicated for collecting operational data from yard truck's daily port operations, e.g., hours of operation, travel distance, CO_2 emmisions, average speed and acceleration, number of jobs each truck completed, breakdown events and duration, parts of the truck that were affected by a malfunction and the spare parts used for the repair etc. Such data (transmitted over 5G) will be exploited by the AI-based algorithm delivering the predictive maintenance service and truck telematics (UC7). Hence, pre-testing of these services is based on establishing 5G communication (and establish API interconnection) between truck and TMS/EAMS. For the remaining use cases dedicated test protocols are presented in Annex 1.

Description	# Iterations	Successful	Test protocol(s)	Comments
5G NSA network testing by Vodafone (local MNO)	Continous testing for the period of two months	Yes	N/A	Testing and evaluation of 5G network at PCT premises illustrate normal operation. *Ready for the trial phase.*
NFV-MANO service orchestration of AI-enabled services with 5G network support for lifecycle management operations	10 per test protocol	Yes	#2, #3, #4, #5	NFV-MANO platform and kubernetes cluster ready to orchestrate AI services (UC3, UC4, UC5) at the port premises. *Ready for the trial phase.*

5G&AI enabled rapid alert system in yard truck operations for collision avoidance (UC3)	Evaluated on 20 video streams recorded from the 4K truck camera. Additionally, on video streams from industrial areas available through open datasets.	Yes	#2, #3	People succesfully detected in truck proximity based on live 4K streams from on-truck camera. *Ready for the trial phase.*
5G&AI enabled video analytics for human presence detection in high risk areas (UC4)	Evaluated on live video data recorded by 4K cameras in PCT premises, during full 8 hour shifts over the span of 5 days	Yes	#2, #4	People successfully detected based on live video input from 4K cameras. *Ready for the trial phase.*
5G&AI enabled container seal detection at the loading/unloading process of vessels (UC5)	Evaluated on video data captured during real time crane operations during full 8 hour shifts over the span of 5 days.	Yes	#2, #5	Container seals succesfully detected based on live video feed from 4K cameras installed on quay side cranes. *Ready for the trial phase.*
Predictive Maintenance (UC7)	CAN-Bus data transmitted from 5G truck during 3 full working shifts.	Yes	#6	Necessary data from predictive maintenance algotithm are transmitted from 5G truck to EAMS. *Ready for trial phase.*
Device management platform ecosystem (UC2)	Tests at straight road segments and tests at 90 degree road turn. Test for 4 iterations.	Yes	#7, #8	Truck driver succesfully manuvers with support of external video feed *Ready for the trial phase*

Table 1: Pre-tests summary, Athens LL

4.2 LL HAMBURG

With around 10 million containers, the Port of Hamburg is ranked No.3 in Europe. The disadvantage of the 70 km Elbe restricting access to the Northern Sea is compensated by the excellent rail network in the port and hinterland, of special importance for inter- and multimodal transport and logistics. Due to special situation as a city port, several terminals for container handling are spread across different parts of the city, which makes an efficient hand-over and automation within the intermodal transport chain (port internal transfers) of great importance for Hamburg's long-term competitiveness. Being part of the city's ITS Policy Strategy 2030 to optimize the transport chain, the inclusion of port transport logistics and hinterland connections was therefore crucial for the City of Hamburg policy makers (https://www.hamburg.com/business/its/11747566/strategy/).

In Hamburg a test field for automated driving has been launched in 2021 to optimize the access of trucks to the port terminals. The test field is available to all OEMs and mobility service providers for Car2X data exchange and other C-ITS functions. More than 26 traffic lights are currently available for Connected Automated Driving (CAD) test runs. The test field is located in the heart of the city close to the ferry boat terminals.

Besides ITS, the environmental pressure is another driver for innovation for the two-million city of Hamburg, ranked number two in Germany with regards to the number of citizens. Air pollution caused by trucks is crucial for the authorities in Hamburg and diesel ban was introduced together with other measures after emissions exceeded the regulations for environmental protection and clean air policy, as agreed in the Aarhus convention 1998. Adopted in German Ordinance on Air Quality Standards and Emission Ceilings, the Federal Government transposed the Aarhus EU directive into national legislation. Accordingly, the limit value for particulate matter was set at 50 µg/m³, which may be exceeded on a maximum of 35 days a year. The average annual value for nitrogen dioxide was set at 40 µg/m³. The EU directive obliges cities and municipalities to draw up action plans for air pollution control. These plans have formed the basis for the implementation of 48 Low Emission Zones (LEZ) with limited access for vehicles with high emissions so far. Hamburg has two restricted road segments where the annual average was exceeded, and diesel banned from entry.

In order to comply with the clean air regulations, the city wants to implement ITS solutions balancing the need for improving air quality with the economic interests of logistics service provider to deliver their goods in time and budget. Therefore, sustainable traffic management based on 5G and Connected and Automated Cooperative Mobility became a key pillar of Hamburg's 2030 ITS policy targets. The four use cases within 5G-LOGINNOV and the related storyboard (see) are reflecting these needs for clean air projects including innovative traffic management and GLOSA-based Automated Truck Platooning powered by current available 5G capabilities in a 5G NSA enviroment.

LL_Hamburg_Storyboard_#1
5G-LOGINNOV Floating Truck & Emission Data (FTED) single vehicle mode
LL_Hamburg_Story_#2
5G-LOGINNOV 5G GLOSA & Automated Truck Platooning (GTP)-under 5G-LOGINNOV green initiative
LL_Hamburg_Story_#3
5G-LOGINNOV dynamic control loop for environment sensitive traffic management actions (DCET)
LL_Hamburg_Story_#4
5G-LOGINNOV Energy Performance optimization with GLOSA
LL_Hamburg_Story_#5
5G-LOGINNOV 5G Cellular Bandwidth on urban roads
LL_Hamburg_Story_#6
5G-LOGINNOV Precise positioning

Table 6: LL_Hamburg_Storyboards Overview

The LL Hamburg has defined the following KPIs which will be measured during the trials. These KPIs are aligned with the above listed storyboards (further details are available in deliverable D3.1)

KPI ID	H-KPI1
Measurable objectives and indicators	Increase average truck speed in single vehicle mode with equipped vehicles (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Increase average truck speed in single mode up to 5%
Description	Increase the average truck speed in single mode with equipped vehicles
Data Needed	Truck/vehicle speed (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI2**
Measurable objectives and indicators	Reduction of acceleration in single mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of average acceleration activities in single mode up to 5%
Description	Reduction of acceleration activities in single mode with equipped vehicles
Data Needed	Acceleration (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI3**
Measurable objectives and indicators	Reduction of stillstand time in single mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of stillstand time in single mode up to 5%
Description	Reduction of stillstand time in single mode with equipped vehicles
Data Needed	Stillstand time (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI4**
Measurable objectives and indicators	Increase average truck speed in platoon vehicle mode with equipped vehicles (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Increase average truck speed in platoon mode > 5%
Description	Increase the average truck speed in platoon mode with equipped vehicles
Data Needed	Truck/vehicle speed (LCMM, Entruck, Conti) per platoon vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI5**
Measurable objectives and indicators	Reduction of acceleration in platoon mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of average acceleration activities in platoon mode > 5%
Description	Reduction of acceleration activities in platoon mode with equipped vehicles
Data Needed	Acceleration (LCMM, Entruck, Conti) per platoon vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI6**
Measurable objectives and indicators	Reduction of stillstand time in platoon mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of stillstand time in platoon mode > 5%
Description	Reduction of stillstand time in platoon mode with equipped vehicles
Data Needed	Stillstand time (LCMM, Entruck, Conti) per platoon vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI7**
Measurable objectives and indicators	Reduction of fuel consumption in single mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of fuel consumption in single mode up to 10%
Description	Reduction of fuel consumption in single mode with equipped vehicles
Data Needed	Fuel consumption (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental

KPI ID	H-KPI8
Measurable objectives and indicators	Reduction of CO_2 emissions in single mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of CO_2 emission in single mode up to 10%
Description	Reduction of CO_2 emission in single mode with equipped vehicles
Data Needed	CO_2 emission (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI9**
Measurable objectives and indicators	Reduction of fuel consumption in platoon mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of fuel consumption in single mode up to 20%
Description	Reduction of fuel consumption in single mode with equipped vehicles
Data Needed	Fuel consumption (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI10**
Measurable objectives and indicators	Reduction of CO_2 emissions in platoon mode (vehicles for LL Hamburg will be equipped with devices for Entruck, Conti IoT and LCMM)
KPI	Reduction of CO_2 emission in platoon mode up to 20%
Description	Reduction of CO_2 emission in single mode with equipped vehicles
Data Needed	CO_2 emission (LCMM, Entruck, Conti) per single vehicle trip
Owner	LCMM T-Systems, Entruck TEC4U, Conti IoT Continental
KPI ID	**H-KPI11**
Measurable objectives and indicators	Optimize Energy Performance Index ‘EPI - cl per ton and km’ (vehicles for LL Hamburg will be equipped with devices for LCMM)
KPI	Increase value of ‘EPI - cl per ton and km’ up to 10% for vehicle trips
Description	Optimize energy performance index ‘EPI - cl per ton and km’
Data Needed	LCMM data per vehicle trips
Owner	LCMM T-Systems
KPI ID	**H-KPI12**
Measurable objectives and indicators	Optimize Acceleration Performance Index ‘API - KWh per ton and km’ (vehicles for LL Hamburg will be equipped with devices for LCMM)
KPI	Increase value of API ‘KWh per ton and km’ up to 10% for vehicle trips
Description	Optimize acceleration performance index ‘API - KWh per ton and km’
Data Needed	LCMM data per vehicle trips
Owner	LCMM T-Systems
KPI ID	**H-KPI13**
Measurable objectives and indicators	5G bandwidth on urban roads
KPI	Extended cellular bandwidth on urban roads by 5G network
Description	5G communication systems will be able to support dedicated bandwidths (per user) over 500MBit/s - depending on deployed network structure. LL Hamburg will use the production network of T-Mobile with 5GNR (in 3.5 GHz spectrum) to get this high capacity
Data Needed	5G bandwidth values during vehicle trips
Owner	Deutsche Telekom
KPI ID	**H-KPI14**
Measurable objectives and indicators	Positioning quality on urban road networks with 5G
KPI	Positioning quality on urban road networks with 5G by 10 cm
Description	The product solution of Deutsche Telekom with the partner Skylark will provide a precision level on 10 cm (comparable with 3 - 10 m for uncorrected GNSS signal. This solution will be integrated in the LL Hamburg

	use cases to increase the precision by factor 10 and to reduce the complexity of the solution (map matching will be much simpler)
Data Needed	5G positioning data during vehicle trips
Owner	Deutsche Telekom
KPI ID	**H-KPI15**
Measurable objectives and indicators	Signal latency in the 5G environment using Mobile Edge Computing
KPI	Average signal latency in the 5G environment will be reduced thru Mobile Edge Computing (MEC) to 10 ms during vehicle trips
Description	Signal latency in the 5G environment will be reduced thru Mobile Edge Computing (MEC). The signal transfer time and the stability of the transmission will be improved. The signal transfer delay (latency) can come down near to 10 ms
Data Needed	Quality data of cellular 5G using MEC during vehicle trips
Owner	Deutsche Telekom
KPI ID	**H-KPI16**
Measurable objectives and indicators	Packed Error Rate (PER) in 5G NSA production network
KPI	Average rate of packed errors during 5G data transmission from vehicle to backend. The KPI will be measured while performing the different use cases. Reduction of PER by 10%.
Description	Mean PER in the 5G environment is an indication of 5G the network performance. The PER will be monitored on the IP layer.
Data Needed	Transmission data and packed error data during vehicle trips
Owner	Deutsche Telekom

Table 7: LL Hamburg KPIs

4.2.1 TEST STRATEGY & TEST CASES

In relation to the definded UCs and storyboards of LL Hamburg the following strategy to test the technical readiness has been chosen and processed.

Derived form the storyboards of D3.1 and the KPIs defined for each KPI relevant test cases has been identified. These test cases have documented in test protocols (see Annex 1) which show in detail the objective of a test case, the preparation and execution steps and the test results. In the case of relevant deviations concerning the expected results also description of soluition or needed further steps are documented.

Overall, the LL Hamburg executed in three single test weeks more then 60 excecutiuons of test cases. The defined 1st test week started beginning of April 2022, the 2nd in May 2022 and the final test week was ein June 2022. All tests have been done on the TAVF in the area of Hamburg using the technical equipment foreseen for the use cases. 16 test protocols finally document the results for each relevant test case. The template for these test protocols is shown below in Figure 8: Template for the LL Hamburg test protocols.

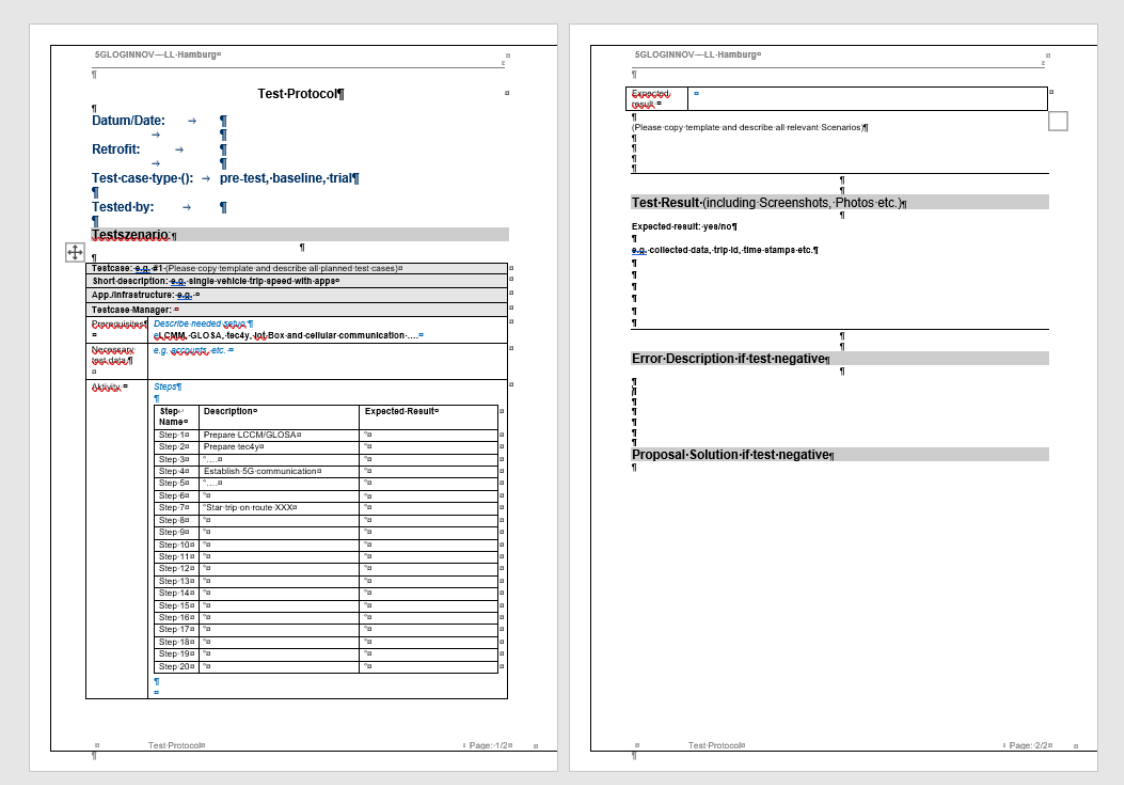


Figure 8: Template for the LL Hamburg test protocols

4.2.2 TEST CASES PLANNING

The testplanning sheet is shown below as example (Figure 9: Planning for test cases LL Hamburg) and available for LL in Annex 2. On demand as sep Excel file can be provided.

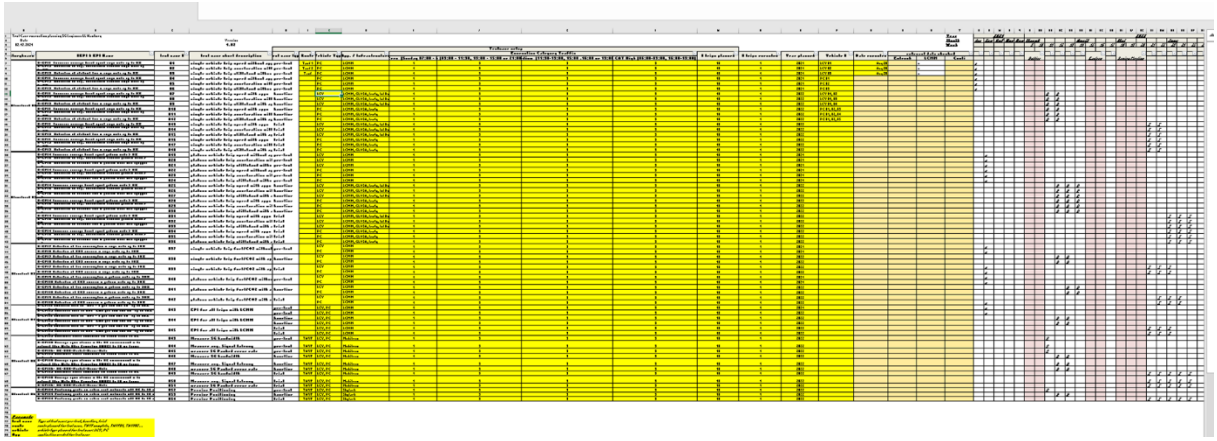


Figure 9: Planning for test cases LL Hamburg

Parameter			
test case type	*Type of test case: pre-test, baseline, trial*		
route	*route planned for test case, TAVF complete, TAVF#1, TAVF#2 ....*		
vehicle type	*vehicle type planned for test case: LCV, PC*		
App	*application needed for test case*		
# trips planned	*number of test case excecutions*		
# trips excecuted	*number of test case excecuted due reporting date*		
Date planned	*date /yymmdd/ next excecution planned*		
	vehicle used/foreseen for test case: LCV#1, LCV#2, PC#1, PC#2, PC#3, LCV = any LCV 1:n,		
Vehicle #	*PCi = any PC 1:n*		
Date excecuted	*date /yymmdd/ last excecution test case*		
Testarea		***duration est. Min***	***distance est. km***
TAVF	*complete round of TAVF long turn only*	***42***	***8,8***
Parking	*Parking to intersection Glaciuschausee/FeldStr.*	*1*	*0,4*
TAVF#1	*Intersection Glaciuschausee/FeldStr. - Intersection Hafenstrr./Landungsbrücken*	*10*	*2,1*
TAVF#2	*Intersection Hafenstrr./Landungsbrücken - Intersection Baumwall/ Otto-Sill Brücke*	*12*	*2,8*
TAVF#3	*Intersection Baumwall/ Otto-Sill Brücke - Intersection Jungiusstr./Gorck-Fock Wall*	*10*	*1,5*
TAVF#4	*Intersection Jungiusstr./Gorck-Fock Wall - Intersection Glaciuschausee/FeldStr.*	*8*	*1,6*
Parking	*Intersection Glaciuschausee/FeldStr. to parking*	*1*	*0,4*
Vehile details			
VW-T	*Diesel, ...*		
Taxi	*...*		
Traffic Cat			***Traffic Cat by Ganglinien City of Hamburg***
zero	CAT Zero (Sunday 07:00 - 09:00)		
Low	CAT Low (09:00 - 11:30, 13:00 - 15:00 or 21:00 - 05:00)		19:00-06:00
Medium	CAT Medium (11:30-13:00, 15:00-16:00 or 19:00-21:00)		09:01- 15:59
High	CAT High (06:00-09:00, 16:00-19:00)		06:00-09:00

Figure 10: Aspects on test case planning and excecutiuon for LL Hamburg

Due 3 single test weeks in April, Mai and June the tests have been executed and data recorded. All available test data have analyzed afterwards to get a clear technical status on the tested compents to start the trials beginning of July 2022 in TAVF of Hamburg. Aspects on test planning are defined above (see Figure 10: Aspects on test case planning and excecutiuon for LL Hamburg). These aspects covers the complexity to operate the tests and trails.

4.2.3 TEST RESULTS

The following overview is showing the different test scenarios documented in the test protocols, states the number of testprotocols documented and the iterations executed by the test team. Per each test scenario the results are summarized, the availability of data stated to measure the KPIs during the trials. For further details per test protocol see Annex 1.

Description	# Iterations	Successful	Test protocol(s)	Comments
Use of LCMM by running vehicle trips, collection of position data, feedback to driver and result overview at the LCMM portal.	*20*	*yes*	*#1* *#2* *#3* *#4*	*LCMM ready for trials.* *LCMM data for* ***KPIs 1-12*** *available.*
Use of LCMM by running vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Parallel use of GLOSA for traffic light forecast during trip.	*8*	*yes*	*#5* *#6*	*LCMM ready for trials.* *LCMM data for* ***KPIs 1-12*** *available* *GLOSA ready for trials.* *GLOSA data available for* ***KPIs 1-12****.* *Irritations on HW issues solved (see #6).*
Use of LCMM @ Skylark device, collection of position data by Skylark (precise position service), result overview at the LCMM portal.	*10*	*yes*	*#7* *#8* *#11*	*LCMM data via skylark device ready for trials.* *Data espaecally for* ***KPI 14*** *available.* *Irritations on configuration of skylark device and within the related data quality solved with retetests #8 and #11.*
Collection of position data, including vehicle speed, acceleration, altitude with Conti IoT Device.	*6*	*yes*	*#9* *#10*	*Conti IoT device ready for the trialse.* *Conti IoT device data available for* ***KPIs 1-10****.*
Use of LCMM by running vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Parallel use of GLOSA platoon for traffic light forecast during trip.	*6*	*yes*	*#12*	*LCMM ready for trials.* *LCMM data for* ***KPIs 1-12*** *available* *GLOSA ready for trials.* *GLOSA data*

				*available for **KPIs 1-12** within platoon mode for KPIs 5,6,9,10.*
Use of Mobileum to measure 5G Bandwidth and Latency during vehicle trips at TAVF	*6*	*yes*	*#13* *#14*	*Mobileum tool setup ready for trials. Cellular data available for **KPIs 13,15,16**.*
Use of Entruck during vehicle trip, collection of position data, overview of results on Entruck Online.	6	yes	#15 #16	Entruck and Skylark ready for trials. Data available for KPIs **1-12** and **14**

Table 2: Test results LL Hamburg

4.3 LL KOPER

The Koper Living Lab targets the implementation of novel 5G technologies which include MANO-based services and network orchestration, Industrial IoT, AI/ML-based video analytics, drone-based security monitoring and cutting-edge prototypes tailored to be operated in the port environment. New 5G technologies tailored to the needs of the port will be tested in trials through several use cases that have already been defined in D1.1. In UC1 Management and Network Orchestration platform (MANO), we primarily address 5G-LOGINNOV MANO architecture and its cloud extensions that will be used for demonstration of automated deployment and life cycle management of a network and applications operated in a 5G-enabled port environment targeting on Industrial IoT applications. Use case 5 - Automation for Ports: Port Control, Logistics and Remote Automation will primarily target Industry 4.0 related port operation with a focus on scenarios related to port control, logistics and remote automation using advanced AI/ML based video processing techniques. Secondly, port equipment monitoring and remote telemetry (supported by the 5G mMTC) will be performed for operating machines. As part of the use case 6 - Mission Critical Communications in Ports, a real-time video surveillance will be implemented using 5G-enabled body-worn cameras carried by security personnel to support their regular and mission critical operations and to provide additional personnel security. In addition, automated and coordinated drone-based surveillance will be implemented for extended ad-hoc video surveillance support, where 5G network will be used to transfer video streams in real time into the port Security Operation Centre. To complement video-based security operations an automated detection of objects, vehicles and personnel movement in a specific port area will be targeted using ML and AI based video analytics.

Trials in Koper Living Lab focuses on 5G use cases, through which we will stress two flavors of the 5G network - private 5G SA and public 5G NSA network. 5G network will be based on the 5G NR NSA architecture deployed over the commercial mobile infrastructure and 5G NR SA deployed over the private 5G infrastructure. The NR NSA radio access network will consist of two base station sites. To support strict port security requirements, commercial Mobile Network Operator (MNO) infrastructure will be extended with Edge Computing capabilities that will assure smart routing of the port-related network services and applications traffic directly to the operations support systems of the Koper LL. In addition to commercial MNO services, the private 5G mobile network with dedicated cloud infrastructure will be built and tailored to the needs of port operation and targeted UCs.

In the following, we define procedures, test strategy, test cases planning and results of trials.

LL_Koper_Storyboard_#1
MANO 5G IoT addressed use case(s): UC #1 related KPIs: K-KPI1, K-KPI2, K-KPI3, K-KPI4, K-KPI5, K-KPI6
LL_Koper_Storyboard_#2
MANO 5G SA network addressed use case(s): UC #1 related KPIs: K-KPI7, K-KPI8, K-KPI9, K-KPI10, K-KPI11
LL_Koper_Storyboard_#3
5G drive test in Koper LL addressed use case(s): UC #1 related KPIs: K-KPI12, K-KPI13, K-KPI14, K-KPI15, K-KPI16, K-KPI17, K-KPI18
LL_Koper_Storyboard_#4
5G Network continuous testing in Koper LL (using qMON) addressed use case(s): UC #1 related KPIs: K-KPI12, K-KPI13, K-KPI14, K-KPI15, K-KPI16, K-KPI17, K-KPI18
LL_Koper_Storyboard_#5
Conti IoT device data collection addressed use case(s): UC #5 related KPIs: K-KPI25, K-KPI26, K-KPI27, K-KPI28, K-KPI29
LL_Koper_Storyboard_#6

Optical Character Recognition of container markings and Container Damage Detection (Koper LL) addressed use case(s): UC #5 related KPIs: K-KPI19, K-KPI20
LL_Koper_Storyboard_#7
Drone and body worn camera-based video streaming addressed use case(s): UC #6 related KPIs: subjective metrics apply here only
LL_Koper_Storyboard_#8
AI/ML based video analytics addressed use case(s): UC #6 related KPIs: K-KPI21, K-KPI22, K-KPI23

Table 8: LL_Koper_Storyboards Overview

The LL Koper has defined the following KPIs (Table 7) which will be measured during the trials and are aligned with the above listed storyboards (further details are available in deliverables D3.1 and D1.4).

KPI ID	KPI	Targeted values	
K-KPI1	Components Onboarding and Configuration (Backend)	5 min (per single component)	Elapsed time from the beginning of component configuration and onboarding process via the orchestrator until the components are ready to deploy
K-KPI2	Deployment Time (Backend)	15 min	Elapsed time from the moment the deployment is started via the orchestrator until the system is ready to use
K-KPI3	Time to Scale (Backend)	5 min	Elapsed time from the moment the scaling request is triggered until the component is scaled and ready to use
K-KPI4	Service Availability (Backend)	99,99 %	Percentage of successful connection tests (RTT)/ service tests (WEB) to the reference service endpoint over a period of time
K-KPI5	Components Onboarding and Configuration (Agent)	3 min (per single component)	Elapsed time from the beginning of component configuration and onboarding process via the orchestrator until the components are ready to deploy
K-KPI6	Deployment Time (Agent)	5 min	Elapsed time from the moment the deployment is started via the orchestrator until the system is ready to use
K-KPI7	Components Onboarding and Configuration (Backend)	10 min (per single component)	Elapsed time from the beginning of component configuration and onboarding process via the orchestrator until the components are ready to deploy
K-KPI8	Deployment Time (Backend)	20 min	Elapsed time from the moment the deployment is started via the orchestrator until the system is ready to use

K-KPI9	Time to Scale (Backend)	10 min	Elapsed time from the moment the scaling request is triggered until the component is scaled and ready to use
K-KPI10	Service Availability (Backend)	99,99 %	Percentage of successful connection tests (RTT)/ service tests (WEB) to the reference service endpoint over a period of time
K-KPI11	Slice Reconfiguration (Backend)	5 min	Elapsed time from the moment the slice reconfiguration is requested until the slice is reconfigured and ready to use
K-KPI12	Area Traffic Capacity	Area is approximately 25715 m^2, DL average is 650 Mbps, Throughput is 25,28 Kbps/m^2	The total traffic throughput served per geographic area (in bps/m^2)
K-KPI13	Availability	99,90 %	Percentage of successful connection tests (RTT)/ service tests (WEB) to the reference service endpoint over a period of time
K-KPI14	Bandwidth	Downlink: 800 Mbps Uplink: 150 Mbps (5G NSA 2600Mhz @20Mhz)	Maximum TCP/IP uplink and downlink bandwidth measured from the end user device on 5G RAN to the reference server located in 5G core
K-KPI15	Connection Density	2-10/m^2	The total number of connected and/or accessible devices per unit area (per km^2)
K-KPI16	Coverage Area Probability	~99 %	The percentage (%) of the area under consideration, in which a service is provided by the mobile radio network to the end user in a quality (i.e. data rate, latency, packet loss rate) that is sufficient for the intended application
K-KPI17	End-to-End Latency	Less than 30ms under normal conditions	Measured round trip time (RTT) from the moment the IP ICMP Echo Request packet leaves the source host until the IP ICMP Echo Reply is received from the destination host
K-KPI18	Reliability	Higher than 99,9 % under normal conditions	The percentage (%) of the amount of sent network layer packets successfully delivered to a given system node (incl. the UE) within the time constraint required by the targeted service, divided by the total number of sent network layer packets
K-KPI19	Model accuracy/reliability		Ratio of success of the computer vision model for detection of

		damages in containers. This ratio will consider false positives, false negatives and true positives, using for this evaluation a set of annotated images that will be considered as the ground truth. The use of 5G will allow the transmitted images to have a higher quality, which will be reflected in a greater precision of the detection model, comparing with the previous schema
K-KPI20	Model Inference Time	Time to analyse each image, related to K-KPI19. Using 5G will allow higher band width, so the transmitted images will not need so high compression rates, which will lead into easier compression / decompression algorithms and lower global inference times for each image
K-KPI21	Model accuracy/reliability	Ratio of success of the computer vision model for detection of people/vehicles not authorised in risk areas. This ratio will consider false positives, false negatives and true positives, using for this evaluation a set of annotated images that will be considered as the ground truth. The use of 5G will allow the transmitted images to have a higher quality, which will be reflected in a greater precision of the detection model, comparing with the previous schema
K-KPI22	Model Inference Time	Time to analyse each image, related to K-KPI21. Using 5G will allow higher band width, so the transmitted images will not need so high compression rates, which will lead into easier compression / decompression algorithms and lower global inference times for each image
K-KPI23	Model accuracy/reliability	Accuracy of the vehicle counting and vehicle model detection
K-KPI24	Model Inference Time	Time to analyse each image, related to K-KPI23. Using 5G will allow higher band width, so the transmitted images will not need so high compression rates, which will lead into easier compression / decompression algorithms and lower global inference times for each image
K-KPI25	Time Trucks Parked in the Area	Measure the amount of time spent by tracked vehicles in fully stopped

		mode (engine off), to determine overall efficiency of use of vehicles
K-KPI26	Truck Speed	Measure the average vehicle speed during vehicle operation
K-KPI27	Truck Acceleration	Measure the vehicle acceleration, based on the information collected from the CAN bus, as well as the GNSS module inside the IoT device. This information can serve as input in improving driving style (with positive impact on fuel consumption), as well as in determining dangerous driving behaviour
K-KPI28	Truck Stand Still Time	Measure the amount of time spent by tracked vehicles in idle mode (engine on, vehicle speed is 0 m/s) , to determine overall efficiency of use of vehicles
K-KPI29	Fuel Consumption	Measure the instantaneous and average fuel consumption, based on information collected from vehicle CAN bus

Table 9: LL_Koper_KPI Overview

4.3.1 TEST STRATEGY & TEST CASES

A general approach on what to test, how to test, what tools to use, and what are expected outcomes is well-defined with storyboards (D3.1), KPIs (D1.4) and test protocols (part of this deliverable). All test cases are divided into pre-test phase and trial phase. The main objective of the pre-test phase is to make sure all components required within a certain test case are in place and integrated accordingly, in order to be able to perform tests as specified by a test protocol. Due to the delayed delivery of certain components, temporarily, provisional components may be used for pre-test phase, but not in trial phase. Test cases should be performed in a real environment which has been previously set up within the Living Lab as described in deployment report (D2.3). It is expected certain modifications/tunings will be needed on components involved in test environment to achieve or overcome expected results (all such modifications should be documented).

As described in test protocols, as many test as possible should be automated and data should be collected in proper manner, therefore data collecting infrastructure is of vital importance and should be regularly monitored. As well, in tests exercising continuous testing, results of data analytics performed on test results also need to be monitored and evaluated regularly in order to make changes in testing environment if required. This way, potential risks can be identified earlier and mitigated accordingly. In test cases performed manually, it is expected majority of potential issues (e.g., illogical, or unexpected results) will be already identified by the knowledgeable person carrying out the test.

Final approval of successfulness of the system under test will be given by comparing results obtained through trials to KPI values set previously in D1.4. In case significant deviation is observed, further explanation will be required.

List of test cases:

Test case	Test case description	Test case type	UC and Storyboard relation

UC1-S1-1 (Koper #1)	Initial 5G IoT System Deployment Automation (collector, reference)	Pre-test, Trial	UC1, Storyboard #1
UC1-S2-1 (Koper #2)	Initial Private 5G System Deployment Automation	Pre-test, Trial	UC1, Storyboard #2
UC1-S3-1 (Koper #3)	Initial 5G Drive test (n7 5G NR, Macro CN)	Pre-test	UC1, Storyboard #3
UC1-S3-2 (Koper #4)	5G Drive test (n7 and n78 5G NR, local CN)	Trial	UC1, Storyboard #3
UC1-S4-1 (Koper #5)	Continuous 5G NSA testing (n7 5G NR, Macro CN)	Pre-test	UC1, Storyboard #4
UC1-S4-2 (Koper #6)	Continuous 5G NSA testing (n7 and n78 5G NR, Macro CN)	Trial	UC1, Storyboard #4
UC1-S4-3 (Koper #7)	Continuous 5G SA testing (n78 5G NR, Local 5G CN)	Pre-test, Trial	UC1, Storyboard #4
UC5-S5-1 (Koper #8)	Collection of position data, including vehicle speed, acceleration, altitude	Pre-test, Trial	UC5, Storyboard #5
UC5-S6-1 (Koper #9)	Optical Character Recognition of container markings and Container Damage Detection	Pre-test, Trial	UC5, Storyboard #6
UC6-S7-1 (Koper #10)	Drone based video streaming	Pre-test, Trial	UC6, Storyboard #7
UC6-S7-2 (Koper #11)	Body worn camera-based video streaming	Pre-test, Trial	UC6, Storyboard #7
UC6-S8-1 (Koper #2)	People and vehicle detection in the controlled area	Pre-test, Trial	UC6, Storyboard #8

Table 8: List of test cases in LL_Koper

4.3.2 TEST CASES PLANNING

In general, complete area of Port of Koper is used for testing and trialling within LL Koper since 5G radio signal should cover the complete area. However, specific test cases like Container OCR and Damage Detection, and Body worn camera-based video streaming, will take place in limited area of interest.

For each test case, a pre-test and then a trial phase is expected. For the time being, majority of pre-test phase tests have been completed. Trials will mainly start in late Q3/2022 (August and September) and in Q4/2022. Due to the delays in procurement procedure (i.e., supply chain issues) some final setups required for trials are not ready yet, which also explains certain significant time gaps in-between end of the pre-test phase and start of the trial phase. As expected, pre-tests and trials related to test cases applying continuous measurements are planned to last more time than event-driven test cases. In any case, all pre-test and trial activities are expected to be completed by the end of February 2023.

As some events to promote and disseminate 5G-LOGINNOV LL Koper activities are also planned in LL Koper in Q4/2022 and in the beginning of 2023 (e.g., Ideathon in cooperation with the Faculty of Maritime Studies and Transport of University of Ljubljana, local stake-holders event), time-plan for certain test cases might be further adapted in order to showcase trials to the interested audience.

4.3.2 TEST RESULTS

The following table summarizes test cases and their preliminary results as achieved during the pre-test phase or tests performed previously in the laboratory environment (see “Test strategy” section for details related to the distinction between the pre-test and trial phase). Test-case-ID is composed as follows: use case ID (e.g., UC1) - storyboard ID (e.g., S1 as storyboard 1) - test enumeration (1, 2, …).

Description	# Iterations (pre-test)	successful	# Test protocol(s)	Comments
Initial 5G IoT System Deployment Automation (collector, Reference server)	3	yes	UC1-S1-1	5G IoT system successfully deployed in lab environment and ready for the pre-test in LL environment.
Initial Private 5G System Deployment Automation	3	yes	UC1-S2-1	Private 5G System deployed and ready for the trial phase
Initial 5G Drive test (n7 5G NR, Macro CN)	1	yes	UC1-S3-1	Initial drive test performed, results expected, setup ready for the trial phase.
5G Drive test (n7 and n78 5G NR, local CN)			UC1-S3-2	This is trial phase test only – continuation of pre-test UC1-S3-1.
Continuous 5G NSA testing (n7 5G NR, Macro CN)	2 months of continuous testing	yes	UC1-S4-1	Pre-test procedure and results do not show any significant anomalies. Ready for the trial phase.
Continuous 5G NSA testing (n7 and n78 5G NR, Macro CN)			UC1-S4-2	This is trial phase test only – continuation of pre-test UC1-S4-1.
Continuous 5G SA testing (n78 5G NR, Local 5G CN)	2 months of continuous testing	yes	UC1-S4-3	Pre-test procedure and results do not show any significant anomalies. Ready for the trial phase.
Collection of position data, including vehicle speed, acceleration, altitude	3 months of regular testing	yes	UC5-S5-1	Pre-test procedure and results allow for the trial phase to start.
Optical Character Recognition of container markings and Container Damage Detection	10	yes	UC5-S6-1	Objects (incl. text and IMDG label) successfully recognized, ready for the trial phase
Drone based video streaming	1 day of pre-testing	yes	UC6-S7-1	Ready for the trial phase.
Body worn camera-based video streaming	1 day of pre-testing	yes	UC6-S7-2	Ready for the trial phase.
People and vehicle detection in the controlled area	10	yes	UC6-S8-1	Objects successfully detected, ready for the trial phase.

Table 9: Pre-test results and comments for LL Koper test cases

ANNEX 1:

LL Athens

Test Protocol Athens#1A

Date: September 2022 – November 2022

Test case type: pre-Test and Trial

Tested by: ICCS, PCT

Test scenario: 5G NSA testing (n78 5G NR)

<table>
<tr><td colspan="2">Testcase: #1A (Athens_Storyboard_#1a) – Based on Koper testcase id: UC1-S4-1</td></tr>
<tr><td colspan="2">Short description: 5G NSA testing (n78 5G NR). Cross collaboration activity with Koper LL, exploiting ININ’s qMNO monitoring system as a common reference architecture for measuring 5G KPIs in Athens LL.</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G NSA Network, gNB with n78 band, qMON system, qMON agents, qMON reference server</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS, PCT</td></tr>
<tr><td>Prerequisites</td><td>5G NSA Network, gNB with n78 band, qMON system, qMON agents, qMON reference server</td></tr>
<tr><td>Necessary test data</td><td>N/A</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a selected location.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. stationary test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
<tr><td>Step 4</td><td>Check if log files with test results were received on qMON Collector.</td><td>Log files are received on the qMON Collector storage server.</td></tr>
<tr><td>Step 5</td><td>Check if test results are visible in qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
<tr><td>Step 6</td><td>Proceed with the continuous testing for the defined time span.</td><td>qMON Agent is running continuously and test results are collected .</td></tr>
<tr><td>Step 7</td><td>Stop the qMON Agent.</td><td>qMON Agent application is not running.</td></tr>
</table></td></tr>
</table>

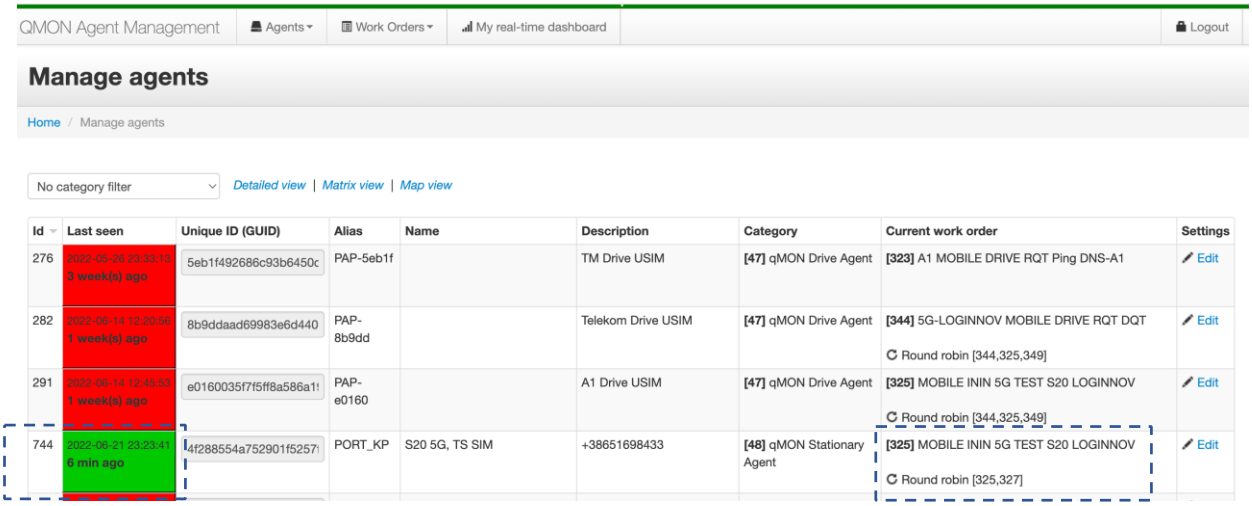
	Step 8	**Verify test results in the qMON Analytics.**	**KPI results with expected values are visible on the qMON Analytics.**	
Expected result	As part of 5G network testing exploiting qMON monitoring platform the 5G KPIs will be collected.			

Test Result

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):



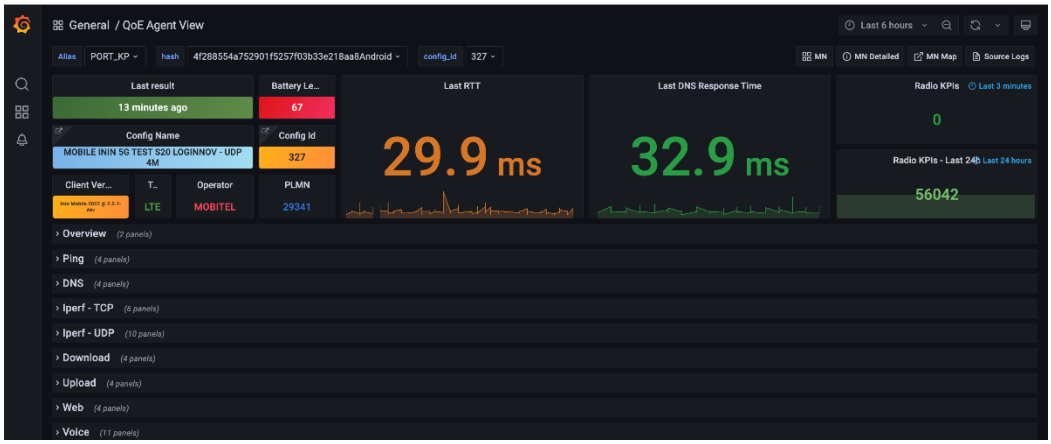
Log files on qMON Collector (step 4) – expected results (UI):

Index of /upload_log/4f288554a752901f5257f03b33e218aa8Android

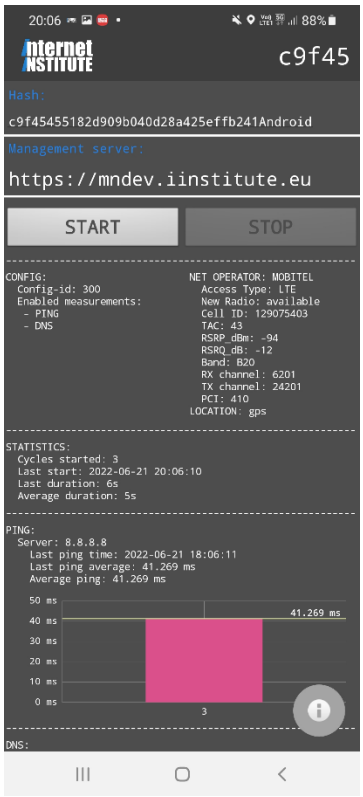
Name	Last modified	Size	Description
Parent Directory		-	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_21-23-38.txt	2022-06-21 21:27	173K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_21-17-54.txt	2022-06-21 21:23	221K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_21-03-40.txt	2022-06-21 21:07	173K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-57-55.txt	2022-06-21 21:03	228K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-43-37.txt	2022-06-21 20:47	171K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-37-51.txt	2022-06-21 20:43	206K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-23-36.txt	2022-06-21 20:27	174K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-17-48.txt	2022-06-21 20:23	207K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-03-34.txt	2022-06-21 20:07	139K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_19-55-05.txt	2022-06-21 20:03	126K	


```
2022-06-21 21:27:33 - INFO - ----------CUSTOM PLUGIN MEASUREMENT----------
2022-06-21 21:27:33 - INFO - Custom Plugin Measurement not enabled.
2022-06-21 21:27:33 - INFO - ---------- VOICE MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Voice Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------SMS MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Sms Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------TCPDUMP----------
2022-06-21 21:27:33 - INFO - TCPDUMP is not alive.
2022-06-21 21:27:33 - INFO - ----------XML START----------
<root>
   <Id agent_id_numeric="744" created_on="Tue 21 Jun 2022 21:27:33 GMT (Greenwich Mean Time)" revision="25" configuration_name="MOBILE ININ 5G TEST S20 LOGINNOV"
configuration_desc="MOBILE APP STATIONARY TEST" category_id="48" category_name="qMON Stationary Agent" agent_descripton="+38651698433" agent_info_technology="LTE"/>
   <Global_data aliasHash="PORT_KP" apn="internet" client_version="InIn Mobile 2022 @ 2.0.1-dev" config_id="325" cycle_id="1655846618374000"
hash="4f288554a752901f5257f03b33e218aa8Android" mobile_mode="1" os_name="Android" os_version="11" wo_duration="234" modem_temperature="53" cpu_temperature="43"
battery_temperature="41" battery_level="67.0" battery_status="3"/>
   <Measurement client_ip="178.58.54.102" client_ipv4_for_geoloc="178.58.54.102" target_ip="89.143.198.178" packet_size_bytes="64" interval_between_icmp_packets_ms="100"
timestamp="2022-06-21 21:26:37" ip_version="4" type="ping_test" first_hop_rtt_ms="-1" traceroute="*;*;213.229.192.209;*;*;*;*;*;*;*;*;*;*" traceroute_duration="42.154"
client_start_gps_latitude="45.549640020213275" client_start_gps_longitude="13.735982276002291" client_start_gps_altitude="45.728174883622714"
client_start_gps_speed_over_ground_knots="0.0" client_start_gps_timestamp="1655846796018" client_start_gps_num_sats="12" client_stop_gps_latitude="45.549640020213275"
client_stop_gps_longitude="13.735982276002291" client_stop_gps_altitude="45.728174883622714" client_stop_gps_speed_over_ground_knots="0.0" client_stop_gps_timestamp="1655846797025"
client_stop_gps_num_sats="12" radio_access_type_start="LTE" radio_cell_id_start="155597002" radio_tac_start="42" radio_rsrq_db_start="-11" radio_rsrp_dbm_start="-110"
radio_net_operator_start="MOBITEL" radio_operator_code_start="29341" radio_lte_rx_channel_start="6201" radio_lte_tx_channel_start="24201" radio_lte_band_start="B20"
radio_lte_pci_start="139" radio_rssi_dbm_start="-86" radio_emm_connection_start="CONNECTED" radio_sinr_db_start="8" radio_tx_power_dbm_start="2" radio_lte_bw_mhz_start="10"
radio_lte_ca_state_start="ADDED" radio_lte_dl_mcs_1_start="2" radio_lte_dl_mcs_2_start="0" radio_lte_ul_mcs_1_start="6" radio_lte_rb_dl_start="0" radio_lte_rb_ul_start="3"
radio_lte_max_rb_dl_start="50" radio_lte_max_rb_ul_start="40" radio_lte_sc_num_start="1" radio_lte_scell_band_start="B7" radio_lte_scell_bw_mhz_start="15"
radio_lte_scell_rx_channel_start="3023" radio_lte_pcc_rxm_RSRP_dbm_start="-102" radio_access_type_stop="LTE" radio_cell_id_stop="155597002" radio_tac_stop="42"
radio_rsrq_db_stop="-11" radio_rsrp_dbm_stop="-110" radio_net_operator_stop="MOBITEL" radio_operator_code_stop="29341" radio_lte_rx_channel_stop="6201"
radio_lte_tx_channel_stop="24201" radio_lte_band_stop="B20" radio_lte_pci_stop="139" radio_rssi_dbm_stop="-86" radio_emm_connection_stop="CONNECTED" radio_sinr_db_stop="8"
radio_tx_power_dbm_stop="2" radio_lte_bw_mhz_stop="10" radio_lte_ca_state_stop="ADDED" radio_lte_dl_mcs_1_stop="2" radio_lte_dl_mcs_2_stop="0" radio_lte_ul_mcs_1_stop="6"
radio_lte_rb_dl_stop="0" radio_lte_rb_ul_stop="3" radio_lte_max_rb_dl_stop="50" radio_lte_max_rb_ul_stop="40" radio_lte_sc_num_stop="1" radio_lte_scell_band_stop="B7"
radio_lte_scell_bw_mhz_stop="15" radio_lte_scell_rx_channel_stop="3023" radio_lte_pcc_rxm_RSRP_dbm_stop="-102">
      <rtt_ms status="Success" status_code="0" sequence_number="1">42.6</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="2">14.5</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="3">30.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="4">29.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="5">29.9</rtt_ms>
   </Measurement>
```


qMON analytics (step 5) – expected results (UI):



qMON Agent status on the Android app (step 7) – expected results (UI):



qMON Analytics (step 8) – expected results (UI):

Error Description if test negative

NA

Proposal Solution if test negative

NA

Test Protocol Athens#1B

Date: September 2022 – November 2022

Test case type: pre-Test and Trial

Tested by: ICCS, PCT

Test scenario: 5G NSA vehicle drive test (n78 5G NR)

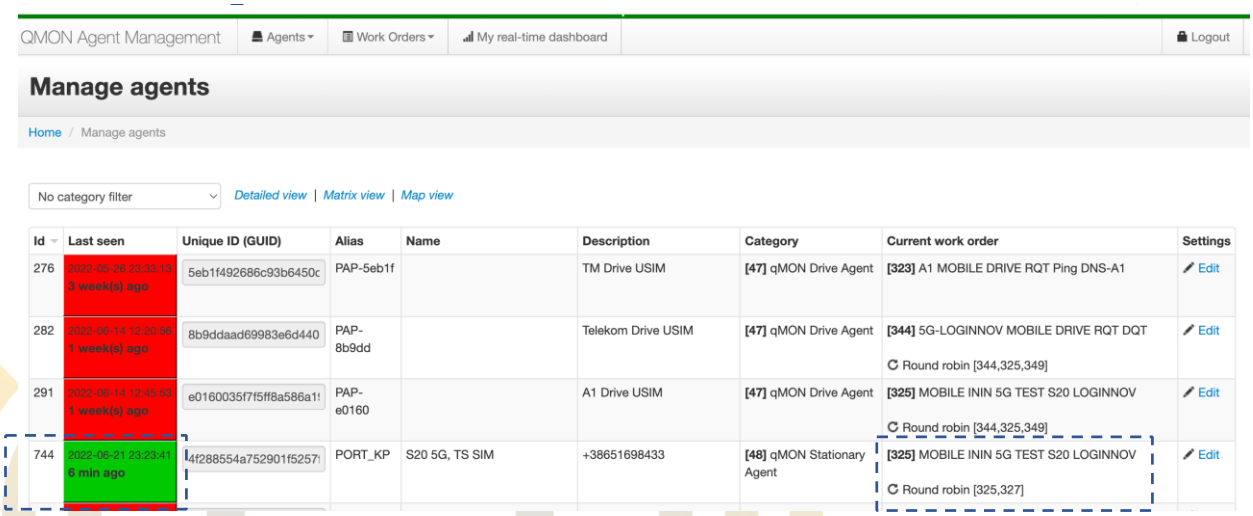
<table>
<tr><td colspan="2">Testcase: #1B (Athens_Storyboard_#1b) – Based on Koper testcase id: UC1-S3-1</td></tr>
<tr><td colspan="2">Short description: 5G NSA vehicle drive test (n78 5G NR). Cross collaboration activity with Koper LL, exploiting ININ’s qMON monitoring system as a common reference architecture for performing a 5G drive test within the port terminal in Athens LL.</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G NSA Network, gNB with band 78, qMON system, qMON agents, qMON reference server, test vehicle</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS, PCT</td></tr>
<tr><td>Prerequisites</td><td>5G NSA Network, gNB with n78 band, qMON system, qMON agents, qMON reference server, Deployed qMON Agents in the test vehicle</td></tr>
<tr><td>Necessary test data</td><td>N/A</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a vehicle.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. drive test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
<tr><td>Step 4</td><td>Check if log files with test results were received on qMON Collector.</td><td>Log files are received on the qMON Collector storage server.</td></tr>
<tr><td>Step 5</td><td>Check if test results are visible in qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
<tr><td>Step 6</td><td>Proceed with the drive test using selected route/area in the port.</td><td>Driving with the vehicle in the selected LL area.</td></tr>
<tr><td>Step 7</td><td>Stop the qMON Agent.</td><td>qMON Agent application is not running.</td></tr>
<tr><td>Step 8</td><td>Verify test results in the qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
</table></td></tr>
<tr><td>Expected result</td><td>As part of 5G network testing exploiting qMON monitoring platform the 5G KPIs will be collected.</td></tr>
</table>

Test Result (including Screenshots, Photos etc.)

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):



Log files on qMON Collector (step 4) – expected results (UI):

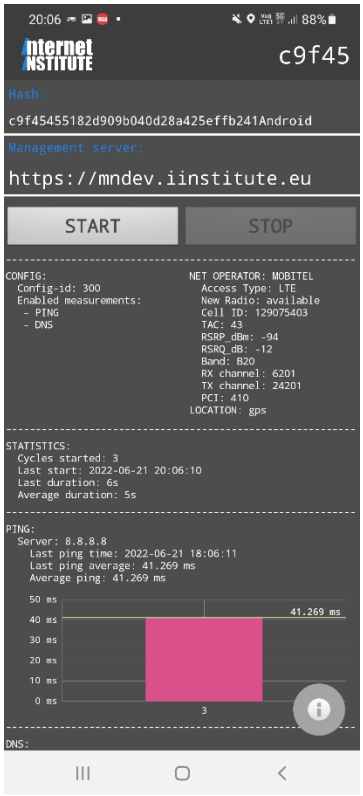
Index of /upload_log/4f288554a752901f5257f03b33e218aa8Android

Name	Last modified	Size	Description
Parent Directory		-	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_21-23-38.txt	2022-06-21 21:27	173K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_21-17-54.txt	2022-06-21 21:23	221K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_21-03-40.txt	2022-06-21 21:07	173K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-57-55.txt	2022-06-21 21:03	228K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-43-37.txt	2022-06-21 20:47	171K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-37-51.txt	2022-06-21 20:43	206K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-23-36.txt	2022-06-21 20:27	174K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-17-48.txt	2022-06-21 20:23	207K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_20-03-34.txt	2022-06-21 20:07	139K	
Log_4f288554a752901f5257f03b33e218aa8Android_2022-06-21_19-55-05.txt	2022-06-21 20:03	126K	


```
2022-06-21 21:27:33 - INFO - ----------CUSTOM PLUGIN MEASUREMENT----------
2022-06-21 21:27:33 - INFO - Custom Plugin Measurement not enabled.
2022-06-21 21:27:33 - INFO - --------------- VOICE MEASUREMENT ---------------
2022-06-21 21:27:33 - INFO - Voice Measurement not enabled.
2022-06-21 21:27:33 - INFO - -------------------SMS MEASUREMENT ---------------
2022-06-21 21:27:33 - INFO - Sms Measurement not enabled.
2022-06-21 21:27:33 - INFO - ---------------TCPDUMP----------------------------
2022-06-21 21:27:33 - INFO - TCPDUMP is not alive.
2022-06-21 21:27:33 - INFO - ---------------XML START----------------------------
<root>
   <Id agent_id_numeric="744" created_on="Tue 21 Jun 2022 21:27:33 GMT (Greenwich Mean Time)" revision="25" configuration_name="MOBILE ININ 5G TEST S20 LOGINNOV"
configuration_desc="MOBILE APP STATIONARY TEST" category_id="48" category_name="qMON Stationary Agent" agent_descripton="+38651698433" agent_info_technology="LTE"/>
   <Global_data aliasHash="PORT_KP" apn="internet" client_version="InIn Mobile 2022 @ 2.0.1-dev" config_id="325" cycle_id="1655846618374000"
hash="4f288554a752901f5257f03b33e218aa8Android" mobile_mode="1" os_name="Android" os_version="11" wo_duration="234" modem_temperature="53" cpu_temperature="43"
battery_temperature="41" battery_level="67.0" battery_status="3"/>
   <Measurement client_ip="178.58.54.102" client_ipv4_for_geoloc="178.58.54.102" target_ip="89.143.198.178" packet_size_bytes="64" interval_between_icmp_packets_ms="100"
timestamp="2022-06-21 21:26:37" ip_version="4" type="ping_test" first_hop_rtt_ms="-1" traceroute="*;*;213.229.192.209;*;*;*;*;*;*;*;*;*;*" traceroute_duration="42.154"
client_start_gps_latitude="45.549640020213275" client_start_gps_longitude="13.735982276002291" client_start_gps_altitude="45.728174883622714"
client_start_gps_speed_over_ground_knots="0.0" client_start_gps_timestamp="1655846796018" client_start_gps_num_sats="12" client_stop_gps_latitude="45.549640020213275"
client_stop_gps_longitude="13.735982276002291" client_stop_gps_altitude="45.728174883622714" client_stop_gps_speed_over_ground_knots="0.0" client_stop_gps_timestamp="1655846797025"
client_stop_gps_num_sats="12" radio_access_type_start="LTE" radio_cell_id_start="155597002" radio_tac_start="42" radio_rsrq_db_start="-11" radio_rsrp_dbm_start="-110"
radio_net_operator_start="MOBITEL" radio_operator_code_start="29341" radio_lte_rx_channel_start="6201" radio_lte_tx_channel_start="24201" radio_lte_band_start="B20"
radio_lte_pci_start="139" radio_rssi_dbm_start="-86" radio_emm_connection_start="CONNECTED" radio_sinr_db_start="8" radio_tx_power_dbm_start="2" radio_lte_bw_mhz_start="10"
radio_lte_ca_state_start="ADDED" radio_lte_dl_mcs_1_start="2" radio_lte_dl_mcs_2_start="0" radio_lte_ul_mcs_1_start="6" radio_lte_rb_dl_start="0" radio_lte_rb_ul_start="3"
radio_lte_max_rb_dl_start="50" radio_lte_max_rb_ul_start="40" radio_lte_sc_num_start="1" radio_lte_scell_band_start="B7" radio_lte_scell_bw_mhz_start="15"
radio_lte_scell_rx_channel_start="3023" radio_lte_pcc_rxm_RSRP_dbm_start="-102" radio_access_type_stop="LTE" radio_cell_id_stop="155597002" radio_tac_stop="42"
radio_rsrq_db_stop="-11" radio_rsrp_dbm_stop="-110" radio_net_operator_stop="MOBITEL" radio_operator_code_stop="29341" radio_lte_rx_channel_stop="6201"
radio_lte_tx_channel_stop="24201" radio_lte_band_stop="B20" radio_lte_pci_stop="139" radio_rssi_dbm_stop="-86" radio_emm_connection_stop="CONNECTED" radio_sinr_db_stop="8"
radio_tx_power_dbm_stop="2" radio_lte_bw_mhz_stop="10" radio_lte_ca_state_stop="ADDED" radio_lte_dl_mcs_1_stop="2" radio_lte_dl_mcs_2_stop="0" radio_lte_ul_mcs_1_stop="6"
radio_lte_rb_dl_stop="0" radio_lte_rb_ul_stop="3" radio_lte_max_rb_dl_stop="50" radio_lte_max_rb_ul_stop="40" radio_lte_sc_num_stop="1" radio_lte_scell_band_stop="B7"
radio_lte_scell_bw_mhz_stop="15" radio_lte_scell_rx_channel_stop="3023" radio_lte_pcc_rxm_RSRP_dbm_stop="-102">
      <rtt_ms status="Success" status_code="0" sequence_number="1">42.6</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="2">14.5</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="3">30.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="4">29.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="5">29.9</rtt_ms>
   </Measurement>
```


qMON analytics (step 5) – expected results (UI):

qMON Agent status on the Android app (step 7) – expected results (UI):



qMON Analytics (step 8) – expected results (UI):

Error Description if test negative

NA

Proposal Solution if test negative

NA

Test Protocol Athens#2

Date: 1st and 2nd week of April 2022

Test case type: pre-test (technical)

Tested by: ICCS

Test scenario: NFV MANO platform

<table>
<tr><td colspan="2">Testcase: #2</td></tr>
<tr><td colspan="2">Short description: NFV-MANO service orchestration of AI-enabled services with 5G network support for lifecycle management operations of various service components, targeting logistics, security and safety applications. The MANO orchestration platform will support use cases 3, 4 and 5.</td></tr>
<tr><td colspan="2">App./Infrastructure: Cellular network, Opensource MANO, Kubernetes cluster, Kubernetes network functions (KNFs) for AI/ML components, edge compute nodes deployment, 4K cameras deployment</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS, PCT</td></tr>
<tr><td>Prerequisites</td><td>Cellular network, Opensource MANO, Kubernetes cluster, Kubernetes network functions (KNFs) for AI/ML components, edge compute nodes deployment, 4K cameras deployment</td></tr>
<tr><td>Necessary test data</td><td>N/A</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start Opensource MANO</td><td>Opensource MANO platform ready for AI/ML service orchestration</td></tr>
<tr><td>Step 2</td><td>Start Kubernetes cluster</td><td>Kubernetes virtualized infrastructure manager (VIM) ready</td></tr>
<tr><td>Step 3</td><td>Establish cellular communication with the edge compute nodes for data plane (e.g., video streaming) and control plane (orchestration of the service components, e.g., AI services) communication</td><td>Compute nodes are active and ready to receive workloads</td></tr>
<tr><td>Step 4</td><td>Deploy Opensource MANO and Kubernetes manifests for Use Case 3</td><td>Activate 5G&AI-enabled rapid alert system components for yard trucks collision avoidance service</td></tr>
<tr><td>Step 5</td><td>Deploy Opensource MANO and Kubernetes manifests for Use Case 4</td><td>Activate 5G&AI-enabled far-edge computing service for human presence detection service</td></tr>
<tr><td>Step 6</td><td>Deploy Opensource MANO and Kubernetes manifests for Use Case 5</td><td>Activate 5G&AI-enabled far-edge computing service for container seal detection</td></tr>
<tr><td>Step 7</td><td>Methodology validation for KPI data collection for Use Cases 3, 4 and 5</td><td>Data for relevant KPIs are collected successfully</td></tr>
</table>
</td></tr>
</table>

Expected result	NFV-MANO service orchestration platform validated and ready to use: the orchestrator delivers the necessary components that compose the system and services for use cases 3, 4 and 5 successfully, including also validation of the methodology for KPI data collection.

Test Result

Expected result: service orchestration to edge compute nodes successful. Input video from cameras is delivered to the containerized functions delivering the AI services for use cases 3, 4 and 5. Expected trial local data collection procedures are validated. Particularly, as already noted, the NFV-MANO platform (**Fehler! Verweisquelle konnte nicht gefunden werden.**) supports the operation of Use Cases 3, 4 and 5 based on the provisioned manifests (**Fehler! Verweisquelle konnte nicht gefunden werden.**, *Figure 13*). Relevant UIs (**Fehler! Verweisquelle konnte nicht gefunden werden.**), databases (**Fehler! Verweisquelle konnte nicht gefunden werden.**), streaming servers, monitoring system, alert generation system, AI/ML inference results and data collections procedures are controlled by the services and deployed through the platform. For more details, please refer to D2.3.

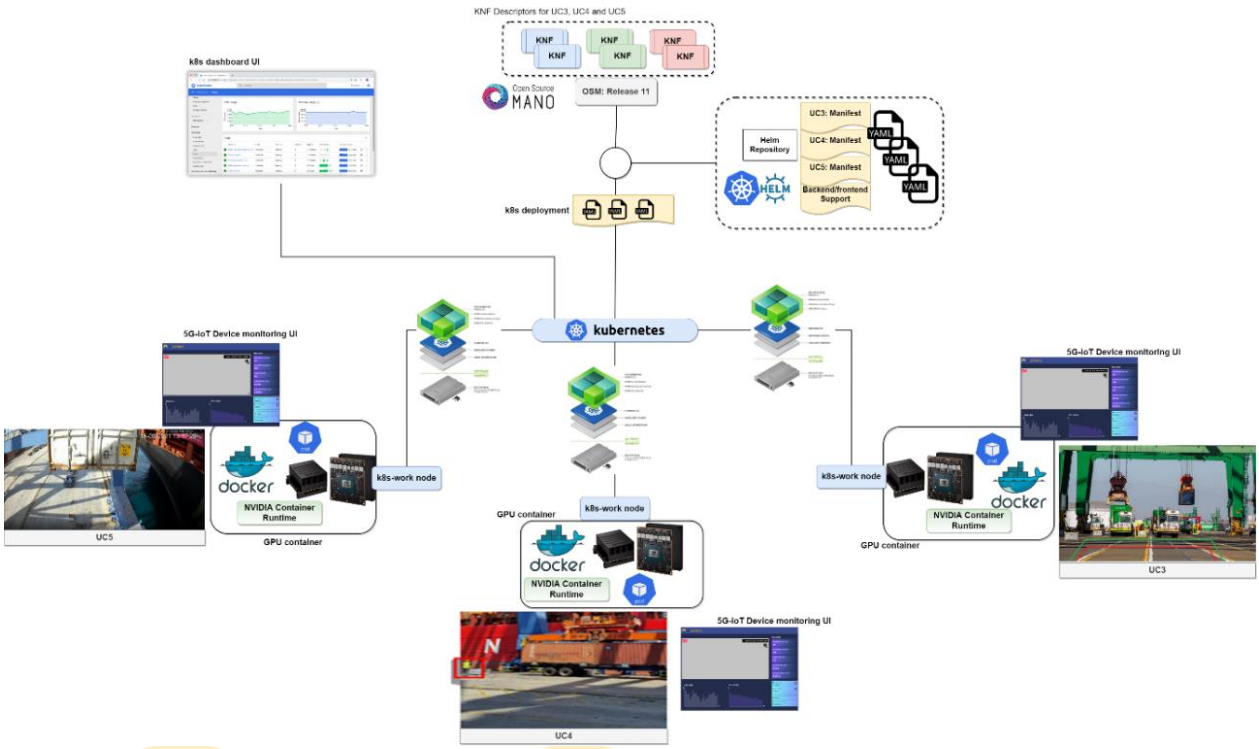


Figure 11 NFV-MANO Platform

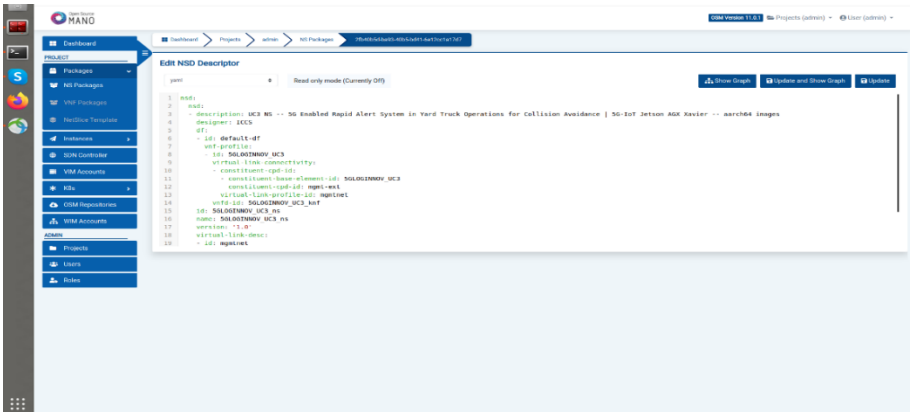


Figure 12 UC3 NSD Descriptor file

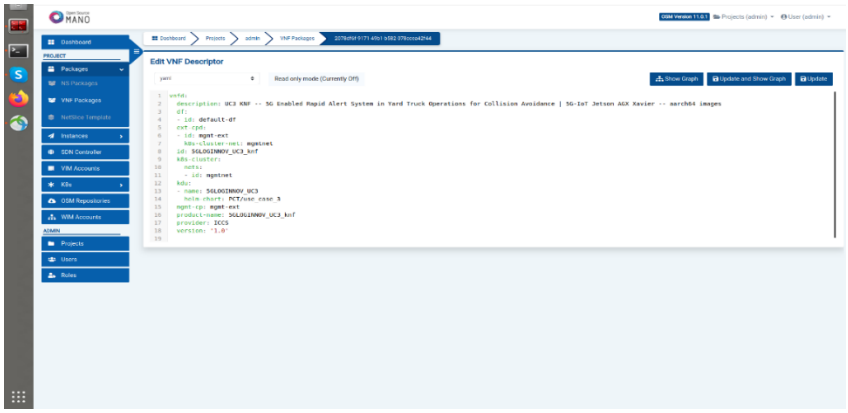


Figure 13 UC3 KNF descriptor file

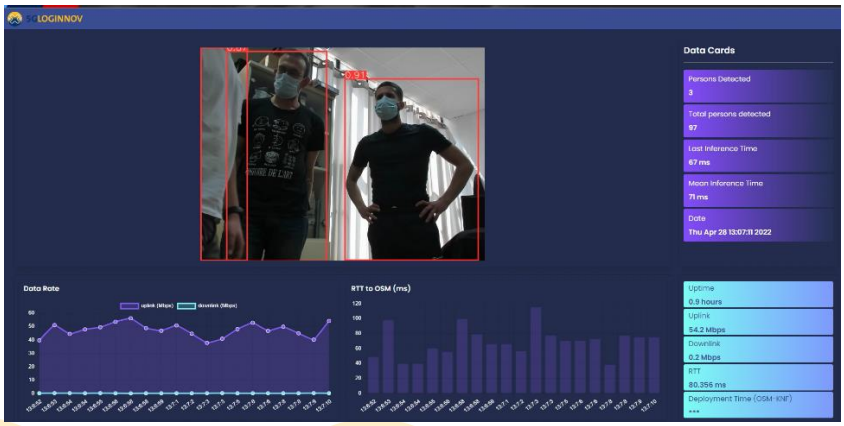


Figure 14: Frontend user interface tailored for human presence detection use case

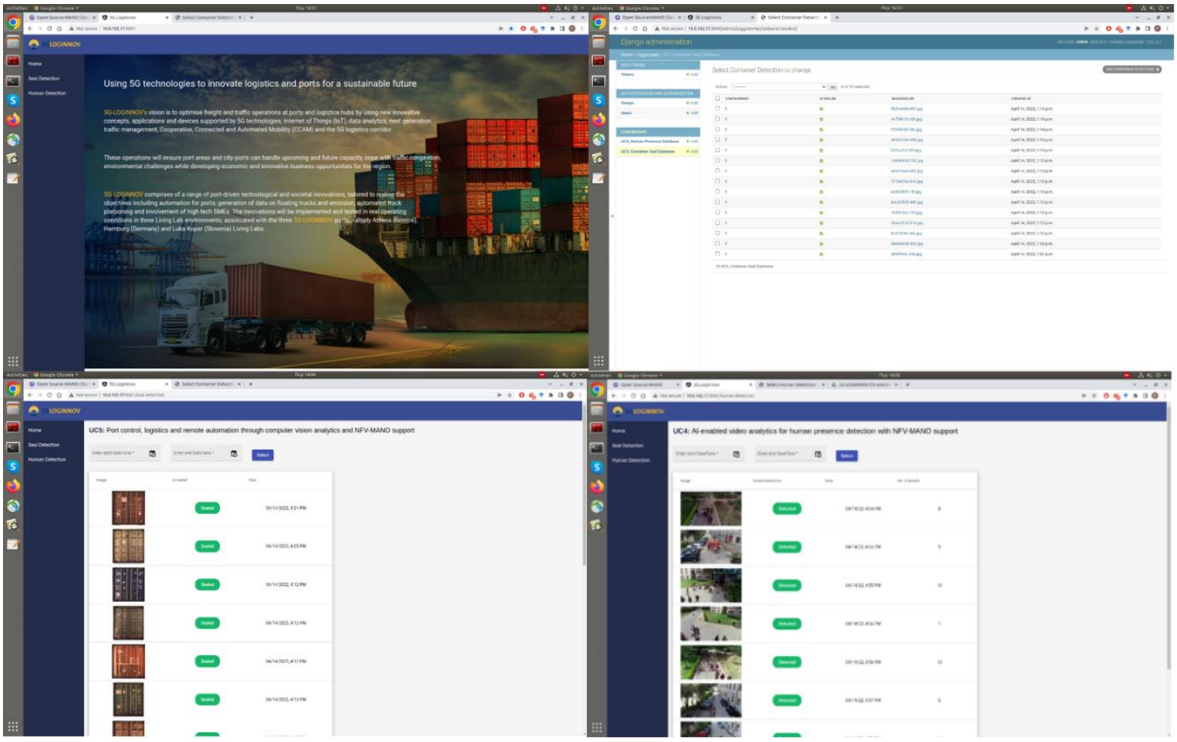


Figure 15: Database collecting AI inferenced frames for service evaluation and service monitoring

Error Description if test negative

Test was successful, no errors.

Proposal Solution if test negative

N/A

Test Protocol Athens#3

Date: November - December 2021

Test case type: test and trial

Tested by: ICCS, PCT

Test scenario: 5G&AI Enabled Rapid Alert System in Yard Truck Operations for Collision Avoidance

<table>
<tr><td colspan="2">Testcase: #3</td></tr>
<tr><td colspan="2">Short description: The current trial will focus in Use Case 3: “5G Enabled Rapid Alert System in Yard Truck Operations for Collision Avoidance”, and will demonstrate the collision avoidance service between 5G trucks and personnel. A 4K camera is deployed on the 5G LOGINNOV truck, oriented to a particular field of view (i.e., a driver’s blind spot). Additionally, a 5G router is equipped on the truck establishing cellular communication between the truck and the edge computing node. The edge node receives the 4K live video feed from the truck over 5G, and the inference engine developed for the collision avoidance service processes the stream. In case of human presence detection in the 5G truck’s proximity the rapid alert delivery system is activated, sending to the truck’s driver the inferenced/annotated video feed of its proximity. For the trials a fixed truck route will be considered, and PCT trained personnel will create “fixed” collision events. The model will be evaluated for its robustness and efficiency under varying light conditions.</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G network, Opensource MANO, Kubernetes, Kubernetes network functions (KNFs) for AI/ML components, edge computing node deployment, 4K camera and 5G router equipped on yard truck</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS, PCT</td></tr>
<tr><td>Prerequisites</td><td>5G network, Opensource MANO, Kubernetes, Kubernetes network functions (KNFs) for AI/ML components, edge computing node deployment, 4K camera and 5G router equipped on yard truck</td></tr>
<tr><td>Necessary test data</td><td>Live 4K video stream captured from the installed camera on truck, capturing video frames of the truck‘s vicinity.</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td colspan="3">Service Initiation</td></tr>
<tr><td>Step 1</td><td>Start Opensource MANO</td><td>Activate Opensource MANO platform for AI/ML service orchestration</td></tr>
<tr><td>Step 2</td><td>Start Kubernetes cluster</td><td>Activate Kubernetes virtualized infrastructure manager (VIM)</td></tr>
<tr><td>Step 3</td><td>Establish 5G communication between the 5G truck and the compute (GPU enabled) node used for the video analytics service</td><td>Compute node and 5G truck are connected and ready to activate the collision avoidance service.</td></tr>
<tr><td>Step 4</td><td>Deploy Opensource MANO and Kubernetes manifests for Use Case 3</td><td>Activating 5G&AI-enabled rapid alert system components for yard trucks collision avoidance service</td></tr>
<tr><td colspan="3">Scenario</td></tr>
</table>
</td></tr>
</table>

	Step 5	5G truck performs a particular route, i.e., moves in a predefined and bounded port area (prioritizing safety of personnel involved in the trials)	The 5G truck follows the predefined route for the trial scenarios.
	Step 6	As the 5G truck is moving in the bounded area, the 4K video feed from the camera's field of view is transmitted to the edge processing node over 5G (uplink)	Send uplink 4K video stream at the GPU enabled compute node over the 5G network
	Step 7	The orchestrated AI model at the edge node processes the live video feed to infer in real time the presence (or absence) of people close to the truck.	Receive and process input video streams for the AI-enabled service at the edge computing node
	Step 8	**Scenario 1: No event detection.** For cases where no person is detected in the truck's vicinity based on the developed AI algorithm's inference, a black screen is illustrated at a tablet installed in the truck's cabin.	No alert, i.e., blank screen is illustrated at the tablet in the truck's cabin
	Step 9	**Scenario 2: Event creation.** Utilize PCT trained personnel, to move inside the trial area (camera's field of view from the truck) and create "fixed" events for the evaluation of the collision avoidance system.	Create fixed events to evaluate the service.
	Step 10	**Scenario 2: Event re-action**. The inference engine delivers over the 5G network (downlink) the 4K inferenced video stream to the tablet installed in the truck's cabin, alerting the driver for potential collision event.	Deliver rapid alerts/video to the yard truck driver for people in vicinity over 5G
	Step 11	Repeat scenarios of steps 8 to 10 in varying light conditions	Get statistical results for the operation of the service
Expected result	Evaluate the efficiency and feasibility of the collision avoidance service		

Test Result and Setup

Scenario setup

The test setup and trials for this use case involves a 5G modem (R5020 5G IoT Router) and a 4K camera (IPC-HFW3841T-ZAS) installed on PCT's yard truck (**Fehler! Verweisquelle konnte nicht gefunden werden.**), as well as a GPU enabled edge computing node receiving over 5G the live 4K stream captured by the truck's camera. In the truck's cabin, a tablet is also installed and will be exploited for the trials.

Figure 16: 4K camera and tablet installed on PCT's yard truck

The trials will demonstrate the AI enabled rapid alert system in two scenarios based on a fixed truck route. In scenario 1 the 5G truck will follow the predefined route where no person will be present. The edge node will receive the uplink 4K video stream in real time, and the developed inference engine will provide no alert, i.e., a black screen is illustrated to the tablet at the 5G truck's cabin, indicating that within the bounding box area, no person is detected according to the developed AI model (**Fehler! Verweisquelle konnte nicht gefunden werden.**, left). In scenario 2, to create a fixed "risk" event, a person will be positioned within the bounding box of the camera's field of view, along the truck's route. The AI model will process the live video feed, detect the person within the bounding box area at the truck's vicinity, and transmit the inferenced 4K video stream (alert) at the tablet in the truck's cabin (**Fehler! Verweisquelle konnte nicht gefunden werden.**, right) over 5G. For more details on the developed service and AI model tailored to the collision avoidance service please refer to D2.3. The model will be evaluated under varying light conditions to evaluate the efficiency and feasibility of the service.

Figure 17: 5G&AI enabled collision alert service

Error Description if test negative

Failure to detect human presence in critical proximity of the truck. This may be due to:

1. Light conditions
2. The fact that in general, object detection algorithms are context- (or background-) aware, in the sense that the background can be expected to affect the algorithms performance. Although most of the time this is not significant, in a safety critical application like the one in hand it should be dully noted
3. Properly determining the bounding boxes whose intersection with human bounding boxes will indicate a 'risk' event is requires a number of trials
4. This is a latency critical application. If the alert is delayed (e.g., due to network conditions, or processing delays) the service will not be feasible as a collision avoidance system

Proposal Solution if test negative

1. Re-training of the human presence detection with more annotated images captured from the specific context, in varying light conditions
2. Re-calibration of the pre-defined, ‘critical’ bounding boxes which determine the notion of the truck’s vicinity as described above
3. Equip a compute node on the truck to employ partial or complete inference service at the locally equipped compute node, to alleviate network delay

Test Protocol Athens#4

Date: July – September 2022

Test case type: test and trial

Tested by: ICCS, PCT

Test scenario: 5G&AI enabled (far-)edge computing service for human presence detection

<table>
<tr><td colspan="2">Testcase: #4</td></tr>
<tr><td colspan="2">Short description: The current trial which concerns Use Case 4: “optimal surveillance cameras and video analytics”, will demonstrate the 5G&AI enabled (far-)edge computing service for human presence detection in high-risk areas, i.e., areas with increased truck traffic and crane operations. A 4K camera is deployed in the area capturing real time events, along with a 5G interface and a GPU enabled edge computing node for processing the live captured video frames and deliver the (far-)edge computing service for human presence detection. The trials will include trained PCT personnel entering the monitored/trial area, in order to create “fixed” safety risk events for evaluating the robustness of the algorithm in varying light conditions.</td></tr>
<tr><td colspan="2">App./Infrastructure: N/A</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS, PCT</td></tr>
<tr><td>Prerequisites</td><td>5G network, Opensource MANO, Kubernetes, Kubernetes network functions (KNFs) for AI/ML components, edge computing node deployment, 4K camera deployment</td></tr>
<tr><td>Necessary test data</td><td>Live 4K video stream captured from the installed camera in the trial area targeting safety and security applications.</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td colspan="3">Service Initiation</td></tr>
<tr><td>Step 1</td><td>Start Opensource MANO</td><td>Activate Opensource MANO platform for AI/ML service orchestration</td></tr>
<tr><td>Step 2</td><td>Start Kubernetes cluster</td><td>Activate Kubernetes virtualized infrastructure manager (VIM)</td></tr>
<tr><td>Step 3</td><td>Establish 5G communication with the edge computing node for data plane (e.g., video streaming) and control plane (orchestration of the service components) communications</td><td>The edge compute node is ready to receive workloads and process video streams</td></tr>
<tr><td>Step 4</td><td>Deploy Opensource MANO and Kubernetes manifests for Use Case 4</td><td>Activating 5G&AI-enabled far-edge computing service for human presence detection</td></tr>
<tr><td colspan="3">Scenario</td></tr>
<tr><td>Step 5</td><td>A 4K camera constantly monitors a risk area (cf. Fehler! Verweisquelle konnte nicht gefunden werden.) where no person should be present. This area is close to the quay side crane, where only trucks should be present that facilitate</td><td>4K video input for the developed AI model is captured in real time</td></tr>
</table>
</td></tr>
</table>

		the horizontal movement of containers within the port premises.	
	Step 6	The 5G edge computing node receives and processes the 4K video stream, to infer the presence/absence of people in the inspected/trial area	Receive and process input video streams for the AI-enabled service at the edge computing node
	Step 7	Utilize PCT trained personnel, to move inside the trial area (camera's field of view, cf. **Fehler! Verweisquelle konnte nicht gefunden werden.**) and create "fixed" risk events for the evaluation of the edge service.	Create fixed events to evaluate the service.
	Step 8	Transmit over the 5G network the inferenced/annotated video (uplink) from the 5G edge node to PCT monitoring platform	Visualize the inferenced results and create respective alerts
	Step 9	Send/store inferenced/annotated frames at PCT database for evaluation	Annotated frames are stored at the back-end system (5G LOGINNOV database) for manual inspection and KPI evaluation
	Step 10	Repeat above steps for varying light conditions to evaluate the robustness of the developed AI model.	N/A
Expected result	Evaluate the 5G&AI enabled (far-)edge computing service for human presence detection in specified risk areas at PCT.		

Test Result

Scenario setup

The test setup and trials for this use case involves a 5G modem (R5020 5G IoT Router), a GPU enabled edge computing node (NVIDIA Jetson AGX Xavier) and a 4K Camera (IPC-HFW3841T-ZAS) for capturing live video frames exploited by the AI model. The 5G connection from/to the edge node establishes both, data plane traffic, i.e., 4K (uplink) annotated/inferenced video streaming to PCT's monitoring platform and alert system, as well as control plane traffic including NFV-MANO service orchestration and lifecycle management operations. For more details on the developed service and AI models please refer to D2.3. In the trials we focus on areas around quay side cranes, and nearby truck routes, where frequent incidents involving boom collisions, gantry collisions or stack collisions along with the presence of stevedoring personnel make the risk for serious bodily injuries considerable. **Fehler! Verweisquelle konnte nicht gefunden werden.** depicts the area besides quay side cranes, where trucks are continuously moving for the horizontal movement of containers. In this area, personnel are prohibited to enter as it poses significant safety risks.

Figure 18: Human presence detection area, besides quay side cranes

Expected results are multifold: (*i*) the service will be exploited to mitigate the risk for serious injuries for persons around the area of interest, i.e., increase safety measures for the employees' workplace, by delivering respective alerts to monitoring system and relevant patrols inspecting nearby areas; (*ii*) the service allows for more efficient personnel resource utilization: "*A-KPI8 Human resource optimization (person-hours)*" by reducing the security/safety patrol frequency or by re-distributing patrols in targeted areas.

Error Description if test negative

Poor performance of the deployed algorithm will be reflected in the measured false positives (i.e. detecting human presence when there is none) and false negatives (i.e. failing to detect actual human presence). If observed, such poor performance is expected to be due to:

- Varying light and shade conditions
- Small size of the objects of interest (in our case, humans) in the captured frame
- Humans in the frame captured from angles hiding characteristic features used by the trained algorithm to detect humans.

Proposal Solution if test negative

- Use additional cameras to capture the area of interest from a larger variety of angles.
- Use additional raw data to re-train the model and increase the efficiency/accuracy of the developed inference engine
- Installation of lights where appropriate, to improve light conditions and visibility

Test Protocol Athens#5

Date: September – October 2023

Test case type: Trial

Tested by: ICCS, PCT

Test scenario5G&AI enabled (far-)edge computing service for container seal detection

<table>
<tr><td colspan="2">Testcase: #5</td></tr>
<tr><td colspan="2">Short description: The current trial which concerns Use Case 5: “Automation for ports: port control, logistics and remote automation”, will demonstrate the 5G&AI enabled (far-)edge computing service for detecting the presence/absence of cargo container seals during the loading/unloading phase of vessels. It includes real (daily) operations at PCT involving: vessels docking at Piraeus port carrying cargo containers; and a quay side crane performing unloading/loading operations from/to vessels to/from yard trucks. The quay side crane is equipped with a 4K camera which monitors the loading/unloading operations, a 5G interface to establish cellular communication with the crane and a (GPU enabled) edge computing node for processing the live captured video frames and deliver the (far-)edge computing service for container seal detection. The service will be evaluated in real PCT operation for the full duration or part of a working shift, under varying light conditions. Multiple shifts will be considered to adequately evaluate the performance of the AI-enabled service.</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G network, Opensource MANO, Kubernetes, Kubernetes network functions (KNFs) for AI/ML components, edge computing node deployment, 4K camera deployment at quay side crane (QC)</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS</td></tr>
<tr><td>Prerequisites</td><td>5G network, Opensource MANO, Kubernetes, Kubernetes network functions (KNFs) for AI/ML components, edge computing node deployment, 4K camera deployment at quay side crane (QC)</td></tr>
<tr><td>Necessary test data</td><td>Live 4K video stream captured from the camera installed at the QC that monitors the loading/unloading operations of containers from/to yard trucks and vessels.</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td colspan="3">Service Initiation</td></tr>
<tr><td>Step 1</td><td>Start Opensource MANO service</td><td>Activate Opensource MANO platform for AI/ML service orchestration</td></tr>
<tr><td>Step 2</td><td>Start Kubernetes cluster</td><td>Activate Kubernetes virtualized infrastructure manager (VIM)</td></tr>
<tr><td>Step 3</td><td>Establish 5G communications with the edge computing node</td><td>Establish 5G communication with the IoT/MEC nodes for data plane (e.g., video streaming) and control plane (orchestration of the service components) communications</td></tr>
<tr><td>Step 4</td><td>Deploy Opensource MANO and Kubernetes manifests for Use Case 5</td><td>Activating 5G&AI-enabled far-edge computing service for container seal detection</td></tr>
</table>
</td></tr>
</table>

	Scenario		
	Step 5	Yard trucks arrive at the QC via two possible lanes (cf. **Fehler! Verweisquelle konnte nicht gefunden werden.**) to be loaded/unloaded with containers	The service will be validated via real/daily port operations at PCT
	Step 6	The QC performs loading and unloading operations between yard trucks and docked vessels. The QC operations are captured in real time by the installed 4K camera.	4K video input for the developed AI model is captured in real time
	Step 7	The 5G edge computing node receives and processes the 4K video stream. This step involves the extraction of the container door from the video frames, and subsequently the inference about the absence/presence of a container seal from the extracted part of the frame, i.e., container door.	Receive and process input video streams for the AI-enabled service at the edge computing node
	Step 8	Inferenced/annotated 4K video is transmitted over 5G (uplink) from the 5G edge computing node to PCT's monitoring system (cf. **Fehler! Verweisquelle konnte nicht gefunden werden.**)	Visualize the inferenced results
	Step 9	Send/store inferenced/annotated frames at PCT database for evaluation	Annotated frames are stored at the back-end system (5G LOGINNOV database) for manual inspection and KPI evaluation
	Step 10	Repeat above steps for varying light conditions to evaluate the robustness of the developed AI/ML models	N/A
Expected result	Evaluate the 5G&AI enabled (far-)edge computing service for container seal detection at the loading/unloading process of vessels.		

Test Result

Scenario setup

The installation at the 5G QC as exploited for the 5G LOGINNOV trials includes the GPU enabled edge computing node (NVIDIA Jetson AGX Xavier) installed in the crane cockpit, a 4K Camera (IPC-HFW3841T-ZAS) and 5G modem (R5020 5G IoT Router), as show in **Fehler! Verweisquelle konnte nicht gefunden werden.**. The camera is connected via (and power by) an ethernet Gigabit connection to a switch located at the crane cockpit. The 5G modem and edge node are also connected to the switch inside the cockpit, enabling 5G connectivity from/to the edge node including both data plane traffic, e.g., 4K (uplink) annotated/inferenced video streaming, as well as control plane traffic including NFV-MANO service orchestration and lifecycle management operations.

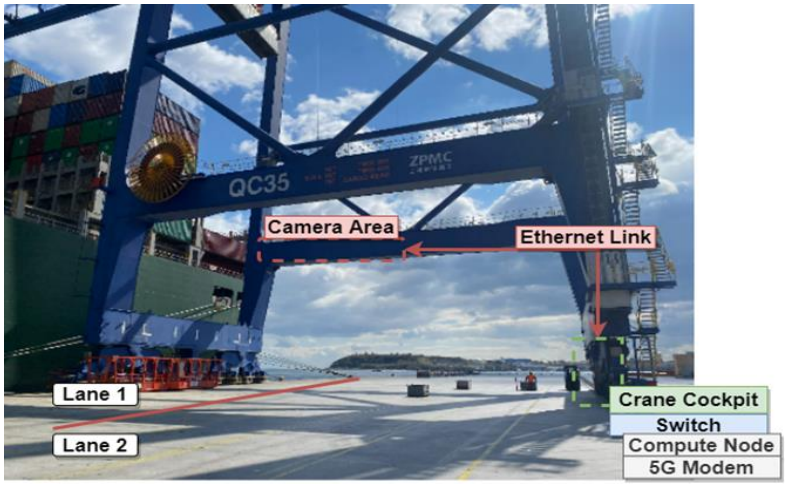


Figure 19: 5G QC service/scenario setup

Fehler! Verweisquelle konnte nicht gefunden werden. depicts the box inside the cockpit crane hosting the GPU enabled edge processing node and the 5G modem for facilitating the cellular communication with the device/crane.

Figure 20: 5G modem and IoT node inside the cockpit of the crane

The bellow figures illustrate the live service, i.e., real inferenced footage from deployed camera at the quay side crane, delivering 4K uplink inferenced/annotated video streams over the 5G NSA network, towards the (or any) internal access terminal requesting the (video) service at Piraeus port. For more details on the AI-enabled algorithms development please refer to D2.3.

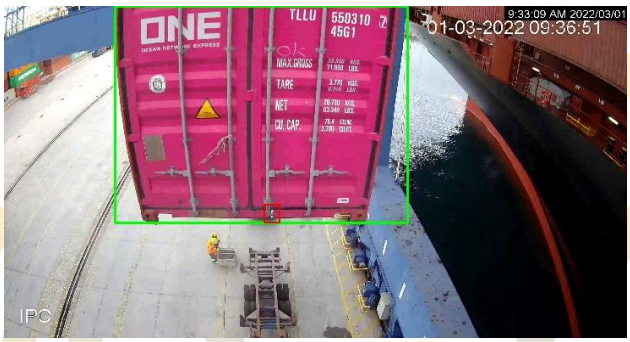


Figure 21: 4K uplink inferenced video stream for the far-egde container seal detection service

Expected results for Use Case 5 are multifold: (*i*) by automating the service (through the developed AI/ML models) the use case removes the need for human personnel (i.e., current practice involves manual inspection from employees at the loading/unloading phase of vessels checking for absent/present seals) at an area with high safety risks, i.e., increased truck traffic and crane operations; (*ii*) the service allows for more efficient personnel resource utilization: "*A-KPI8 Human resource optimization (person-hours)*" by reducing hours spent in container seal checking or by redistributing human personnel to other tasks/jobs. Additionally, the service (*iii*) aims at improving the logistics supply chain by reducing the vessel stay at Piraeus port: "*A-KPI13: Vessel Operation Completion Time*". Particularly, a mother vessel at Piraeus needs (on average) about 3000 stevedore moves for operations completion. Seal-presence check currently requires one person and about 30 seconds to complete. Reducing this time by, e.g., 3 seconds per container, results to 9000 seconds (or 2.5 hours) reduction of vessel stay at the port.

Error Description if test negative

The detection of cargo container seals bears significant challenges:

1. The task involves detecting very small objects (i.e. the various types of seals) in a large surface (i.e. the container door) which is rich and random in texture and features, e.g., letters, rust, damages, stickers, etc.
2. During the loading/unloading process, the container may move along a large variety of trajectories when passing in front of the camera. This implies that the camera may capture the passing container from quite varying distances and angles.
3. Like all computer vision algorithms, our system is expected to be sensitive to light conditions. The current algorithm performs poorly on frames captured during the night.

All of the above may impair the seal detection accuracy of the deployed algorithm.

Proposal Solution if test negative

- Use additional cameras to capture the container movement from various angles and improve the detection accuracy of the seals.
- Use additional raw data to re-train the model and increase the efficiency/accuracy of the developed inference engine.
- Installation of night lights can improve the performance of the system during the night

Test Protocol Athens#6

Date: July 2022 – February 2023

Test case type: Trial

Tested by: ICCS, PCT

Test scenario: Predictive Maintenance Service

<table>
<tr><td colspan="2">Testcase: #6</td></tr>
<tr><td colspan="2">Short description: The current trial which concerns Use Case 7: “Predictive Maintenance”, will demonstrate the efficiency of the AI algorithm based on data accumulated from the fleet of 5G connected trucks participating in PCT’s daily port operations. 5G LOGINNOV trucks will be equipped with a telematics device connected to CAN-Bus data, and a 5G interface to establish cellular communication. CAN-Bus data will flow to PCT’s enterprise management system (EAMS), where the predictive maintenance algorithm resides, storing also daily logs of truck (and truck part functional) operations. EAMS additionally includes/stores the description of breakdown events, the part of the truck that was affected and the spare parts used for the repair. The trials phase will evaluate the efficiency of the predicive maintenance service in two scenarios. The first scenario is dedicated to deciding the maintenance schedule of the yard trucks, whereas the second case will be focused on determining the quantity and type of the spare parts required for maintenance.</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G network, CAN-Bus data, AI/ML predictive maintenance algorithm, EAMS system</td></tr>
<tr><td colspan="2">Testcase Manager: ICCS, PCT</td></tr>
<tr><td>Prerequisites</td><td>5G network, CAN-Bus data, AI/ML predictive maintenance algorithm, EAMS system</td></tr>
<tr><td>Necessary test data</td><td>CAN-Bus data from 5G yard truck operations paricipating in daily port operations, historical telemetry data, maintenance and breakdown data of the yard trucks fleet</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Establish 5G communication between yard truck and EAMS</td><td>Truck connected to EAMS over 5G</td></tr>
<tr><td>Step 2</td><td>5G trucks transmit CAN-Bus data from daily port operation to EAMS</td><td>Data are accumulated at EAMS</td></tr>
<tr><td>Step 3</td><td>Initiate user interface (cf. Fehler! Verweisquelle konnte nicht gefunden werden.) for the predictive maintenance tool</td><td>Start user interface to exploit the prediction maintenance service</td></tr>
<tr><td>Step 4</td><td>Select the time period of logged data used for the prediction, e.g., last 3 months of 5G truck operations.</td><td>AI service is trained based on data accumulated over a specific time period</td></tr>
<tr><td>Step 5</td><td>Select specific yard truck parts that the prediction will be made for</td><td>Select specific truck parts to predict potential break downs</td></tr>
<tr><td>Step 6</td><td>Select the time period for predicting potential future break down events of selected truck parts (Step 4)</td><td>Date of potential break down</td></tr>
<tr><td>Step 7</td><td>Acquire (predicted) date of potential malfunction</td><td>Get potential date for part breakdown</td></tr>
</table>
</td></tr>
</table>

	Step 8	Acquire prediction of necessary parts to repair/fix the foreseen problem	Get number and type of parts necessary to repair the damaged part
	Step 9	Evaluate prediction of steps 7 and 8	Evaluate results
	Step 10	Repeat above steps for various training and testing periods to evaluated the efficiency of the algorithm	Average results over multiple evaluation of the AI service
Expected result	The success criteria of the trial will be based on the accuracy of the prediction date, i.e., foreseen breakdown, and the truck part that failed for the first scenario, while the predicted type and quantity of spare parts to be used for the repair with determine the success rate of the second scenario, addressing relevant KPIs of the Use Case 7.		

Test Result

For the trials of 5G-LOGINNOV that will showcase the predictive maintenance tool, PCT will focus in two main scenarios. The first scenario is dedicated to deciding the maintenance schedule of yard trucks, whereas the second case will be focused on determining the quantity of the spare parts required for maintenance. The user will be able to select the time period of data that the prediction will be based on as well as the period and the specific spare parts for which the predictions need to be made (**Fehler! Verweisquelle konnte nicht gefunden werden.**). The potential input data of the AI algorithm that are expected to be utilized include historical telemetry data, maintenance and breakdown data of the yard trucks fleet as well as telemetry data accumulated from the 5G yard trucks for the period of WP3 trials. The expected outcome of the UC will be a list of potential (predicted) dates of vehicles malfunction, i.e., break down, as well as the spare part requirements to repair/fix the foreseen problem. Predictions will be made for the one month and at the end of the month the maintenance/breakdown work orders will be extracted from EAMS. The success criteria of the trial will be based on the accuracy of the prediction date and truck part that failed for the first scenario while the type and quantity of spare parts used will determine the success rate of the second scenario, addressing all KPIs of the Use Case 7.

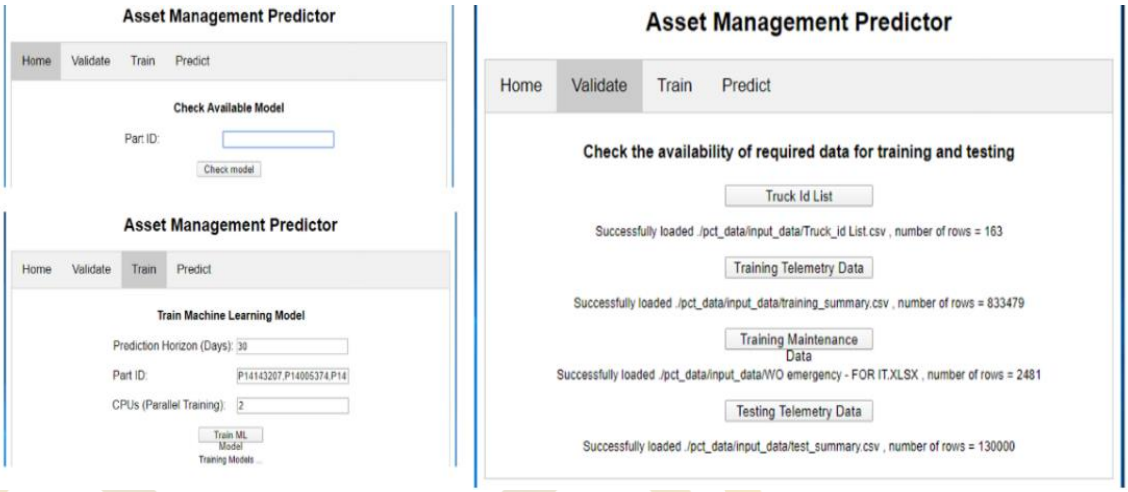


Figure 22: Predictive maintenance tool web interface

Error Description if test negative

N/A

Proposal Solution if test negative

N/A

Test Protocol Athens#7

Date: 01/06/2022

Test case type: pre-test (technical)

Tested by: Vodafone Innovus

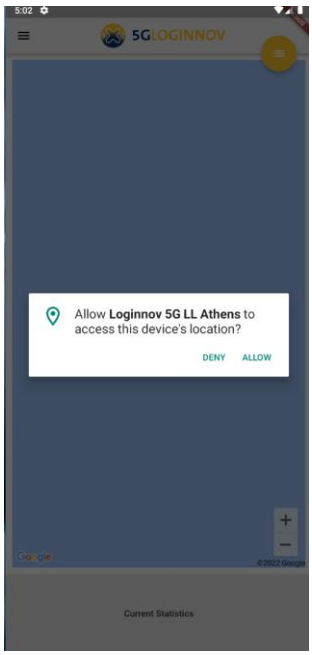
Test scenario: Device management platform ecosystem

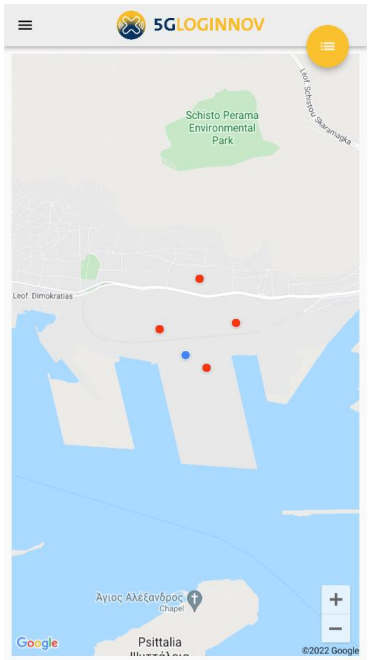
<table>
<tr><td colspan="2">Testcase: #7</td></tr>
<tr><td colspan="2">Short description: Back end system test for localization multicast and video multicast to 3 devices.</td></tr>
<tr><td colspan="2">App./Infrastructure: Web and video server (application server), mobile application for Android with camera.5G network</td></tr>
<tr><td colspan="2">Testcase Manager: VODA</td></tr>
<tr><td>Prerequisites</td><td>Cellular connectivity, online application server. Day light time for the mobile cameras transmit acceptable video.</td></tr>
<tr><td>Necessary test data</td><td>N/A</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Create accounts for app users</td><td>Users are created in the application server</td></tr>
<tr><td>Step 2</td><td>Start application server</td><td>Services of position and video feed are online</td></tr>
<tr><td>Step 3</td><td>User login to mobile application</td><td>Users enter the application</td></tr>
<tr><td>Step 4</td><td>Allow location access</td><td>Once location access is enabled the truck location is reported to the rest of the truck fleet.</td></tr>
<tr><td>Step 5</td><td>Nearest trucks are displayed on the map</td><td>Truck positions are visible on the map</td></tr>
<tr><td>Step 6</td><td>Selecting the closest truck – (withing 30 meters)</td><td>The user is represented to select the nearest convenient camera</td></tr>
<tr><td>Step 7</td><td>View adjacent truck mobile camera while reversing</td><td>Live video feed is presented at the user.</td></tr>
<tr><td>Step 7</td><td>Measure latency and video quality</td><td>Video feed quality should be adequate for live monitoring</td></tr>
</table>
</td></tr>
<tr><td>Expected result</td><td>With successful test of the scenario the user can view his own truck from the camera on another truck and also view the position on the map.</td></tr>
</table>

Test Result (including Screenshots, Photos etc.)

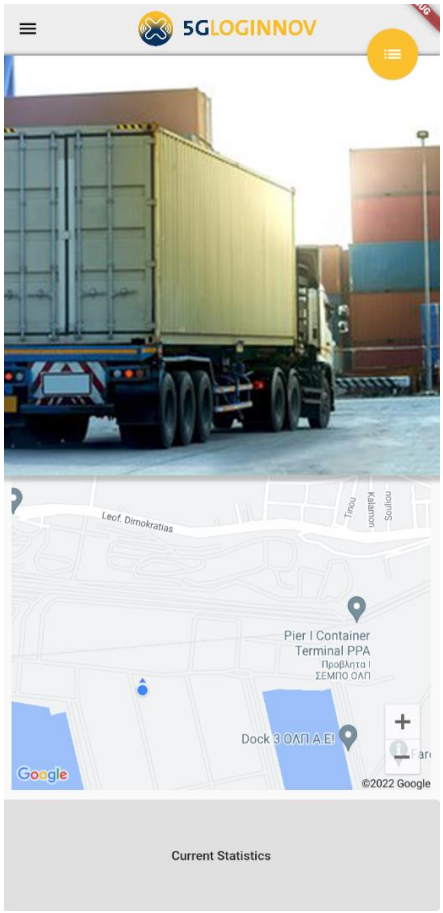
Expected result: yes

Screenshots of the mobile application, once location access is allowed, with the positions of other trucks (in red) and the current mobile device (in blue).





Test video feed from mobile phone of another truck.



Error Description if test negative

N/A

Proposal Solution if test negative

N/A

Test Protocol Athens#8

Date: 01/10/2022

Test case type: Trial

Tested by: Vodafone Innovus, PCT

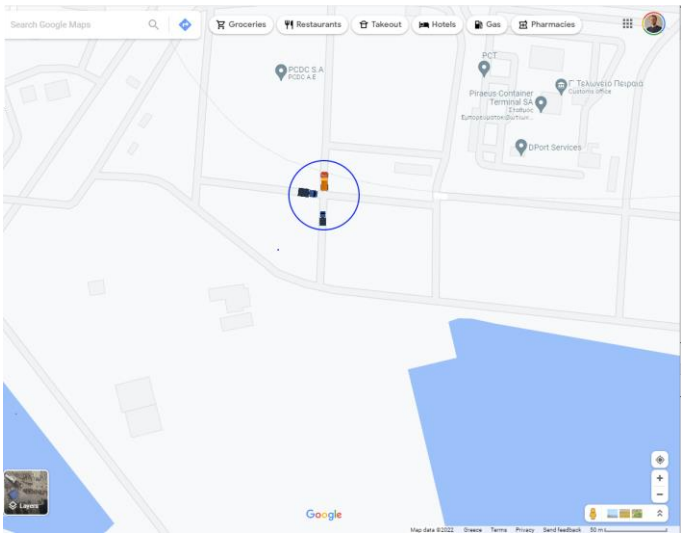
Test scenario: Device management platform ecosystem

<table>
<tr><td colspan="2">Testcase: #8</td></tr>
<tr><td colspan="2">Short description: The basic scenario consists of 3 (or more vehicles) of which one is maneuvering. Performing 90 degree back turn often requires external human help or camera on the back side of the truck.</td></tr>
<tr><td colspan="2">App./Infrastructure: Web and video server (application server), mobile application for Android with camera.5G network</td></tr>
<tr><td colspan="2">Testcase Manager: Vodafone Innovus, PCT</td></tr>
<tr><td>Prerequisites</td><td>Cellular connectivity, online video server, mobile phones installed on trucks, day light time for the mobile cameras transmit acceptable video.</td></tr>
<tr><td>Necessary test data</td><td>N/A</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start application server</td><td>Service should be online</td></tr>
<tr><td>Step 2</td><td>Mobile application receives position and video feed</td><td>The user can view other trucks positions and video.</td></tr>
<tr><td>Step 3</td><td>The driver picks up a container and taps on the phone that the truck is carrying container.</td><td>A record of pick-up container is registered</td></tr>
<tr><td>Step 4</td><td>The driver leaves a container and taps on the phone that the truck is not carrying container anymore.</td><td>A record of left container is registered</td></tr>
<tr><td>Step 5</td><td>A 5G truck started to maneuver for parking – Truck A.
Another 5G truck (B) is near (30 meters) in line of sight will transmit video feed the truck A.
A 3rd 5G truck (C) is near (30 meters) in line of sight will transmit video feed the parking truck A. Truck C should be in angle with truck A</td><td>N/A</td></tr>
<tr><td>Step 6</td><td>Driver at truck A can view its vehicle through the app, via 2 cameras,</td><td>The driver can park the truck using video feed from the 2 other vehicles.</td></tr>
</table>
</td></tr>
<tr><td>Expected result</td><td>It is expected that during this scenario the driver will be able to maneuver the truck with assistance of the external cameras (from other truck). Also, to retrieve information about the trucks and empty runs.</td></tr>
</table>

Test Result (including Screenshots, Photos etc.)

Expected result: Truck driver to be able to view the truck he is from external sources real time. The application should automatically detect nearby trucks and enable the user to select live feed from those devices.

The following map depicts 1 vehicle (orange) that is performing 90-degree backwards maneuvering. 2 trucks in vicinity (30 meters or less) are automatically identified and live feed is available to the driver.



Error Description if test negative

N/A

Proposal Solution if test negative

N/A

LL Hamburg

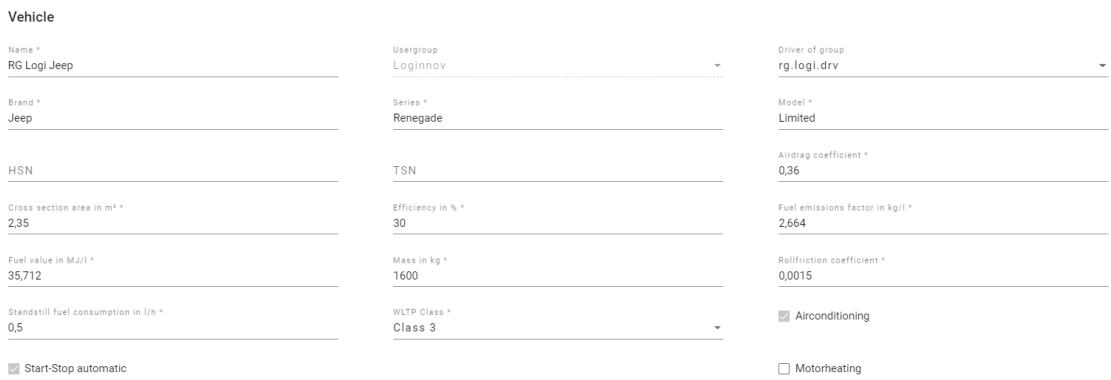
Test Protocol HH#1

Datum/Date: **06.04.2022**

Test case type (): **Test (technical)**

Tested by: **T-Systems**

Testszenario:

Testcase: LCMM App & portal	
Short description: Use of LCMM by running vehicle trips, collection of position data, feedback to driver, result overview at the LCMM portal	
App./Infrastructure: LCMM APP iOS Version 43.2 / Android Version 43.2	
Testcase Manager: *Ralf Grigutsch*	
Prerequisites	*Describe needed setup:* **LCMM as App and access to LCMM portal** **TAVF test field accessible** **5G Connectivity**
Necessary test data	*e.g. accounts, etc.* **Access data: Account rg.logi.drv,** **Vehicle: rg.logi.jeep with standard car parameter**  *Figure 23 Screenshot vehicle configuration test #1*
Aktivity	*Steps*

Step Name	Description	Expected Result
Step 1	Start iOS device	Device starts
Step 2	Check connectivity	5G Connectivity available
Step 3	Start LCMM App	Start screen visible
Step 4	Select vehicle	RG Logi Jeep selectable
Step 5	Login App with account @ iOS device	Login successful
Step 6	Select Expert Mode for further data during test trip	Expert mode screen available

	Step 7	Position device near front windshield within prepared device holder	Fixed device near windshield	
	Step 8	Connect device with power cable	External power accessible	
	Step 9	Start vehicle engine	Vehicle ready for test trip	
	Step 10	Push start button at LCMM App	Button changes to label 'Stop' and collection of position (GNSS) data starts	
	Step 11	Start test trip & collect data	Trip on the TAVF	
	Step 12	During Trip: Check (if possible) screen changes, hints and values in the LCMM APP	Changes of colour (green, yellow, red) available Counters for expert mode provide different numbers on collected GNSS data, communication (request – response)	
	Step 13	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data	
	Step 14	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot	
	Step 15	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal	
	Step 16	Compare trip results with driver's trip experience	Successful trip with LCMM	
	Step 17	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available	
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal*			

Test Result (including Screenshots, Photos etc.)

Expected results fulfilled: yes

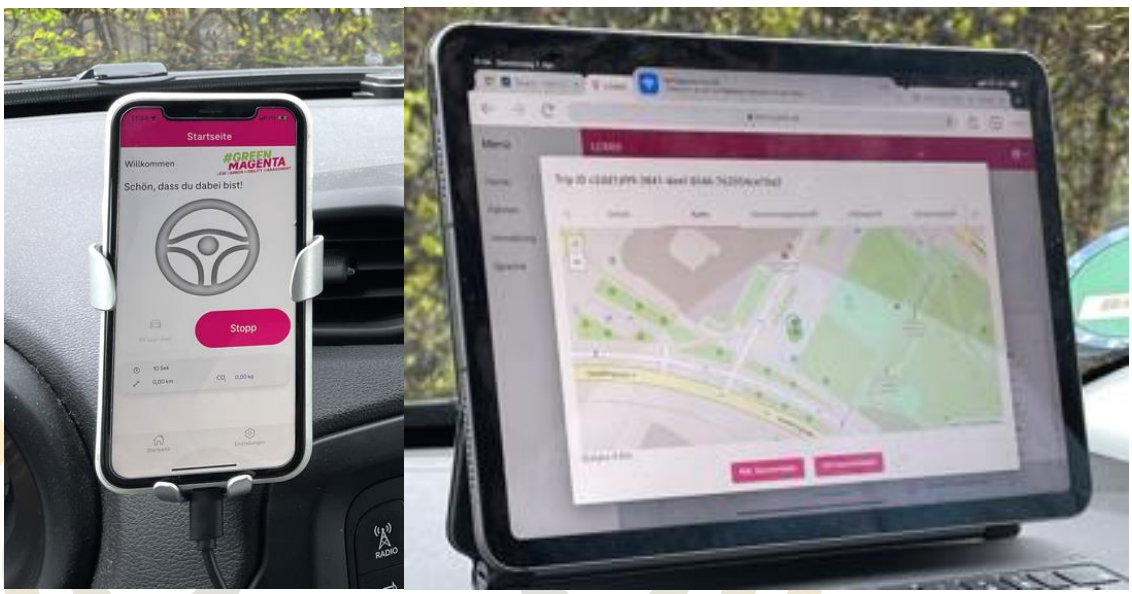


Figure 24 Screenshots LCMM App & portal test #1

Details | Map | Speed Profile | Altitude Profile | Emission Profile | Way Profil

Vehicle RG Logi Jeep	Group name Loginnov.	Start time 06.04.2022, 11:11	End time 06.04.2022, 11:23
Duration 0:11:44	Distance 4,1 km	Speed 21,2 km/h	Fuel Consumption 5,8 l/100km
CO2 Emission 0,6 kg	Zero fuel distance 1.304 m	Standstill time 0:03:09	ACC Cycle 142,5 %
Aero Cycle 72,4 %	Percentage Standstill Cycle 58,8 %	Percentage Work Cyle 114,2 %	Energy Performance Index (EPI) 3,7 l/100km*t
Acceleration Performance Index (API) 5,4 kWh/100km*t	AccWork 1,1 MJ	AeroWork 0,1 MJ	Standstill work 0,1 MJ
RollWork 0,1 MJ	GradeWork 0,6 MJ		
Cross section area 2.35 m²	Efficiency 30 %	Fuel emissions factor 2.664 kg/l	Fuel value 35.712 MJ/l
Mass 1600 kg	Rollfriction coefficient 0.0015	Standstill fuel consumption 0.5 l/h	Motorheating ☐
Airconditioning ☑	Start-Stop automatic ☑		

Figure 25 Overview LCMM results #1

Distance 4,14 Km

Figure 26 Trip route test #1

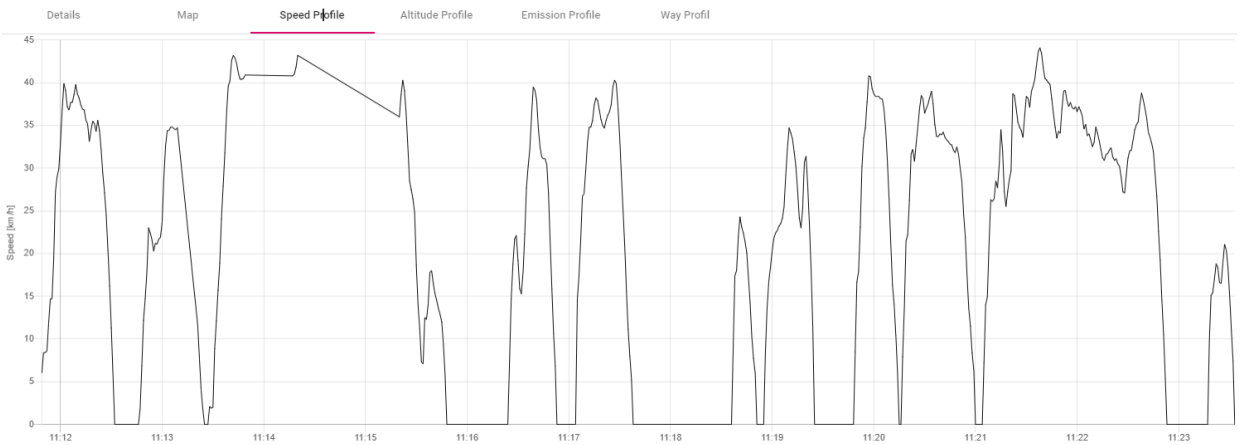


Figure 27 Speed profile test #1

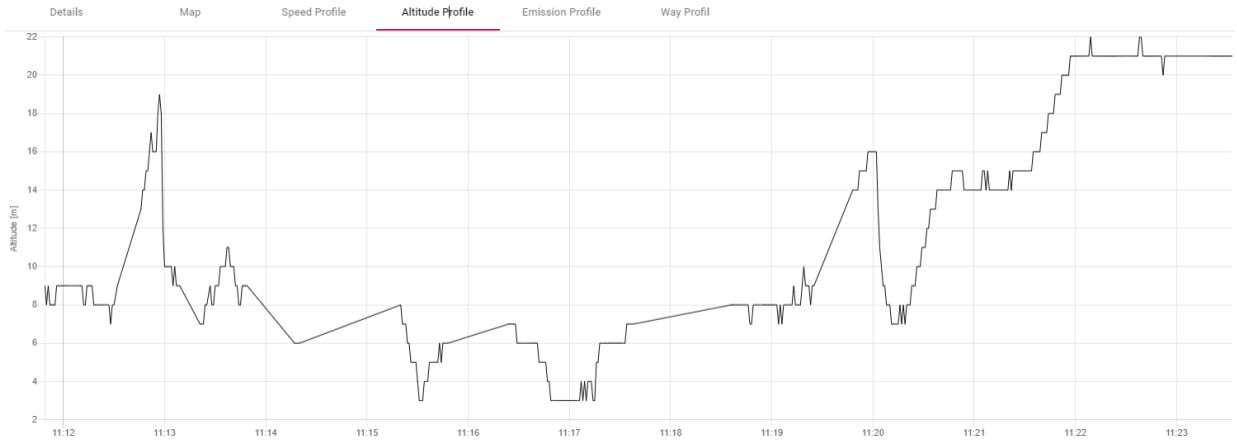


Figure 28 Altitude profile test #1

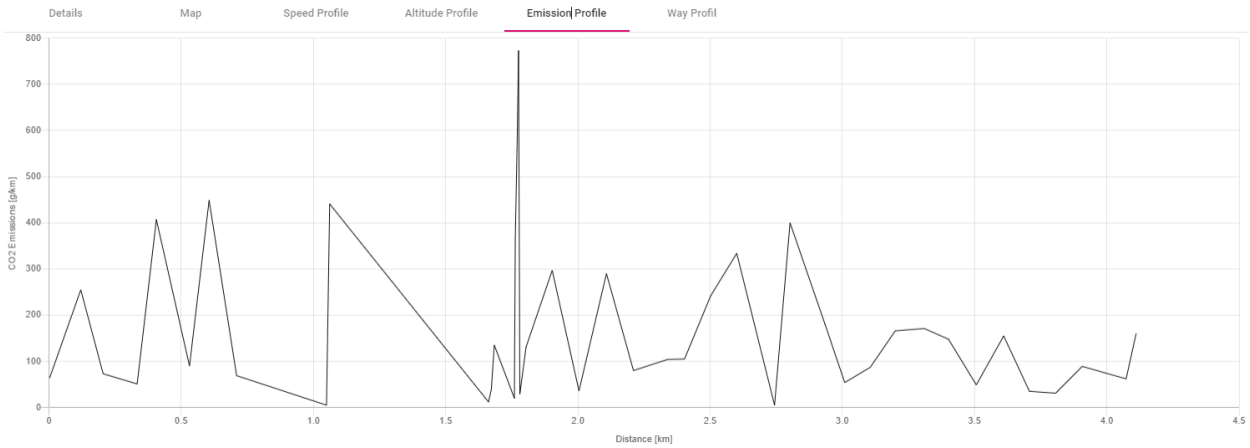


Figure 29 Emission profile test #1

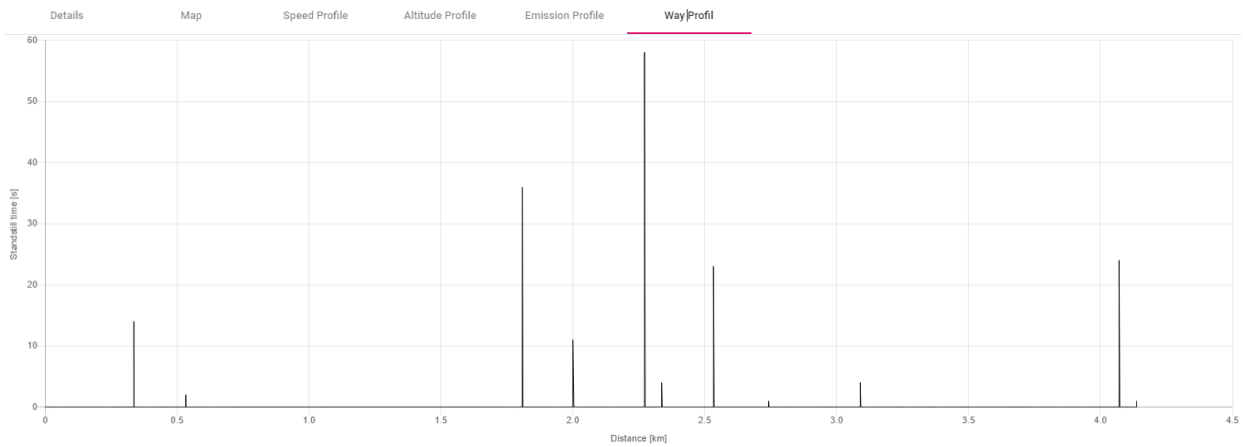


Figure 30 Way profile test #1

Error Description if test negative

Test was successful, no errors.

Proposal Solution if test negative

n.a

Test Protocol HH#2

Datum/Date: 06.04.2022

Test case type (): Test (technical)

Tested by: T-Systems

Testszenario:

Testcase: LCMM App & portal	
Short description: Use of LCMM by running additional vehicle trip , collection of position data, feedback to driver, result overview at the LCMM portal	
App./Infrastructure: LCMM APP iOS Version 43.2 / Android Version 43.2	
Testcase Manager: *Ralf Grigutsch*	
Prerequisites	*Describe needed setup:* **LCMM as App and access to LCMM portal** **TAVF test field accessible** **5G Connectivity**
Necessary test data	*e.g. accounts, etc.* **Access data: Account rg.logi.drvc,** **Vehicle: rg.logi.jeep with standard car parameter**

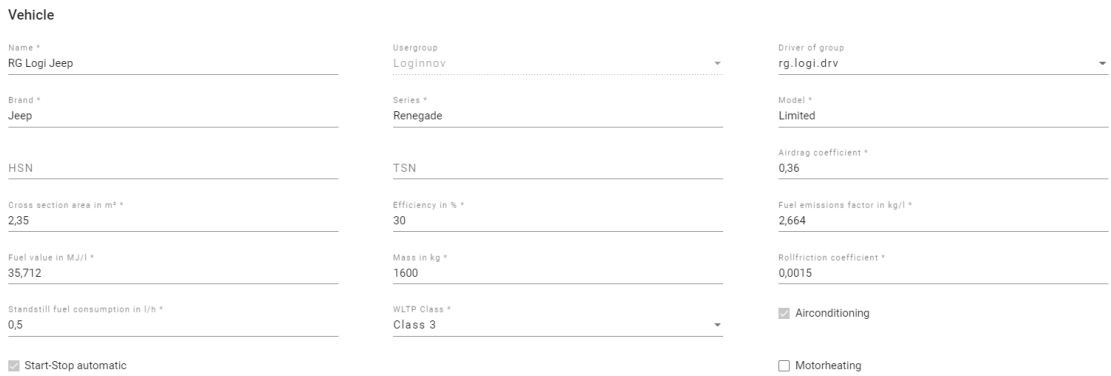


Figure 31 Screenshot vehicle configuration test #2

Aktivity

Steps

Step Name	Description	Expected Result
Step 1	Start iOS device	Device starts
Step 2	Check connectivity	5G Connectivity available
Step 3	Start LCMM App	Start screen visible
Step 4	Select vehicle	RG Logi Jeep selectable
Step 5	Login App with account @ iOS device	Login successful
Step 6	Select Expert Mode for further data during test trip	Expert mode screen available
Step 7	Position device near front windshield within prepared device holder	Fixed device near windshield
Step 8	Connect device with power cable	External power accessible
Step 9	Start vehicle engine	Vehicle ready for test trip

	Step 10	Push start button at LCMM App	Button changes to label ‘Stop’ and collection of position (GNSS) data starts
	Step 11	Start test trip & collect data	Trip on the TAVF
	Step 12	During Trip: Check (if possible) screen changes, hints and values in the LCMM APP	Changes of colour (green, yellow, red) available Counters for expert mode provide different numbers on collected GNSS data, communication (request – response)
	Step 13	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data
	Step 14	Ruin with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
	Step 15	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal
	Step 16	Compare trip results with driver’s trip experience	Successful trip with LCMM
	Step 17	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal*		

Test Result (including Screenshots, Photos etc.)

Expected results fulfilled: yes

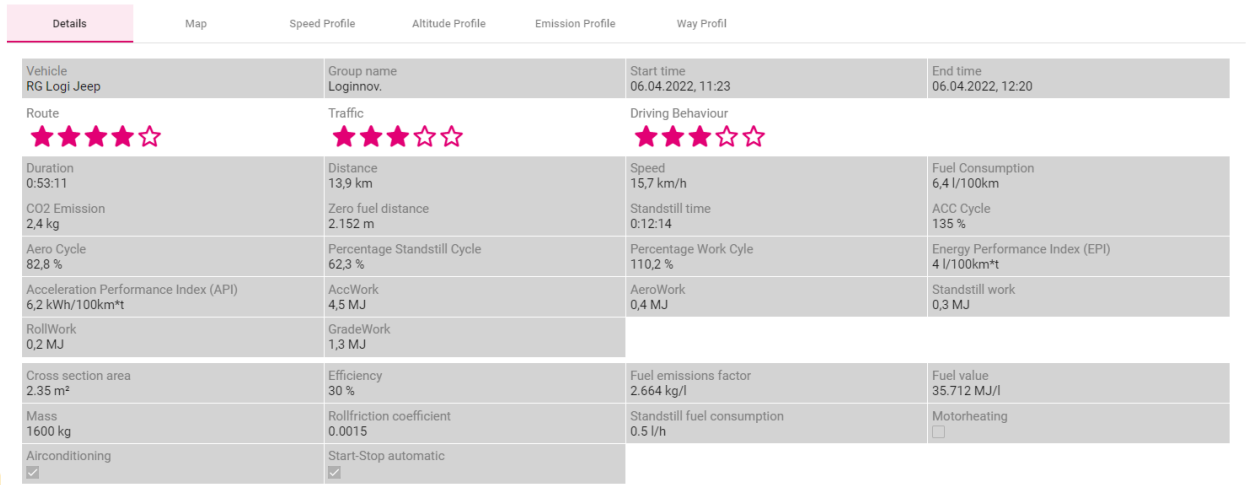


Figure 32 LCCM overview results test #2

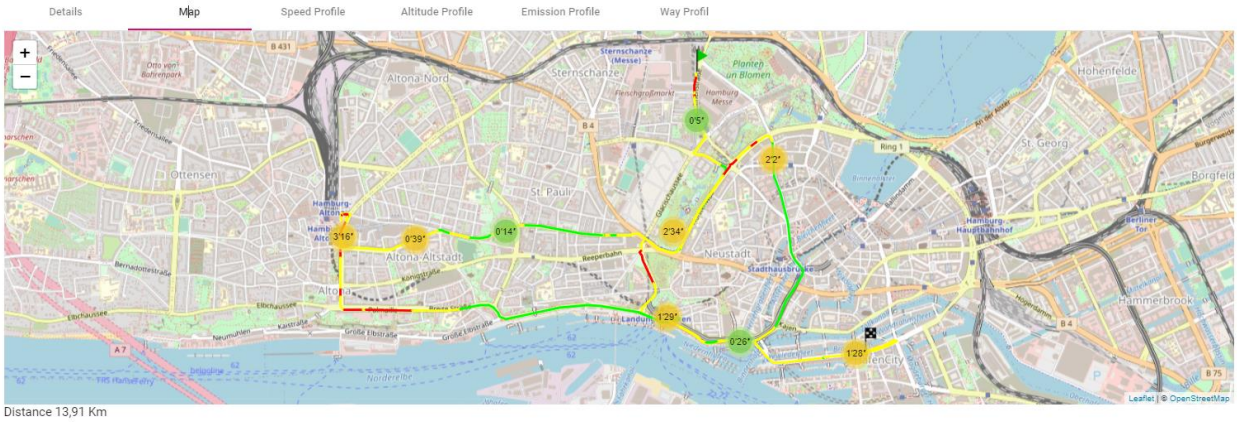


Figure 33 Trip route test #2

Figure 34 Trip route – satellite view - test #2

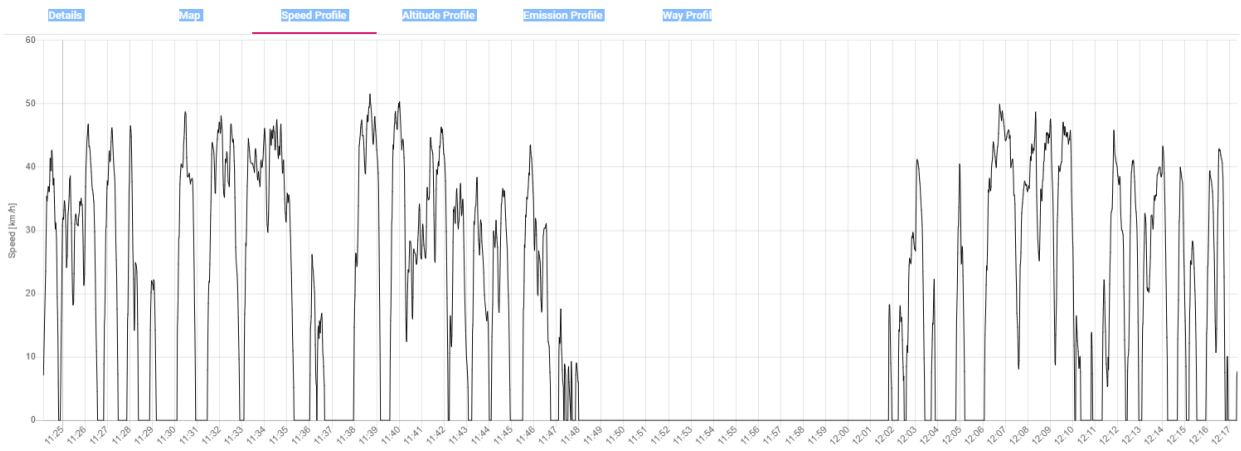


Figure 35 Speed profile test #2

Figure 36 Altitude profile test #2

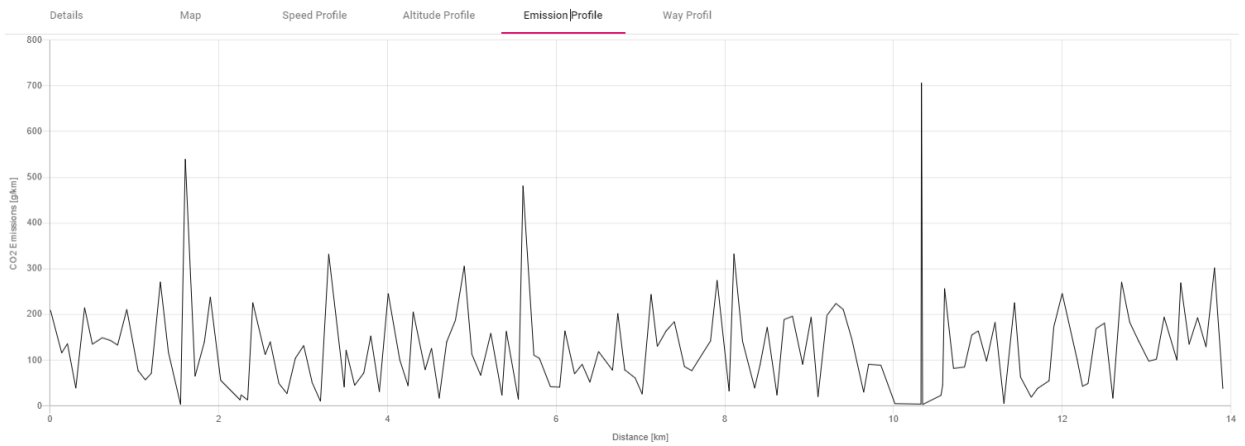


Figure 37 Emission profile test #2

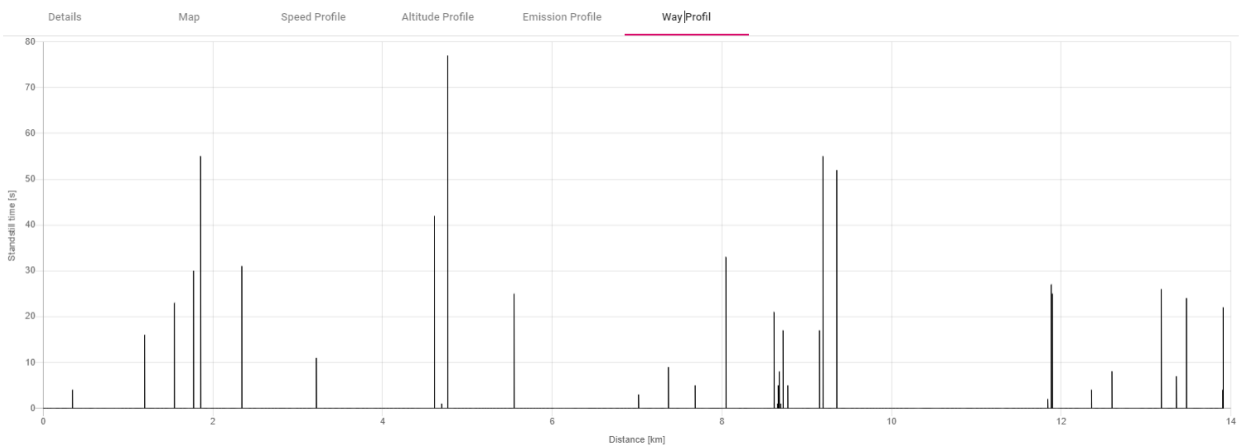


Figure Way profile test #2

Error Description if test negative

Test was successful, no errors.

Proposal Solution if test negative

n.a

Test Protocol HH#3

Datum/Date: 06.04.2022 #3

Test case type (): Test (technical)

Tested by: T-Systems

Testszenario:

Testcase: Test LCMM	
Short description: Use of LCMM by running additional vehicle trip , collection of position data, feedback to driver, result overview at the LCMM portal	
App./Infrastructure: LCMM APP iOS Version 43.2 / Android Version 43.2	
Testcase Manager: *Ralf Grigutsch*	
Prerequisites	*Describe needed setup:* **LCMM as App and access to LCMM portal** **TAVF test field accessible** **5G Connectivity**
Necessary test data	*e.g. accounts, etc.* **Access data: Account rg.logi.drv,** **Vehicle: rg.logi.jeep with standard car parameter**

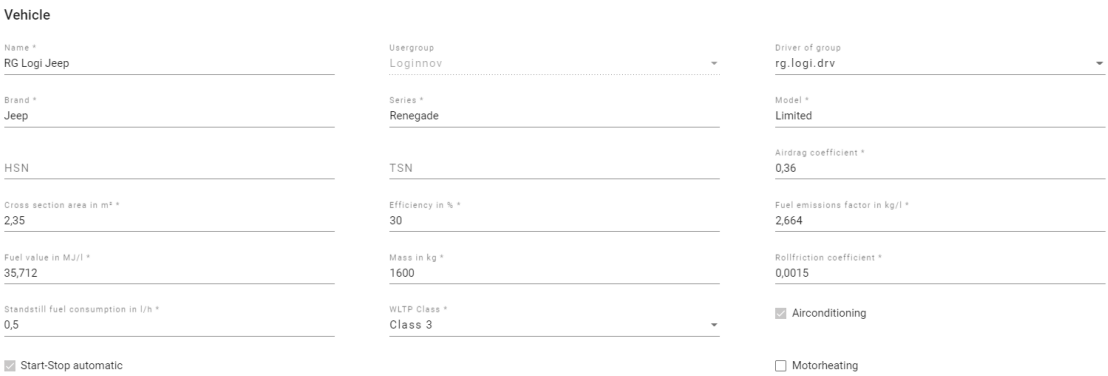


Figure 38 Screenshot vehicle configuration test #3

Aktivity

Steps

Step Name	Description	Expected Result
Step 1	Start iOS device	Device starts
Step 2	Check connectivity	5G Connectivity available
Step 3	Start LCMM App	Start screen visible
Step 4	Select vehicle	RG Logi Jeep selectable
Step 5	Login App with account @ iOS device	Login successful
Step 6	Select Expert Mode for further data during test trip	Expert mode screen available
Step 7	Position device near front windshield within prepared device holder	Fixed device near windshield
Step 8	Connect device with power cable	External power accessible

	Step 9	Start vehicle engine	Vehicle ready for test trip	
	Step 10	Push start button at LCMM App	Button changes to label ‘Stop’ and collection of position (GNSS) data starts	
	Step 11	Start test trip & collect data	Trip on the TAVF	
	Step 12	During Trip: Check (if possible) screen changes, hints and values in the LCMM APP	Changes of colour (green, yellow, red) available Counters for expert mode provide different numbers on collected GNSS data, communication (request – response)	
	Step 13	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data	
	Step 14	Ruin with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot	
	Step 15	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal	
	Step 16	Compare trip results with driver’s trip experience	Successful trip with LCMM	
	Step 17	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available	
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal*			

Test Result (including Screenshots, Photos etc.)

Expected results fulfilled: yes

Details | Map | Speed Profile | Altitude Profile | Emission Profile | Way Profil

Vehicle RG Logi Jeep	Group name Loginnov.	Start time 06.04.2022, 15:22	End time 06.04.2022, 15:55
Route ★★★☆☆	Traffic ★★★☆☆	Driving Behaviour ★★★☆☆	
Duration 0:32:30	Distance 10,2 km	Speed 18,8 km/h	Fuel Consumption 6,5 l/100km
CO2 Emission 1,8 kg	Zero fuel distance 1.395 m	Standstill time 0:11:48	ACC Cycle 153,8 %
Aero Cycle 84,6 %	Percentage Standstill Cycle 75,9 %	Percentage Work Cyle 126,2 %	Energy Performance Index (EPI) 4,1 l/100km*t
Acceleration Performance Index (API) 6,7 kWh/100km*t	AccWork 3,6 MJ	AeroWork 0,2 MJ	Standstill work 0,3 MJ
RollWork 0,1 MJ	GradeWork 1,1 MJ		
Cross section area 2.35 m²	Efficiency 30 %	Fuel emissions factor 2.664 kg/l	Fuel value 35.712 MJ/l
Mass 1600 kg	Rollfriction coefficient 0.0015	Standstill fuel consumption 0.5 l/h	Motorheating ☐
Airconditioning ☑	Start-Stop automatic ☑		

Figure 39 LCMM results test #3

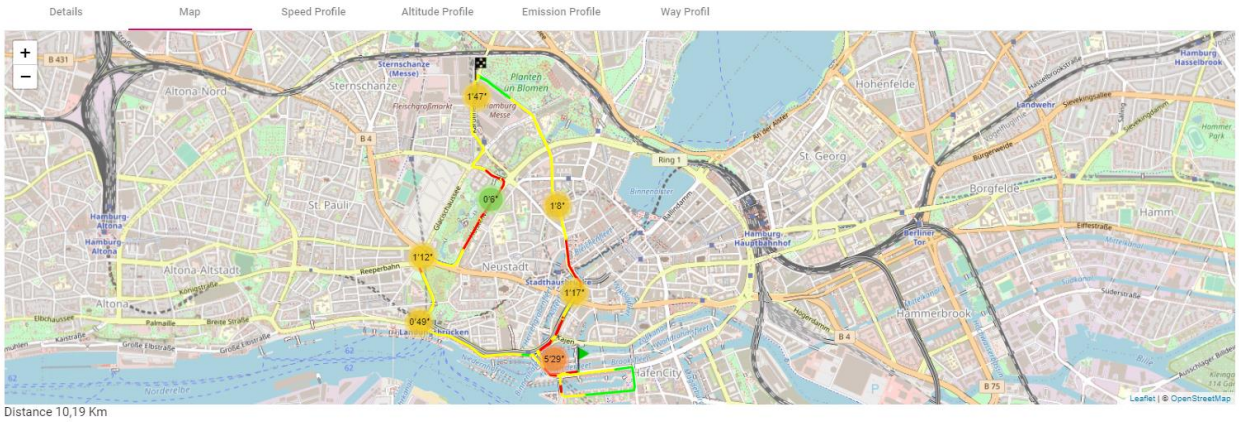


Figure 40 Trip route test #3

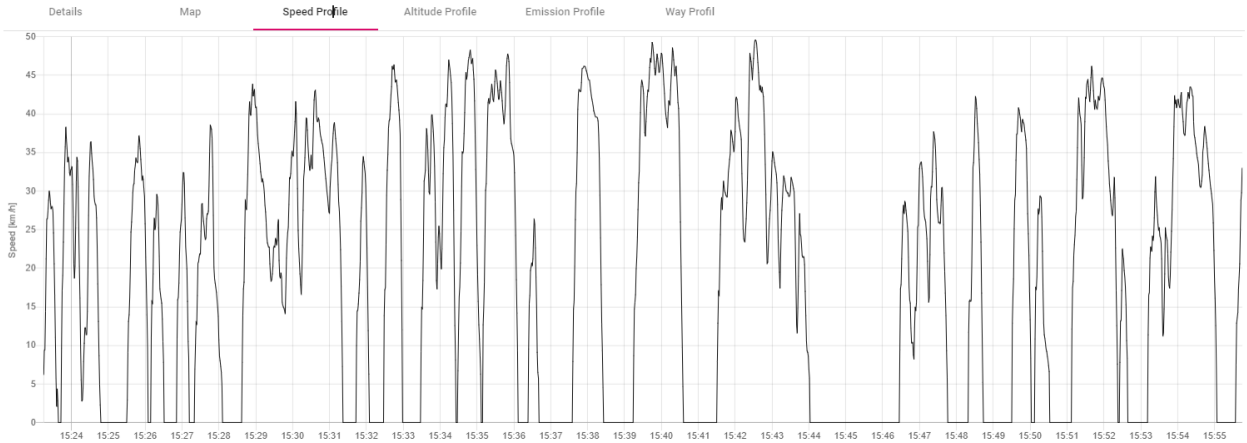


Figure 41 Speed profile test #3

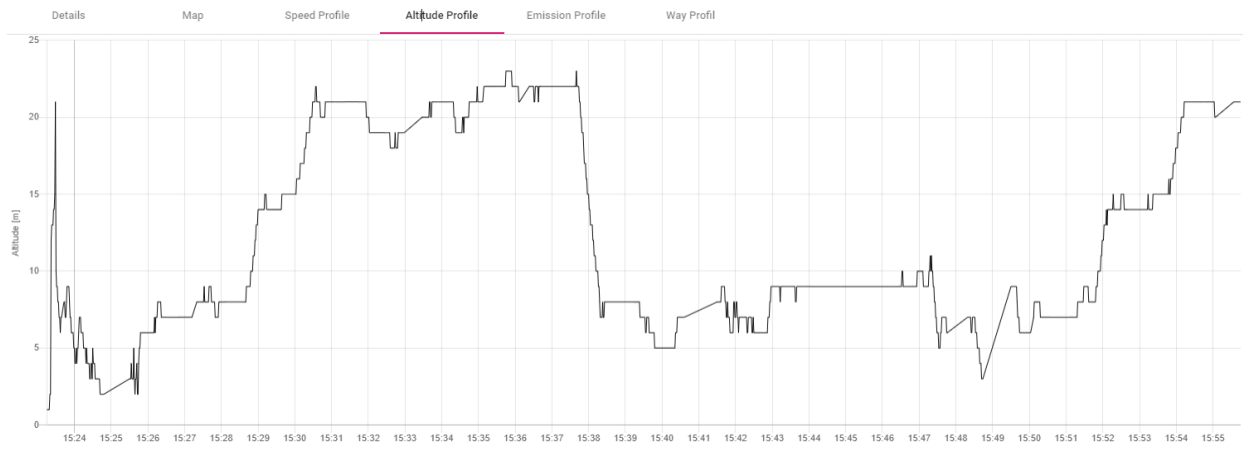


Figure 42 Altitude profile test #3

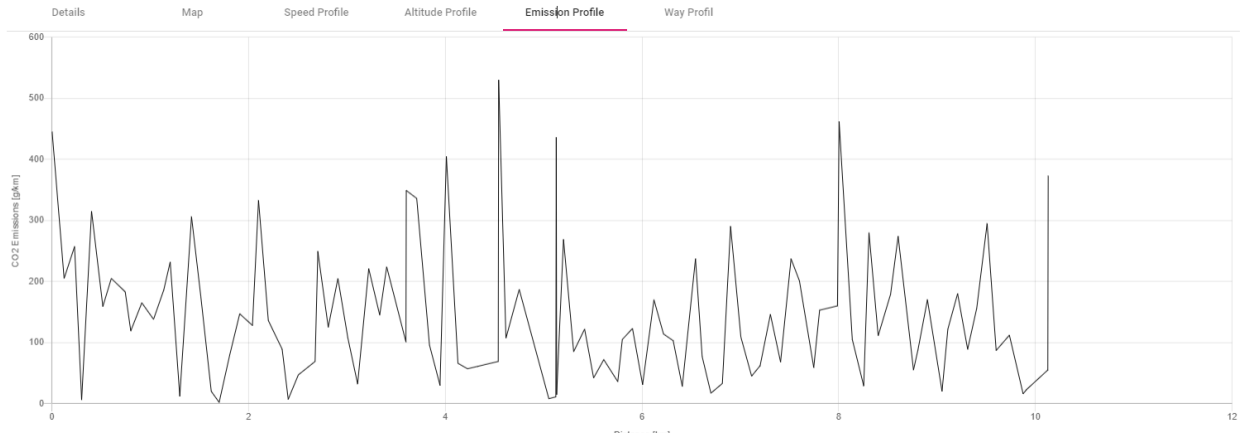


Figure 43 Emission profile test #3

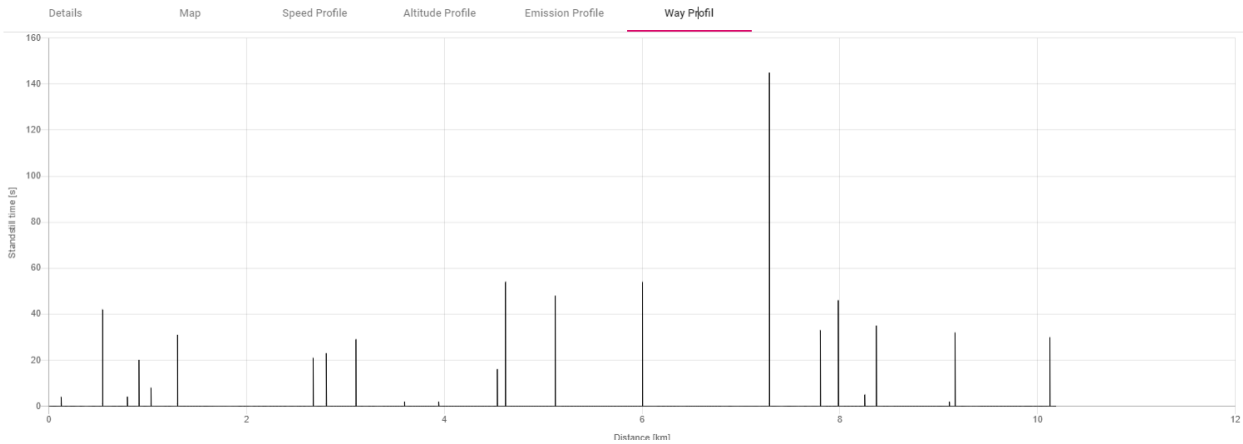


Figure 44 Way profile test #3

Error Description if test negative

Test was successful, no errors.

Proposal Solution if test negative

n.a

Test Protocol HH#4

Datum/Date: 06.04.2022 #4

Test case type (): Test (technical)

Tested by: T-Systems

Testszenario:

Testcase: Test LCMM	
Short description: Use of LCMM by running additional vehicle trip , collection of position data, feedback to driver, result overview at the LCMM portal	
App./Infrastructure: LCMM APP iOS Version 43.2 / Android Version 43.2	
Testcase Manager: *Ralf Grigutsch*	
Prerequisites	*Describe needed setup:* **LCMM as App and access to LCMM portal** **TAVF test field accessible** **5G Connectivity**
Necessary test data	*e.g. accounts, etc.* **Access data: Account rg.logi.drvc,** **Vehicle: rg.logi.jeep with standard car parameter**

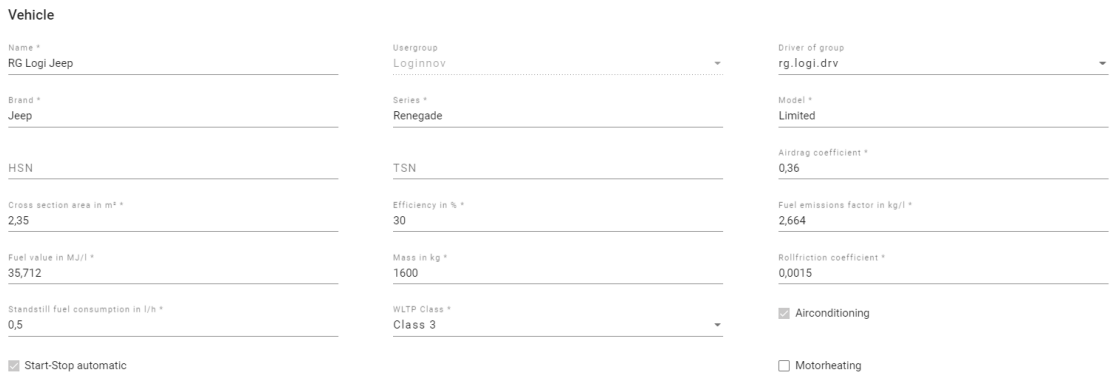


Figure 45 Vehicle configuration test #4

Aktivity — *Steps*

Step Name	Description	Expected Result
Step 1	Start iOS device	Device starts
Step 2	Check connectivity	5G Connectivity available
Step 3	Start LCMM App	Start screen visible
Step 4	Select vehicle	RG Logi Jeep selectable
Step 5	Login App with account @ iOS device	Login successful
Step 6	Select Expert Mode for further data during test trip	Expert mode screen available
Step 7	Position device near front windshield within prepared device holder	Fixed device near windshield
Step 8	Connect device with power cable	External power accessible

	Step 9	Start vehicle engine	Vehicle ready for test trip	
	Step 10	Push start button at LCMM App	Button changes to label ‘Stop’ and collection of position (GNSS) data starts	
	Step 11	Start test trip & collect data	Trip on the TAVF	
	Step 12	During Trip: Check (if possible) screen changes, hints and values in the LCMM APP	Changes of colour (green, yellow, red) available Counters for expert mode provide different numbers on collected GNSS data, communication (request – response)	
	Step 13	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data	
	Step 14	Ruin with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot	
	Step 15	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal	
	Step 16	Compare trip results with driver’s trip experience	Successful trip with LCMM	
	Step 17	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available	
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal*			

Test Result (including Screenshots, Photos etc.)

Expected results: yes

Details | Map | Speed Profile | Altitude Profile | Emission Profile | Way Profil

Vehicle RG Logi Jeep	Group name Loginnov.	Start time 06.04.2022, 15:55	End time 06.04.2022, 16:14
Route ★★★☆☆	Traffic ★★☆☆☆	Driving Behaviour ★★★☆☆	
Duration 0:17:58	Distance 5,3 km	Speed 17,7 km/h	Fuel Consumption 6,7 l/100km
CO2 Emission 0,9 kg	Zero fuel distance 816 m	Standstill time 0:07:10	ACC Cycle 164,2 %
Aero Cycle 94,6 %	Percentage Standstill Cycle 85,9 %	Percentage Work Cyle 136,3 %	Energy Performance Index (EPI) 4,2 l/100km*t
Acceleration Performance Index (API) 7,5 kWh/100km*t	AccWork 2,2 MJ	AeroWork 0,1 MJ	Standstill work 0,2 MJ
RollWork 0,1 MJ	GradeWork 0,3 MJ		
Cross section area 2.35 m²	Efficiency 30 %	Fuel emissions factor 2.664 kg/l	Fuel value 35.712 MJ/l
Mass 1600 kg	Rollfriction coefficient 0.0015	Standstill fuel consumption 0.5 l/h	Motorheating ☐
Airconditioning ☑	Start-Stop automatic ☑		

Figure 46 LCMM results test #4

Figure 47 Trip route test #4

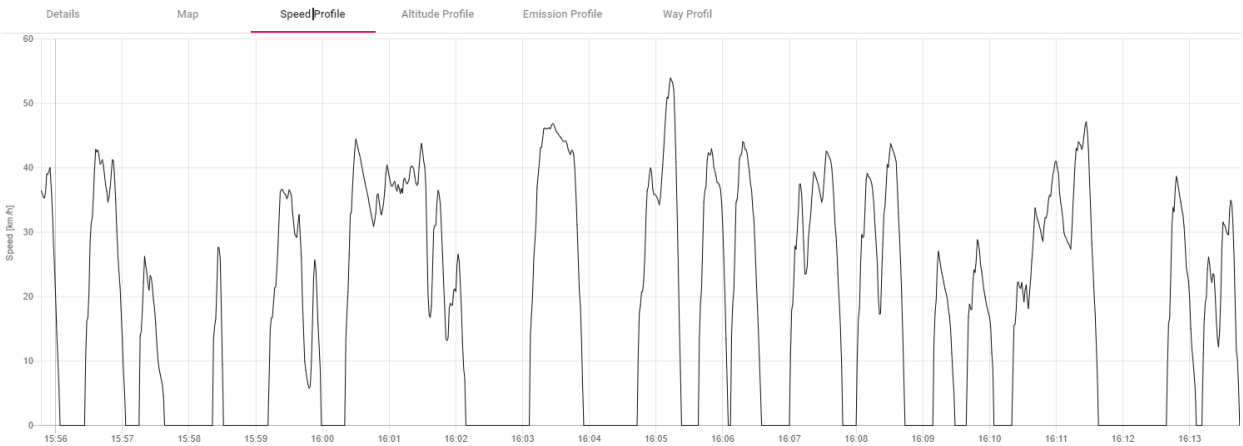


Figure 48 LCMM speed profile #4

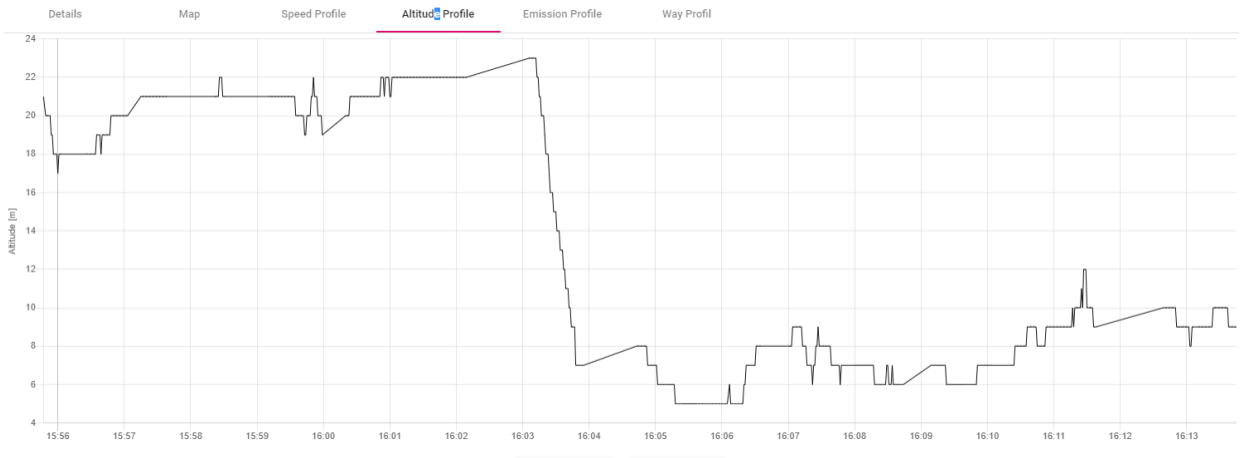


Figure 49 Altitude profile test #4

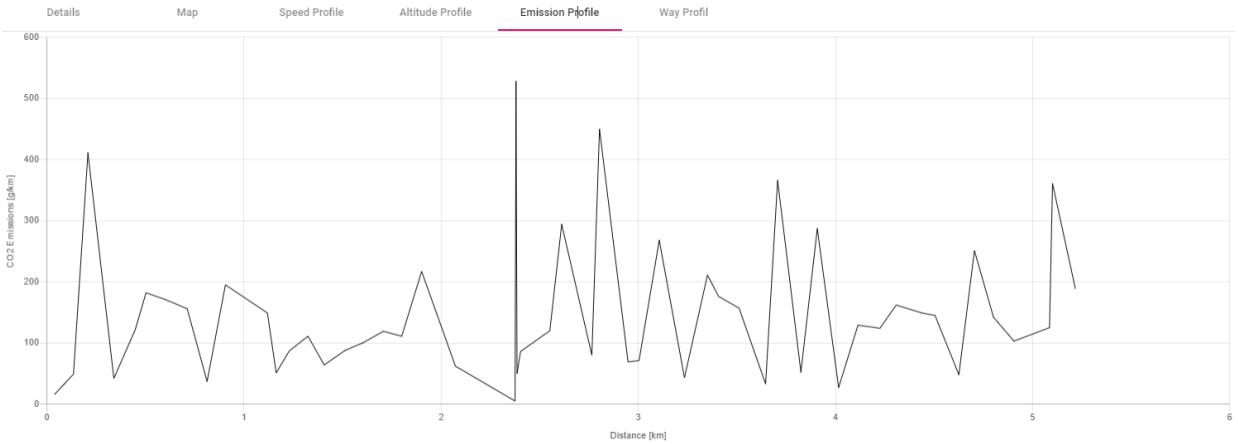


Figure 50 Emissions profile test #4

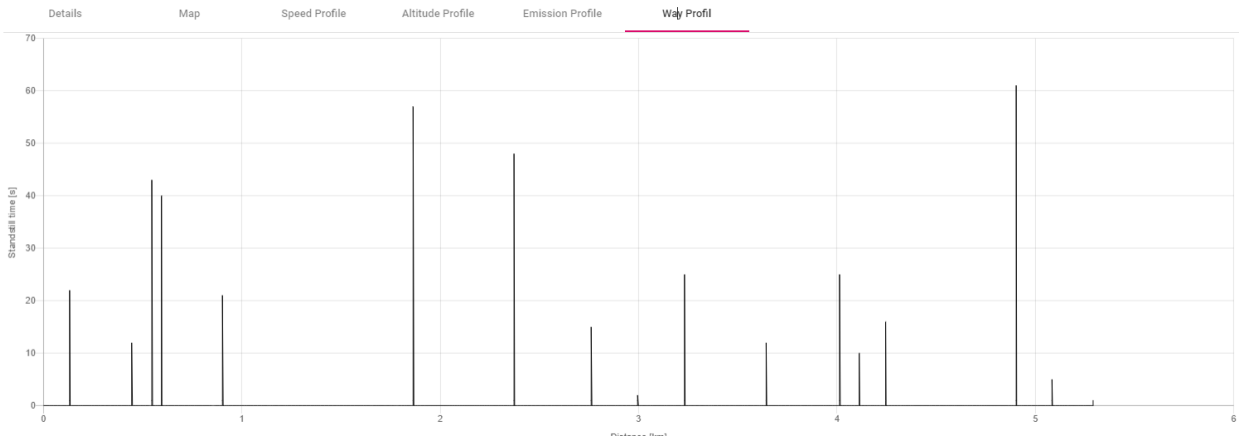


Figure 51 Way profile test #4

Error Description if test negative

Test was successful, no errors

Proposal Solution if test negative

n.a

Test Protocol HH#5

Datum/Date: ***06.04.2022***

Test case type (): ***Test (technical)***

Tested by: ***T-Systems***

Testszenario:

<table>
<tr><td colspan="2">Testcase: Test LCMM & GLOSA</td></tr>
<tr><td colspan="2">Short description:
Use of LCMM by running vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Use of GLOSA for traffic light forecast during trip.</td></tr>
<tr><td colspan="2">App./Infrastructure: LCMM APP iOS Version 43.2 and Traffic Light Assistant V1.1 (GLOSA) for Android</td></tr>
<tr><td colspan="2">Testcase Manager: Ralf Grigutsch</td></tr>
<tr><td>Prerequisites</td><td>Describe needed setup:
LCMM as App and access to LCMM portal
TAVF test field accessible
GLOSA App (no account needed)
GLOSA service at MEC</td></tr>
<tr><td>Necessary test data</td><td>e.g. accounts, etc.
Access data: Account rg.logi.drv,
Vehicle: rg.logi.jeep with standard car parameter
See Test Protocol #1 - #4</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start iOS & Android device</td><td>Devices start</td></tr>
<tr><td>Step 2</td><td>Check connectivity</td><td>5G Connectivity available</td></tr>
<tr><td>Step 3</td><td>Start LCMM App</td><td>Start screen visible</td></tr>
<tr><td>Step 4</td><td>Select vehicle</td><td>RG Logi Jeep selectable</td></tr>
<tr><td>Step 5</td><td>Login App with account @ iOS device</td><td>Login successful</td></tr>
<tr><td>Step 6</td><td>Select Expert Mode for further data during test trip</td><td>Expert mode screen available</td></tr>
<tr><td>Step 7</td><td>Position device near front windshield within prepared device holder</td><td>Fixed device near windshield</td></tr>
<tr><td>Step 8</td><td>Connect device with power cable</td><td>External power accessible</td></tr>
<tr><td>Step 9</td><td>Start vehicle engine</td><td>Vehicle ready for test trip</td></tr>
<tr><td>Step 10</td><td>Push start button at LCMM App</td><td>Button changes to label ‘Stop’ and collection of position (GNSS) data starts</td></tr>
<tr><td>Step 11</td><td>Start GLOSA App</td><td>App visible at Android device see current position on the road</td></tr>
<tr><td>Step 12</td><td>Start test trip @ collect data</td><td>Trip on the TAVF</td></tr>
</table></td></tr>
</table>

	Step 13	During Trip: Check (if possible) screen changes, hints and values in the LCMM APP	Changes of colour (green, yellow, red) available Counters for expert mode provide different numbers on collected GNSS data, communication (request – response)
	Step 14	During Trip: Check available information within GLOSA App. e.g. track, traffic light forecast, hint for driving behaviour	The driver will be informed on traffic light forecast in seconds and will be informed whether the next traffic light phase will be reached in time with current speed or to reduce speed.
	Step 15	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data
	Step 16	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
	Step 17	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal
	Step 18	Compare trip results with driver's trip experience	Successful trip with LCMM
	Step 19	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal. Use of GLOSA (App & MEC) for traffic light forecast during trips successful.*		

Test Result (including Screenshots, Photos etc.)

Expected results: LCMM yes (see Test Protocol #3), GLOSA partially yes, but revision of visualization needed

Figure 52 Setup onboard vehicle test #5

Error Description if test negative

From technical point of view GLOSA run well at TAVF, traffic light forecast and communication but within stillstand scenario during trips, e.g. waiting for green light at traffic light, the positioning of the vehicle on the screen was quite irritating. Moving GNSS positions within stillstand forces App to replace the vehicle on the screen by each second.
But we have recognized communication faults (Mobile Network) preparing the setup and during arrival and return to the TAVF. Potentially automatic switch between 4G and 5G network on the devices could be a reason for that. This behavior should be investigated and the device setup should set to '5G only' if possible.

Proposal Solution if test negative

Re-Test with different devices and setups suggested. Within stillstand scenario the vehicle on the screen should not move permanently, e.g. use of gyro sensor to detect stillstand during trips.

Test Protocol HH#6

Datum/Date: ***07.04.2022 #6***

Test case type (): ***Test (technical)***

Tested by: ***T-Systems***

Testszenario:

<table>
<tr><td colspan="2">Testcase: Re-Test LCMM & GLOSA</td></tr>
<tr><td colspan="2">Short description:
Use of LCMM during vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Use of GLOSA for traffic light forecast during trip.</td></tr>
<tr><td colspan="2">App./Infrastructure: LCMM APP iOS Version 43.2 and Traffic Light Assistant V1.1 (GLOSA) for Android</td></tr>
<tr><td colspan="2">Testcase Manager: Ralf Grigutsch</td></tr>
<tr><td>Prerequisites</td><td>Describe needed setup:
LCMM as App and access to LCMM portal
TAVF test field accessible
GLOSA App
GLOSA service at MEC</td></tr>
<tr><td>Necessary test data</td><td>e.g. accounts, etc.
Access data: Account rg.logi.drv,
Vehicle: rg.logi.jeep with standard car parameter
See Test Protocol #1 - #5</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start iOS & Android device</td><td>Devices start</td></tr>
<tr><td>Step 2</td><td>Check connectivity</td><td>5G Connectivity available</td></tr>
<tr><td>Step 3</td><td>Start LCMM App</td><td>Start screen visible</td></tr>
<tr><td>Step 4</td><td>Select vehicle</td><td>RG Logi Jeep selectable</td></tr>
<tr><td>Step 5</td><td>Login App with account @ iOS device</td><td>Login successful</td></tr>
<tr><td>Step 6</td><td>Select Expert Mode for further data during test trip</td><td>Expert mode screen available</td></tr>
<tr><td>Step 7</td><td>Position device near front windshield within prepared device holder</td><td>Fixed device near windshield</td></tr>
<tr><td>Step 8</td><td>Connect device with power cable</td><td>External power accessible</td></tr>
<tr><td>Step 9</td><td>Start vehicle engine</td><td>Vehicle ready for test trip</td></tr>
<tr><td>Step 10</td><td>Push start button at LCMM App</td><td>Button changes to label ‘Stop’ and collection of position (GNSS) data starts</td></tr>
<tr><td>Step 11</td><td>Start GLOSA App</td><td>App visible at Android device see current position on the road</td></tr>
<tr><td>Step 12</td><td>Start test trip @ collect data</td><td>Trip on the TAVF</td></tr>
<tr><td>Step 13</td><td>During Trip: Check (if possible) screen changes, hints and values in the LCMM APP</td><td>Changes of colour (green, yellow, red) available
Counters for expert mode provide different numbers on collected GNSS data,</td></tr>
</table></td></tr>
</table>

			communication (request – response)
	Step 14	During Trip: Check available information within GLOSA App. e.g. track, traffic light forecast, hint for driving behaviour	The driver will be informed on traffic light forecast in seconds and will be informed whether the next traffic light phase will be reached in time with current speed or to reduce speed.
	Step 15	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data
	Step 16	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
	Step 17	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal
	Step 18	Compare trip results with driver's trip experience	Successful trip with LCMM
	Step 19	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal. Use of GLOSA for traffic light forecast during trips successful.*		

Test Result (including Screenshots, Photos etc.)

Expected results: LCMM yes (see Test Protocol #4), GLOSA partially yes, but revision of visualization needed. After change of devices no other results then test #5. Need to retest in the next planned test week with additional setups.

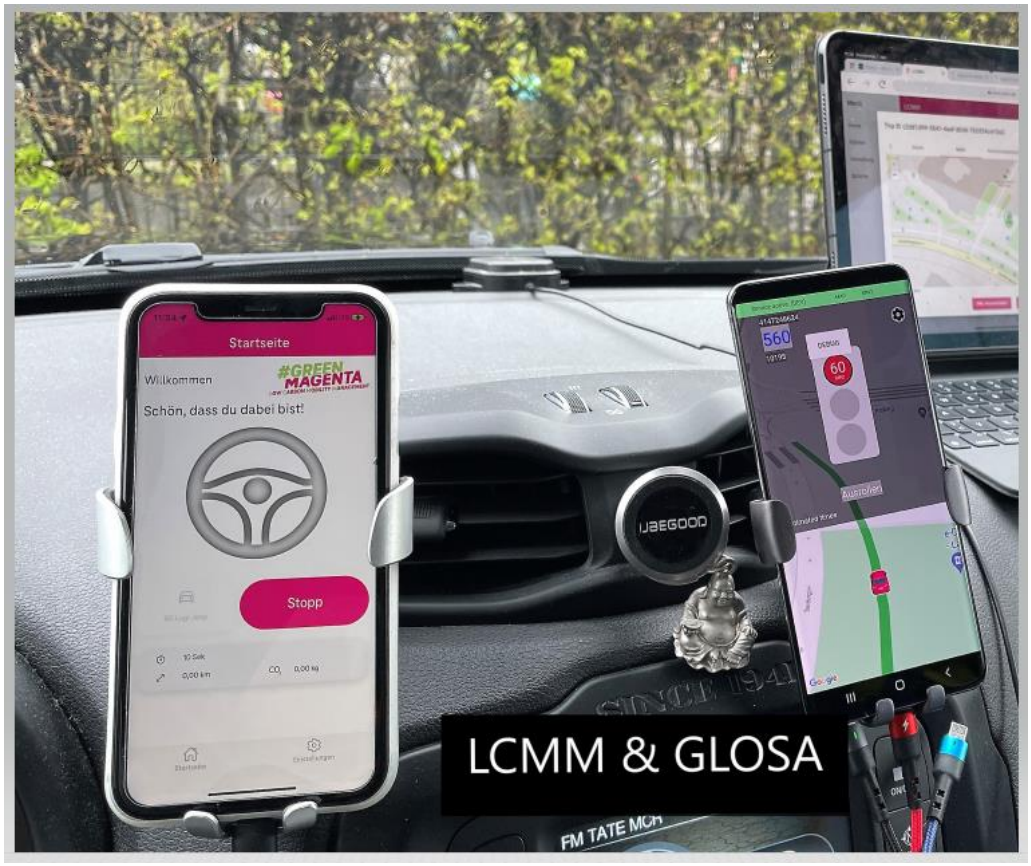


Figure 53 Setup onboard vehicle test #6 (Re test GLOSA)

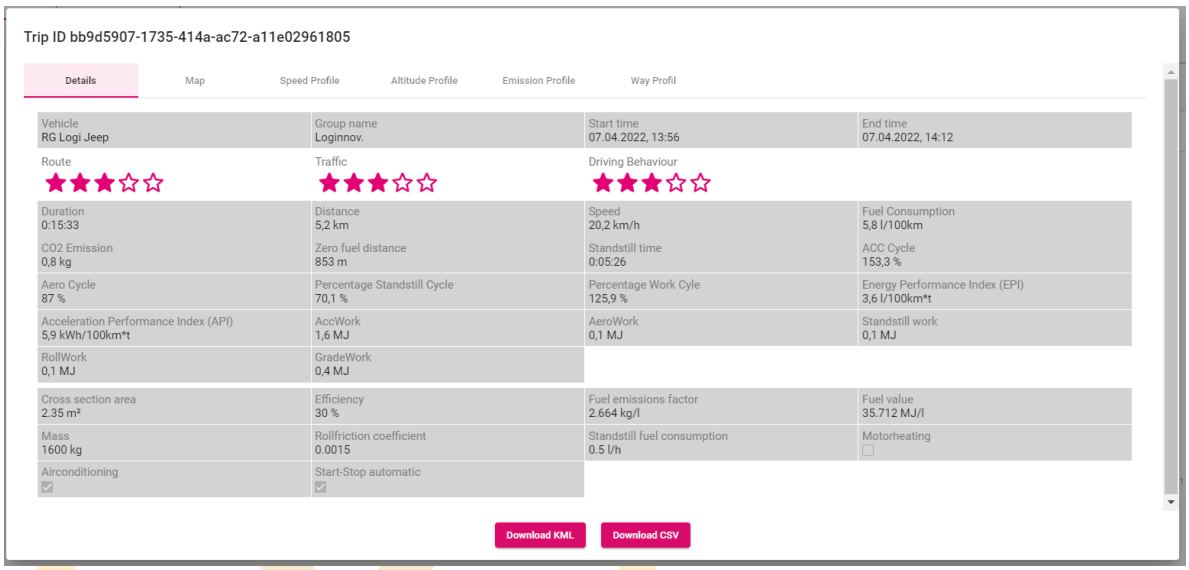


Figure 54 LCMM results test #6 (Re test GLOSA)

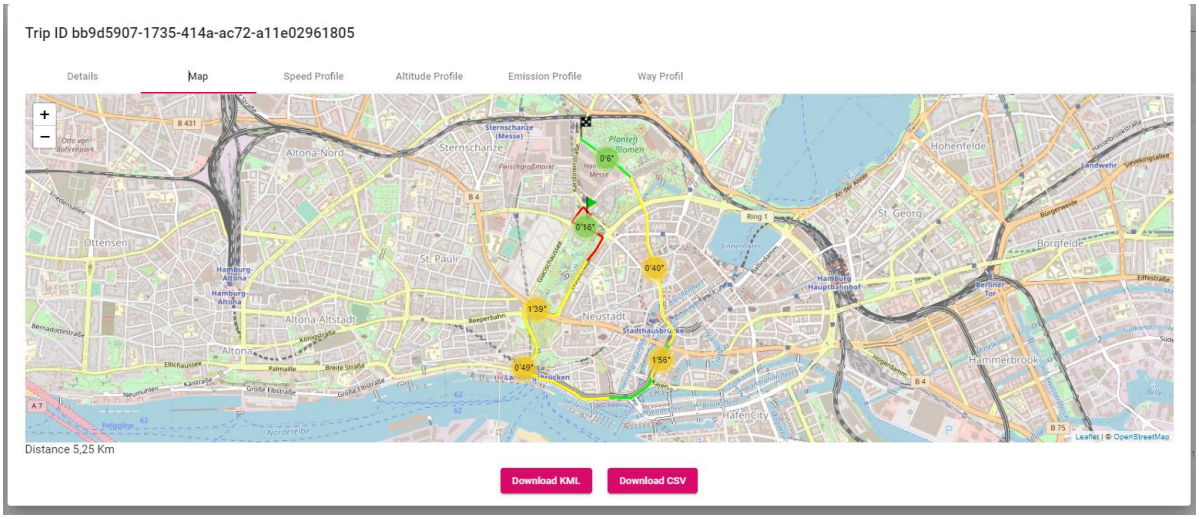


Figure 55 Trip route test #6 (Re test GLOSA)

Error Description if test negative

From technical point of view GLSOA run well, traffic light forecast, communication but within stillstand scenario during trips, e.g. waiting for green light at traffic light, the positioning of the vehicle on the screen was irritating. Moving GNSS positions within stillstand forces App to replace the vehicle on the screen by each second.

But we have recognized communication faults (Mobile Network) preparing the setup and during arrival and return to the TAVF. Potentially automatic switch between 4G and 5G network on the devices could be a reason for that. This behavior should be investigated and the device setup should set o '5G only', if possible.

Proposal Solution if test negative

Re-Test with different devices and setups suggested. Within stillstand scenario the vehicle on the screen should not move permanently. Use gyro sensor to detect stillstand during trips.

Test Protocol HH#7

Datum/Date: ***06.04.2022 #7***

Test case type (): ***Test (technical)***

Tested by: ***T-Systems***

Testszenario:

Testcase: Test LCMM @ Skylark	
Short description: Use of LCMM @ Skylark device, collection of position data by Skylark (precise position service), result overview at the LCMM portal.	
App./Infrastructure: LCMM @ Skylark on Skylark device and LCMM, LCMM APP iOS Version 43.2	
Testcase Manager: *Ralf Grigutsch*	
Prerequisites	*Describe needed setup:* **LCMM App and LCMM portal** **TAVF test field accessible** **Skylark device and account** **LCMM core application at Skylark device**
Necessary test data	*e.g. accounts, etc.* **Skylark account** **Access data: Account rg.logi.drv,** **Vehicle: rg.logi.jeep with standard car parameter and ps skylark test**

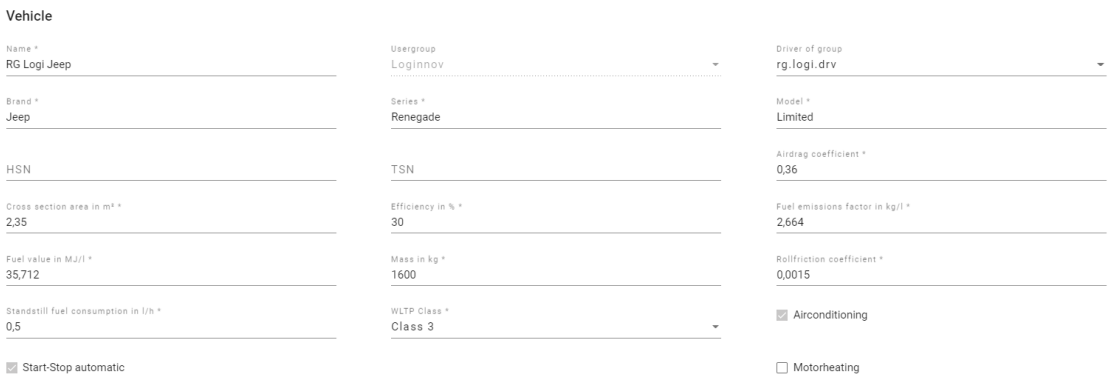


Figure 56 Vehicle configuration LCMM App test #7

Figure 57 Vehicle configuration LCMM @ Skylark test #7

Activity

Step Name	Description	Expected Result
Step 1	Start iOS device	Devices start
Step 2	Check connectivity	5G Connectivity available
Step 3	Start LCMM App	Start screen visible
Step 4	Select vehicle	RG Logi Jeep selectable
Step 5	Login App with account @ iOS device	Login successful
Step 6	Deploy antenna for skylark device near windshield	Antenna deployed
Step 7	Connect Skylark device with surf stick	Surf stick connected
Step 8	Connect device with power cable	Power on
Step 9	Start vehicle engine	Vehicle ready
Step 10	Wait for device to boot and start sending data	Vehicle ready for test trip
Step 11	Start test trip with Skylark and LCMM and collect data	Trip on the TAVF
Step 12	During Trip: Check (if possible) LCMM UI	Vehicle passenger checks at LCMM portal collect data and trip routes
Step 13	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
Step 14	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal
Step 15	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available

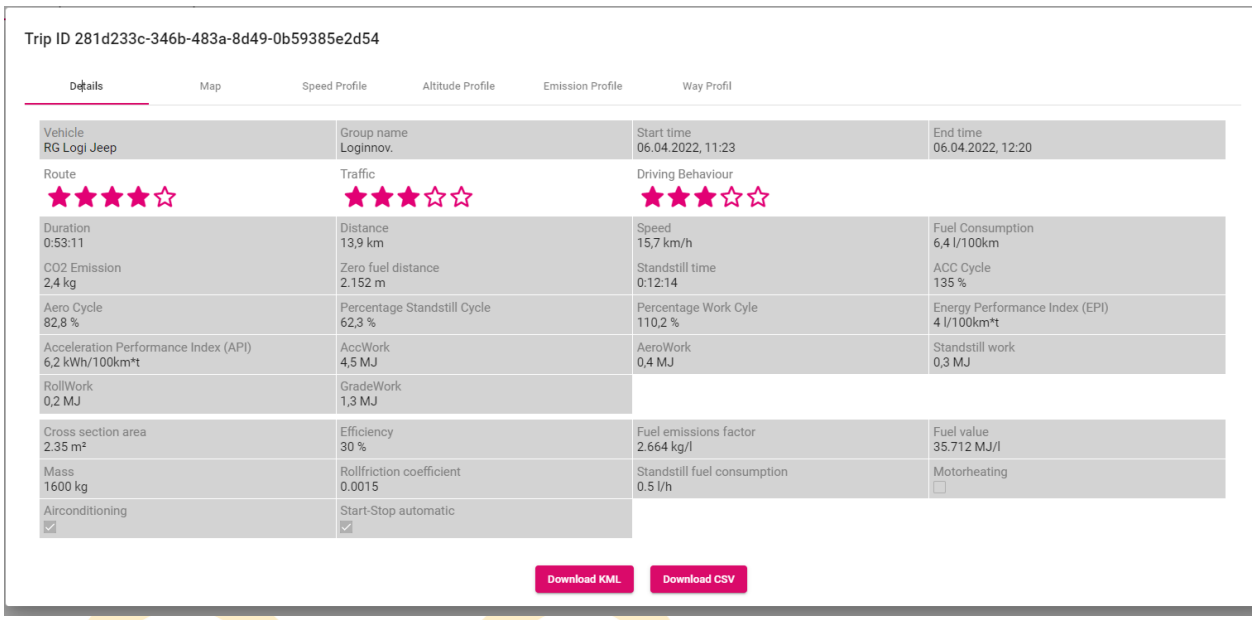
Expected result:

See column Use of LCMM @ Skylark device, Collection of position data, result overview at the LCMM portal. Obviously trip routes are 'equal'. Analysis of accuracy not objective during technical tests.

Test Result (including Screenshots, Photos etc.)

Expected results fulfilled: Data available, data quality insufficient

Figure 58 Skylark device onboard test vehicle test #7



Trip ID 281d233c-346b-483a-8d49-0b59385e2d54

Details | Map | Speed Profile | Altitude Profile | Emission Profile | Way Profil

Vehicle: RG Logi Jeep	Group name: Loginnov.	Start time: 06.04.2022, 11:23	End time: 06.04.2022, 12:20
Route: ★★★★☆	Traffic: ★★★☆☆	Driving Behaviour: ★★★☆☆	
Duration: 0:53:11	Distance: 13,9 km	Speed: 15,7 km/h	Fuel Consumption: 6,4 l/100km
CO2 Emission: 2,4 kg	Zero fuel distance: 2.152 m	Standstill time: 0:12:14	ACC Cycle: 135 %
Aero Cycle: 82,8 %	Percentage Standstill Cycle: 62,3 %	Percentage Work Cyle: 110,2 %	Energy Performance Index (EPI): 4 l/100km*t
Acceleration Performance Index (API): 6,2 kWh/100km*t	AccWork: 4,5 MJ	AeroWork: 0,4 MJ	Standstill work: 0,3 MJ
RollWork: 0,2 MJ	GradeWork: 1,3 MJ		
Cross section area: 2.35 m²	Efficiency: 30 %	Fuel emissions factor: 2.664 kg/l	Fuel value: 35.712 MJ/l
Mass: 1600 kg	Rollfriction coefficient: 0.0015	Standstill fuel consumption: 0.5 l/h	Motorheating: ☐
Airconditioning: ☑	Start-Stop automatic: ☑		

Download KML | Download CSV

Figure 59 LCMM results LCMM App test #7

Figure 60 LCMM Trip route test #7

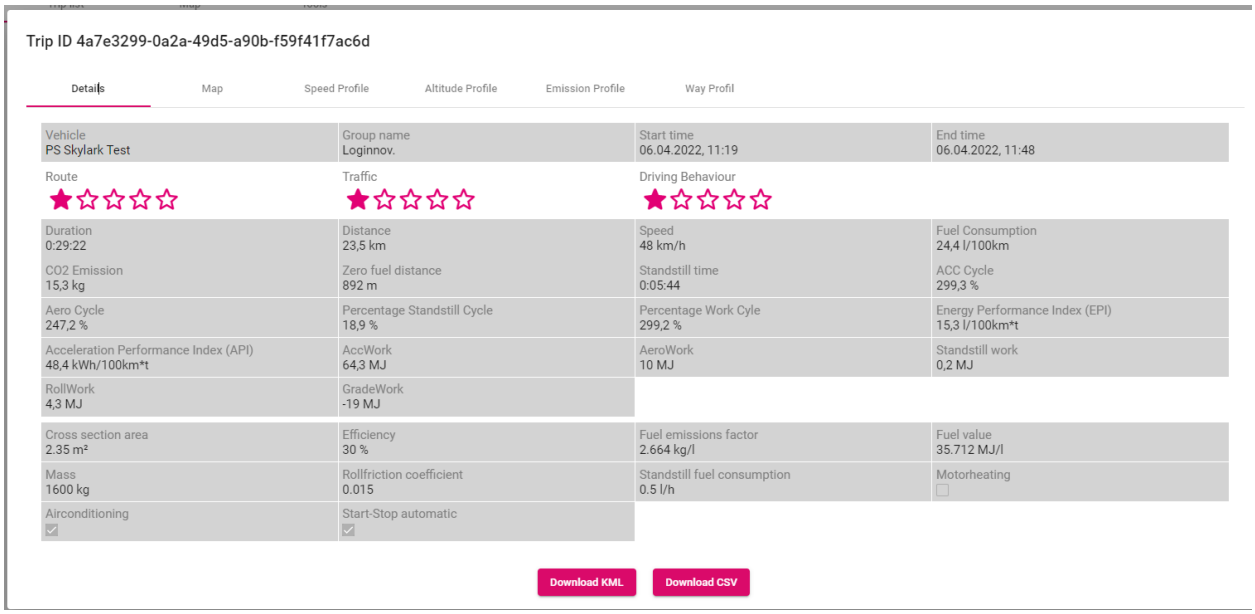


Figure 61 LCMM results LCMM @ Skylark test #7

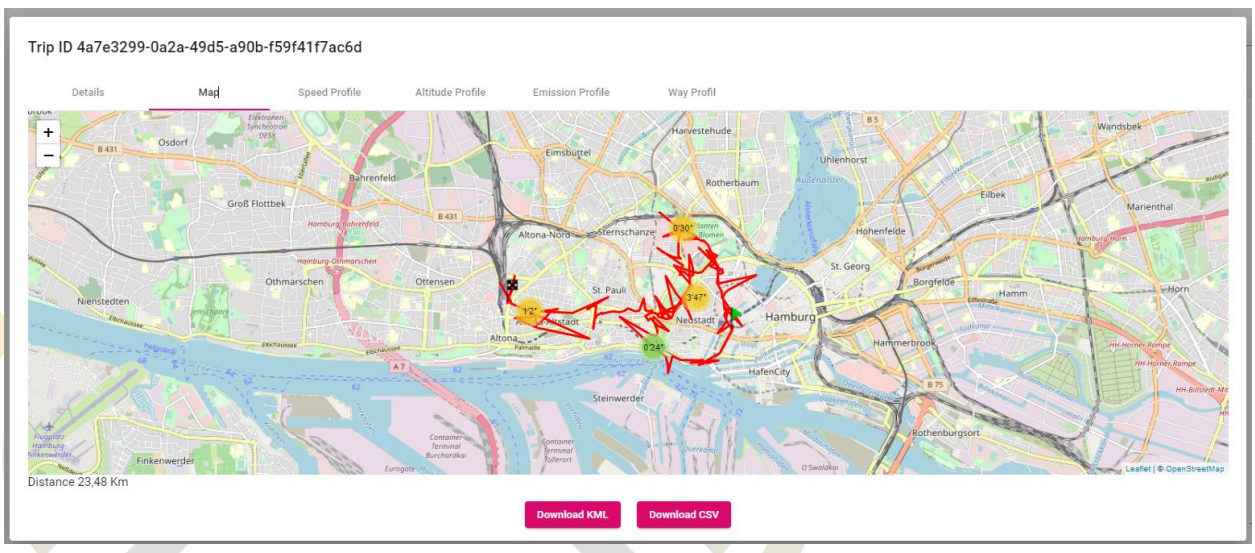


Figure 62 LCMM @ Skylark trip route test #7

Error Description if test negative

Position data by skylark available but positions always deviate from real position and position collected by LCMM with standard device. Data by Skylark not useable for LCMM analysis or further analysis.

Proposal Solution if test negative

Unclear why Skylark device data spread over the test area. Assumptions on loss of connectivity, loss of electric power (Start-Stop of vehicle), configuration error or defects on antenna or device.

Options for needed retest during next test option.

Reset device and/or account
Use different antenna
Replace antenna
Use another device or antenna
Skylark software configuration to be checked

Test Protocol HH#8

Datum/Date: ***07.04.2022 #8***

Test case type (): ***Test (technical)***

Tested by: ***T-Systems***

Testszenario:

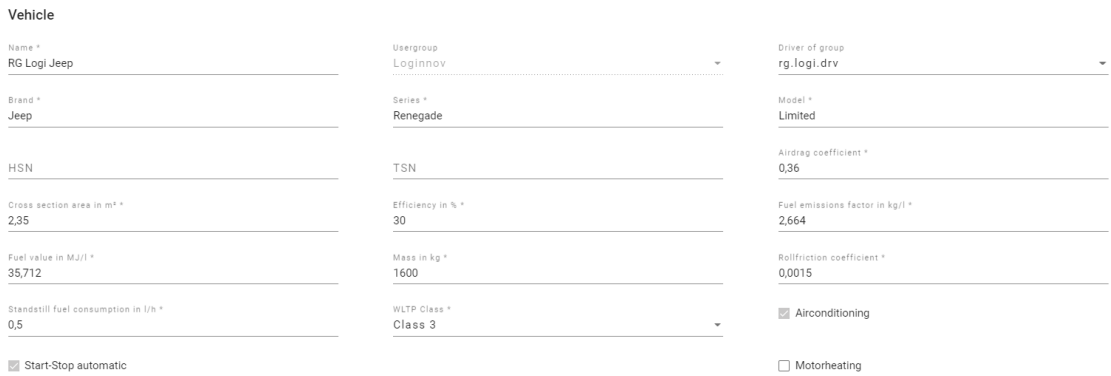
<table>
<tr><td colspan="2">Testcase: Test LCMM @ Skylark</td></tr>
<tr><td colspan="2">Short description: Use of LCMM @ Skylark device, collection of position data by Skylark (precise position service), result overview at the LCMM portal.</td></tr>
<tr><td colspan="2">App./Infrastructure: LCMM @ Skylark on Skylark device</td></tr>
<tr><td colspan="2">Testcase Manager: Ralf Grigutsch</td></tr>
<tr><td>Prerequisites</td><td>Describe needed setup:
LCMM App and LCMM portal
TAVF test field accessible
Skylark device and account
LCMM core application at Skylark device</td></tr>
<tr><td>Necessary test data</td><td>e.g. accounts, etc.
Skylark account
Access data: Account rg.logi.drv,
Vehicle: rg.logi.jeep with standard car parameter and ps skylark test
 

Figure 63 Vehicle configuration LCMM @ Skylark test #8</td></tr>
<tr><td>Activity</td><td>
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start iOS device</td><td>Devices start</td></tr>
<tr><td>Step 2</td><td>Check connectivity</td><td>5G Connectivity available</td></tr>
<tr><td>Step 3</td><td>Start LCMM App</td><td>Start screen visible</td></tr>
<tr><td>Step 4</td><td>Select vehicle</td><td>RG Logi Jeep selectable</td></tr>
<tr><td>Step 5</td><td>Login App with account @ iOS device</td><td>Login successful</td></tr>
<tr><td>Step 6</td><td>Deploy antenna for skylark device near windshield</td><td>Antenna deployed</td></tr>
<tr><td>Step 7</td><td>Connect Skylark device with surf stick</td><td>Surf stick connected</td></tr>
<tr><td>Step 8</td><td>Connect device with power cable</td><td>Power on</td></tr>
<tr><td>Step 9</td><td>Start vehicle engine</td><td>Vehicle ready</td></tr>
</table>
</td></tr>
</table>

	Step 10	Wait for device to boot and start sending data	Vehicle ready for test trip	
	Step 11	Start test trip with Skylark and LCMM and collect data	Trip on the TAVF	
	Step 12	During Trip: Check (if possible) LCMM UI	Vehicle passenger checks at LCMM portal collect data and trip routes	
	Step 13	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot	
	Step 14	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal	
	Step 15	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available	
Expected result:	*See column Use of LCMM @ Skylark device, Collection of position data, result overview at the LCMM portal. Obviously trip routes are 'equal'. Analysis of accuracy not objective during technical tests.*			

Test Result (including Screenshots, Photos etc.)

Expected results fulfilled: yes

By using different skylark device with the skylark account the test trip was successful by using a different vehicle. With regards to Test Protocol #7 the skylark device seems to have a defect.
The following trip data with skylark position data have calculated by LCMM.

Figure 64 Vehicle onboard view for Re test Skylark at different vehicle test #8

Vehicle PS platoon test	Group name T-Systems.	Start time 07.04.2022, 13:56	
Route ★★★☆☆	Traffic ★★☆☆☆	Driving Behaviour ★☆☆☆☆	
Duration 0:45:26	Distance 16 km	Speed 21,2 km/h	Fuel Consumption 5,6 l/100km
CO2 Emission 2,4 kg	Zero fuel distance 0 m	Standstill time 0:15:24	ACC Cycle 161,1 %
Aero Cycle 48,2 %	Percentage Standstill Cycle 85 %	Percentage Work Cyle 143,7 %	Energy Performance Index (EPI) 4,3 l/100km*t
Acceleration Performance Index (API) 6,7 kWh/100km*t	AccWork 4,6 MJ	AeroWork 0,6 MJ	Standstill work 0,3 MJ
RollWork 2 MJ	GradeWork 0,4 MJ		
Cross section area 2.57 m²	Efficiency 25 %	Fuel emissions factor 2.664 kg/l	Fuel value 35.712 MJ/l
Mass 1305 kg	Rollfriction coefficient 0.015	Standstill fuel consumption 0.5 l/h	Motorheating ☐
Airconditioning ☐	Start-Stop automatic ☑		

Figure 65 LCMM results by LCMM App test #8

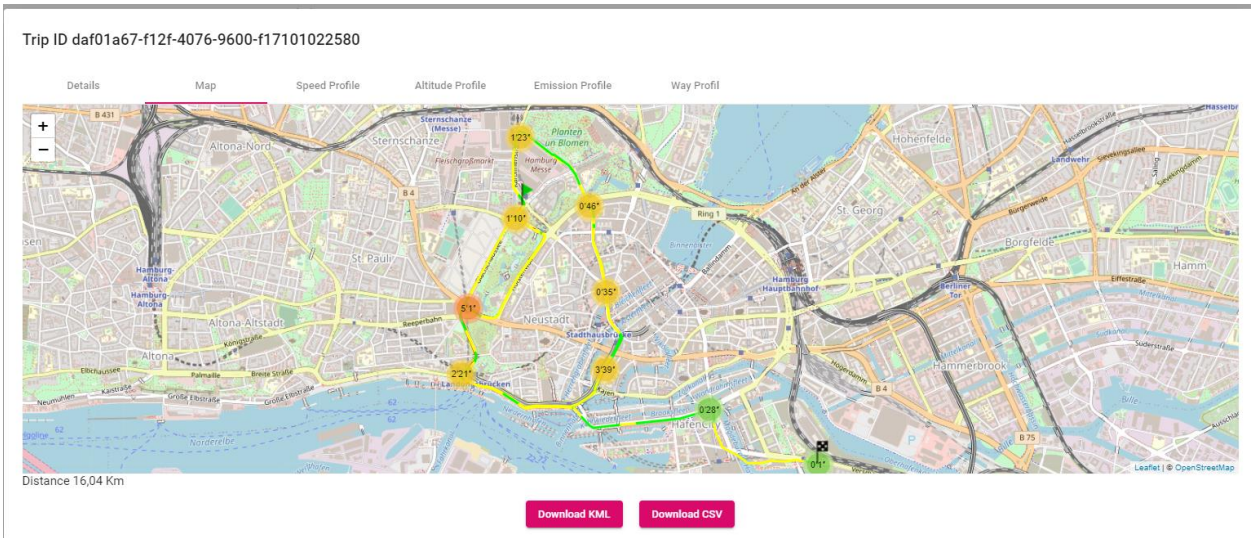


Figure 66 LCMM @ Skylark trip route test #8

Error Description if test negative

Test successful. It is assumed that the skylark of test #7 has a defect. Within the next planned test week addition iterations of the test should be performed to verify the assumption.

Proposal Solution if test negative

n.a.

Test Protocol HH#9

Datum/Date: 07.04.2022 #9

Test case type (): Test (technical)

Tested by: Continental

Testszenario:

<table>
<tr><td colspan="2">Testcase: data collection using Continental IoT device 351940280066111</td></tr>
<tr><td colspan="2">Short description: Collection of position data, including vehicle speed, acceleration, altitude</td></tr>
<tr><td colspan="2">App./Infrastructure:</td></tr>
<tr><td colspan="2">Testcase Manager: Alex Budisan</td></tr>
<tr><td>Prerequisites</td><td>Continental IoT device connected to test vehicle</td></tr>
<tr><td>Necessary test data</td><td>-</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Connect IoT device to power source</td><td>IoT device can be powered on</td></tr>
<tr><td>Step 2</td><td>Fix GNSS and GPS antennas near windshield</td><td>Antennas are in place</td></tr>
<tr><td>Step 3</td><td>Connect IoT device to CAN interface</td><td>IoT device has inductive connection to vehicle CAN interface</td></tr>
<tr><td>Step 4</td><td>Turn ignition on</td><td>IoT device is powered on and starts connection to cellular network</td></tr>
<tr><td>Step 5</td><td>Start test drive</td><td>IoT device collects location and vehicle data</td></tr>
<tr><td>Step 6</td><td>Stop test drive and turn ignition off</td><td>IoT device powers off</td></tr>
</table></td></tr>
<tr><td>Expected result</td><td>All data from trip is collected (e.g. GNSS data, fuel consumption)</td></tr>
</table>

Test Result (including Screenshots, Photos etc.)

Expected result: ok

Figure 67 Entruck and Conti IoT devices installed in same vehicle

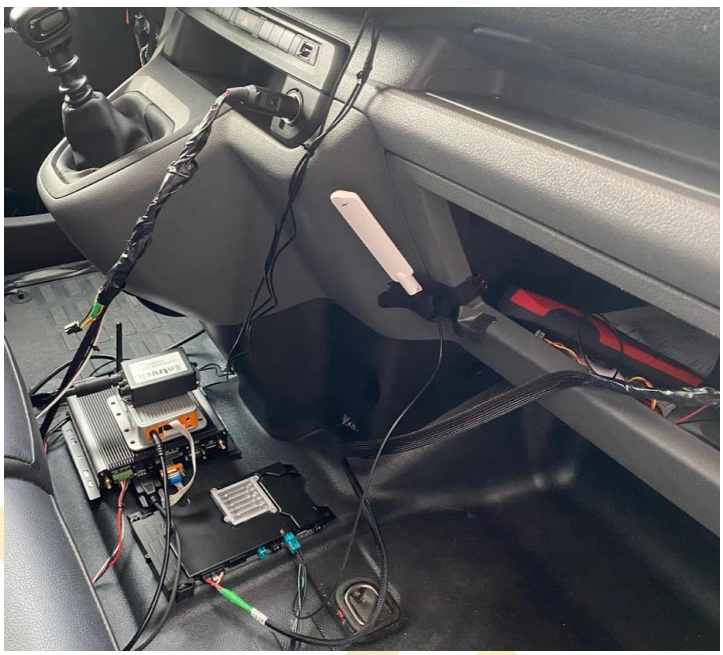


Figure 68 Entruck and Conti IoT devices installed in same vehicle (antennas also pictured)

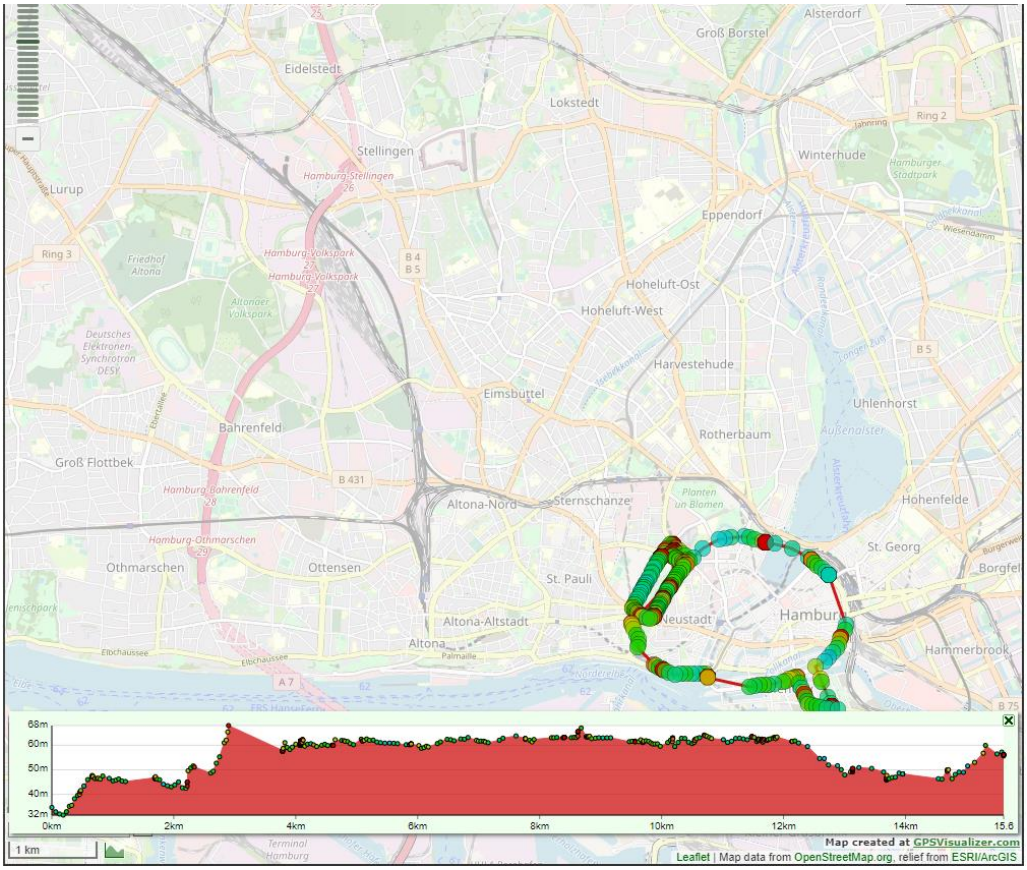


Figure 69 Data collected over test drive from device 351940280066111

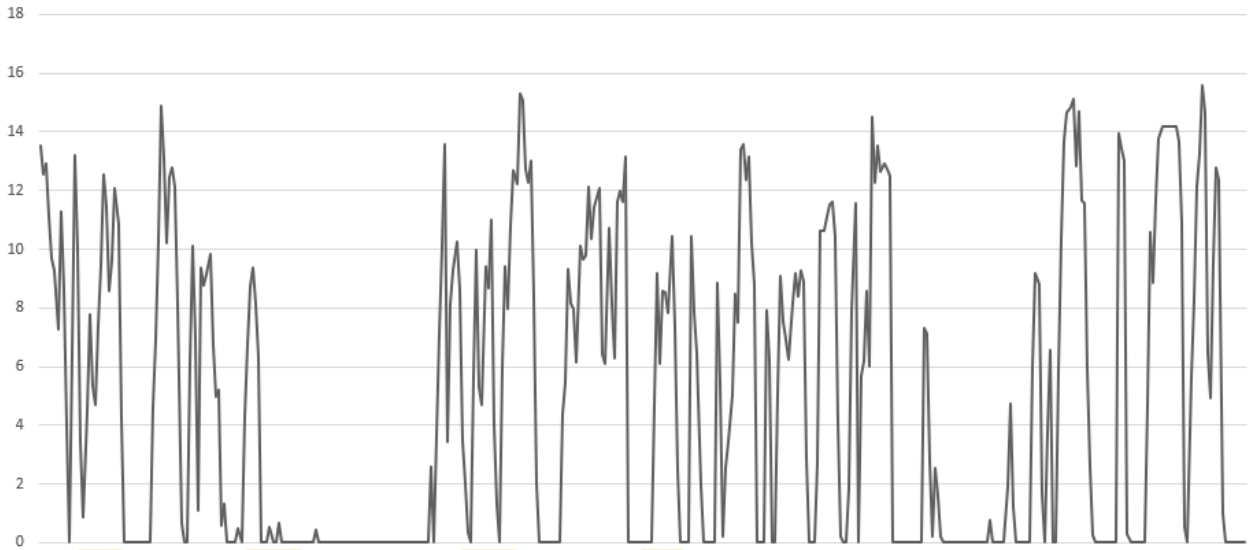


Figure 70 Vehicle speed over test drive (values in m/s)

Error Description if test negative

Test successful

Proposal Solution if test negative

n.a.

Test Protocol HH#10

Datum/Date: 07.04.2022

Test case type (): Test (technical)

Tested by: Continental

Testszenario:

Testcase: data collection using Continental IoT device 351940280066434	
Short description: Collection of position data, including vehicle speed, acceleration, altitude	
App./Infrastructure:	
Testcase Manager: *Alex Budisan*	
Prerequisites	*Continental IoT device connected to test vehicle*
Necessary test data	-
Aktivity	*Steps*
Expected result	*All data from trip is collected (e.g. GNSS data, fuel consumption)*

Step Name	Description	Expected Result
Step 1	Connect IoT device to power source	IoT device can be powered on
Step 2	Fix GNSS and GPS antennas near windshield	Antennas are in place
Step 3	Connect IoT device to CAN interface	IoT device has inductive connection to vehicle CAN interface
Step 4	Turn ignition on	IoT device is powered on and starts connection to cellular network
Step 5	Start test drive	IoT device collects location and vehicle data
Step 6	Stop test drive and turn ignition off	IoT device powers off

Test Result (including Screenshots, Photos etc.)

Expected result: ok

Figure 71 Entruck and Conti IoT devices installed in same vehicle

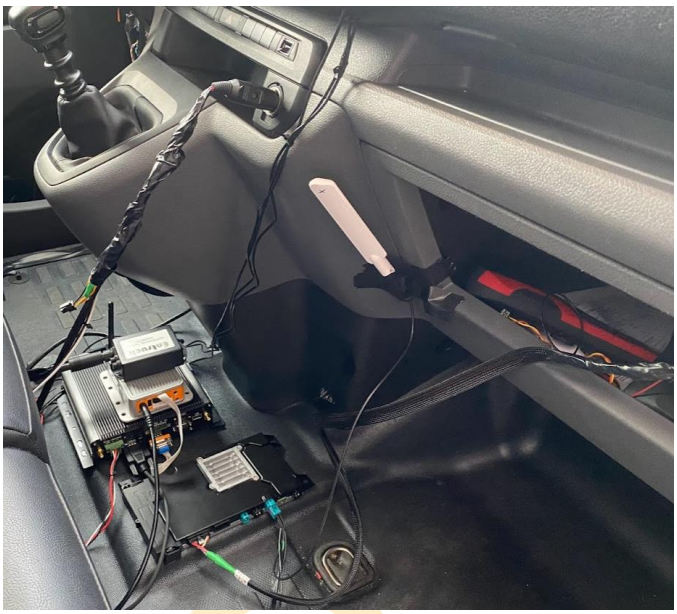


Figure 72 Entruck and Conti IoT devices installed in same vehicle (antennas also pictured)

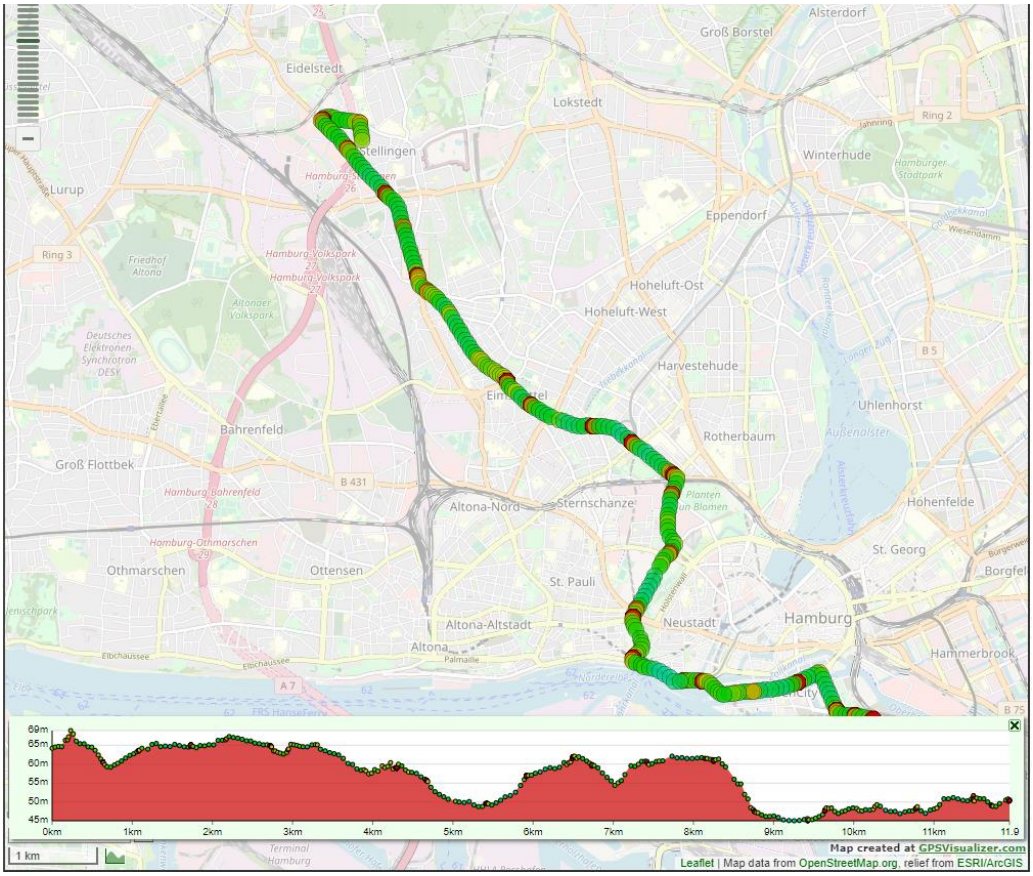


Figure 73 Data collected over test drive from device 351940280066434

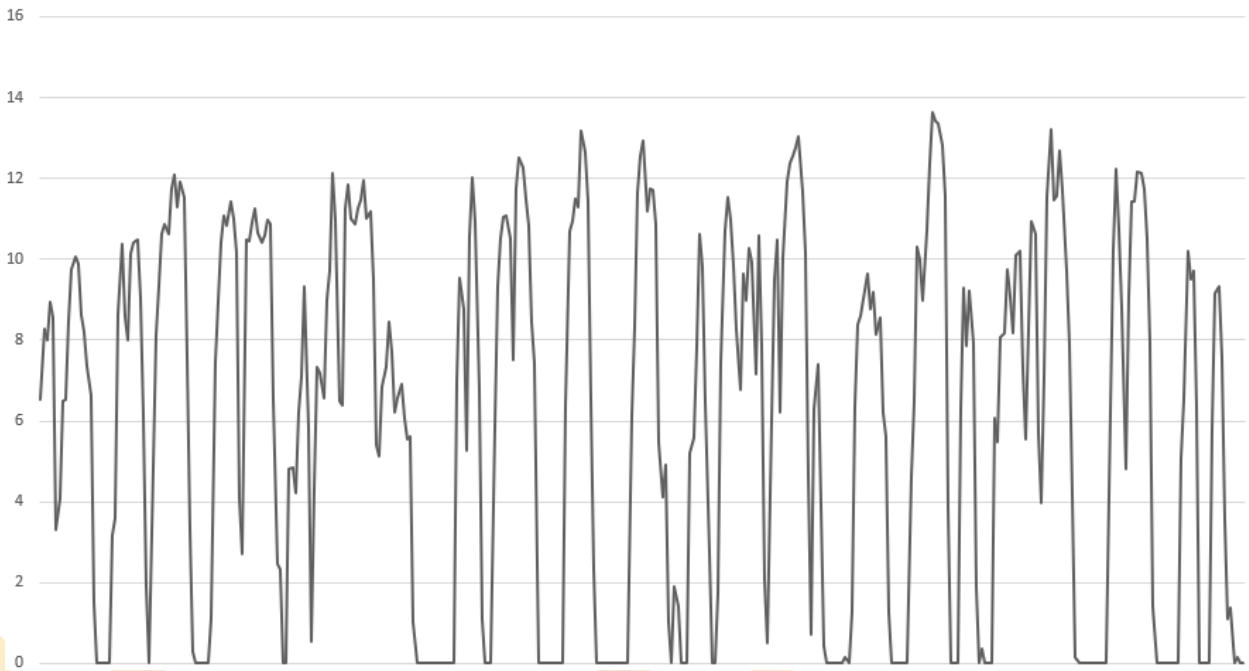


Figure 74 Vehicle speed over test drive (values in m/s)

Error Description if test negative

Test sucessful

Proposal Solution if test negative

n.a.

Test Protocol HH#11

Datum/Date: ***24.05.2022 #11***

Test case type (): ***Test (technical)***

Tested by: T-Systems

Testszenario:

Testcase: Test LCMM @ Skylark	
Short description: Use of LCMM @ Skylark device, collection of position data by Skylark (precise position service), result overview at the LCMM portal. **Re test with regards to test #7 and test #8, verify assumption one Skylark device has a defect.**	
App./Infrastructure: LCMM @ Skylark on Skylark device, LCMM APP iOS Version 43.2	
Testcase Manager: *Ralf Grigutsch*	
Prerequisites	*Describe needed setup:* **LCMM App and LCMM portal** **TAVF test field accessible** **Skylark device and account** **LCMM core application at Skylark device**
Necessary test data	*e.g. accounts, etc.* **Skylark account** **Access data: Account rg.logi.drv,** **Vehicle: rg.logi.jeep with standard car parameter and ps skylark test**

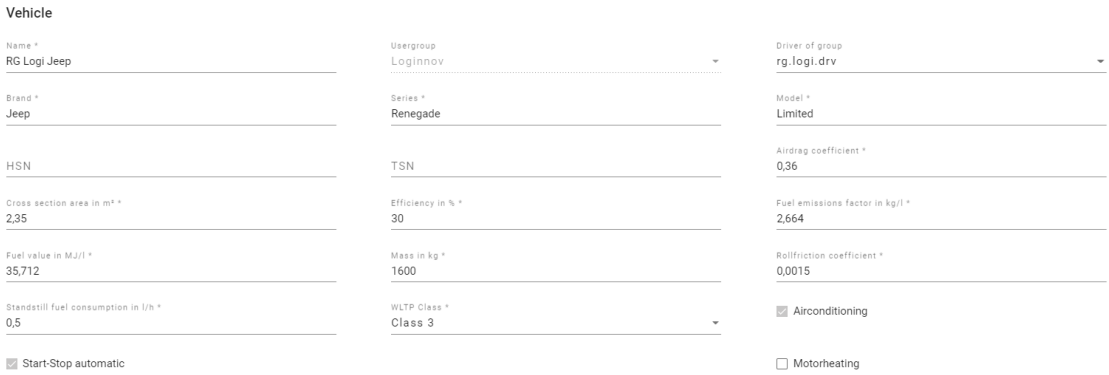


Figure 75 Vehicle configuration LCMM App test #11

Figure 76 Vehicle configuration LCMM @ Skylark test #11

Activity

Step Name	Description	Expected Result
Step 1	Start iOS device	Devices start
Step 2	Check connectivity	5G Connectivity available
Step 3	Start LCMM App	Start screen visible
Step 4	Select vehicle	RG Logi Jeep selectable
Step 5	Login App with account @ iOS device	Login successful
Step 6	Deploy antenna for skylark device near windshield	Antenna deployed
Step 7	Connect Skylark device with surf stick	Surf stick connected
Step 8	Connect device with power cable	Power on
Step 9	Start vehicle engine	Vehicle ready
Step 10	Wait for device to boot and start sending data	Vehicle ready for test trip
Step 11	Start test trip with Skylark and LCMM and collect data	Trip on the TAVF
Step 12	During Trip: Check (if possible) LCMM UI	Vehicle passenger checks at LCMM portal collect data and trip routes
Step 13	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
Step 14	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal
Step 15	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Numbers are available

Expected result:

See column Use of LCMM @ Skylark device, Collection of position data, result overview at the LCMM portal. Trip routes are 'equal'. Analysis of accuracy not objective during technical tests.

Test Result (including Screenshots, Photos etc.)

Expected results: yes

Based on the results and assumption of test #7 and test #8 the developer tests did not confirm a defect of one Skylark devices (indoor lab tests) but identified a different configuration of the Skylark devices.

Important for the configuration and the placement of the Skylark device onboard are the parameters for device orientation settings and calibration. These configuration needs to be aligned to the placement within the vehicle and to the vehicle front.

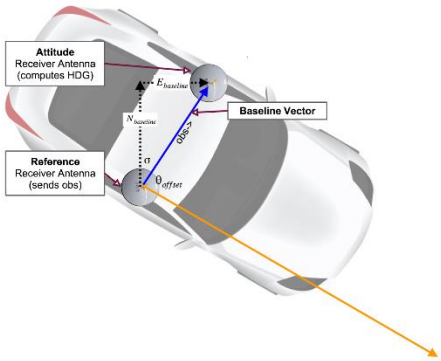


Figure 77 Skylark device alignment test #11

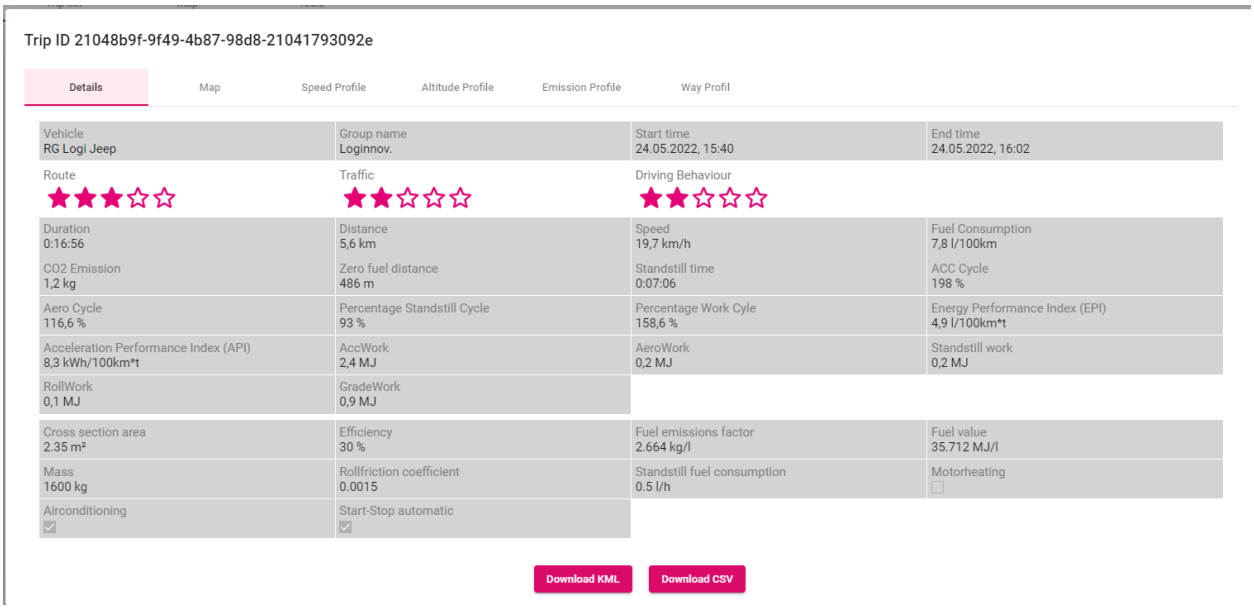


Figure 78 LCMM App results test #11

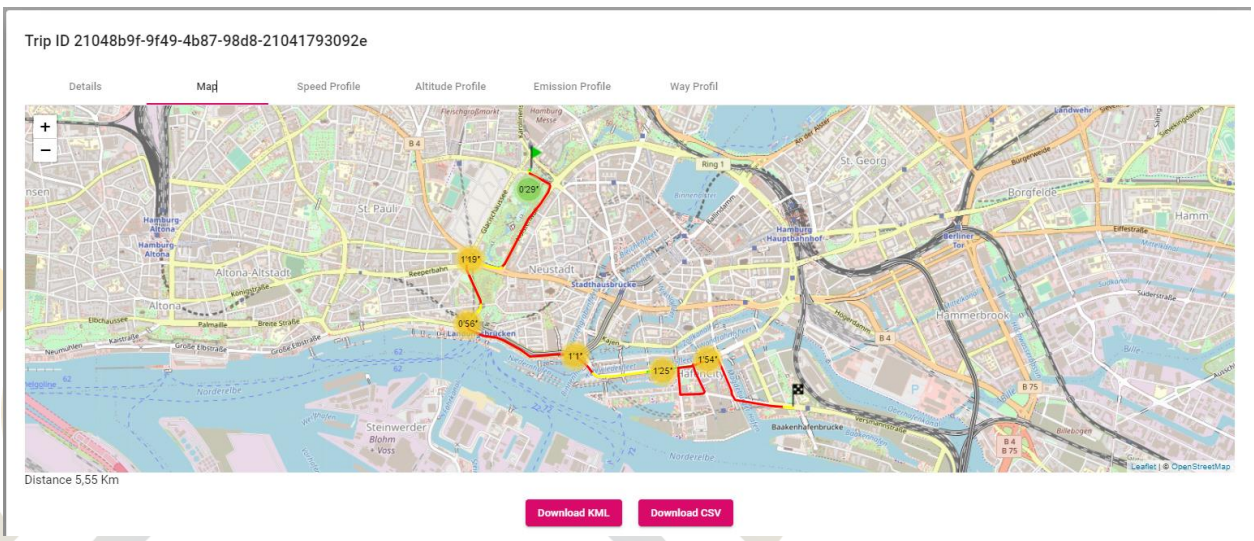


Figure 79 LCMM trip route test #11

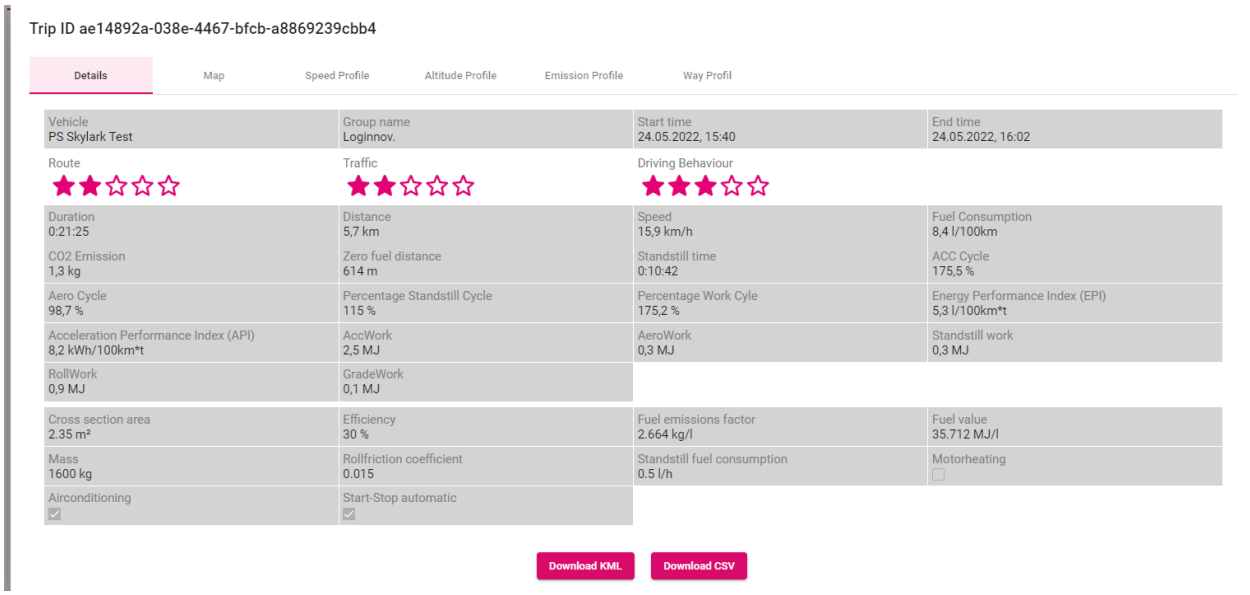


Figure 80 LCMM @ Skylark results test #11

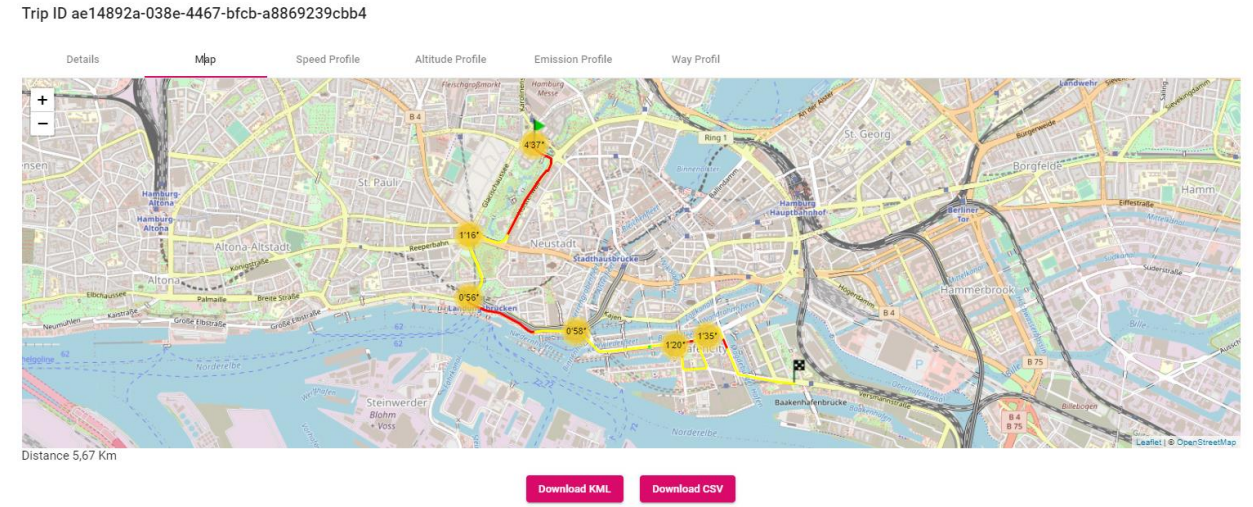


Figure 81 LCMM @ Skylark trip route test #11

Error Description if test negative

Test successful.
Hints for the trials and the use of the Skylark device:
Calibration within the vehicles needed before performing trial execution.
It is suggested to have a calibration trip per day before each trial iteration day.

Proposal Solution if test negative

n.a.

Test Protocol HH#12

Datum/Date: 24.05.2022

Test case type (): Test (technical)

Tested by: T-Systems

Testszenario:

<table>
<tr><td colspan="2">Testcase: Test GLOSA Platoon</td></tr>
<tr><td colspan="2">Short description:
Use of LCMM by running vehicle trip, collection of position data, feedback to driver, result overview at the LCMM portal. Use of GLOSA platoon for traffic light forecast during trip.</td></tr>
<tr><td colspan="2">App./Infrastructure: LCMM APP iOS Version 43.2 (1x) and Traffic Light Assistant V1.1 (GLOSA) for Android (2x)</td></tr>
<tr><td colspan="2">Testcase Manager: Ralf Grigutsch</td></tr>
<tr><td>Prerequisites</td><td>Describe needed setup:
LCMM as App and access to LCMM portal
TAVF test field accessible
GLOSA App
GLOSA service at MEC</td></tr>
<tr><td>Necessary test data</td><td>e.g. accounts, etc.
Access data: Account rg.logi.drv,
Vehicle: rg.logi.jeep with standard car parameter
See Test Protocol #1 - #4</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start iOS & Android device</td><td>Devices start</td></tr>
<tr><td>Step 2</td><td>Check connectivity</td><td>5G Connectivity available</td></tr>
<tr><td>Step 3</td><td>Start LCMM App</td><td>Start screen visible</td></tr>
<tr><td>Step 4</td><td>Select vehicle</td><td>RG Logi Jeep selectable</td></tr>
<tr><td>Step 5</td><td>Login App with account @ iOS device</td><td>Login successful</td></tr>
<tr><td>Step 6</td><td>Select Expert Mode for further data during test trip</td><td>Expert mode screen available</td></tr>
<tr><td>Step 7</td><td>Position device near front windshield within prepared device holder</td><td>Fixed device near windshield</td></tr>
<tr><td>Step 8</td><td>Connect device with power cable</td><td>External power accessible</td></tr>
<tr><td>Step 9</td><td>Start vehicle engine</td><td>Vehicle ready for test trip</td></tr>
<tr><td>Step 10</td><td>Push start button at LCMM App</td><td>Button changes to label ‘Stop’ and collection of position (GNSS) data starts</td></tr>
<tr><td>Step 11</td><td>Start GLOSA App Device #1</td><td>App visible at Android device see current position on the road</td></tr>
<tr><td>Step 12</td><td>Start GLOSA App Device #2</td><td>App visible at Android device see current position on the road</td></tr>
<tr><td>Step 13</td><td>Configure Platoon setup at Device #1 (Platoon mode: true, Platoon ID: 321, Platoon Index: 1, Vehicle Color: red)</td><td>Parameters set</td></tr>
</table></td></tr>
</table>

			For the test both devices will be placed in one vehicle to compare information during the test. During trials platoon vehicles will be equipped each with a device and each vehicle device will be configured in the order to the position within the platoon.	
		Step 14	Configure Platoon setup at Device #2 (Platoon mode: true, Platoon ID: 321, Platoon Index: 2, Vehicle Color: green)	Parameters set
		Step 15	Start test trip @ collect data	Trip on the TAVF
		Step 16	During Trip: LCMM will only be use to collect position data for trip execution. Check (if possible) screen changes, hints and values in the LCMM APP.	Changes of colour (green, yellow, red) available
		Step 17	During Trip: Check available information within GLOSA App. e.g. track, traffic light forecast, hint for driving behavior Device #1 (Red): Lead Vehicle Device #2 (Green): last vehicle of the platoon	The drivers will be informed on traffic light forecast in seconds and will be informed whether the next traffic light phase will be reached in time with current speed or to reduce speed. Data on both devices are equal. Service uses in platoon mode always positions of last platoon vehicle for calculation estimations.
		Step 15	Stop trip by pushing the Stop button	LCMM finalizes trip and provides trip summary data
		Step 16	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
		Step 17	Check trip and available data at LCCM portal via Laptop, tablet etc.	Access to trip at LCMM portal
		Step 18	Compare trip results with driver's trip experience	Successful trip with LCMM
		Step 19	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time.	Numbers are available
Expected result	*5G Connectivity available, Use of LCMM successful, collection of position data, feedback to driver, result overview at the LCMM portal. Use of GLOSA (App & MEC) for traffic light forecast during trips successful on all platoon devices..*			

Test Result (including Screenshots, Photos etc.)

Expected results: yes

Configure Platoon setup at Device #1 (Left side), (Platoon mode: true, Platoon ID: 321, Platoon Index: 1, Vehicle Color: red).
Configure Platoon setup at Device #2 Right side, (Platoon mode: true, Platoon ID: 321, Platoon Index: 2, Vehicle Color: green).
For the test both devices have been placed in one vehicle to compare information during the test. During trials platoon vehicles will be equipped each with a device and each vehicle device will be configured in the order to the position within the platoon.

Figure 82 GLOSA platoon configuration test #12

Figure 83 GLOSA platoon during test #12

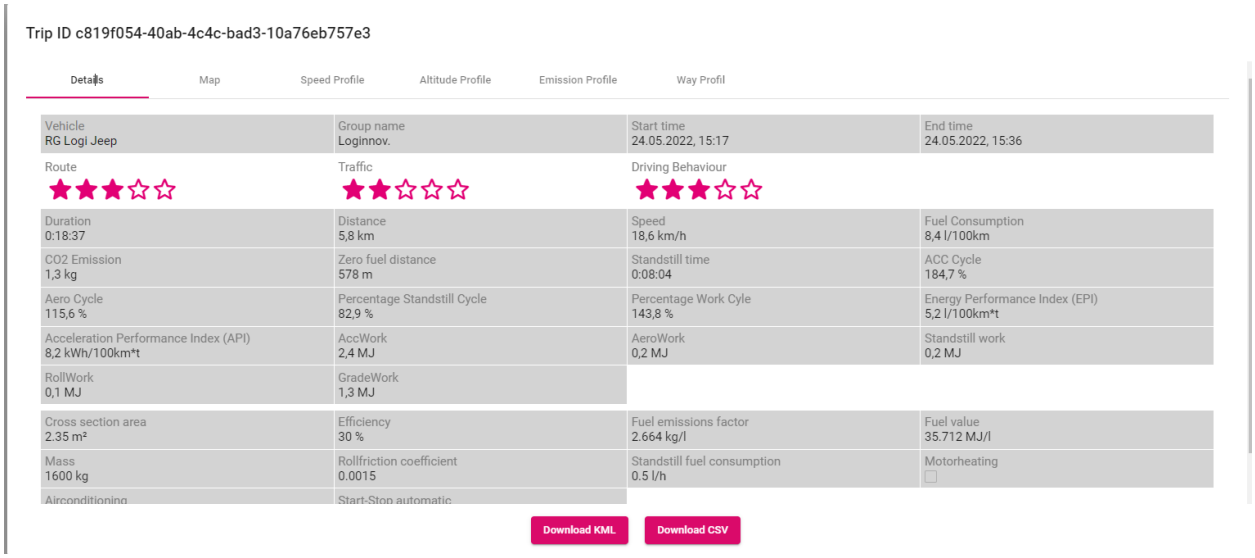


Figure 84 LCMM results related to GLOSA platoon during test #12

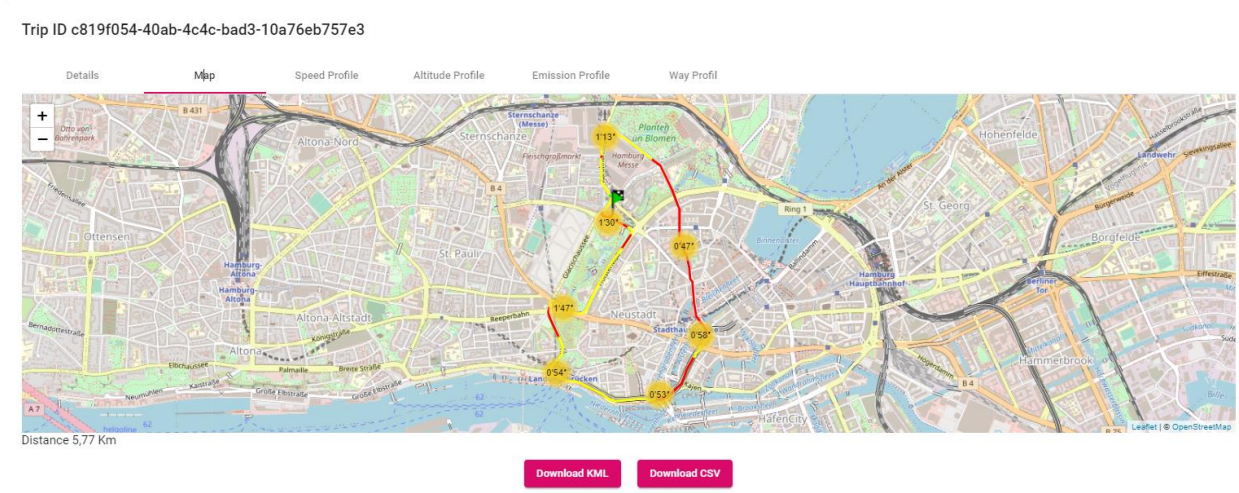


Figure 85 LCMM trip route related to GLOSA platoon during test #12

Error Description if test negative

Test successful.

Proposal Solution if test negative

n.a.

Test Protocol HH#13 and HH#14

Datum/Date: ***24.05.2022***

Test case type (): ***Test (technical)***

Tested by: T-Systems

Testszenario:

Testcase: Test 5G Connectivity tool Mobileum
Short description: Use of Mobileum to measure 5G Bandwidth and Latency during vehicle trips at TAVF
App./Infrastructure: Mobileum
Testcase Manager: *Dirk Hetzer*
Describe needed setup: **Vehicle equipped with mobileum** **TAVF test field accessible**
e.g. accounts, etc.
Steps

Step Name	Description	Expected Result
Step 1	Deploy antenna	Antenna fixed
Step 2	Connect device with antenna	Device and antenna connected
Step 3	Connect device with power cable	Vehicle ready
Step 4	Start vehicle engine, ensure electric power during test	Engine is running, electric power available
Step 5	Wait for 15 min for boot process of device	Mobileum device is operational
Step 6	Start test trip & collect data	Trip on the TAVF and collect data
Step 7	During Trip: Check data collection	Optional check device is working
Step 8	Stop trip and stop data collection	Stop trip
Step 9	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
Step 10	Check trip and available data at Mobileum portal via Laptop, tablet etc.	Access data at Mobileum portal

Test Result (including Screenshots, Photos etc.)

Expected results: yes

- Expected data rates in 5G NSA production network up to 620 MBit/s during drive test realized.
- Round trip delay (ping) between 17 and 40 ms is based on NSA configuration without MEC support.
- Test results in production network shows high variance according to real production set-up (DSS 2.1 GHz and NR 3.6 GHz coverage)

- Different network conditions will lead to higher variance during the test drive. Bandwidth and latency results meets expectation.
- Measurements are done as integration of multiple test replications. Single test procedure runs over 2 min.

Figure 86 Mobileum during test #13/14

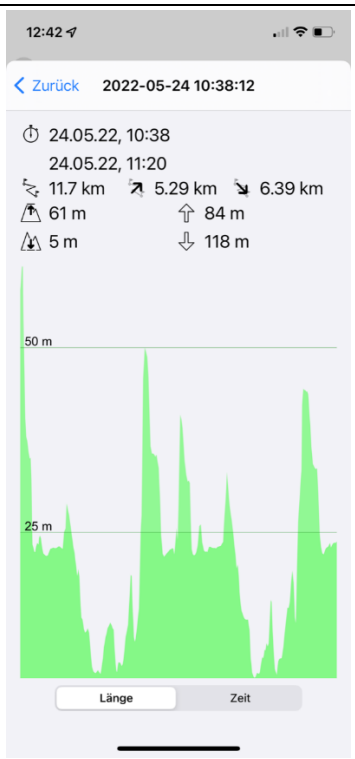
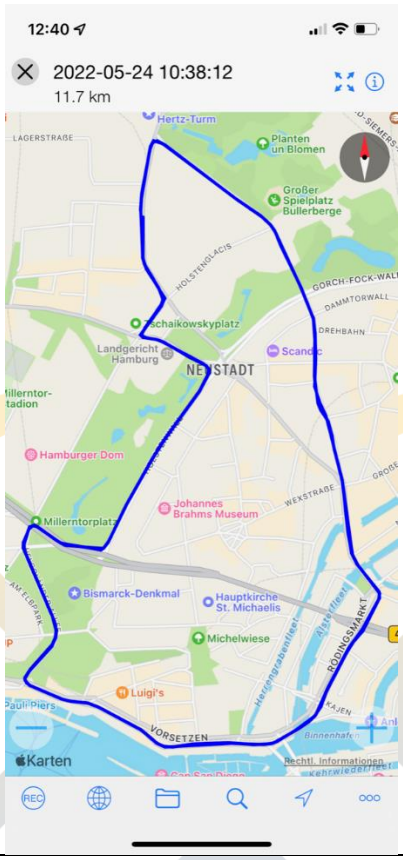


Figure 87 Mobileum altitude profile test #13/14



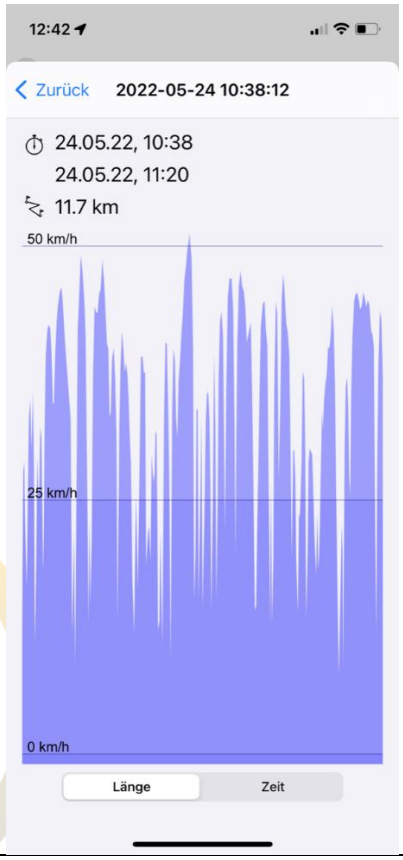


Figure 88 Mobileum trip route test #13/14	*Figure 89 Mobileum speed profile test #13/14*

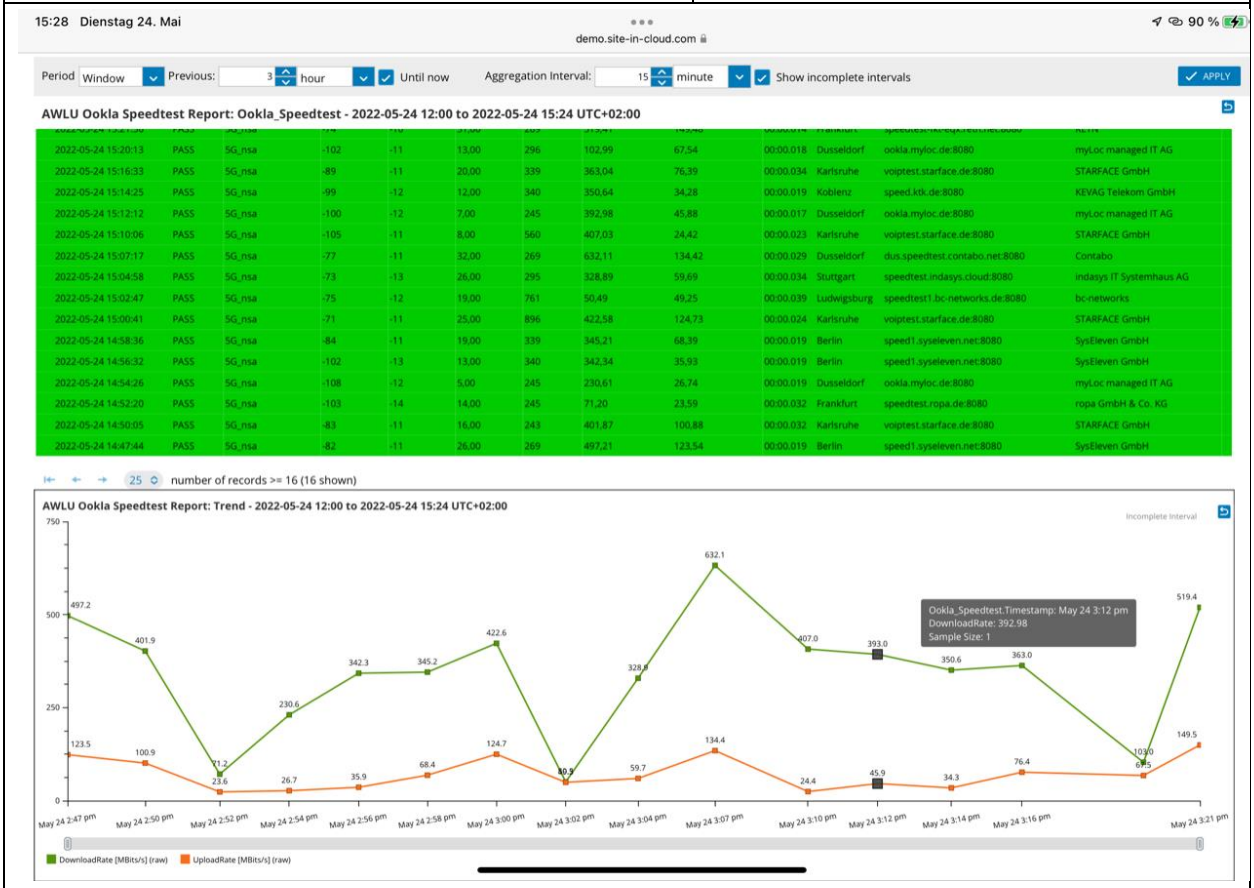


Figure 90 Mobileum speedtest test #13

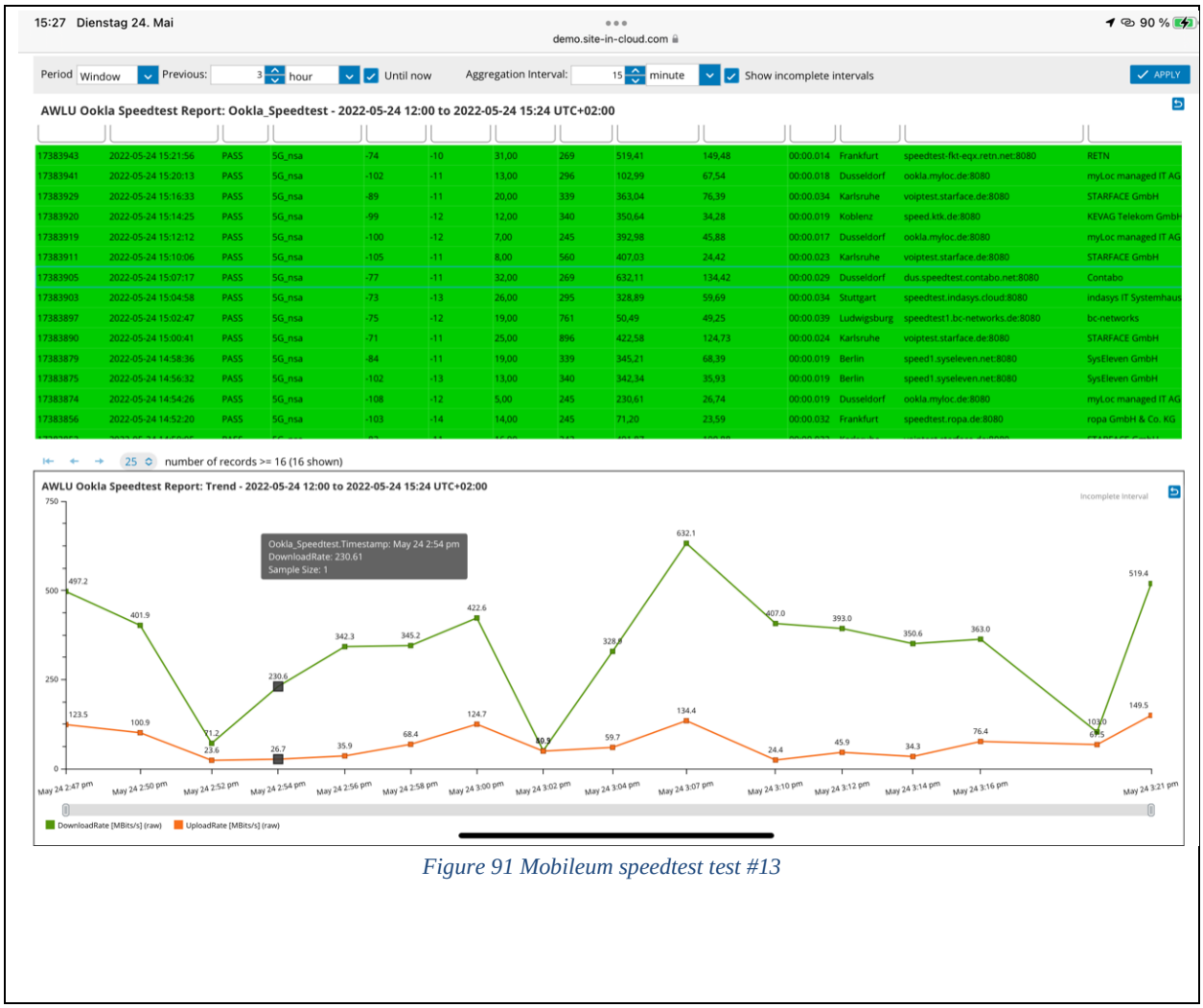
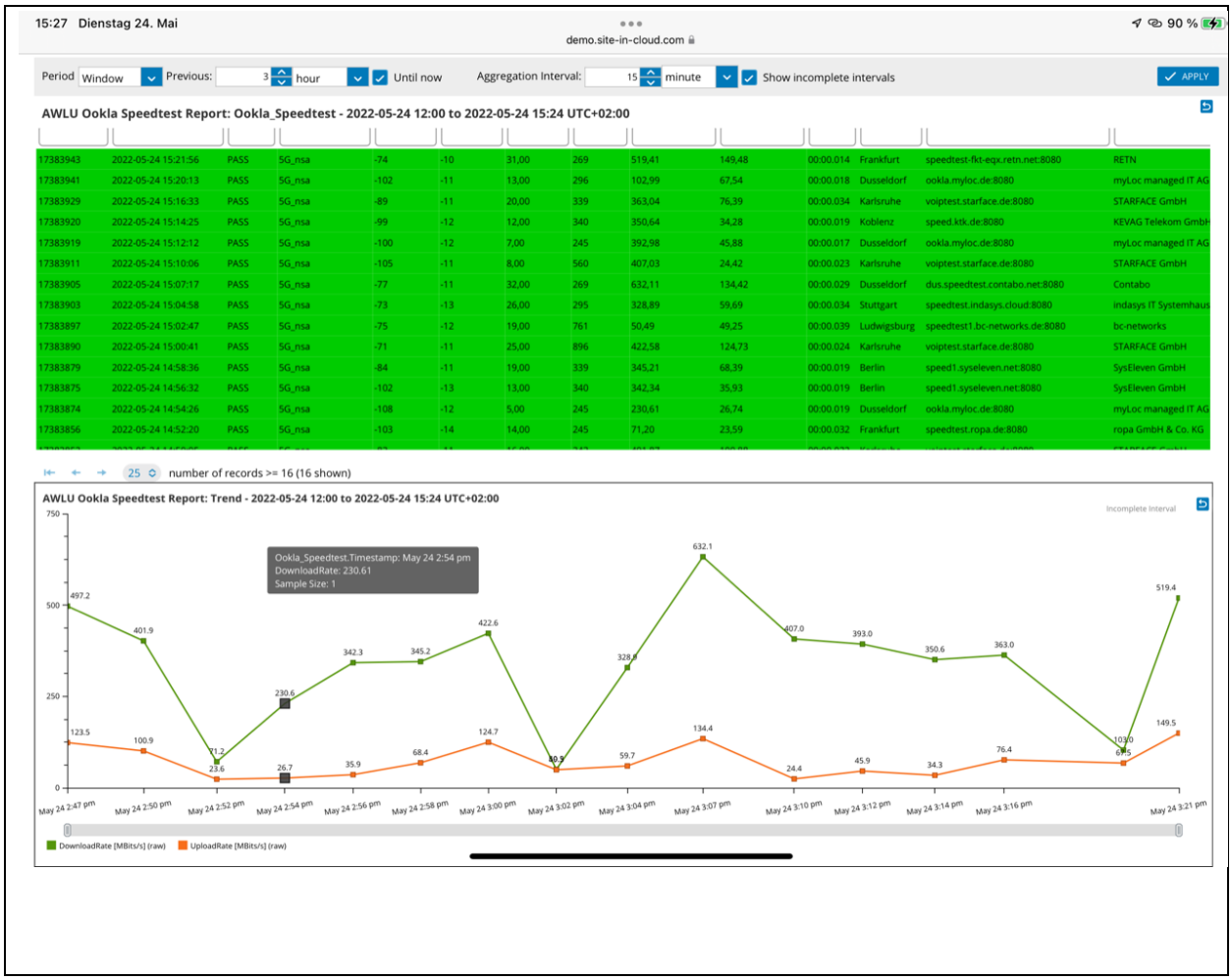
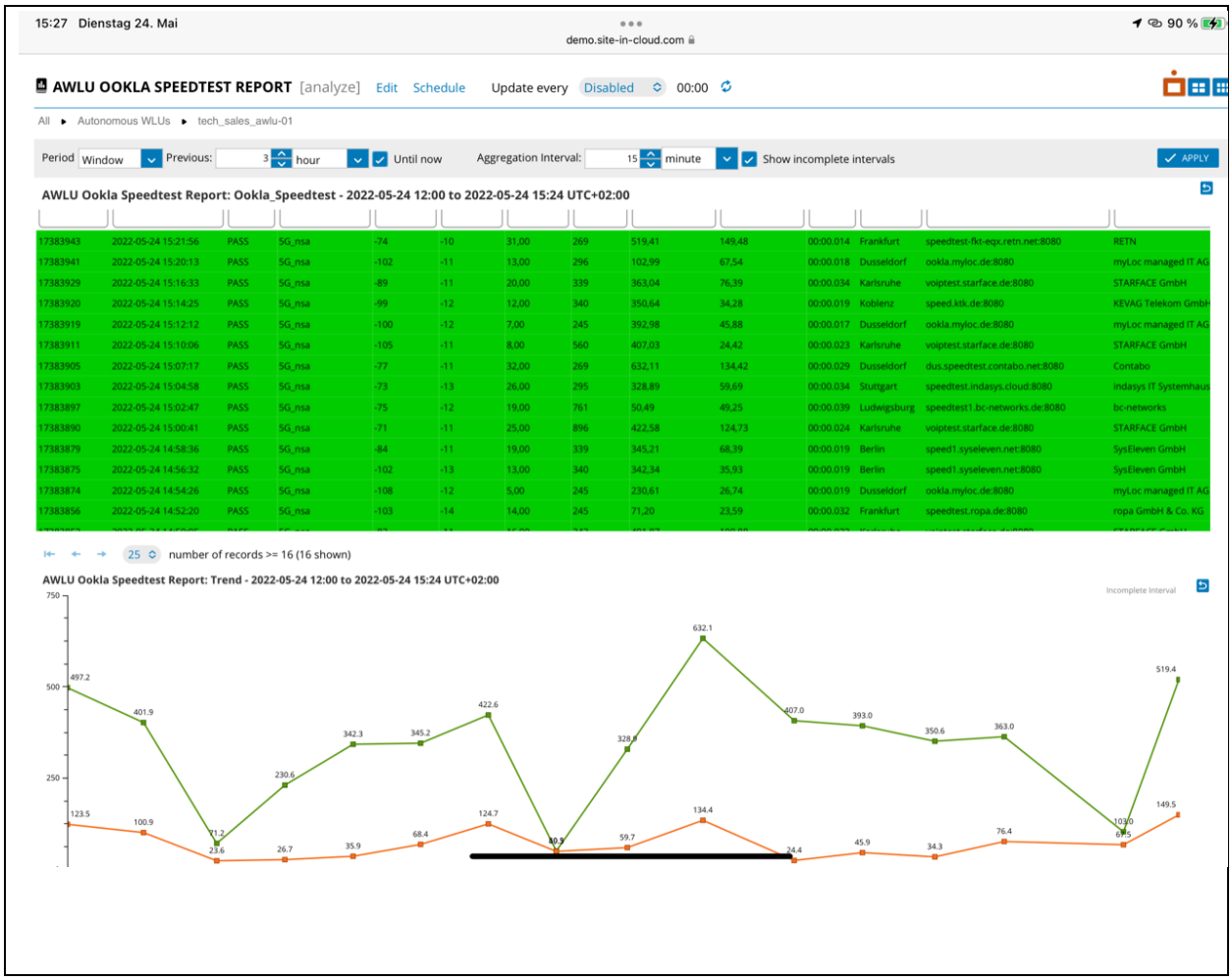


Figure 91 Mobileum speedtest test #13


15:27 Dienstag 24. Mai
demo.site-in-cloud.com
90 %
Period Window Previous: 3 hour Until now Aggregation Interval: 15 minute Show incomplete intervals APPLY
AWLU Ookla Speedtest Report: Ookla_Speedtest - 2022-05-24 12:00 to 2022-05-24 15:24 UTC+02:00
17383943 2022-05-24 15:21:56 PASS 5G_nsa -74 -10 31,00 269 519,41 149,48 00:00.014 Frankfurt speedtest-fkt-eqx.retn.net:8080 RETN
17383941 2022-05-24 15:20:13 PASS 5G_nsa -102 -11 13,00 296 102,99 67,54 00:00.018 Dusseldorf ookla.myloc.de:8080 myLoc managed IT AG
17383929 2022-05-24 15:16:33 PASS 5G_nsa -89 -11 20,00 339 363,04 76,39 00:00.034 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
17383920 2022-05-24 15:14:25 PASS 5G_nsa -99 -12 12,00 340 350,64 34,28 00:00.019 Koblenz speed.ktk.de:8080 KEVAG Telekom GmbH
17383919 2022-05-24 15:12:12 PASS 5G_nsa -100 -12 7,00 245 392,98 45,88 00:00.017 Dusseldorf ookla.myloc.de:8080 myLoc managed IT AG
17383911 2022-05-24 15:10:06 PASS 5G_nsa -105 -11 8,00 560 407,03 24,42 00:00.023 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
17383905 2022-05-24 15:07:17 PASS 5G_nsa -77 -11 32,00 269 632,11 134,42 00:00.029 Dusseldorf dus.speedtest.contabo.net:8080 Contabo
17383903 2022-05-24 15:04:58 PASS 5G_nsa -73 -13 26,00 295 328,89 59,69 00:00.034 Stuttgart speedtest.indasys.cloud:8080 indasys IT Systemhaus
17383897 2022-05-24 15:02:47 PASS 5G_nsa -75 -12 19,00 761 50,49 49,25 00:00.039 Ludwigsburg speedtest1.bc-networks.de:8080 bc-networks
17383890 2022-05-24 15:00:41 PASS 5G_nsa -71 -11 25,00 896 422,58 124,73 00:00.024 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
17383879 2022-05-24 14:58:36 PASS 5G_nsa -84 -11 19,00 339 345,21 68,39 00:00.019 Berlin speed1.syseleven.net:8080 SysEleven GmbH
17383875 2022-05-24 14:56:32 PASS 5G_nsa -102 -13 13,00 340 342,34 35,93 00:00.019 Berlin speed1.syseleven.net:8080 SysEleven GmbH
17383874 2022-05-24 14:54:26 PASS 5G_nsa -108 -12 5,00 245 230,61 26,74 00:00.019 Dusseldorf ookla.myloc.de:8080 myLoc managed IT AG
17383856 2022-05-24 14:52:20 PASS 5G_nsa -103 -14 14,00 245 71,20 23,59 00:00.032 Frankfurt speedtest.ropa.de:8080 ropa GmbH & Co. KG
25 number of records >= 16 (16 shown)
AWLU Ookla Speedtest Report: Trend - 2022-05-24 12:00 to 2022-05-24 15:24 UTC+02:00
Incomplete Interval
Ookla_Speedtest.Timestamp: May 24 2:54 pm
DownloadRate: 230.61
Sample Size: 1
750
500
250
0
497.2
401.9
71.2
230.6
342.3
345.2
422.6
328.9
632.1
407.0
393.0
350.6
363.0
519.4
123.5
100.9
23.6
26.7
35.9
68.4
124.7
40.9
59.7
134.4
24.4
45.9
34.3
76.4
103.0
149.5
May 24 2:47 pm
May 24 2:50 pm
May 24 2:52 pm
May 24 2:54 pm
May 24 2:56 pm
May 24 2:58 pm
May 24 3:00 pm
May 24 3:02 pm
May 24 3:04 pm
May 24 3:07 pm
May 24 3:10 pm
May 24 3:12 pm
May 24 3:14 pm
May 24 3:16 pm
May 24 3:21 pm
DownloadRate [MBits/s] (raw)
UploadRate [MBits/s] (raw)


15:27 Dienstag 24. Mai
demo.site-in-cloud.com
90 %
AWLU OOKLA SPEEDTEST REPORT [analyze] Edit Schedule Update every Disabled 00:00
All ▸ Autonomous WLUs ▸ tech_sales_awlu-01
Period Window Previous: 3 hour Until now Aggregation Interval: 15 minute Show incomplete intervals APPLY
AWLU Ookla Speedtest Report: Ookla_Speedtest - 2022-05-24 12:00 to 2022-05-24 15:24 UTC+02:00
17383943 2022-05-24 15:21:56 PASS 5G_nsa -74 -10 31,00 269 519,41 149,48 00:00.014 Frankfurt speedtest-fkt-eqx.retn.net:8080 RETN
17383941 2022-05-24 15:20:13 PASS 5G_nsa -102 -11 13,00 296 102,99 67,54 00:00.018 Dusseldorf ookla.myloc.de:8080 myLoc managed IT AG
17383929 2022-05-24 15:16:33 PASS 5G_nsa -89 -11 20,00 339 363,04 76,39 00:00.034 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
17383920 2022-05-24 15:14:25 PASS 5G_nsa -99 -12 12,00 340 350,64 34,28 00:00.019 Koblenz speed.ktk.de:8080 KEVAG Telekom GmbH
17383919 2022-05-24 15:12:12 PASS 5G_nsa -100 -12 7,00 245 392,98 45,88 00:00.017 Dusseldorf ookla.myloc.de:8080 myLoc managed IT AG
17383911 2022-05-24 15:10:06 PASS 5G_nsa -105 -11 8,00 560 407,03 24,42 00:00.023 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
17383905 2022-05-24 15:07:17 PASS 5G_nsa -77 -11 32,00 269 632,11 134,42 00:00.029 Dusseldorf dus.speedtest.contabo.net:8080 Contabo
17383903 2022-05-24 15:04:58 PASS 5G_nsa -73 -13 26,00 295 328,89 59,69 00:00.034 Stuttgart speedtest.indasys.cloud:8080 indasys IT Systemhaus
17383897 2022-05-24 15:02:47 PASS 5G_nsa -75 -12 19,00 761 50,49 49,25 00:00.039 Ludwigsburg speedtest1.bc-networks.de:8080 bc-networks
17383890 2022-05-24 15:00:41 PASS 5G_nsa -71 -11 25,00 896 422,58 124,73 00:00.024 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
17383879 2022-05-24 14:58:36 PASS 5G_nsa -84 -11 19,00 339 345,21 68,39 00:00.019 Berlin speed1.syseleven.net:8080 SysEleven GmbH
17383875 2022-05-24 14:56:32 PASS 5G_nsa -102 -13 13,00 340 342,34 35,93 00:00.019 Berlin speed1.syseleven.net:8080 SysEleven GmbH
17383874 2022-05-24 14:54:26 PASS 5G_nsa -108 -12 5,00 245 230,61 26,74 00:00.019 Dusseldorf ookla.myloc.de:8080 myLoc managed IT AG
17383856 2022-05-24 14:52:20 PASS 5G_nsa -103 -14 14,00 245 71,20 23,59 00:00.032 Frankfurt speedtest.ropa.de:8080 ropa GmbH & Co. KG
25 number of records >= 16 (16 shown)
AWLU Ookla Speedtest Report: Trend - 2022-05-24 12:00 to 2022-05-24 15:24 UTC+02:00
Incomplete Interval
750
500
250
497.2
401.9
230.6
342.3
345.2
422.6
328.9
632.1
407.0
393.0
350.6
363.0
519.4
123.5
100.9
23.6
26.7
35.9
68.4
124.7
59.7
134.4
24.4
45.9
34.3
76.4
149.5

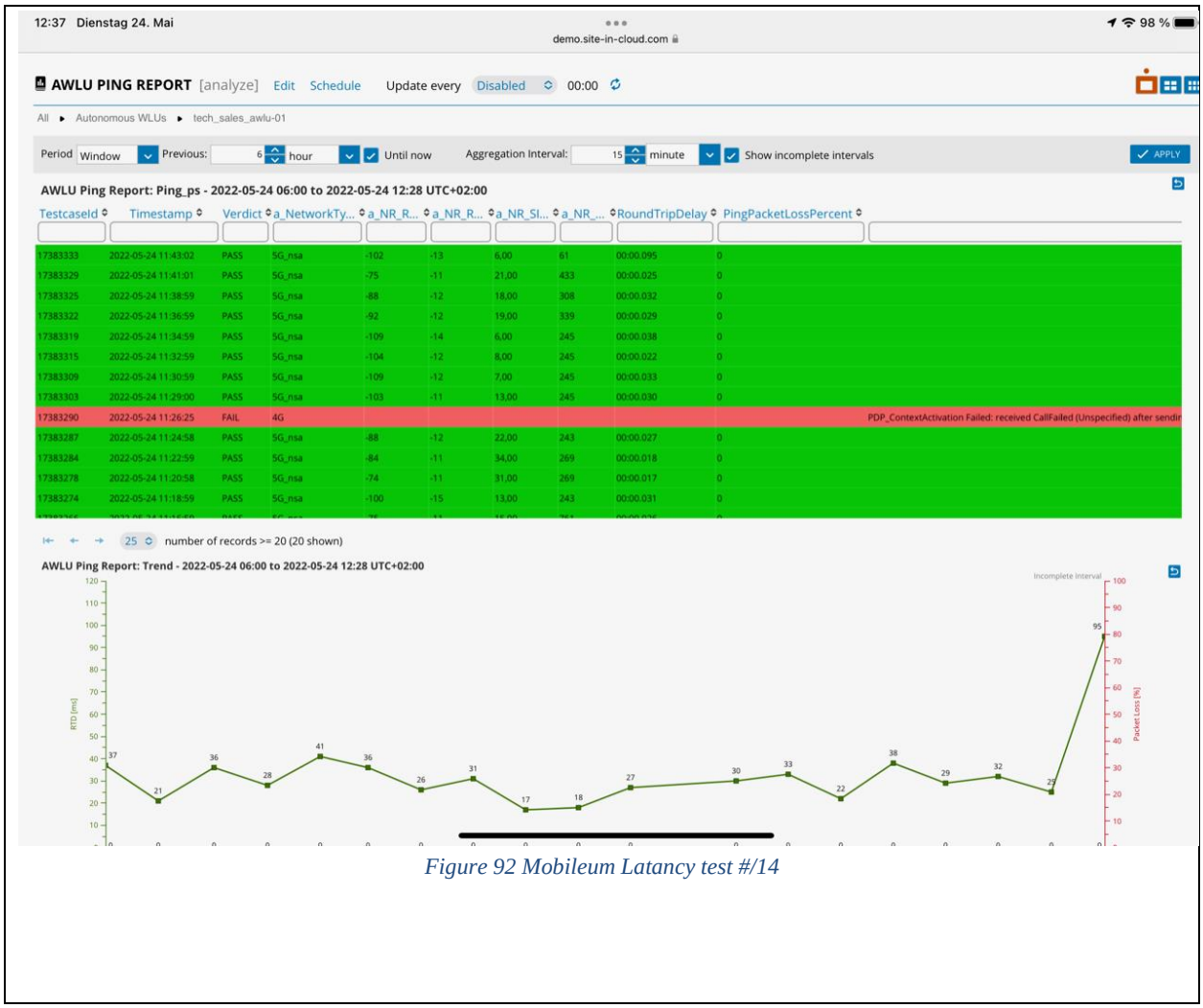
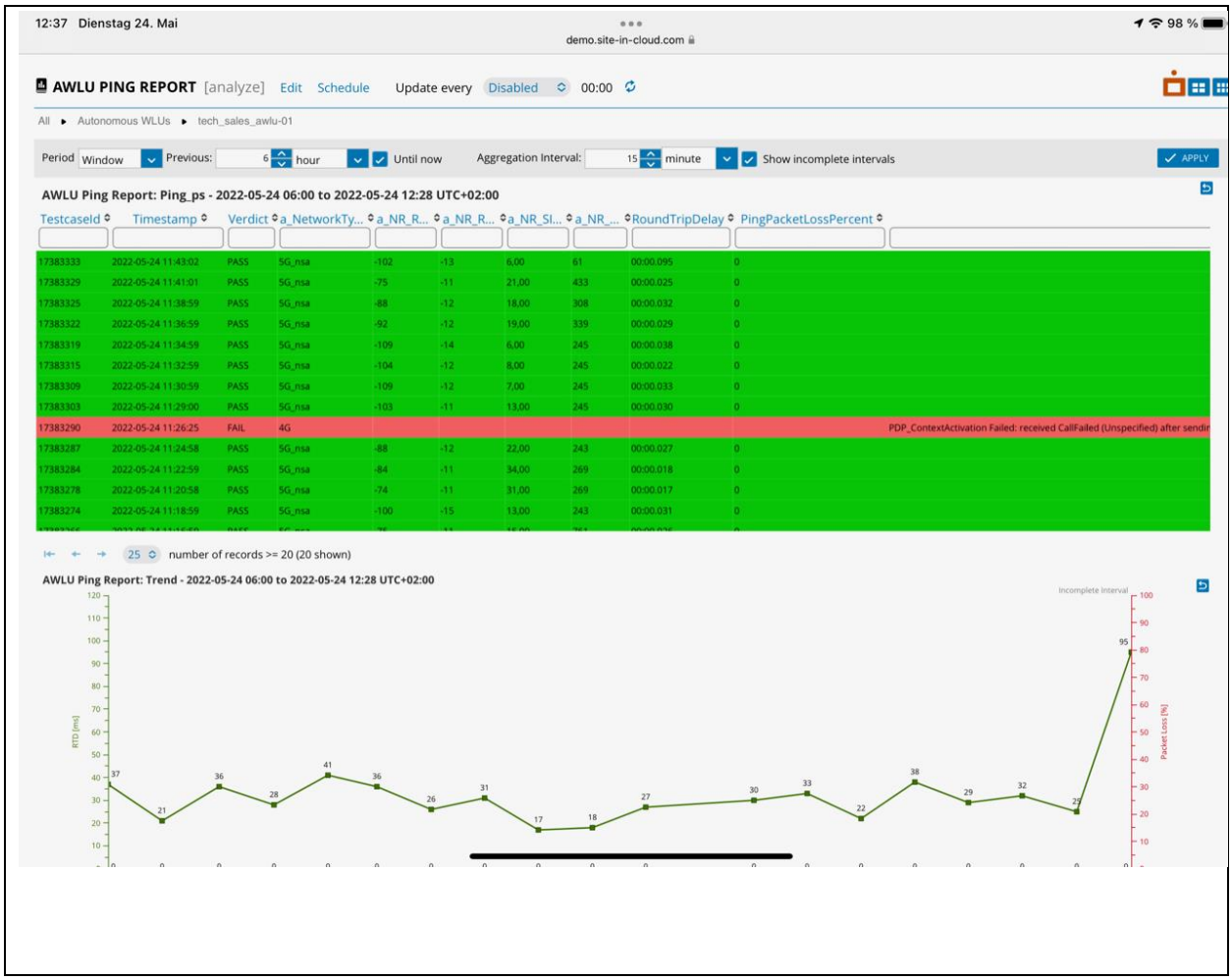
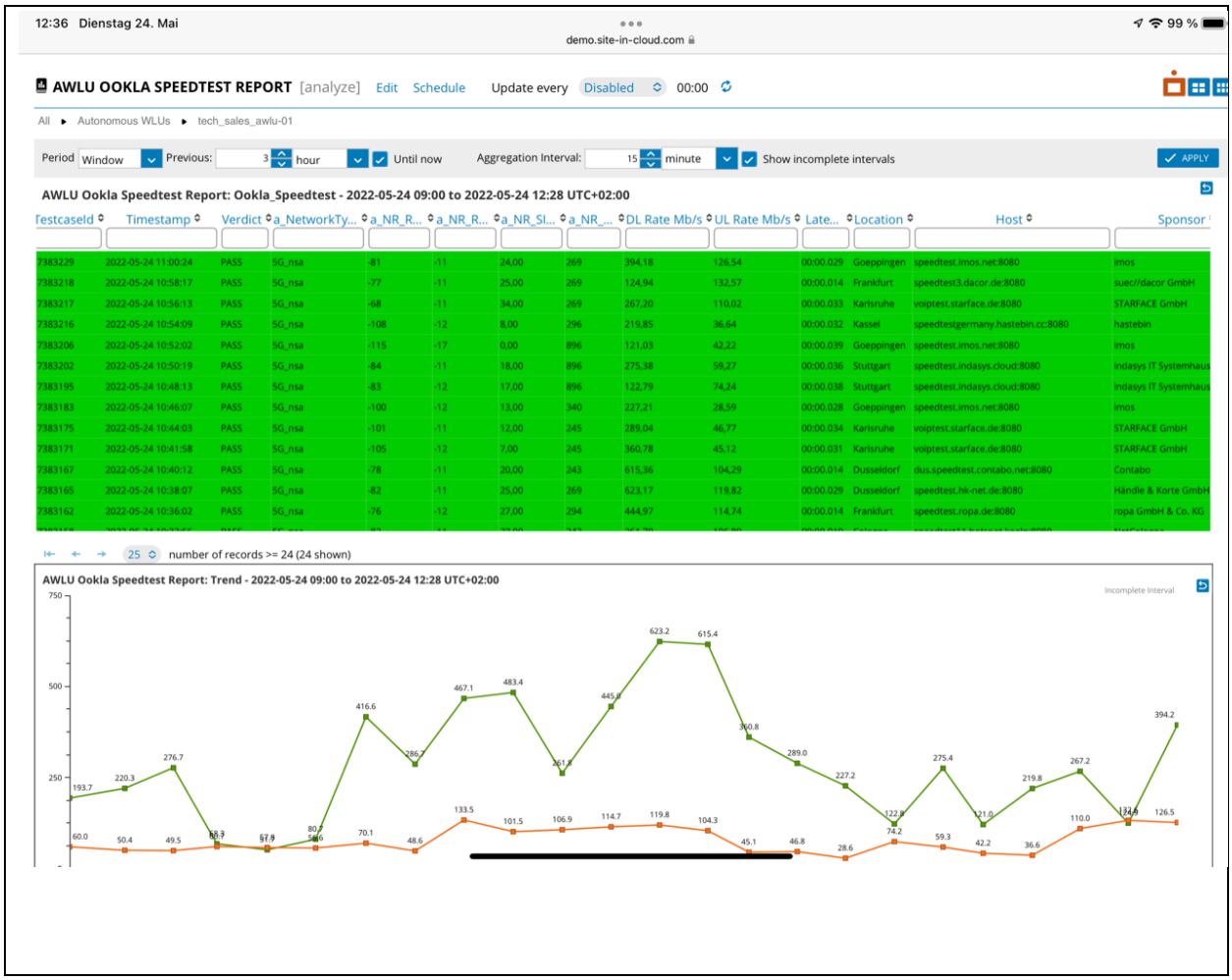


Figure 92 Mobileum Latancy test #/14


12:37 Dienstag 24. Mai
demo.site-in-cloud.com
98 %
AWLU PING REPORT [analyze] Edit Schedule Update every Disabled 00:00
All ▸ Autonomous WLUs ▸ tech_sales_awlu-01
Period Window Previous: 6 hour Until now Aggregation Interval: 15 minute Show incomplete intervals APPLY
AWLU Ping Report: Ping_ps - 2022-05-24 06:00 to 2022-05-24 12:28 UTC+02:00
TestcaseId Timestamp Verdict a_NetworkTy... a_NR_R... a_NR_R... a_NR_SI... a_NR_... RoundTripDelay PingPacketLossPercent
17383333 2022-05-24 11:43:02 PASS 5G_nsa -102 -13 6,00 61 00:00.095 0
17383329 2022-05-24 11:41:01 PASS 5G_nsa -75 -11 21,00 433 00:00.025 0
17383325 2022-05-24 11:38:59 PASS 5G_nsa -88 -12 18,00 308 00:00.032 0
17383322 2022-05-24 11:36:59 PASS 5G_nsa -92 -12 19,00 339 00:00.029 0
17383319 2022-05-24 11:34:59 PASS 5G_nsa -109 -14 6,00 245 00:00.038 0
17383315 2022-05-24 11:32:59 PASS 5G_nsa -104 -12 8,00 245 00:00.022 0
17383309 2022-05-24 11:30:59 PASS 5G_nsa -109 -12 7,00 245 00:00.033 0
17383303 2022-05-24 11:29:00 PASS 5G_nsa -103 -11 13,00 245 00:00.030 0
17383290 2022-05-24 11:26:25 FAIL 4G PDP_ContextActivation Failed: received CallFailed (Unspecified) after sendir
17383287 2022-05-24 11:24:58 PASS 5G_nsa -88 -12 22,00 243 00:00.027 0
17383284 2022-05-24 11:22:59 PASS 5G_nsa -84 -11 34,00 269 00:00.018 0
17383278 2022-05-24 11:20:58 PASS 5G_nsa -74 -11 31,00 269 00:00.017 0
17383274 2022-05-24 11:18:59 PASS 5G_nsa -100 -15 13,00 243 00:00.031 0
25 number of records >= 20 (20 shown)
AWLU Ping Report: Trend - 2022-05-24 06:00 to 2022-05-24 12:28 UTC+02:00
Incomplete Interval
RTD [ms]
Packet Loss [%]
37 21 36 28 41 36 26 31 17 18 27 30 33 22 38 29 32 25 95


12:36 Dienstag 24. Mai
demo.site-in-cloud.com
99 %
AWLU OOKLA SPEEDTEST REPORT [analyze] Edit Schedule Update every Disabled 00:00
All ▸ Autonomous WLUs ▸ tech_sales_awlu-01
Period Window Previous: 3 hour Until now Aggregation Interval: 15 minute Show incomplete intervals APPLY
AWLU Ookla Speedtest Report: Ookla_Speedtest - 2022-05-24 09:00 to 2022-05-24 12:28 UTC+02:00
TestcaseId Timestamp Verdict a_NetworkTy... a_NR_R... a_NR_R... a_NR_SI... a_NR_... DL Rate Mb/s UL Rate Mb/s Late... Location Host Sponsor
7383229 2022-05-24 11:00:24 PASS 5G_nsa -81 -11 24,00 269 394,18 126,54 00:00.029 Goeppingen speedtest.imos.net:8080 imos
7383218 2022-05-24 10:58:17 PASS 5G_nsa -77 -11 25,00 269 124,94 132,57 00:00.014 Frankfurt speedtest3.dacor.de:8080 suec//dacor GmbH
7383217 2022-05-24 10:56:13 PASS 5G_nsa -68 -11 34,00 269 267,20 110,02 00:00.033 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
7383216 2022-05-24 10:54:09 PASS 5G_nsa -108 -12 8,00 296 219,85 36,64 00:00.032 Kassel speedtestgermany.hastebin.cc:8080 hastebin
7383206 2022-05-24 10:52:02 PASS 5G_nsa -115 -17 0,00 896 121,03 42,22 00:00.039 Goeppingen speedtest.imos.net:8080 imos
7383202 2022-05-24 10:50:19 PASS 5G_nsa -84 -11 18,00 896 275,38 59,27 00:00.036 Stuttgart speedtest.indasys.cloud:8080 indasys IT Systemhaus
7383195 2022-05-24 10:48:13 PASS 5G_nsa -83 -12 17,00 896 122,79 74,24 00:00.038 Stuttgart speedtest.indasys.cloud:8080 indasys IT Systemhaus
7383183 2022-05-24 10:46:07 PASS 5G_nsa -100 -12 13,00 340 227,21 28,59 00:00.028 Goeppingen speedtest.imos.net:8080 imos
7383175 2022-05-24 10:44:03 PASS 5G_nsa -101 -11 12,00 245 289,04 46,77 00:00.034 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
7383171 2022-05-24 10:41:58 PASS 5G_nsa -105 -12 7,00 245 360,78 45,12 00:00.031 Karlsruhe voiptest.starface.de:8080 STARFACE GmbH
7383167 2022-05-24 10:40:12 PASS 5G_nsa -78 -11 20,00 243 615,36 104,29 00:00.014 Dusseldorf dus.speedtest.contabo.net:8080 Contabo
7383165 2022-05-24 10:38:07 PASS 5G_nsa -82 -11 25,00 269 623,17 119,82 00:00.029 Dusseldorf speedtest.hk-net.de:8080 Händle & Korte GmbH
7383162 2022-05-24 10:36:02 PASS 5G_nsa -76 -12 27,00 294 444,97 114,74 00:00.014 Frankfurt speedtest.ropa.de:8080 ropa GmbH & Co. KG
25 number of records >= 24 (24 shown)
AWLU Ookla Speedtest Report: Trend - 2022-05-24 09:00 to 2022-05-24 12:28 UTC+02:00
Incomplete Interval
750
500
250
193.7
220.3
276.7
416.6
286.7
467.1
483.4
361.5
445.0
623.2
615.4
360.8
289.0
227.2
122.8
275.4
121.0
219.8
267.2
394.2
60.0
50.4
49.5
70.1
48.6
133.5
101.5
106.9
114.7
119.8
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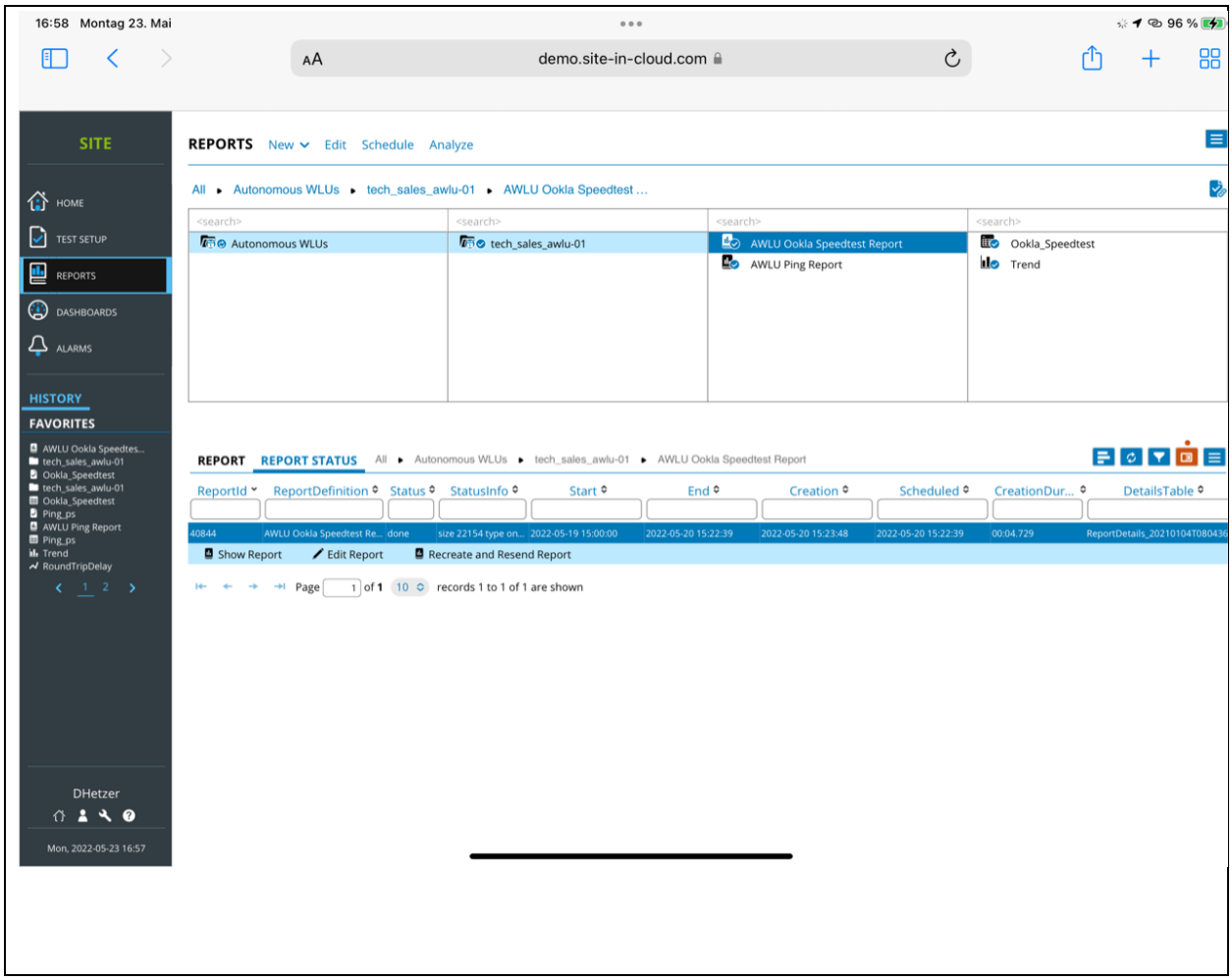
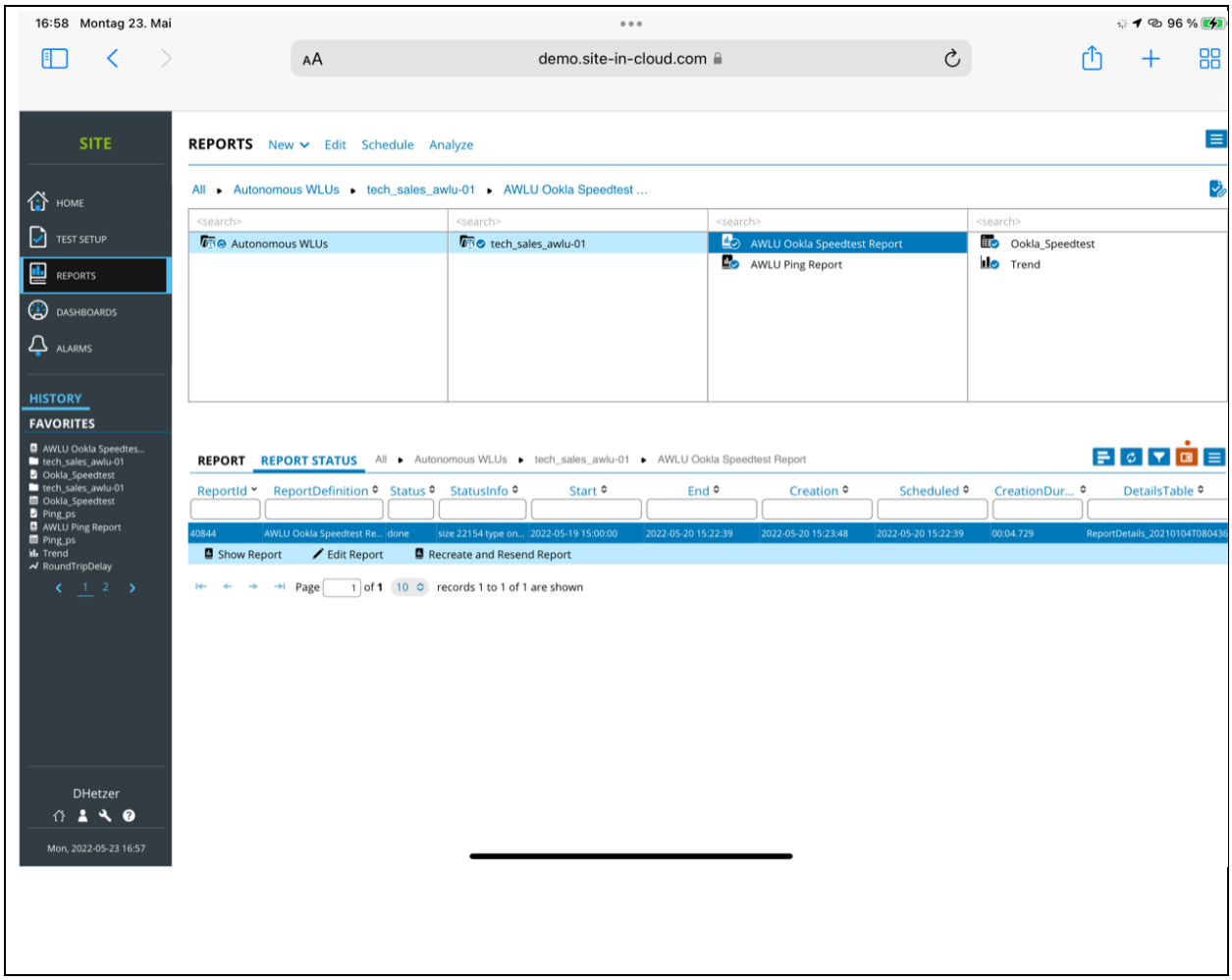
46.8
28.6
74.2
59.3
42.2
36.6
110.0
126.5


16:58 Montag 23. Mai
96 %
AA
demo.site-in-cloud.com
SITE
HOME
TEST SETUP
REPORTS
DASHBOARDS
ALARMS
HISTORY
FAVORITES
AWLU Ookla Speedtes...
tech_sales_awlu-01
Ookla_Speedtest
tech_sales_awlu-01
Ookla_Speedtest
Ping_ps
AWLU Ping Report
Ping_ps
Trend
RoundTripDelay
DHetzer
Mon, 2022-05-23 16:57
REPORTS New Edit Schedule Analyze
All ▸ Autonomous WLUs ▸ tech_sales_awlu-01 ▸ AWLU Ookla Speedtest ...
<search>
Autonomous WLUs
tech_sales_awlu-01
AWLU Ookla Speedtest Report
AWLU Ping Report
Ookla_Speedtest
Trend
REPORT REPORT STATUS
All ▸ Autonomous WLUs ▸ tech_sales_awlu-01 ▸ AWLU Ookla Speedtest Report
ReportId
ReportDefinition
Status
StatusInfo
Start
End
Creation
Scheduled
CreationDur...
DetailsTable
40844
AWLU Ookla Speedtest Re...
done
size 22154 type on...
2022-05-19 15:00:00
2022-05-20 15:22:39
2022-05-20 15:23:48
2022-05-20 15:22:39
00:04.729
ReportDetails_20210104T080436
Show Report
Edit Report
Recreate and Resend Report
Page 1 of 1 10 records 1 to 1 of 1 are shown



Error Description if test negative

Tests successful.

Proposal Solution if test negative

n.a.

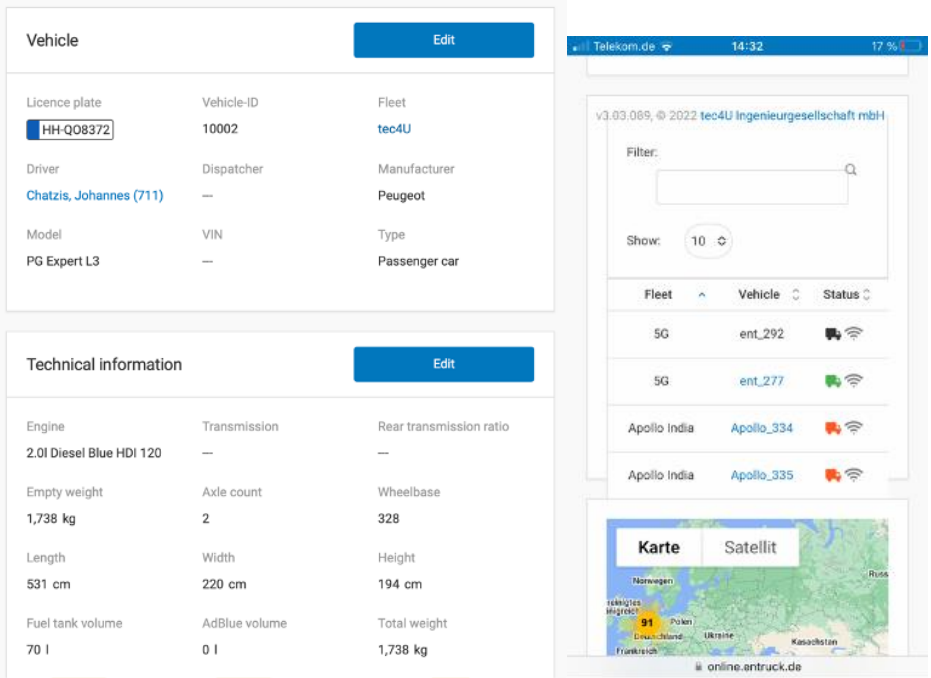
Testprotocol HH#15

Datum/Date: 07.04.2022

Test case type (): Test (technical, pre-test)

Tested by: tec4U

Testszenario:

<table>
<tr><td colspan="2">Testcase: Pre-test Entruck 5G</td></tr>
<tr><td colspan="2">Short description:
Use of Entruck during vehicle trip, collection of position data, overview of results on Entruck Online.</td></tr>
<tr><td colspan="2">App./Infrastructure: Entruck onboard Unit 6.277_ENT62018 + Skylark Evaluation Platform</td></tr>
<tr><td colspan="2">Testcase Manager: Johannes Chatzis</td></tr>
<tr><td>Prerequisites</td><td>• Access to CAN Bus of test vehicle
• 5G online connection of Entruck OBU
• Connection Entruck OBU - Skylark device
• Vehicle registered on Entruck Online</td></tr>
<tr><td>Necessary test data</td><td>N1 Vehicle – Peugeot Partner PG L3, 2021my
 
</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start Vehicle</td><td>Engine on</td></tr>
<tr><td>Step 2</td><td>Check Test LED for CAN Connection</td><td>Flashing / 1s green</td></tr>
<tr><td>Step 3</td><td>Check status of vehicle in Entruck Online</td><td>Vehicle status is online</td></tr>
<tr><td>Step 4</td><td>Check status LED Entruck OBU</td><td>green</td></tr>
<tr><td>Step 5</td><td>Run vehicle on defined TAVF sequence</td><td>Start test on TAVF</td></tr>
</table></td></tr>
</table>

	Step 6	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
	Step 7	Check trip and available data on Entruck Online via Laptop, tablet etc	Access to trip on Entruck Online
	Step 8	Compare trip results with driver's trip experience	Successful trip with LCMM
	Step 9	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Figures are available
Expected result	*5G Connectivity available, connectivity with Entruck online, connectivity with CAN Bus available, collection of position data, telemetry data of vehicle, result overview on Entruck online.*		

Test Result (including Screenshots, Photos etc.)

Expected results: vehicle is online, position and fuel consumption are available in Entruck online. Position is given by Skylark.

Skylark position not yet sufficient with accuracy > 1m

Figure 93 Entruck OBU on test vehicle #1 (connectivity)

Figure 94 Entruck Swift test #1

Figure 95 Entruck Trip route test #1

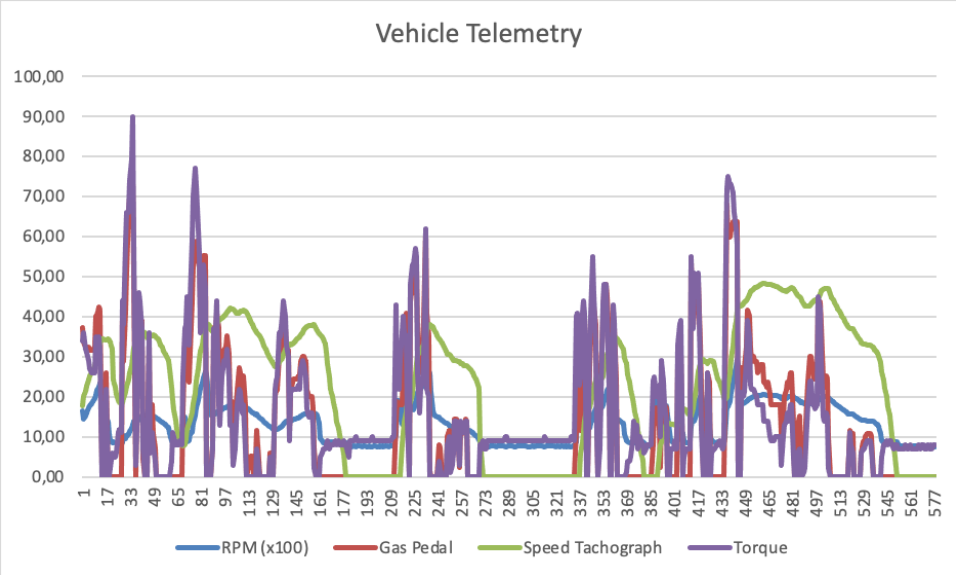


Figure 96 Entruck Engine data test #1

Error Description if test negative

No error but need of calibration

Proposal Solution if test negative

Calibration of Skylark device.

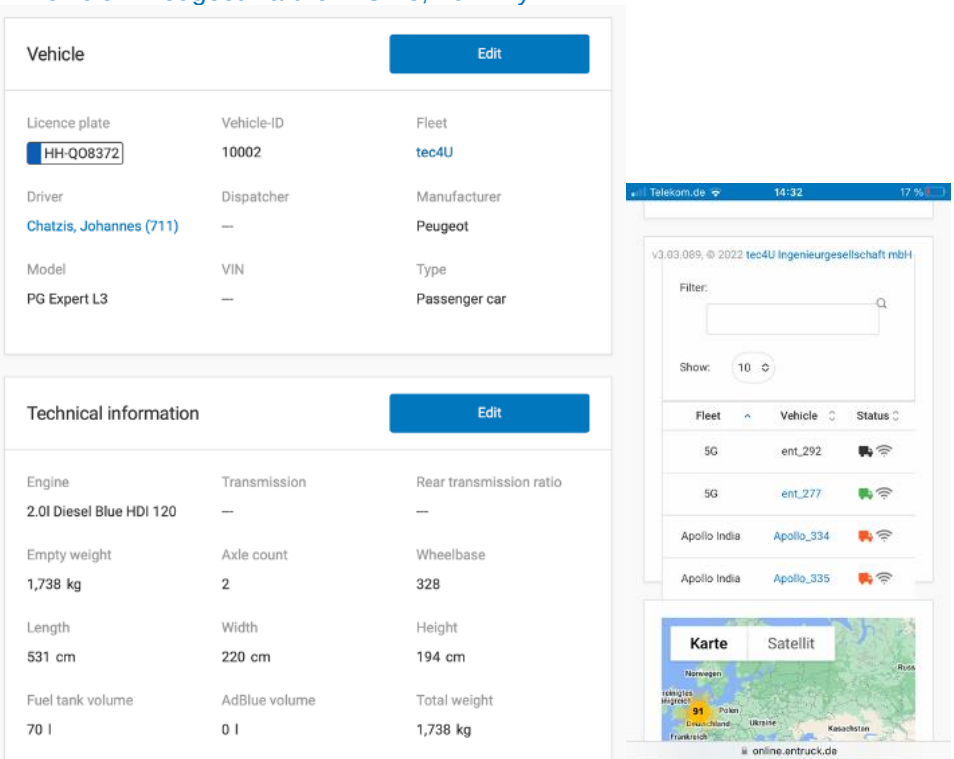
Testprotocol HH#16

Datum/Date: 07.04.2022

Test case type (): Test (technical, pre-test)

Tested by: tec4U

Testszenario:

<table>
<tr><td colspan="2">Testcase: Pre-test Entruck 5G</td></tr>
<tr><td colspan="2">Short description:
Use of Entruck during vehicle trip, collection of position data, overview of results on Entruck Online.</td></tr>
<tr><td colspan="2">App./Infrastructure: Entruck onboard Unit 6.277_ENT62018 + Skylark Evaluation Platform</td></tr>
<tr><td colspan="2">Testcase Manager: Johannes Chatzis</td></tr>
<tr><td>Prerequisites</td><td>• Access to CAN Bus of test vehicle
• 5G online connection of Entruck OBU
• Connection Entruck OBU - Skylark device
• Vehicle registered on Entruck Online</td></tr>
<tr><td>Necessary test data</td><td>N1 Vehicle – Peugeot Partner PG L3, 2021my
 
</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start Vehicle</td><td>Engine on</td></tr>
<tr><td>Step 2</td><td>Check Test LED for CAN Connection</td><td>Flashing / 1s green</td></tr>
</table></td></tr>
</table>

	Step 3	Check status of vehicle in Entruck Online	Vehicle status is online
	Step 4	Check status LED Entruck OBU	green
	Step 5	Run vehicle on defined TAVF sequence	Start test on TAVF
	Step 6	Run with the vehicle to defined parking slots and stop engine	Arrive at defined parking slot
	Step 7	Check trip and available data on Entruck Online via Laptop, tablet etc	Access to trip on Entruck Online
	Step 8	Compare trip results with driver's trip experience	Successful trip with LCMM
	Step 9	Check results concerning availability of numbers for KPIs: Speed, acceleration and stillstand time	Figures are available
Expected result	*5G Connectivity available, connectivity with Entruck online, connectivity with CAN Bus available, collection of position data, telemetry data of vehicle, result overview on Entruck online.*		

Test Result (including Screenshots, Photos etc.)

Expected results: vehicle is online, position and fuel consumption are available in Entruck online. Position is given by Skylark.

Skylark position sufficient with accuracy > 0,5m

Figure 97 Entruck OBU on test vehicle

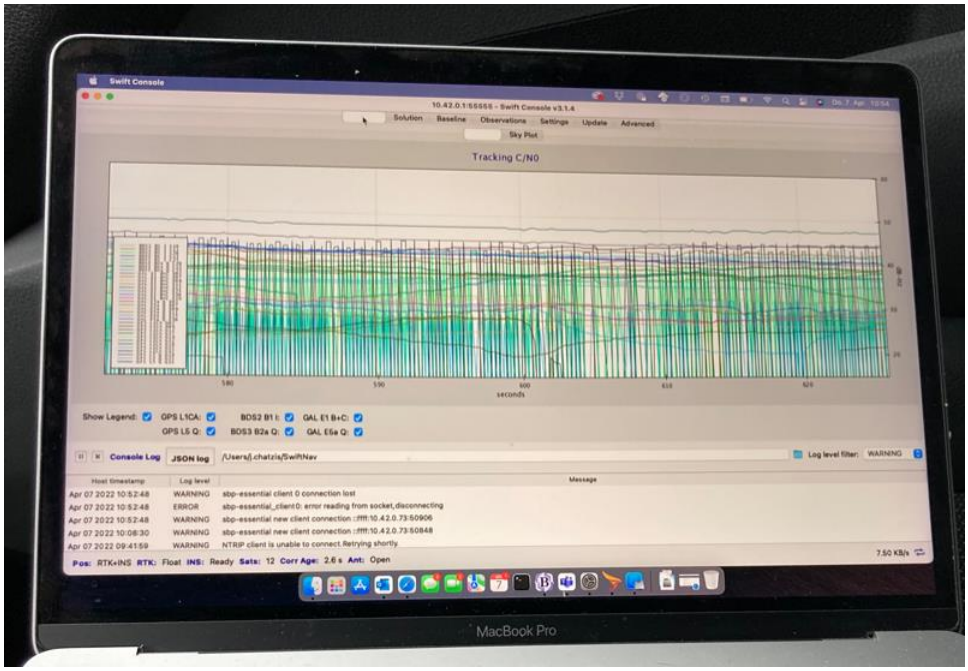


Figure 98 Entruck Swift test

Figure 99 Entruck trip route test #2

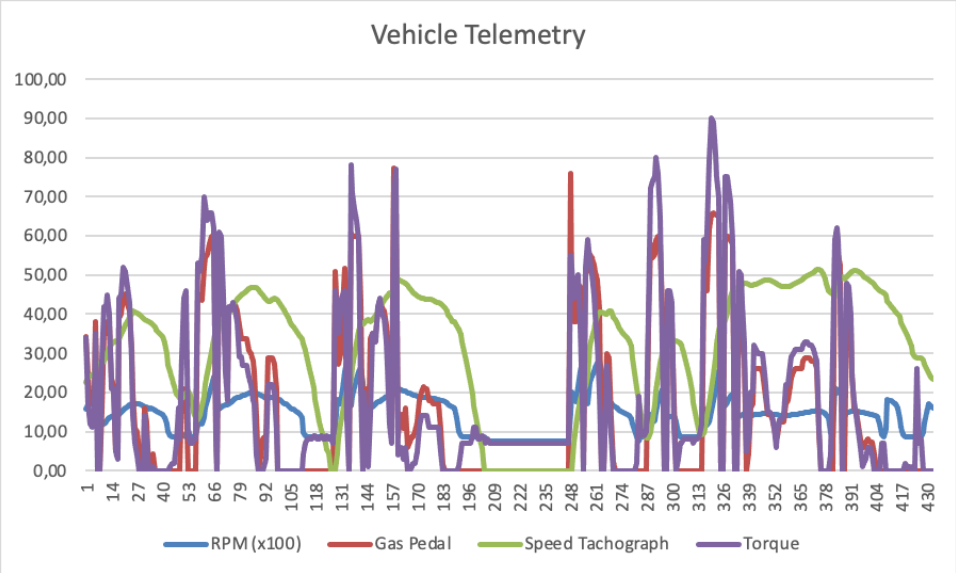


Figure 100 Entruck Engine data drive #2

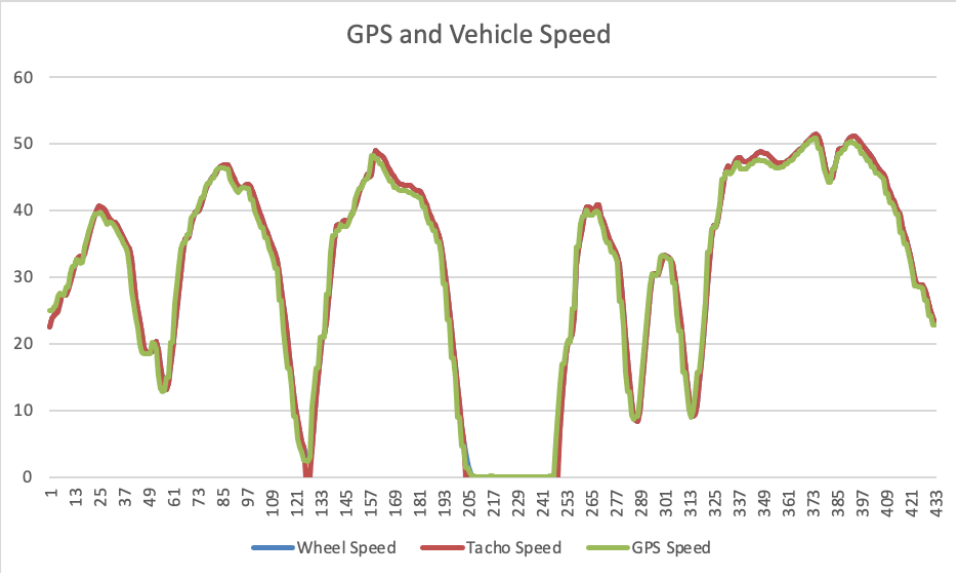


Figure 101 Entruck – Vehicle, Tacho and GPSD Speed drive #2

Error Description if test negative

TEST OK

Proposal Solution if test negative

TEST OK

LL Koper

Testprotocol Koper#1

Datum/Date: Oct 2022, Jan 2022

Test case type (): Pre-test, Trial

Tested by: ININ, LK

Test scenario:

<table>
<tr><td colspan="3">Testcase: UC1-S1-1 (STORYBOARD_#1)</td></tr>
<tr><td colspan="3">Short description: Initial 5G IoT System Deployment Automation (collector, reference)</td></tr>
<tr><td colspan="3">App./Infrastructure: IaaS in Luka Koper</td></tr>
<tr><td colspan="3">Testcase Manager: Jurij Mirnik, Luka Korsic</td></tr>
<tr><td>Prerequisites</td><td colspan="2">- Kubernetes cluster deployed in IaaS in Luka Koper
- Opensource MANO (rel. 10) deployed in IaaS in Luka Koper</td></tr>
<tr><td>Necessary test data</td><td colspan="2">- NA</td></tr>
<tr><td>Activity</td><td colspan="2">Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Onboard VNF and NS descriptors in OSM10</td><td>VNF and NS descriptors are successfully onboarded.</td></tr>
<tr><td>Step 2</td><td>Provision and deploy rMON Collector and Reference server components via OSM 10.</td><td>rMON Collector and Reference server components are successfully deployed.</td></tr>
<tr><td>Step 3</td><td>Provision and deploy Test Agent component via OSM 10.</td><td>Test Agent component is successfully deployed.</td></tr>
<tr><td>Step 4</td><td>Check if all required containers are running.</td><td>All containers are running.</td></tr>
<tr><td>Step 5</td><td>Verify the deployment time.</td><td>Deployment time should be less than 5 min.</td></tr>
<tr><td>Step 6</td><td>Increase compute resources for rMON Collector component.</td><td>Scaling time should be less than 30 sec.</td></tr>
<tr><td>Step 7</td><td>Run measurements from 5G UE with 5G Test Agent for the duration 1 day</td><td>rMON backend services are reachable from the 5G Test agent.</td></tr>
</table></td></tr>
</table>

Expected result	*rMON backend components (i.e. rMON Collector server and rMON Reference server) are successfully deployed on Luka Koper IaaS via provisioning from OSM10.* *K-KPI1: Components Onboarding and Configuration (Backend)* *K-KPI2: Deployment Time (Backend)* *K-KPI3: Time to Scale (Backend)* *K-KPI4: Service Availability (Backend)* *K-KPI5: Components Onboarding and Configuration (Agent)* *K-KPI6: Deployment Time (Agent)*

Test Result (including Screenshots, Photos etc.)

Expected result: yes

Deployed components (step 1- step 4) – expected results (Kubernetes Dashboard UI):

Backend

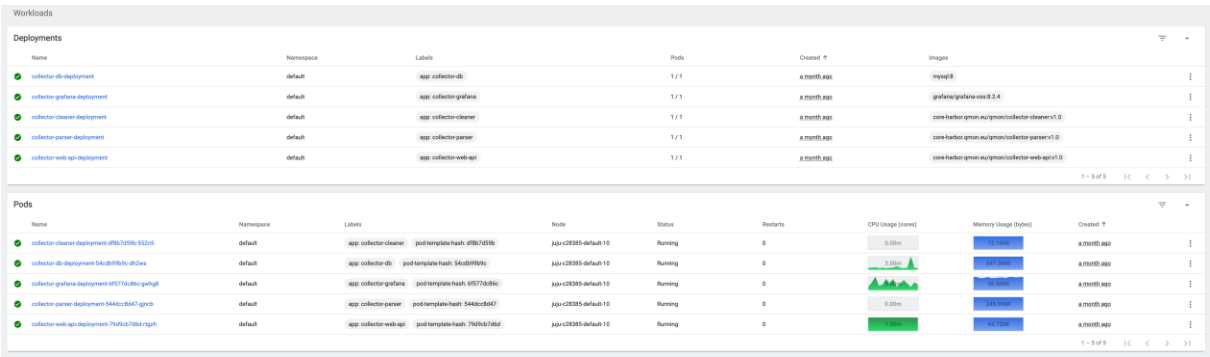


Figure 102: Screenshot – successfully deployed 5G IoT System backend components.

Agent

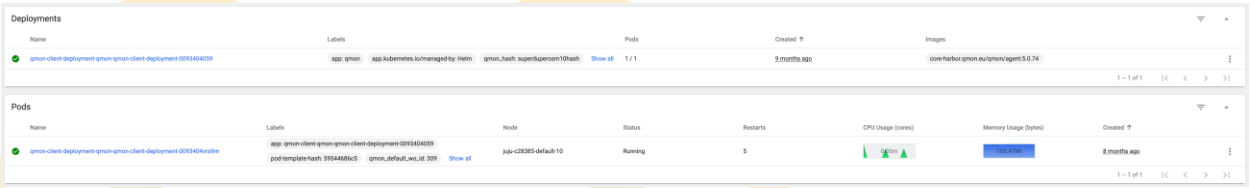


Figure 103: Screenshot – successfully deployed testing agents related to 5G IoT System.

Deployment and scaling time (step 5, step 6) – expected results (kubectl CLI):

```
[qoe@qoe-juju:~$ kubectl get po collector-db-deployment-54cdb99b9c-hr8t7  -o json | jq -r '.status.conditions'
[
  {
    "lastProbeTime": null,
    "lastTransitionTime": "2022-04-22T22:21:11Z",
    "status": "True",
    "type": "Initialized"
  },
  {
    "lastProbeTime": null,
    "lastTransitionTime": "2022-04-22T22:21:13Z",
    "status": "True",
    "type": "Ready"
  },
  {
    "lastProbeTime": null,
    "lastTransitionTime": "2022-04-22T22:21:13Z",
    "status": "True",
    "type": "ContainersReady"
  },
  {
    "lastProbeTime": null,
    "lastTransitionTime": "2022-04-22T22:21:04Z",
    "status": "True",
    "type": "PodScheduled"
  }
]
```

Figure 104: Screenshot – checking deployment and scaling time (expected output).

Service availability (step 7) – expected results (rMON Collector UI):

5G UE connected to Private 5G Mobile System

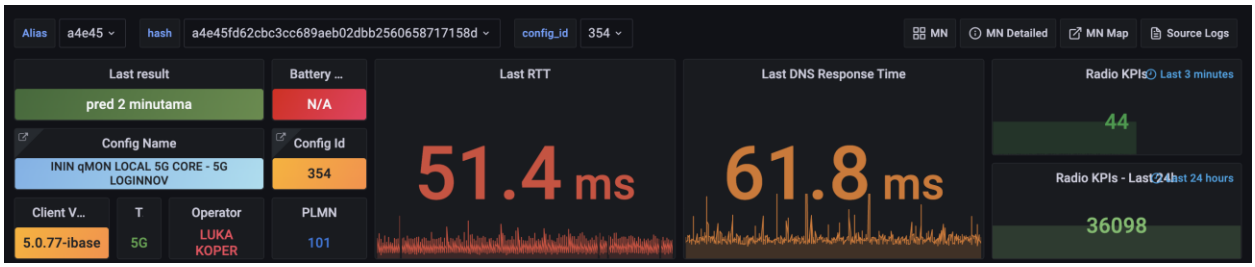


Figure 105: Example of measurement results (multiple parameters) proving UE is successfully connected to the 5G system.

Service Availability:

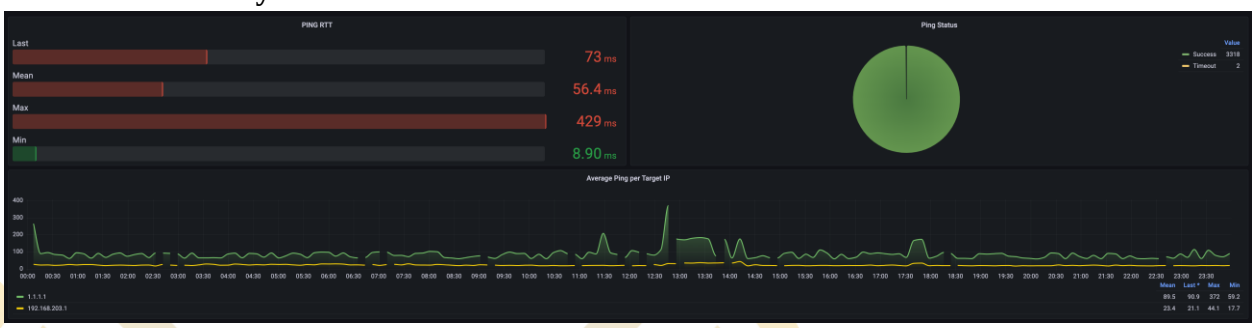


Figure 106: Service availability measurement.

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#2

Datum/Date: Apr 2022, Jan 2023

Test case type (): Pre-test, Trial

Tested by: ININ

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC1-S2-1 (STORYBOARD_#2)</td></tr>
<tr><td colspan="2">Short description: Initial Private 5G System Deployment Automation</td></tr>
<tr><td colspan="2">App./Infrastructure: Portable IaaS (ININ)</td></tr>
<tr><td colspan="2">Testcase Manager: Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td>- Kubernetes cluster deployed in portable IaaS
- Opensource MANO (rel. 10) deployed in IaaS in Luka Koper</td></tr>
<tr><td>Necessary test data</td><td>- NA</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Onboard VNF and NS descriptors in OSM10</td><td>VNF and NS descriptors are successfully onboarded.</td></tr>
<tr><td>Step 2</td><td>Provision and deploy Privat 5G Mobile System components via OSM 10.</td><td>5G Mobile System components are successfully deployed.</td></tr>
<tr><td>Step 3</td><td>Provision and deploy Test Agent component via OSM 10.</td><td>Test Agent component is successfully deployed.</td></tr>
<tr><td>Step 4</td><td>Check if all required containers are running.</td><td>All containers are running.</td></tr>
<tr><td>Step 5</td><td>Verify the deployment time.</td><td>Deployment time should be less than 5 min.</td></tr>
<tr><td>Step 6</td><td>Increase compute resources for 5G CN component.</td><td>Scaling time should be less than 30 sec.</td></tr>
<tr><td>Step 7</td><td>Connect to Private 5G System with the 5G UE.</td><td>5G UE successfully registers to Private 5G Mobile System.</td></tr>
<tr><td>Step 8</td><td>Reconfigure TDD profile on the Private 5G System slice.</td><td>Slice configuration parameters are reconfigured.</td></tr>
</table></td></tr>
</table>

Expected result	*Private 5G System components (i.e. CN and gNB) are successfully deployed on portable IaaS via provisioning from OSM10.* *K-KPI7: Components Onboarding and Configuration (Backend)* *K-KPI8: Deployment Time (Backend)* *K-KPI9: Time to Scale (Backend)* *K-KPI10: Service Availability (Backend)* *K-KPI11: Slice Reconfiguration (Backend)*

Test Result (including Screenshots, Photos etc.)

Expected result: yes

Deployed components (step 1- step 4) – expected results (Kubernetes Dashboard UI):

Private 5G Mobile System

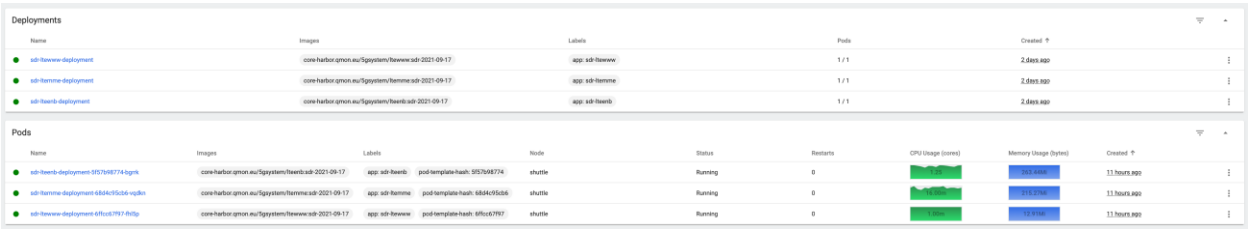


Figure 107: Screenshot – successfully deployed Private 5G System.

Agent

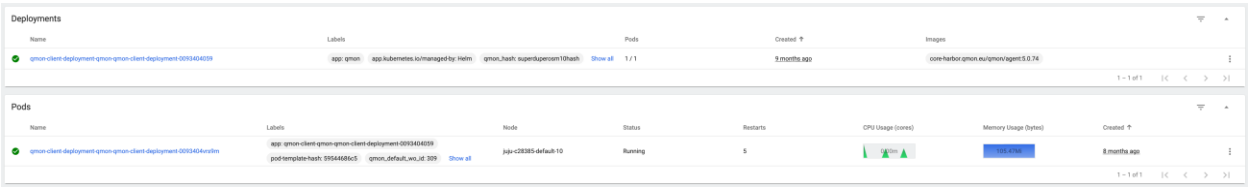


Figure 108: Screenshot – successfully deployed testing agents related to Private 5G System.

Deployment and scaling time (step 5, step 6) – expected results (kubectl CLI):

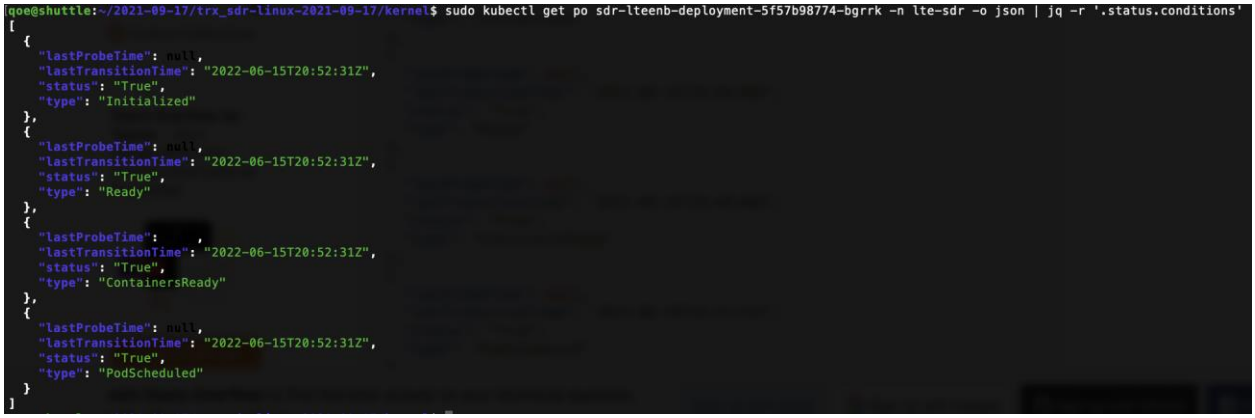


Figure 109: Screenshot – checking deployment and scaling time (expected output).

Service availability (step 7) – expected results:

5G UEs connected to Private 5G Mobile System (5G Management UI)

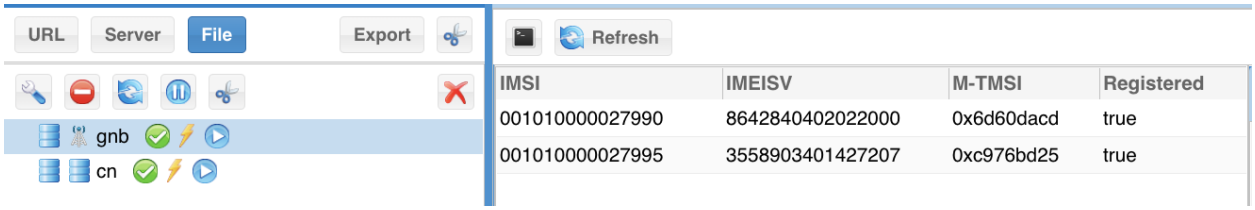


Figure 110: Screenshot showing 5G UEs are successfully connected to the Private 5G System.

Service Availability (rMON Collector UI)

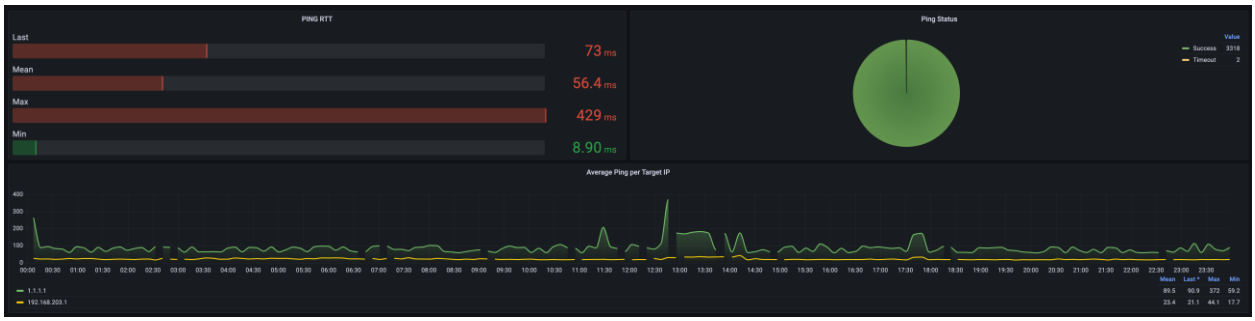


Figure 111: Screenshot – checking deployment and scaling time (expected output).

Slice reconfiguration (step 8) – expected results (Kubernetes Dashboard UI):

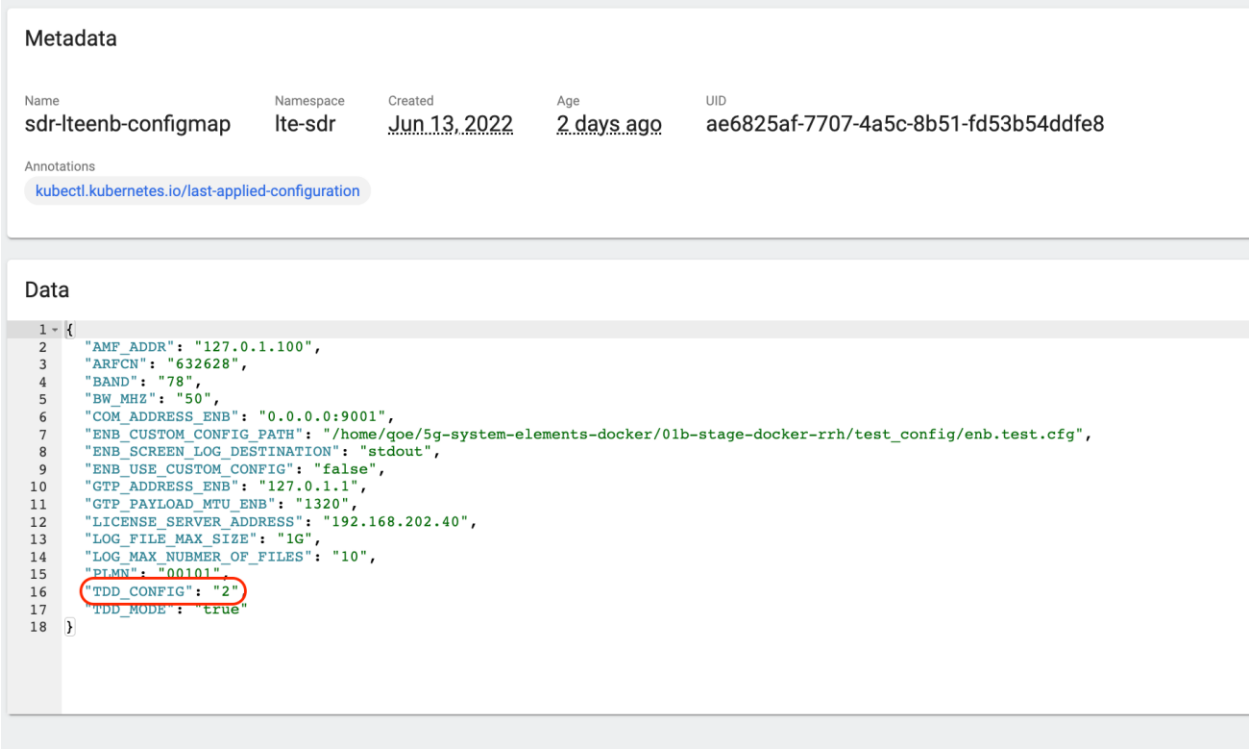


Figure 112: Slice reconfiguration in Private 5G System (SA) - initial status, i.e., before reconfiguration is triggered.

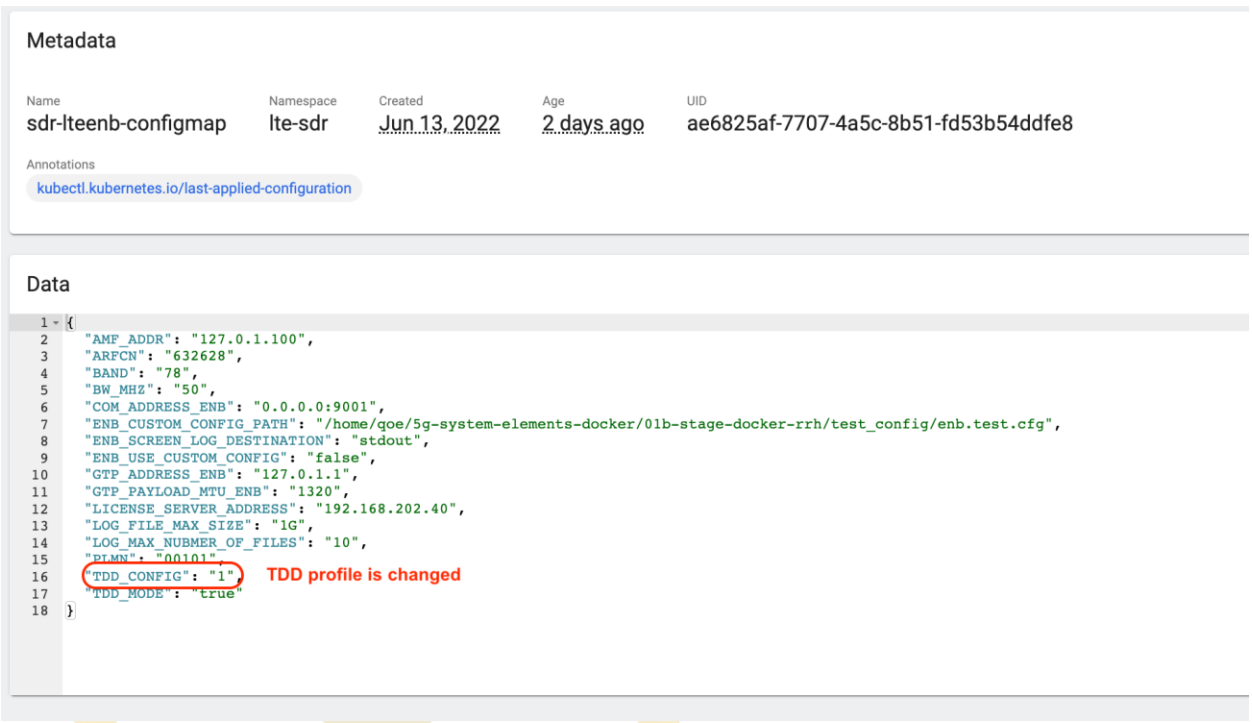


Figure 113: Slice reconfiguration in Private 5G System (SA) - after the successful reconfiguration (TDD profile has changed).

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#3

Datum/Date: Feb 2022

Test case type (): Pre-test

Tested by: ININ, LK

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC1-S3-1 (STORYBOARD_#3)</td></tr>
<tr><td colspan="2">Short description: Initial 5G Drive test (n7 5G NR, Macro CN)</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G Network, gNb with n7 band, NSA assured macro EPC, qMON system, qMON agents, qMON reference server, Macro IaaS</td></tr>
<tr><td colspan="2">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td>- Operational 5G NSA network with deployed n7 gNb and NSA assured macro EPC.
- Operational qMON System with prepared WO (Work Orders) on qMON management.
- Operational qMON Reference Server in macro IaaS.
- Deployed qMON Agents in the test vehicle.</td></tr>
<tr><td>Necessary test data</td><td>- NA</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a vehicle.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. drive test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
<tr><td>Step 4</td><td>Check if log files with test results were received on qMON Collector.</td><td>Log files are received on the qMON Collector storage server.</td></tr>
<tr><td>Step 5</td><td>Check if test results are visible in qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
<tr><td>Step 6</td><td>Proceed with the drive test using selected route/area in the port.</td><td>Driving with the vehicle in the selected LL area.</td></tr>
</table></td></tr>
</table>

	Step 7	**Stop the qMON Agent.**	**qMON Agent application is not running.**
	Step 8	**Verify test results in the qMON Analytics.**	**KPI results with expected values are visible on the qMON Analytics.**
Expected result	*As part of a 5G drive test the following KPIs were collected:* *K-KPI 13: Availability* *K-KPI 14: Bandwidth* *K-KPI 17: End-to-End Latency* *K-KPI 18: Reliability* *Other 5G related KPI such as (RSRP, RSRQ, SINR, TX Power etc)*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

Figure 114: Screenshots showing qMON agent status (qMON agent is an Android application installed on the mobile device, i.e., smart-phone, used for the drive test).

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):

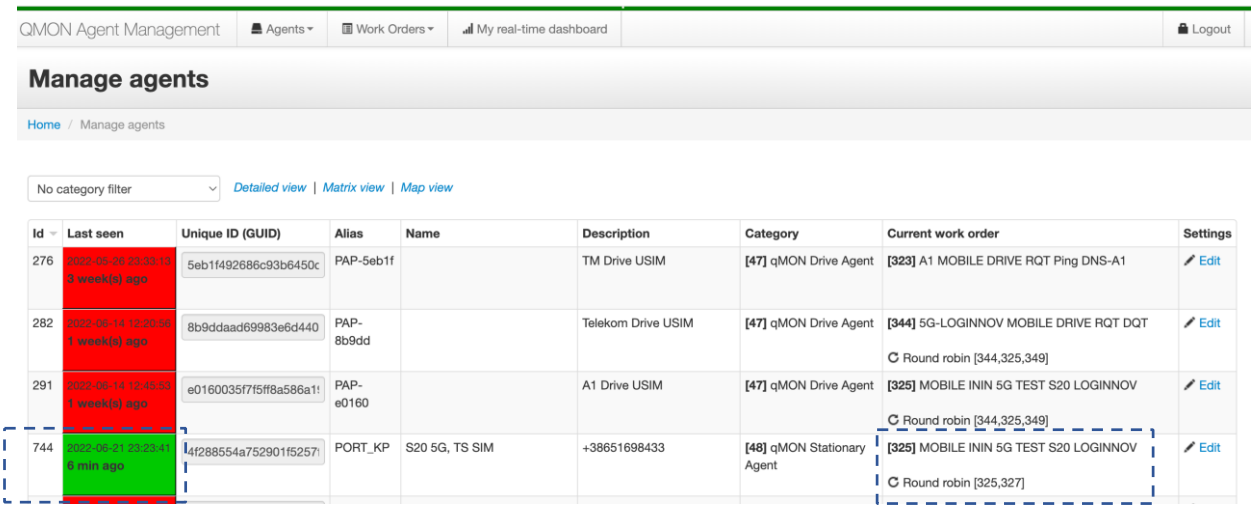
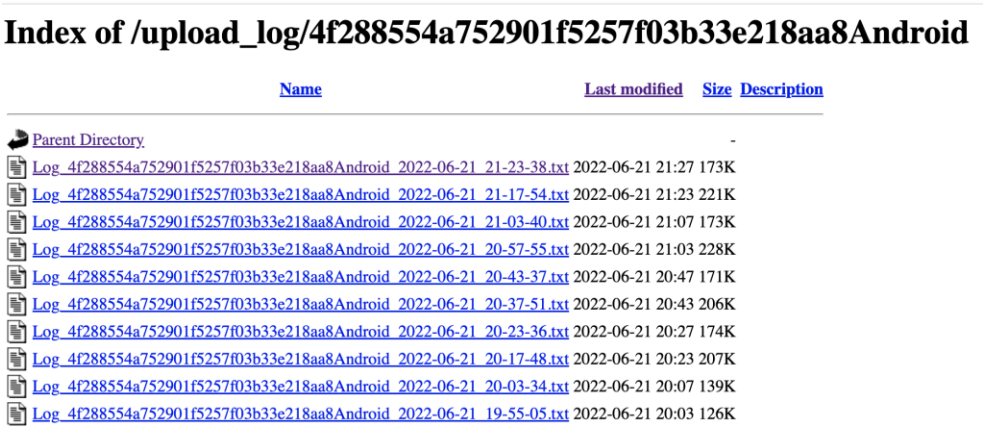


Figure 115: qMON agent status as presented in qMON management dashboard (green means the agent is active).

Log files on qMON Collector (step 4) – expected results (UI):




```
2022-06-21 21:27:33 - INFO - ----------CUSTOM PLUGIN MEASUREMENT----------
2022-06-21 21:27:33 - INFO - Custom Plugin Measurement not enabled.
2022-06-21 21:27:33 - INFO - ---------- VOICE MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Voice Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------SMS MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Sms Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------TCPDUMP----------
2022-06-21 21:27:33 - INFO - TCPDUMP is not alive.
2022-06-21 21:27:33 - INFO - ----------XML START----------
<root>
   <Id agent_id_numeric="744" created_on="Tue 21 Jun 2022 21:27:33 GMT (Greenwich Mean Time)" revision="25" configuration_name="MOBILE ININ 5G TEST S20 LOGINNOV"
configuration_desc="MOBILE APP STATIONARY TEST" category_id="48" category_name="qMON Stationary Agent" agent_descripton="+38651698433" agent_info_technology="LTE"/>
   <Global_data aliasHash="PORT_KP" apn="internet" client_version="InIn Mobile 2022 @ 2.0.1-dev" config_id="325" cycle_id="1655846618374000"
hash="4f288554a752901f5257f03b33e218aa8Android" mobile_mode="1" os_name="Android" os_version="11" wo_duration="234" modem_temperature="53" cpu_temperature="43"
battery_temperature="41" battery_level="67.0" battery_status="3"/>
   <Measurement client_ip="178.58.54.102" client_ipv4_for_geoloc="178.58.54.102" target_ip="89.143.198.178" packet_size_bytes="64" interval_between_icmp_packets_ms="100"
timestamp="2022-06-21 21:26:37" ip_version="4" type="ping_test" first_hop_rtt_ms="-1" traceroute="*;*;213.229.192.209;*;*;*;*;*;*;*;*;*;*" traceroute_duration="42.154"
client_start_gps_latitude="45.549640020213275" client_start_gps_longitude="13.735982276002291" client_start_gps_altitude="45.728174883622714"
client_start_gps_speed_over_ground_knots="0.0" client_start_gps_timestamp="1655846796018" client_start_gps_num_sats="12" client_stop_gps_latitude="45.549640020213275"
client_stop_gps_longitude="13.735982276002291" client_stop_gps_altitude="45.728174883622714" client_stop_gps_speed_over_ground_knots="0.0" client_stop_gps_timestamp="1655846797025"
client_stop_gps_num_sats="12" radio_access_type_start="LTE" radio_cell_id_start="155597002" radio_tac_start="42" radio_rsrq_db_start="-11" radio_rsrp_dbm_start="-110"
radio_net_operator_start="MOBITEL" radio_operator_code_start="29341" radio_lte_rx_channel_start="6201" radio_lte_tx_channel_start="24201" radio_lte_band_start="B20"
radio_lte_pci_start="139" radio_rssi_dbm_start="-86" radio_emm_connection_start="CONNECTED" radio_sinr_db_start="8" radio_tx_power_dbm_start="2" radio_lte_bw_mhz_start="10"
radio_lte_ca_state_start="ADDED" radio_lte_dl_mcs_1_start="2" radio_lte_dl_mcs_2_start="0" radio_lte_ul_mcs_1_start="6" radio_lte_rb_dl_start="0" radio_lte_rb_ul_start="3"
radio_lte_max_rb_dl_start="50" radio_lte_max_rb_ul_start="40" radio_lte_sc_num_start="1" radio_lte_scell_band_start="B7" radio_lte_scell_bw_mhz_start="15"
radio_lte_scell_rx_channel_start="3023" radio_lte_pcc_rxm_RSRP_dbm_start="-102" radio_access_type_stop="LTE" radio_cell_id_stop="155597002" radio_tac_stop="42"
radio_rsrq_db_stop="-11" radio_rsrp_dbm_stop="-110" radio_net_operator_stop="MOBITEL" radio_operator_code_stop="29341" radio_lte_rx_channel_stop="6201"
radio_lte_tx_channel_stop="24201" radio_lte_band_stop="B20" radio_lte_pci_stop="139" radio_rssi_dbm_stop="-86" radio_emm_connection_stop="CONNECTED" radio_sinr_db_stop="8"
radio_tx_power_dbm_stop="2" radio_lte_bw_mhz_stop="10" radio_lte_ca_state_stop="ADDED" radio_lte_dl_mcs_1_stop="2" radio_lte_dl_mcs_2_stop="0" radio_lte_ul_mcs_1_stop="6"
radio_lte_rb_dl_stop="0" radio_lte_rb_ul_stop="3" radio_lte_max_rb_dl_stop="50" radio_lte_max_rb_ul_stop="40" radio_lte_sc_num_stop="1" radio_lte_scell_band_stop="B7"
radio_lte_scell_bw_mhz_stop="15" radio_lte_scell_rx_channel_stop="3023" radio_lte_pcc_rxm_RSRP_dbm_stop="-102">
      <rtt_ms status="Success" status_code="0" sequence_number="1">42.6</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="2">14.5</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="3">30.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="4">29.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="5">29.9</rtt_ms>
   </Measurement>
```


Figure 116: List of log files (measurement results) uploaded by qMON Agent to qMON Collector.

qMON analytics (step 5) – expected results (UI):

Figure 117: Graphical representation of results (qMON Analytics tool).

Step 6: driving across selected area in the LL Koper.

qMON Agent status on the Android app (step 7) – expected results (UI):

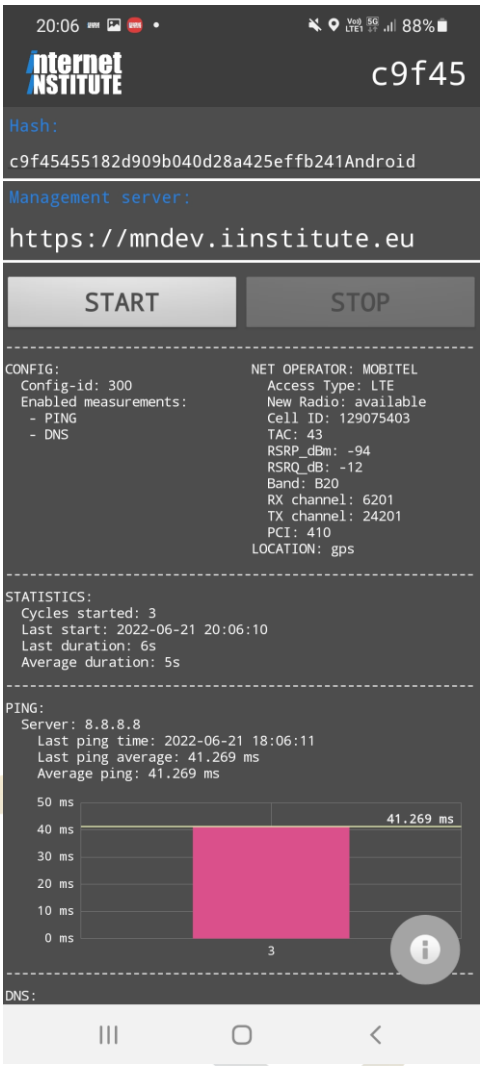


Figure 118: qMON Agent status while performing measurements.

qMON Analytics (step 8) – expected results (UI):

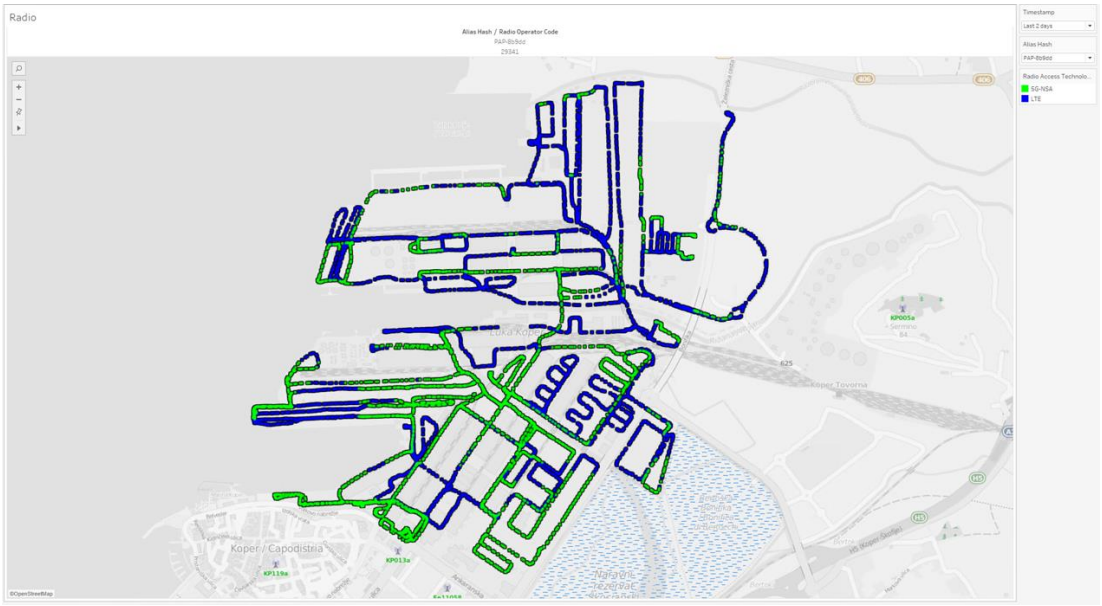


Figure 119: qMON Analytics tool showing drive test route.

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#4

Datum/Date: Oct 2022, Feb 2023

Test case type (): Trial

Tested by: ININ, LK

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC1-S3-2 (STORYBOARD_#3)</td></tr>
<tr><td colspan="2">Short description: 5G Drive test (n7 and n78 5G NR, Local CN)</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G Network, gNb with n7 band and n78, NSA assured local EPC, qMON system, qMON agents, qMON reference server, Mobile IaaS</td></tr>
<tr><td colspan="2">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td>- Operational 5G NSA network with deployed n7 and n79 gNb and NSA assured local EPC deployed on Mobile/MEC IaaS.
- Operational qMON System with prepared WO (Work Orders) on qMON management.
- Operational qMON Reference Server in local IaaS.
- Deployed qMON Agents in the test vehicle.</td></tr>
<tr><td>Necessary test data</td><td>- NA</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a vehicle.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. drive test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
<tr><td>Step 4</td><td>Check if log files with test results were received on qMON Collector.</td><td>Log files are received on the qMON Collector storage server.</td></tr>
<tr><td>Step 5</td><td>Check if test results are visible in qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
<tr><td>Step 6</td><td>Proceed with the drive test using selected route/area in the port.</td><td>Driving with the vehicle in the selected LL area.</td></tr>
</table></td></tr>
</table>

	Step 7	**Stop the qMON Agent.**	**qMON Agent application is not running.**
	Step 8	**Verify test results in the qMON Analytics.**	**KPI results with expected values are visible on the qMON Analytics.**
Expected result	*As part of a 5G drive test the following KPIs were collected:* *K-KPI 13: Availability* *K-KPI 14: Bandwidth* *K-KPI 17: End-to-End Latency* *K-KPI 18: Reliability* *Other 5G related KPI such as (RSRP, RSRQ, SINR, TX Power etc)*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

Figure 120: Screenshots showing qMON agent status (qMON agent is an Android application installed on the mobile device, i.e., smart-phone, used for the drive test).

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):

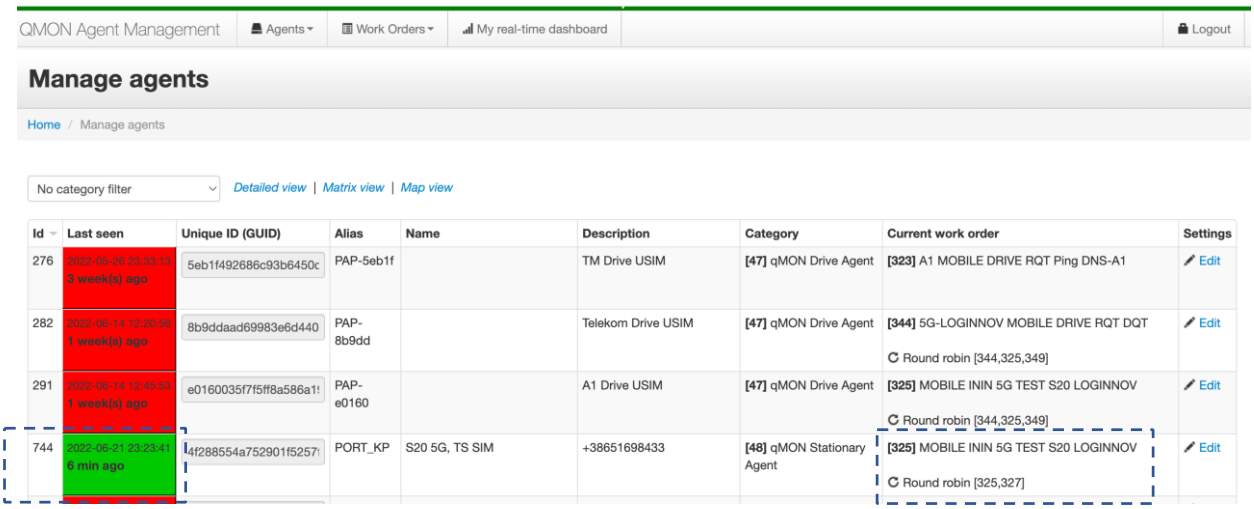
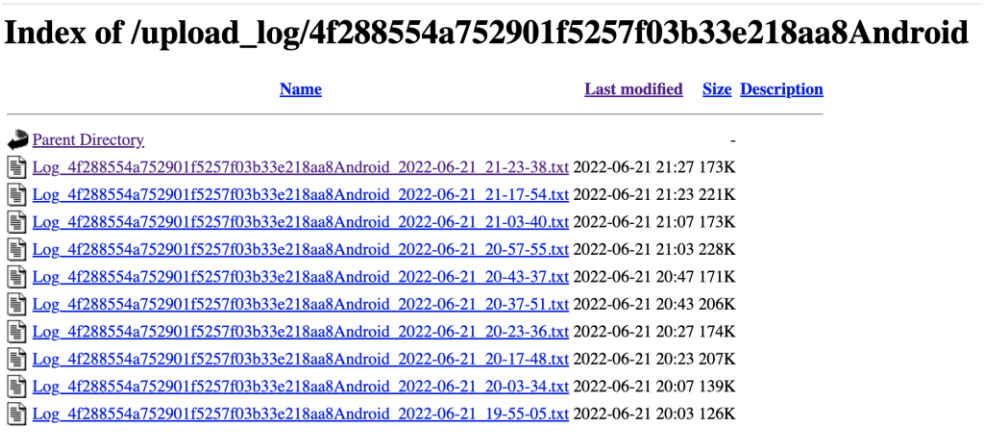


Figure 121: qMON agent status as presented in qMON management dashboard (green means the agent is active).

Log files on qMON Collector (step 4) – expected results (UI):




```
2022-06-21 21:27:33 - INFO - ----------CUSTOM PLUGIN MEASUREMENT----------
2022-06-21 21:27:33 - INFO - Custom Plugin Measurement not enabled.
2022-06-21 21:27:33 - INFO - ---------- VOICE MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Voice Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------SMS MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Sms Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------TCPDUMP----------
2022-06-21 21:27:33 - INFO - TCPDUMP is not alive.
2022-06-21 21:27:33 - INFO - ----------XML START----------
<root>
   <Id agent_id_numeric="744" created_on="Tue 21 Jun 2022 21:27:33 GMT (Greenwich Mean Time)" revision="25" configuration_name="MOBILE ININ 5G TEST S20 LOGINNOV"
configuration_desc="MOBILE APP STATIONARY TEST" category_id="48" category_name="qMON Stationary Agent" agent_descripton="+38651698433" agent_info_technology="LTE"/>
   <Global_data aliasHash="PORT_KP" apn="internet" client_version="InIn Mobile 2022 @ 2.0.1-dev" config_id="325" cycle_id="1655846618374000"
hash="4f288554a752901f5257f03b33e218aa8Android" mobile_mode="1" os_name="Android" os_version="11" wo_duration="234" modem_temperature="53" cpu_temperature="43"
battery_temperature="41" battery_level="67.0" battery_status="3"/>
   <Measurement client_ip="178.58.54.102" client_ipv4_for_geoloc="178.58.54.102" target_ip="89.143.198.178" packet_size_bytes="64" interval_between_icmp_packets_ms="100"
timestamp="2022-06-21 21:26:37" ip_version="4" type="ping_test" first_hop_rtt_ms="-1" traceroute="*;*;213.229.192.209;*;*;*;*;*;*;*;*;*;*" traceroute_duration="42.154"
client_start_gps_latitude="45.549640020213275" client_start_gps_longitude="13.735982276002291" client_start_gps_altitude="45.728174883622714"
client_start_gps_speed_over_ground_knots="0.0" client_start_gps_timestamp="1655846796018" client_start_gps_num_sats="12" client_stop_gps_latitude="45.549640020213275"
client_stop_gps_longitude="13.735982276002291" client_stop_gps_altitude="45.728174883622714" client_stop_gps_speed_over_ground_knots="0.0" client_stop_gps_timestamp="1655846797025"
client_stop_gps_num_sats="12" radio_access_type_start="LTE" radio_cell_id_start="155597002" radio_tac_start="42" radio_rsrq_db_start="-11" radio_rsrp_dbm_start="-110"
radio_net_operator_start="MOBITEL" radio_operator_code_start="29341" radio_lte_rx_channel_start="6201" radio_lte_tx_channel_start="24201" radio_lte_band_start="B20"
radio_lte_pci_start="139" radio_rssi_dbm_start="-86" radio_emm_connection_start="CONNECTED" radio_sinr_db_start="8" radio_tx_power_dbm_start="2" radio_lte_bw_mhz_start="10"
radio_lte_ca_state_start="ADDED" radio_lte_dl_mcs_1_start="2" radio_lte_dl_mcs_2_start="0" radio_lte_ul_mcs_1_start="6" radio_lte_rb_dl_start="0" radio_lte_rb_ul_start="3"
radio_lte_max_rb_dl_start="50" radio_lte_max_rb_ul_start="40" radio_lte_sc_num_start="1" radio_lte_scell_band_start="B7" radio_lte_scell_bw_mhz_start="15"
radio_lte_scell_rx_channel_start="3023" radio_lte_pcc_rxm_RSRP_dbm_start="-102" radio_access_type_stop="LTE" radio_cell_id_stop="155597002" radio_tac_stop="42"
radio_rsrq_db_stop="-11" radio_rsrp_dbm_stop="-110" radio_net_operator_stop="MOBITEL" radio_operator_code_stop="29341" radio_lte_rx_channel_stop="6201"
radio_lte_tx_channel_stop="24201" radio_lte_band_stop="B20" radio_lte_pci_stop="139" radio_rssi_dbm_stop="-86" radio_emm_connection_stop="CONNECTED" radio_sinr_db_stop="8"
radio_tx_power_dbm_stop="2" radio_lte_bw_mhz_stop="10" radio_lte_ca_state_stop="ADDED" radio_lte_dl_mcs_1_stop="2" radio_lte_dl_mcs_2_stop="0" radio_lte_ul_mcs_1_stop="6"
radio_lte_rb_dl_stop="0" radio_lte_rb_ul_stop="3" radio_lte_max_rb_dl_stop="50" radio_lte_max_rb_ul_stop="40" radio_lte_sc_num_stop="1" radio_lte_scell_band_stop="B7"
radio_lte_scell_bw_mhz_stop="15" radio_lte_scell_rx_channel_stop="3023" radio_lte_pcc_rxm_RSRP_dbm_stop="-102">
      <rtt_ms status="Success" status_code="0" sequence_number="1">42.6</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="2">14.5</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="3">30.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="4">29.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="5">29.9</rtt_ms>
   </Measurement>
```


Figure 122: List of log files (measurement results) uploaded by qMON Agent to qMON Collector.

qMON analytics (step 5) – expected results (UI):

Figure 123: Graphical representation of results (qMON Analytics tool).

Step 6: driving across selected area in the LL Koper.

qMON Agent status on the Android app (step 7) – expected results (UI):

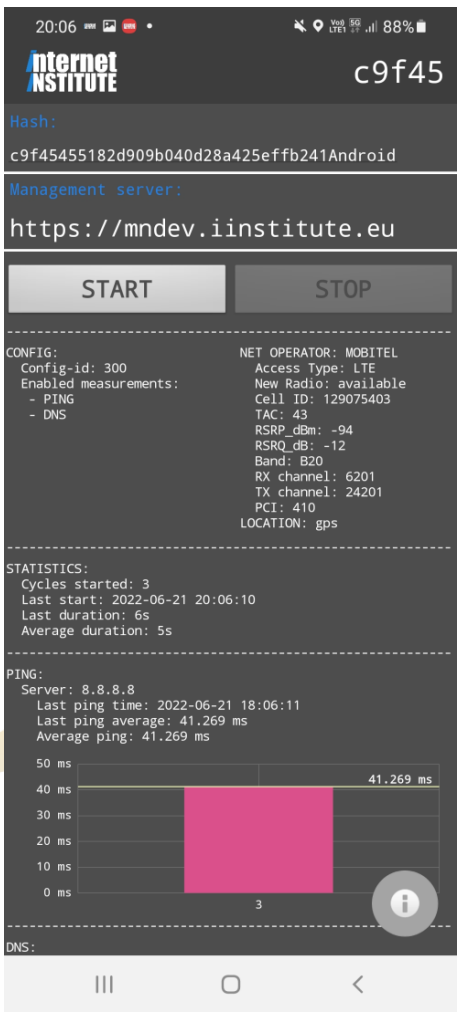


Figure 124: qMON Agent status while performing measurements.

qMON Analytics (step 8) – expected results (UI):

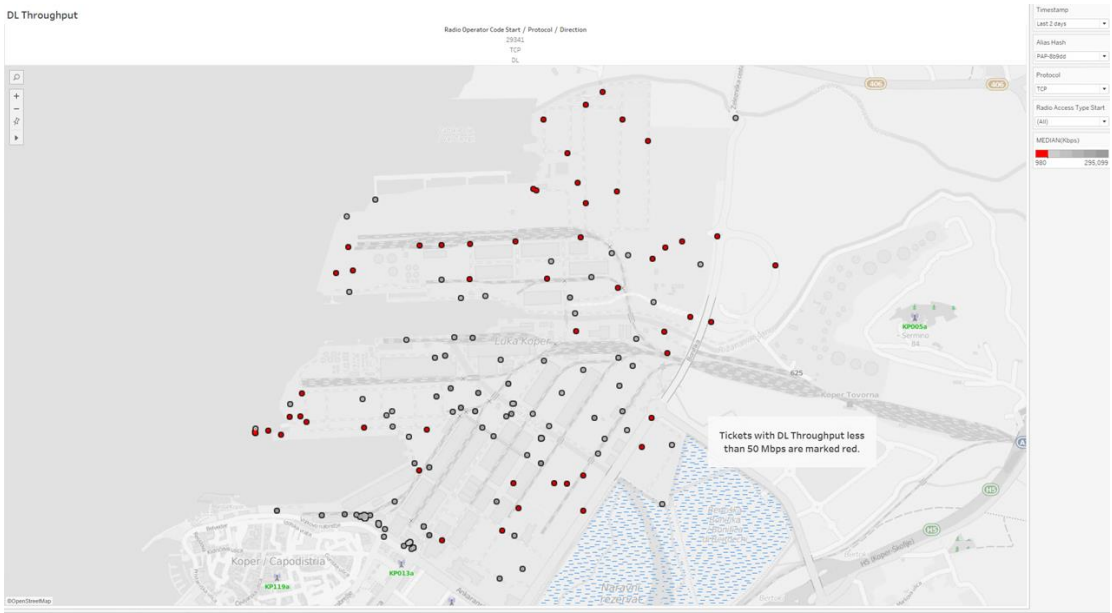


Figure 125: qMON Analytics tool showing locations where "DL Throughput" measurement has been performed.

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#5

Datum/Date: May – Aug 2022

Test case type (): Pre-test

Tested by: ININ, LK, TS

Test scenario:

<table>
<tr><td colspan="3">Testcase: UC1-S4-1 (STORYBOARD_#4)</td></tr>
<tr><td colspan="3">Short description: Continuous 5G NSA testing (n7 5G NR, Macro CN)</td></tr>
<tr><td colspan="3">App./Infrastructure: 5G NSA Network, gNb with n7 band, NSA assured Macro EPC, qMON system, qMON agents, qMON reference server, Macro IaaS</td></tr>
<tr><td colspan="3">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td colspan="2">- Operational 5G NSA network with deployed n7 gNb and NSA assured Macro EPC deployed.
- Operational qMON System with prepared WO (Work Orders) on qMON management.
- Operational qMON Reference Server in Macro IaaS.
- Deployed qMON Agents in the selected location in the port area.</td></tr>
<tr><td>Necessary test data</td><td colspan="2">- NA</td></tr>
<tr><td>Activity</td><td colspan="2">Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a selected location.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. stationary test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
<tr><td>Step 4</td><td>Check if log files with test results were received on qMON Collector.</td><td>Log files are received on the qMON Collector storage server.</td></tr>
<tr><td>Step 5</td><td>Check if test results are visible in qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
<tr><td>Step 6</td><td>Proceed with the continuous testing for the defined time span.</td><td>qMON Agent is running continuously and test results are collected .</td></tr>
</table></td></tr>
</table>

	Step 7	**Stop the qMON Agent.**	**qMON Agent application is not running.**
	Step 8	**Verify test results in the qMON Analytics.**	**KPI results with expected values are visible on the qMON Analytics.**
Expected result	*As part of a continuous 5G test the following KPIs will be collected:* *K-KPI 13: Availability* *K-KPI 14: Bandwidth* *K-KPI 17: End-to-End Latency* *K-KPI 18: Reliability* *Other 5G related KPI such as (RSRP, RSRQ, SINR, TX Power etc)*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

Figure 126: Screenshots showing qMON agent status (qMON agent is an Android application installed on the mobile device, i.e., smart-phone, used for the test).

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):

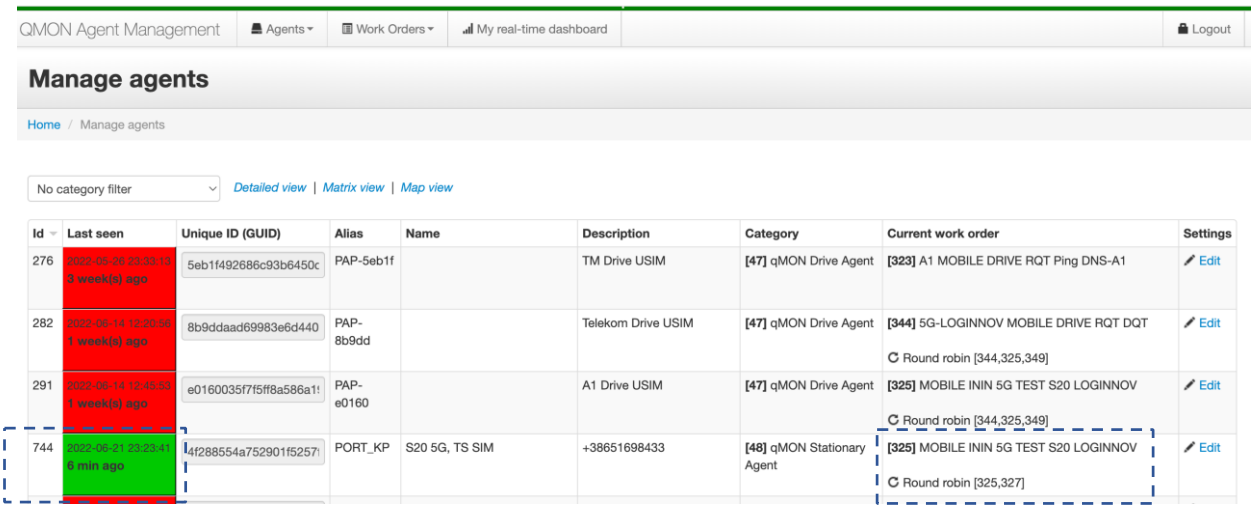
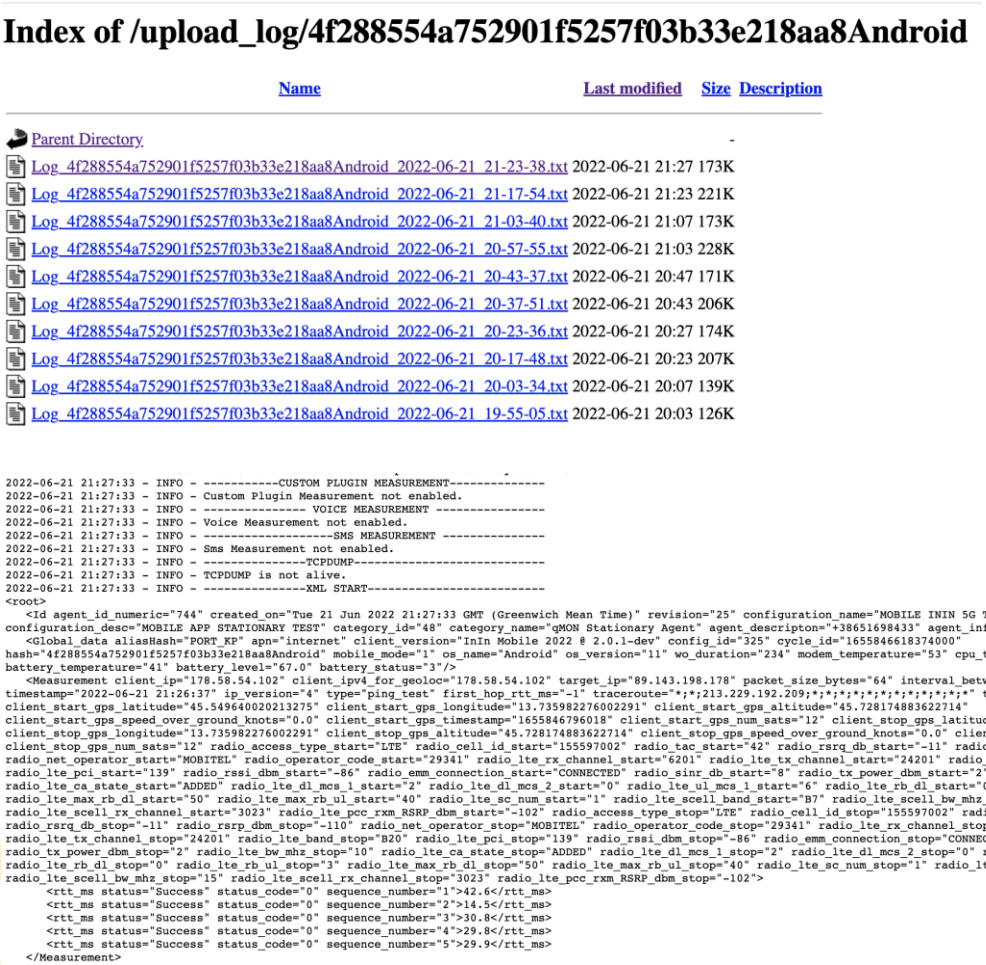


Figure 127: qMON agent status as presented in qMON management dashboard (green means the agent is active).

Log files on qMON Collector (step 4) – expected results (UI):




```
2022-06-21 21:27:33 - INFO - ----------CUSTOM PLUGIN MEASUREMENT--------------
2022-06-21 21:27:33 - INFO - Custom Plugin Measurement not enabled.
2022-06-21 21:27:33 - INFO - ---------- VOICE MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Voice Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------SMS MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Sms Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------TCPDUMP----------
2022-06-21 21:27:33 - INFO - TCPDUMP is not alive.
2022-06-21 21:27:33 - INFO - ----------XML START----------
<root>
   <Id agent_id_numeric="744" created_on="Tue 21 Jun 2022 21:27:33 GMT (Greenwich Mean Time)" revision="25" configuration_name="MOBILE ININ 5G TEST S20 LOGINNOV"
configuration_desc="MOBILE APP STATIONARY TEST" category_id="48" category_name="qMON Stationary Agent" agent_descripton="+38651698433" agent_info_technology="LTE"/>
   <Global_data aliasHash="PORT_KP" apn="internet" client_version="InIn Mobile 2022 @ 2.0.1-dev" config_id="325" cycle_id="1655846618374000"
hash="4f288554a752901f5257f03b33e218aa8Android" mobile_mode="1" os_name="Android" os_version="11" wo_duration="234" modem_temperature="53" cpu_temperature="43"
battery_temperature="41" battery_level="67.0" battery_status="3"/>
   <Measurement client_ip="178.58.54.102" client_ipv4_for_geoloc="178.58.54.102" target_ip="89.143.198.178" packet_size_bytes="64" interval_between_icmp_packets_ms="100"
timestamp="2022-06-21 21:26:37" ip_version="4" type="ping_test" first_hop_rtt_ms="-1" traceroute="*;*;213.229.192.209;*;*;*;*;*;*;*;*;*;*" traceroute_duration="42.154"
client_start_gps_latitude="45.549640020213275" client_start_gps_longitude="13.735982276002291" client_start_gps_altitude="45.728174883622714"
client_start_gps_speed_over_ground_knots="0.0" client_start_gps_timestamp="1655846796018" client_start_gps_num_sats="12" client_stop_gps_latitude="45.549640020213275"
client_stop_gps_longitude="13.735982276002291" client_stop_gps_altitude="45.728174883622714" client_stop_gps_speed_over_ground_knots="0.0" client_stop_gps_timestamp="1655846797025"
client_stop_gps_num_sats="12" radio_access_type_start="LTE" radio_cell_id_start="155597002" radio_tac_start="42" radio_rsrq_db_start="-11" radio_rsrp_dbm_start="-110"
radio_net_operator_start="MOBITEL" radio_operator_code_start="29341" radio_lte_rx_channel_start="6201" radio_lte_tx_channel_start="24201" radio_lte_band_start="B20"
radio_lte_pci_start="139" radio_rssi_dbm_start="-86" radio_emm_connection_start="CONNECTED" radio_sinr_db_start="8" radio_tx_power_dbm_start="2" radio_lte_bw_mhz_start="10"
radio_lte_ca_state_start="ADDED" radio_lte_dl_mcs_1_start="2" radio_lte_dl_mcs_2_start="0" radio_lte_ul_mcs_1_start="6" radio_lte_rb_dl_start="0" radio_lte_rb_ul_start="3"
radio_lte_max_rb_dl_start="50" radio_lte_max_rb_ul_start="40" radio_lte_sc_num_start="1" radio_lte_scell_band_start="B7" radio_lte_scell_bw_mhz_start="15"
radio_lte_scell_rx_channel_start="3023" radio_lte_pcc_rxm_RSRP_dbm_start="-102" radio_access_type_stop="LTE" radio_cell_id_stop="155597002" radio_tac_stop="42"
radio_rsrq_db_stop="-11" radio_rsrp_dbm_stop="-110" radio_net_operator_stop="MOBITEL" radio_operator_code_stop="29341" radio_lte_rx_channel_stop="6201"
radio_lte_tx_channel_stop="24201" radio_lte_band_stop="B20" radio_lte_pci_stop="139" radio_rssi_dbm_stop="-86" radio_emm_connection_stop="CONNECTED" radio_sinr_db_stop="8"
radio_tx_power_dbm_stop="2" radio_lte_bw_mhz_stop="10" radio_lte_ca_state_stop="ADDED" radio_lte_dl_mcs_1_stop="2" radio_lte_dl_mcs_2_stop="0" radio_lte_ul_mcs_1_stop="6"
radio_lte_rb_dl_stop="0" radio_lte_rb_ul_stop="3" radio_lte_max_rb_dl_stop="50" radio_lte_max_rb_ul_stop="40" radio_lte_sc_num_stop="1" radio_lte_scell_band_stop="B7"
radio_lte_scell_bw_mhz_stop="15" radio_lte_scell_rx_channel_stop="3023" radio_lte_pcc_rxm_RSRP_dbm_stop="-102">
      <rtt_ms status="Success" status_code="0" sequence_number="1">42.6</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="2">14.5</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="3">30.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="4">29.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="5">29.9</rtt_ms>
   </Measurement>
```


Figure 128: List of log files (measurement results) uploaded by qMON Agent to qMON Collector.

qMON analytics (step 5) – expected results (UI):

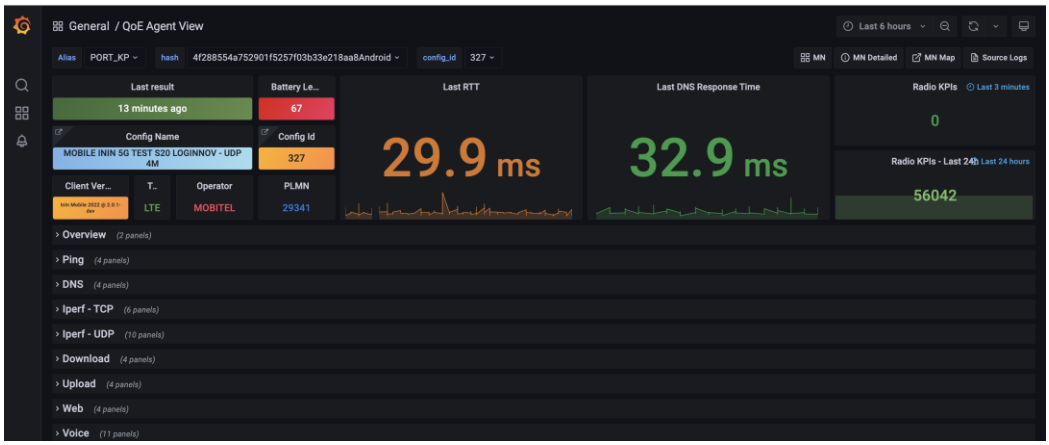


Figure 129: Graphical representation of results (qMON Analytics tool).

Step 6: continuous testing.

qMON Agent status on the Android app (step 7) – expected results (UI):

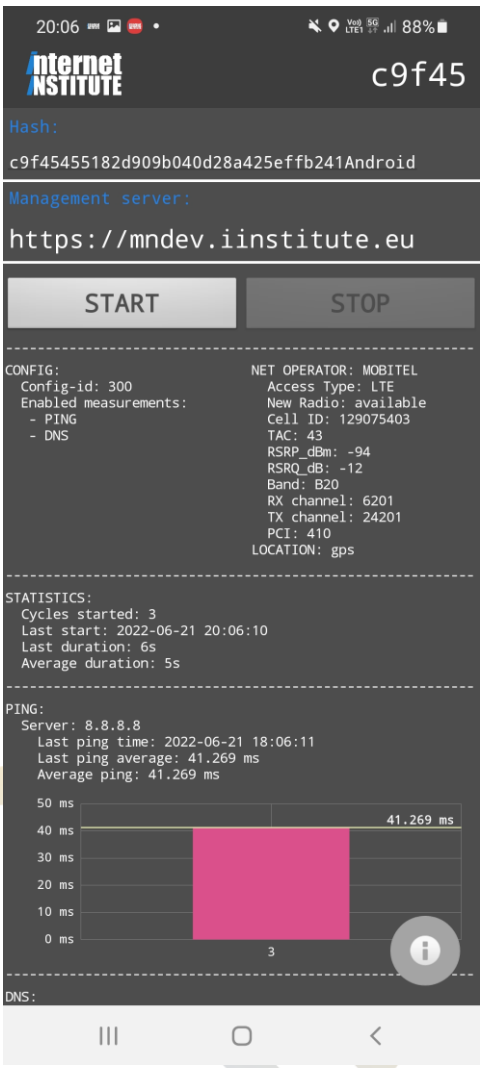


Figure 130: qMON Agent status while performing measurements.

qMON Analytics (step 8) – expected results (UI):

Figure 131: Graphical representation of results (qMON Analytics tool).

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#6

Datum/Date: Sept 2022 – Feb 2023

Test case type (): Trial

Tested by: ININ, LK, TS

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC1-S4-2 (STORYBOARD_#4)</td></tr>
<tr><td colspan="2">Short description: Continuous 5G NSA testing (n7 & n78 5G NR, Local CN)</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G NSA Network, gNb with n7 and n78 band, NSA assured Local EPC, qMON system, qMON agents, qMON reference server, Local IaaS</td></tr>
<tr><td colspan="2">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td>- Operational 5G NSA network with deployed n7 and n78 gNb and NSA assured Local EPC.
- Operational qMON System with prepared WO (Work Orders) on qMON management.
- Operational qMON Reference Server in Local IaaS.
- Deployed qMON Agents in the selected location in the port area.</td></tr>
<tr><td>Necessary test data</td><td>- NA</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a selected location.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. stationary test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
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</table></td></tr>
</table>

	Step 7	**Stop the qMON Agent.**	**qMON Agent application is not running.**
	Step 8	**Verify test results in the qMON Analytics.**	**KPI results with expected values are visible on the qMON Analytics.**
Expected result	*As part of a continuous 5G test the following KPIs will be collected:* *K-KPI 13: Availability* *K-KPI 14: Bandwidth* *K-KPI 17: End-to-End Latency* *K-KPI 18: Reliability* *Other 5G related KPI such as (RSRP, RSRQ, SINR, TX Power etc)*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

Figure 132: Screenshots showing qMON agent status (qMON agent is an Android application installed on the UE used for the test.

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):

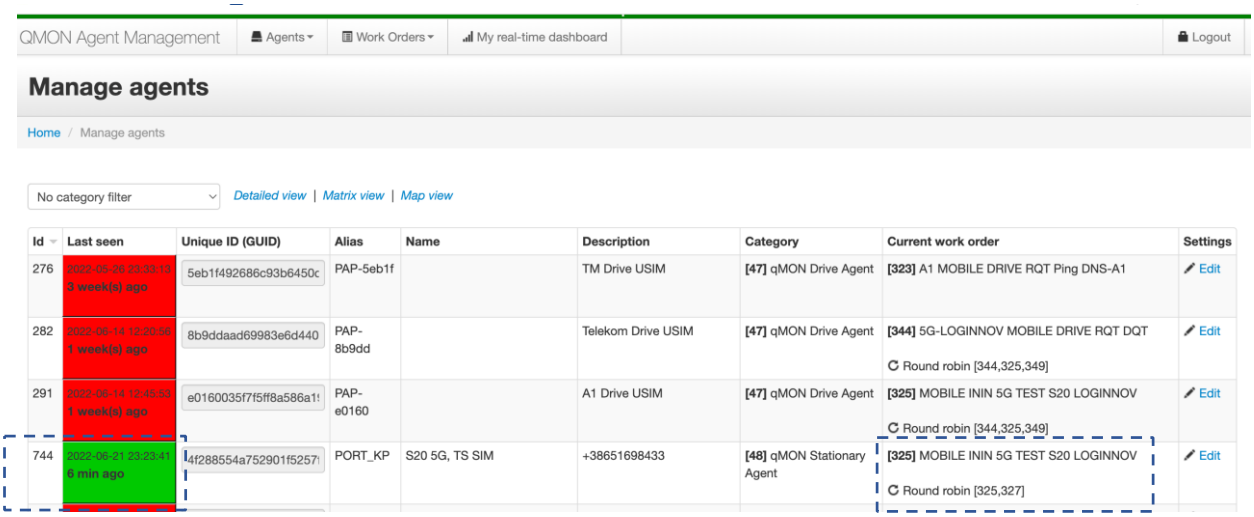
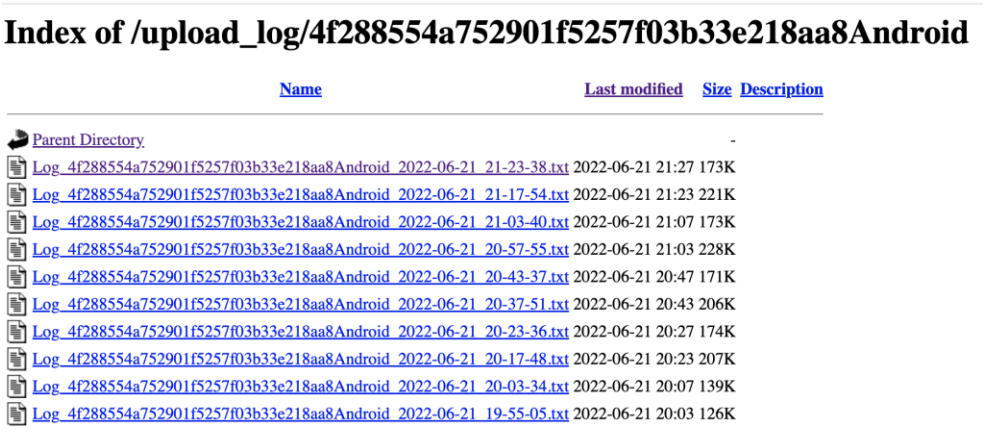


Figure 133: qMON agent status as presented in qMON management dashboard (green means the agent is active).

Log files on qMON Collector (step 4) – expected results (UI):



```
2022-06-21 21:27:33 - INFO - ----------CUSTOM PLUGIN MEASUREMENT----------
2022-06-21 21:27:33 - INFO - Custom Plugin Measurement not enabled.
2022-06-21 21:27:33 - INFO - ---------- VOICE MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Voice Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------SMS MEASUREMENT ----------
2022-06-21 21:27:33 - INFO - Sms Measurement not enabled.
2022-06-21 21:27:33 - INFO - ----------TCPDUMP----------
2022-06-21 21:27:33 - INFO - TCPDUMP is not alive.
2022-06-21 21:27:33 - INFO - ----------XML START----------
<root>
   <Id agent_id_numeric="744" created_on="Tue 21 Jun 2022 21:27:33 GMT (Greenwich Mean Time)" revision="25" configuration_name="MOBILE ININ 5G TEST S20 LOGINNOV"
configuration_desc="MOBILE APP STATIONARY TEST" category_id="48" category_name="qMON Stationary Agent" agent_descripton="+38651698433" agent_info_technology="LTE"/>
   <Global_data aliasHash="PORT_KP" apn="internet" client_version="InIn Mobile 2022 @ 2.0.1-dev" config_id="325" cycle_id="1655846618374000"
hash="4f288554a752901f5257f03b33e218aa8Android" mobile_mode="1" os_name="Android" os_version="11" wo_duration="234" modem_temperature="53" cpu_temperature="43"
battery_temperature="41" battery_level="67.0" battery_status="3"/>
   <Measurement client_ip="178.58.54.102" client_ipv4_for_geoloc="178.58.54.102" target_ip="89.143.198.178" packet_size_bytes="64" interval_between_icmp_packets_ms="100"
timestamp="2022-06-21 21:26:37" ip_version="4" type="ping_test" first_hop_rtt_ms="-1" traceroute="*;*;213.229.192.209;*;*;*;*;*;*;*;*;*;*" traceroute_duration="42.154"
client_start_gps_latitude="45.549640020213275" client_start_gps_longitude="13.735982276002291" client_start_gps_altitude="45.728174883622714"
client_start_gps_speed_over_ground_knots="0.0" client_start_gps_timestamp="1655846796018" client_start_gps_num_sats="12" client_stop_gps_latitude="45.549640020213275"
client_stop_gps_longitude="13.735982276002291" client_stop_gps_altitude="45.728174883622714" client_stop_gps_speed_over_ground_knots="0.0" client_stop_gps_timestamp="1655846797025"
client_stop_gps_num_sats="12" radio_access_type_start="LTE" radio_cell_id_start="155597002" radio_tac_start="42" radio_rsrq_db_start="-11" radio_rsrp_dbm_start="-110"
radio_net_operator_start="MOBITEL" radio_operator_code_start="29341" radio_lte_rx_channel_start="6201" radio_lte_tx_channel_start="24201" radio_lte_band_start="B20"
radio_lte_pci_start="139" radio_rssi_dbm_start="-86" radio_emm_connection_start="CONNECTED" radio_sinr_db_start="8" radio_tx_power_dbm_start="2" radio_lte_bw_mhz_start="10"
radio_lte_ca_state_start="ADDED" radio_lte_dl_mcs_1_start="2" radio_lte_dl_mcs_2_start="0" radio_lte_ul_mcs_1_start="6" radio_lte_rb_dl_start="0" radio_lte_rb_ul_start="3"
radio_lte_max_rb_dl_start="50" radio_lte_max_rb_ul_start="40" radio_lte_sc_num_start="1" radio_lte_scell_band_start="B7" radio_lte_scell_bw_mhz_start="15"
radio_lte_scell_rx_channel_start="3023" radio_lte_pcc_rxm_RSRP_dbm_start="-102" radio_access_type_stop="LTE" radio_cell_id_stop="155597002" radio_tac_stop="42"
radio_rsrq_db_stop="-11" radio_rsrp_dbm_stop="-110" radio_net_operator_stop="MOBITEL" radio_operator_code_stop="29341" radio_lte_rx_channel_stop="6201"
radio_lte_tx_channel_stop="24201" radio_lte_band_stop="B20" radio_lte_pci_stop="139" radio_rssi_dbm_stop="-86" radio_emm_connection_stop="CONNECTED" radio_sinr_db_stop="8"
radio_tx_power_dbm_stop="2" radio_lte_bw_mhz_stop="10" radio_lte_ca_state_stop="ADDED" radio_lte_dl_mcs_1_stop="2" radio_lte_dl_mcs_2_stop="0" radio_lte_ul_mcs_1_stop="6"
radio_lte_rb_dl_stop="0" radio_lte_rb_ul_stop="3" radio_lte_max_rb_dl_stop="50" radio_lte_max_rb_ul_stop="40" radio_lte_sc_num_stop="1" radio_lte_scell_band_stop="B7"
radio_lte_scell_bw_mhz_stop="15" radio_lte_scell_rx_channel_stop="3023" radio_lte_pcc_rxm_RSRP_dbm_stop="-102">
      <rtt_ms status="Success" status_code="0" sequence_number="1">42.6</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="2">14.5</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="3">30.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="4">29.8</rtt_ms>
      <rtt_ms status="Success" status_code="0" sequence_number="5">29.9</rtt_ms>
   </Measurement>
```

Figure 134: List of log files (measurement results) uploaded by qMON Agent to qMON Collector.

qMON analytics (step 5) – expected results (UI):

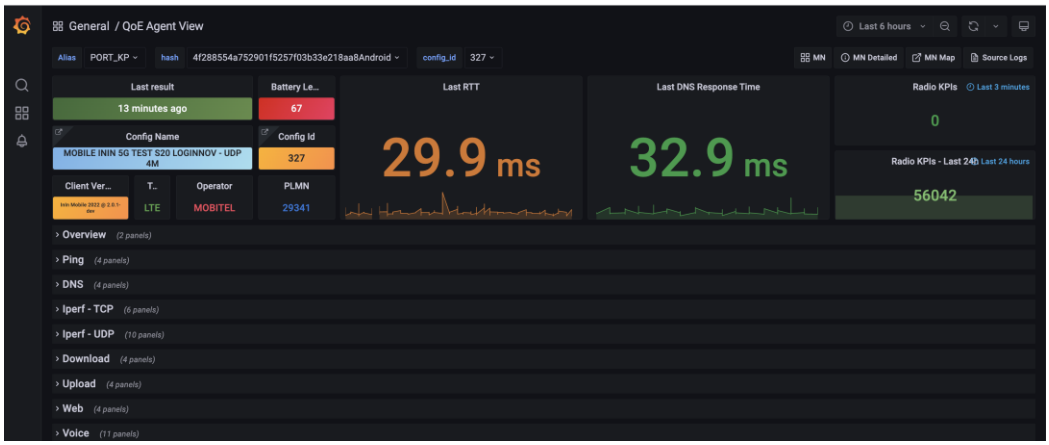


Figure 135: Graphical representation of results (qMON Analytics tool).

Step 6: continuous testing.

qMON Agent status on the Android app (step 7) – expected results (UI):

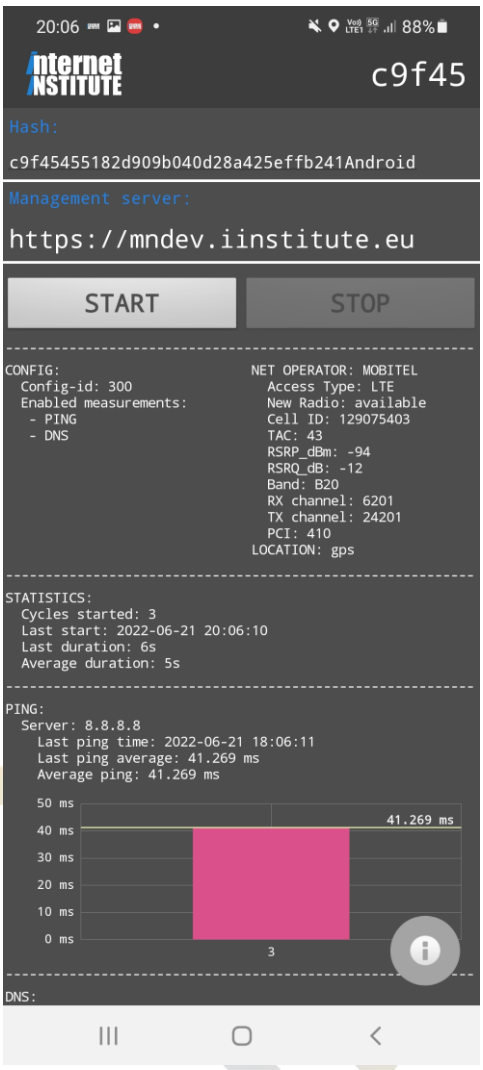


Figure 136: qMON Agent status while performing measurements.

qMON Analytics (step 8) – expected results (UI):

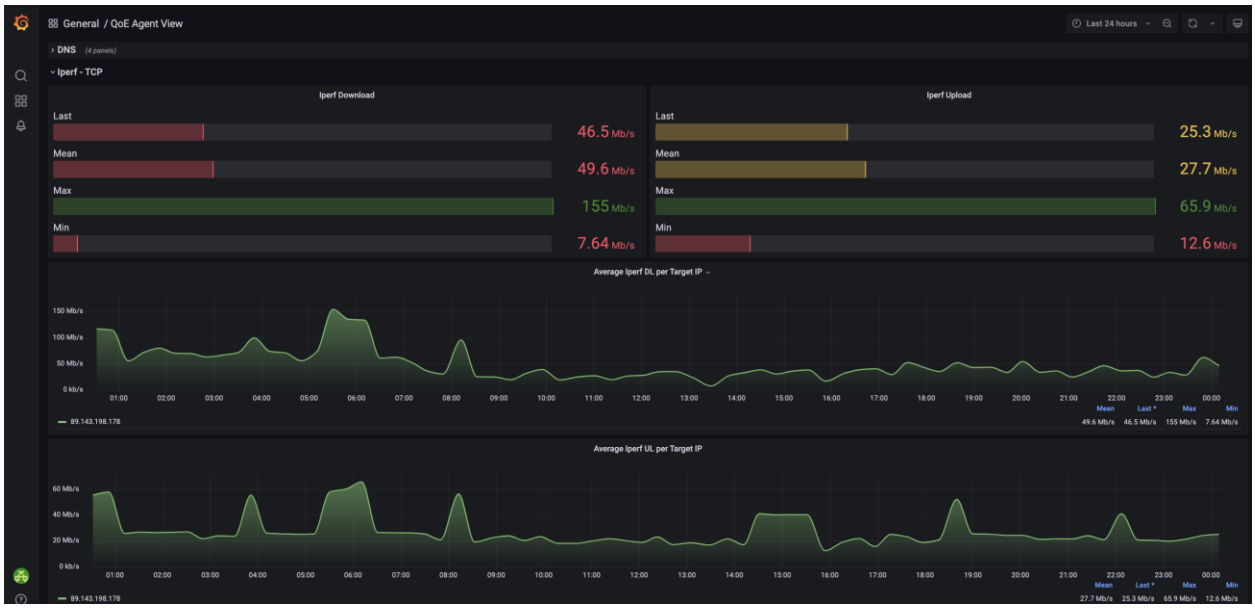


Figure 137: Graphical representation of results (qMON Analytics tool).

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#7

Datum/Date: May 2022 – Feb 2023

Test case type (): Pre-test, Trial

Tested by: ININ, LK

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC1-S4-3 (STORYBOARD_#4)</td></tr>
<tr><td colspan="2">Short description: Continuous 5G SA testing (n78 5G NR, Local 5G CN)</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G SA Network, gNb with n78 band, SA assured 5G CN, qMON system, qMON agents, qMON reference server, Mobile IaaS</td></tr>
<tr><td colspan="2">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td>- Operational 5G SA network with deployed n78 gNb and 5G CN.
- Operational qMON System with prepared WO (Work Orders) on qMON management.
- Operational qMON Reference Server in Mobile IaaS.
- Deployed qMON Agents in the selected location in the LL area.</td></tr>
<tr><td>Necessary test data</td><td>- NA</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start prepared qMON Agent deployed in a selected location.</td><td>qMON Agent application is running.</td></tr>
<tr><td>Step 2</td><td>Check if qMON Agent is connected to the qMON Management.</td><td>qMON Agent status is green.</td></tr>
<tr><td>Step 3</td><td>Apply correct WO (e.g. stationary test methodology) to the qMON Agent.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
<tr><td>Step 4</td><td>Check if log files with test results were received on qMON Collector.</td><td>Log files are received on the qMON Collector storage server.</td></tr>
<tr><td>Step 5</td><td>Check if test results are visible in qMON Analytics.</td><td>KPI results with expected values are visible on the qMON Analytics.</td></tr>
<tr><td>Step 6</td><td>Proceed with the continuous testing for the defined time span.</td><td>qMON Agent is running continuously and test results are collected.</td></tr>
</table></td></tr>
</table>

	Step 7	**Stop the qMON Agent.**	**qMON Agent application is not running.**
	Step 8	**Verify test results in the qMON Analytics.**	**KPI results with expected values are visible on the qMON Analytics.**
Expected result	*As part of a continuous 5G test the following KPIs will be collected:* *K-KPI 13: Availability* *K-KPI 14: Bandwidth* *K-KPI 17: End-to-End Latency* *K-KPI 18: Reliability* *Other 5G related KPI such as (RSRP, RSRQ, SINR, TX Power etc)*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

qMON Agent status on the Android app (step 1) – expected results (UI):

Figure 138: Screenshots showing qMON agent status (qMON agent is an Android application installed on the UE used for the test.

qMON Agent status indicated on the qMON management (step 2 & 3) – expected results (UI):

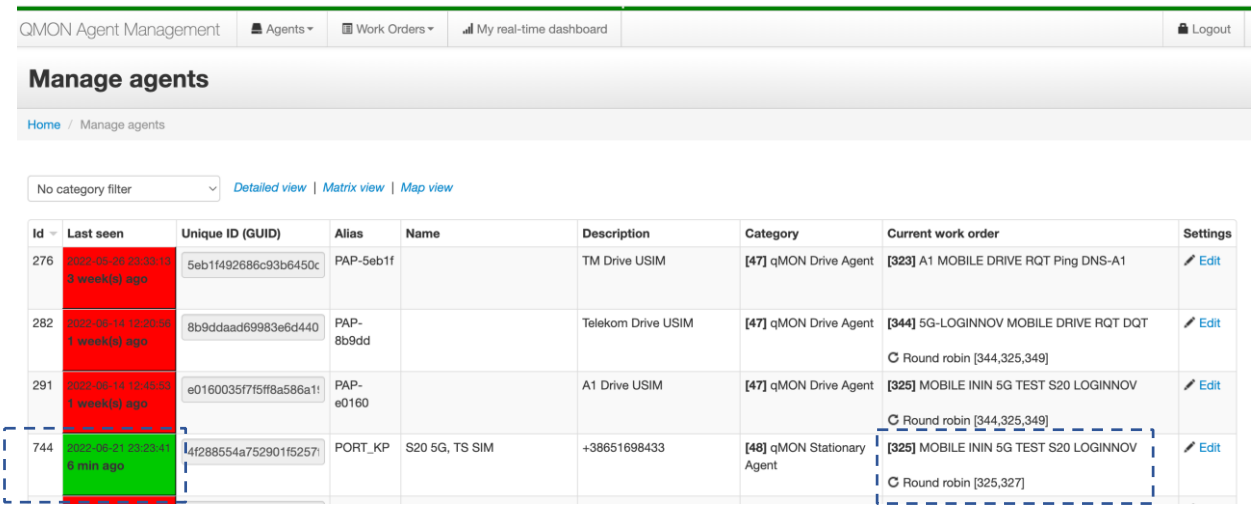


Figure 139: qMON agent status as presented in qMON management dashboard (green means the agent is active).

Log files on qMON Collector (step 4) – expected results (UI):

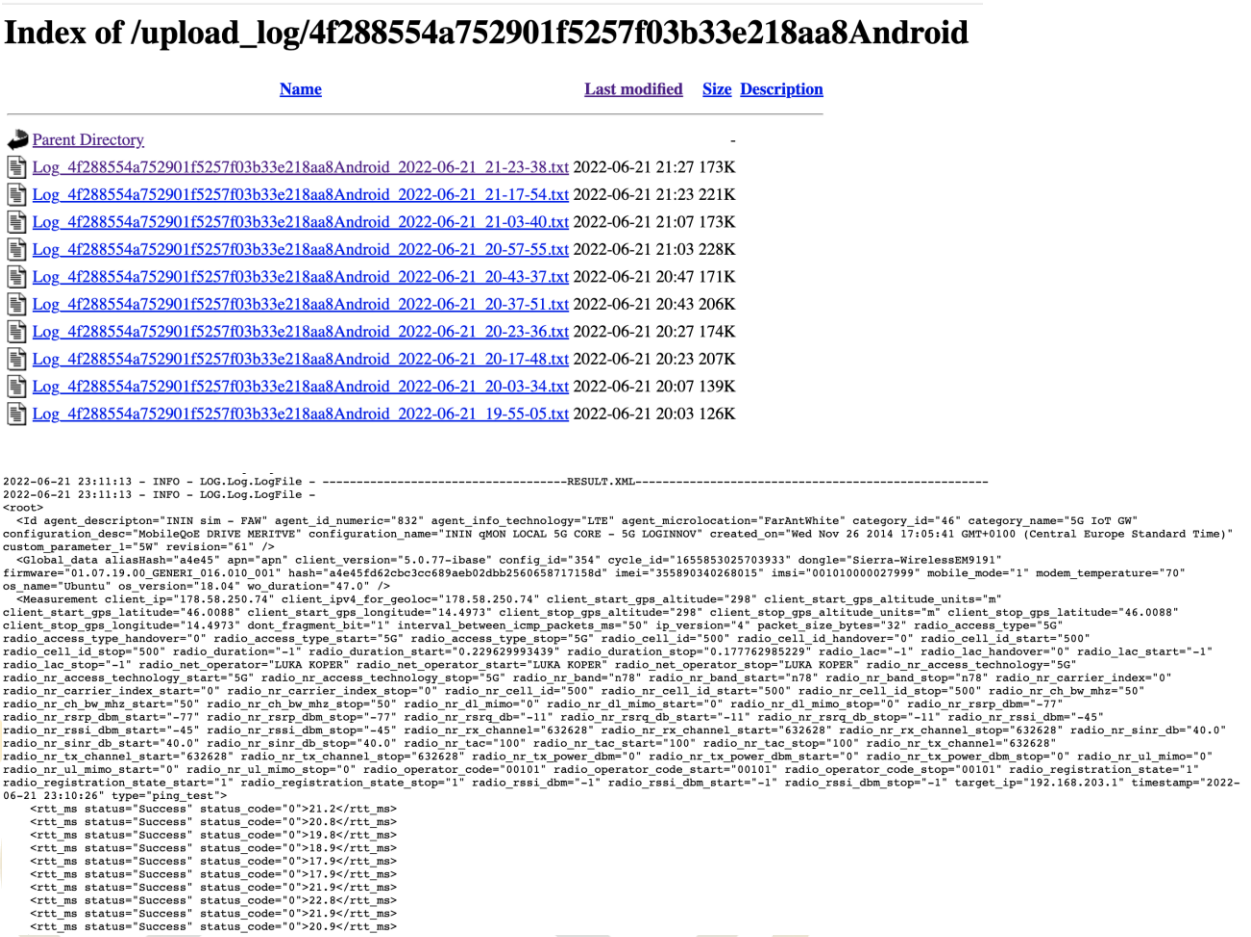


Figure 140: List of log files (measurement results) uploaded by qMON Agent to qMON Collector.

qMON analytics (step 5) – expected results (UI):

Figure 141: Graphical representation of results (qMON Analytics tool).

Step 6: continuous testing.

qMON Agent status on the Android app (step 7) – expected results (UI):

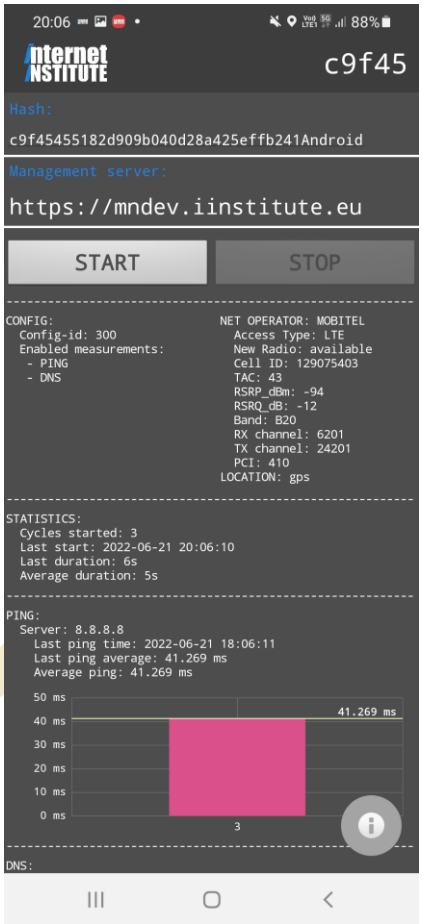


Figure 142: qMON Agent status while performing measurements.

qMON Analytics (step 8) – expected results (UI):

Figure 143: Graphical representation of results (qMON Analytics tool).

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#8

Datum/Date: Apr 2022 – Feb 2023

Test case type (): Pre-test, Trial

Tested by: CONTI, LK

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC5-S5-1 (STORYBOARD_#5)</td></tr>
<tr><td colspan="2">Short description: Collection of position data, including vehicle speed, acceleration, altitude</td></tr>
<tr><td colspan="2">App./Infrastructure: backend system in Luka Koper</td></tr>
<tr><td colspan="2">Testcase Manager: Alex Budisan</td></tr>
<tr><td>Prerequisites</td><td>Continental IoT device connected to test vehicle (IoT device connected to vehicle power supply, GNSS and GPs antennas connected to device, IoT device connected to vehicle CAN bus)
Backend system is active</td></tr>
<tr><td>Necessary test data</td><td>-</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Turn the ignition on</td><td>IoT device is powered on and starts connection to cellular network</td></tr>
<tr><td>Step 2</td><td>Start test drive</td><td>IoT device collects location and vehicle data</td></tr>
<tr><td>Step 3</td><td>Stop test drive and turn ignition off</td><td>IoT device powers off</td></tr>
</table></td></tr>
<tr><td>Expected result</td><td>All data from trip is collected (e.g. GNSS data, fuel consumption, standstill time)</td></tr>
</table>

Test Result (including Screenshots, Photos etc.)

Expected result: ok

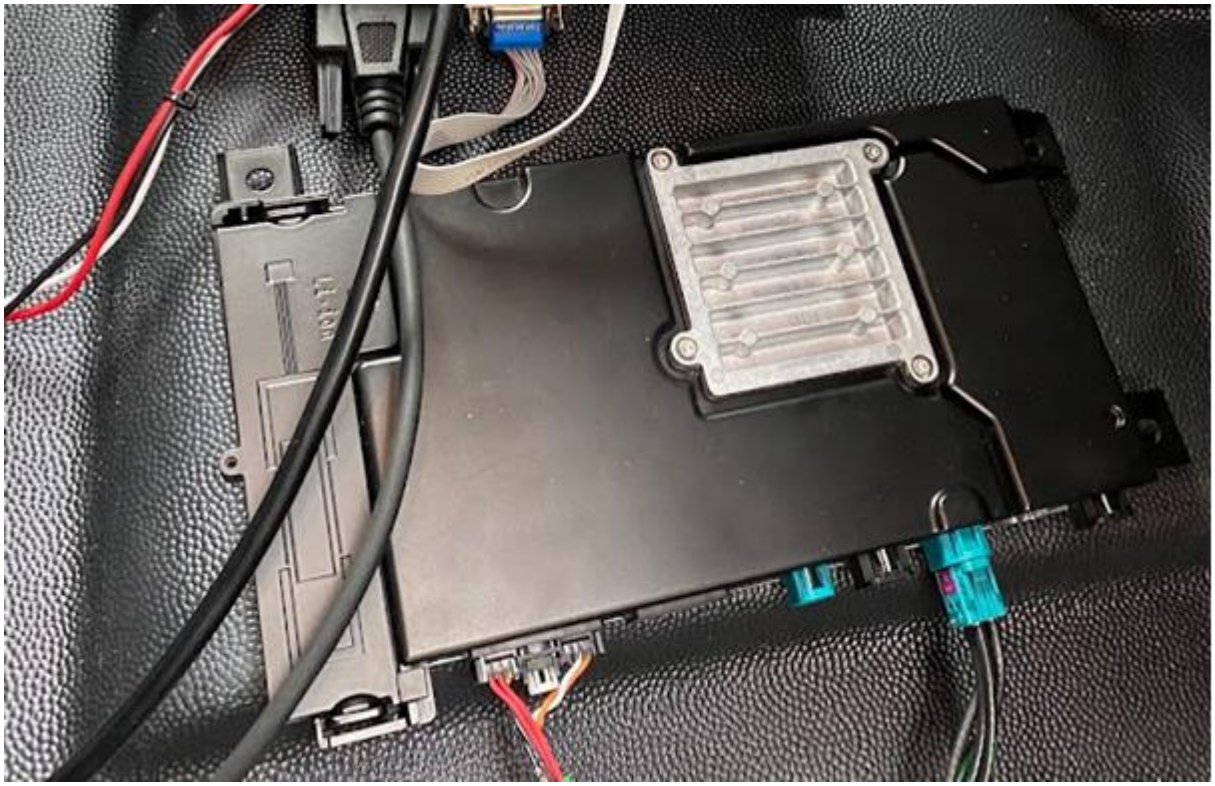


Figure 1 Conti IoT device installed in vehicle

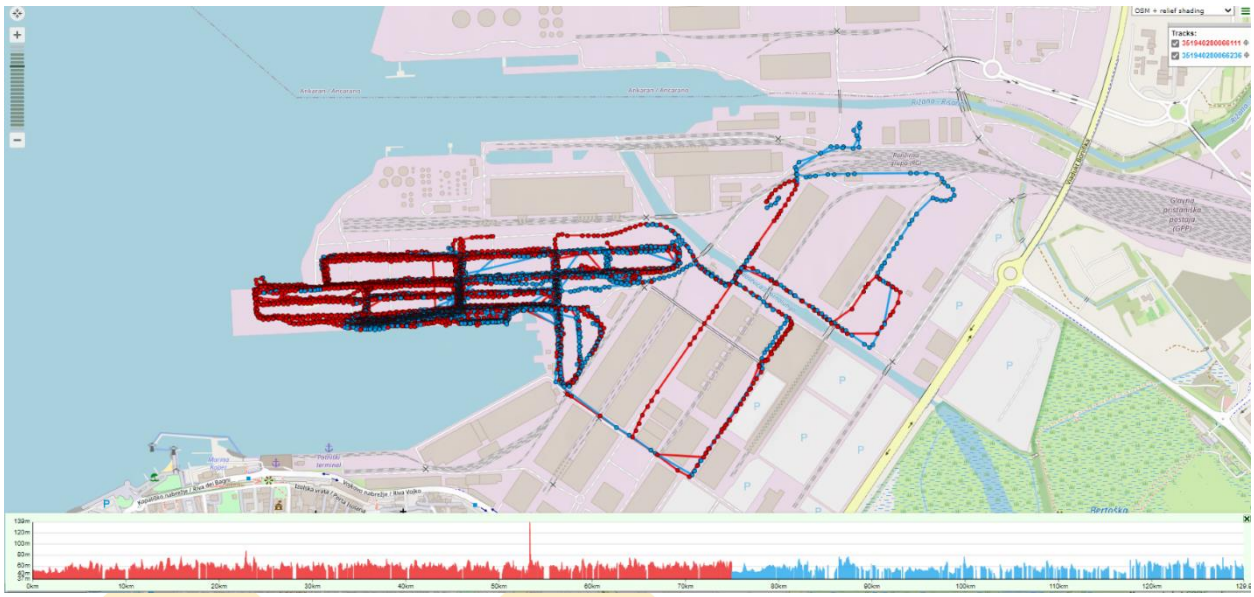


Figure 2 Location data collected from multiple vehicles

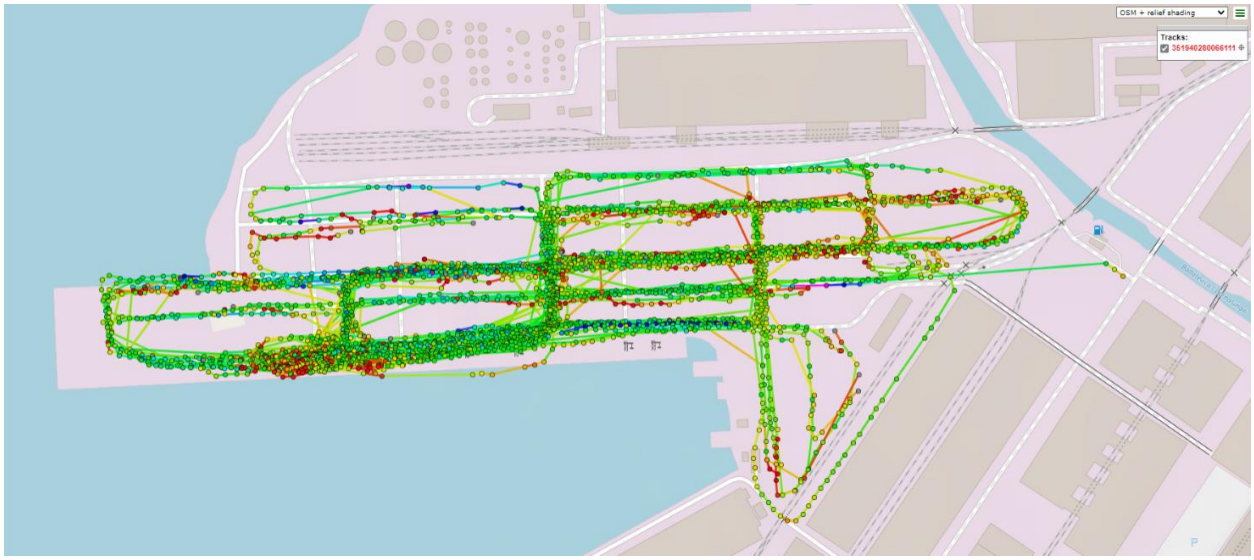


Figure 3 Speed information collected from single vehicle

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#9

Datum/Date: Dec 2021 – Jan 2022, Oct 2022 – Feb 2023

Test case type (): Trial

Tested by: VICOM, LK

Test scenario:

Testcase: UC5-S6-1 (STORYBOARD_#6)	
Short description: Optical Character Recognition of container markings and Container Damage Detection	
App./Infrastructure: IaaS in Luka Koper	
Testcase Manager: *Jurij Minrik, Andoni Cortés*	
Prerequisites	- *Kafka server to transmit information between modules, listening on a topic* - *List of the containers for that day. This will be used as ground truth to measure the accuracy of the system. This information should be added to the system by means of a json file.* - *Perception instance module deployed* - *Data Analysis module deployed*
Necessary test data	- *Video Streaming from cameras A, B, Cr and Cl (installed in the STS crane)* - *Four cameras connected and functional or if this were not possible, cameras could be replaced by videos, each corresponding to each of the cameras.*
Aktivity	*Steps*

Step Name	**Description**	**Expected Result**
Step 1	Cameras capturing video	Video streaming sent to the 5G network
Step 2	Establish 5G communication	
Step 3	PI receiving video stream	Video Streaming received by the PI
Step 4	PI analyzes received image	Image analysis is performed
Step 4	PI sending results to Kafka topic	Results of the PI published in the Kafka topic
Step 5	Data processing generates output	Results of the post processing in the Kafka topic
Step 6	Inference time of each module is processed	Inference time less than time to manually process

	Step 7	Calculate the accuracy of the result comparing with the list of codes from the port	If a container detected id matches with one in the provided list, then accuracy is incremented.
Expected result	*Json with the following information:* - *Container detection (bounding box location and confidence)* - *Identification number (code, bbox and confidence)* - *IMDG labels (type, bbox, confidence)* - *Damages (type, bbox, confidence)* *K-KPI20 - Model Inference Time* *K-KPI19 - Model accuracy/reliability of the identification detection*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

Container detection, text detection:

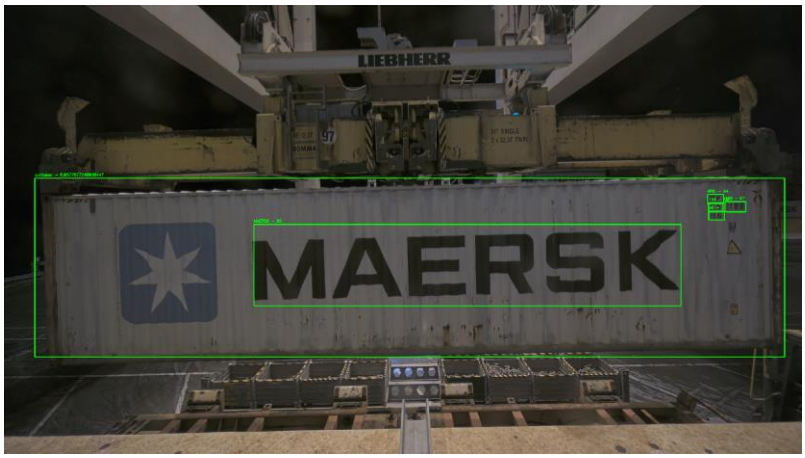


Figure : Detecting container and text placed on the container.

Container detection, text detection and IMDG label detection:

Figure 144: Detecting container, then texts and finally the IMDG label.

Damages detection:

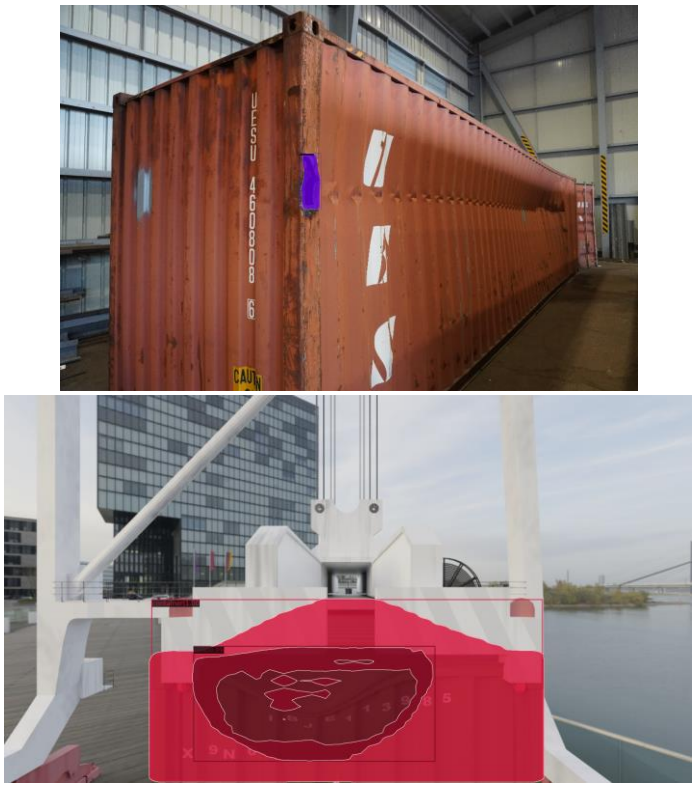


Figure 145: Detecting damages on surfaces.

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#10

Datum/Date: Apr 2022, Jan 2023

Test case type (): Pre-test, Trial

Tested by: ININ, LK

Test scenario:

<table>
<tr><td colspan="2">Testcase: UC6-S7-1 (STORYBOARD_#7)</td></tr>
<tr><td colspan="2">Short description: Drone based video streaming</td></tr>
<tr><td colspan="2">App./Infrastructure: 5G Network, 5G UE, Drone with flight control and video streaming application (smart phone based), Video proxy application</td></tr>
<tr><td colspan="2">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td>- Operational 5G network in port environment.
- Operational video streaming proxy component deployed in Mobile IaaS.
- Operational mobile terminal used as video proxy between drone and 5G RAN (use appropriate 5G-enabled USIM card).
- Operational client devices to play the live streams received from drone.
- Deployed drone connected to the 5G UE.</td></tr>
<tr><td>Necessary test data</td><td>- NA</td></tr>
<tr><td>Activity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start video proxy application on 5G UE.</td><td>Video proxy application is running.</td></tr>
<tr><td>Step 2</td><td>Verify that video streaming is working on all client devices (e.g. mobiles phones, computers, dashboards)</td><td>Video stream from a drone camera is received on client devices.</td></tr>
<tr><td>Step 3</td><td>Start with the flight according to the schedule, stick to the flight trajectory as required.</td><td>Drone is flying according to the expected route.</td></tr>
<tr><td>Step 4</td><td>Based on a test plan evaluate received video stream according to subjective MOS score (1 - 5).</td><td>MOS score is taken.</td></tr>
<tr><td>Step 5</td><td>Stop video streaming applications when arriving at the end of the planned track.</td><td>qMON Agent status indicate usage of applied WO.</td></tr>
</table></td></tr>
</table>

Expected result	*As part of a Drone based video streaming subjective MOS score evaluation will be taken.*

Test Result (including Screenshots, Photos etc.)

Expected result: yes

Drone based video streaming (step 1 - 5) – expected results:

Figure 146: Streaming video from the drone to the UE.

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#11

Datum/Date: Apr 2022, Jan 2023

Test case type (): Pre-test, Trial

Tested by: ININ, LK

Test scenario:

<table>
<tr><td colspan="3">Testcase: UC6-S7-2 (STORYBOARD_#7)</td></tr>
<tr><td colspan="3">Short description: Body worn camera-based video streaming</td></tr>
<tr><td colspan="3">App./Infrastructure: 5G Network, 5G UE, Wearable camera with video streaming application (e.g. dedicated or smart phone based), Video proxy application.</td></tr>
<tr><td colspan="3">Testcase Manager: Jurij Mirnik, Janez Sterle, Luka Korsic, Rudolf Sušnik</td></tr>
<tr><td>Prerequisites</td><td colspan="2">- Operational 5G network in port environment.
- Operational video streaming proxy component deployed in Mobile IaaS.
- Operational mobile terminal used as video proxy between drone and 5G RAN (use appropriate 5G-enabled USIM card).
- Operational client devices to play the live streams received from drone.
- Deployed drone connected to the 5G UE.</td></tr>
<tr><td>Necessary test data</td><td colspan="2">- NA</td></tr>
<tr><td>Activity</td><td colspan="2">Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Start video application (on dedicated wearable camera or smart phone based) and video proxy application.</td><td>Video application and video proxy is running.</td></tr>
<tr><td>Step 2</td><td>Verify that video streaming is working on all client devices (e.g. mobiles phones, computers, dashboards).</td><td>Video stream from a wearable camera is received on client devices.</td></tr>
<tr><td>Step 3</td><td>Start with the defined security procedure.</td><td>Correlate received video with taken security procedures.</td></tr>
<tr><td>Step 4</td><td>Based on a test plan evaluate received video stream according to subjective MOS score (1 - 5).</td><td>MOS score is taken.</td></tr>
<tr><td>Step 5</td><td>Stop video streaming applications when arriving at the</td><td>Video application and video proxy stopped.</td></tr>
</table></td></tr>
</table>

		end of the planned security procedure.	
Expected result	*As part of a body worn camera-based video streaming subjective MOS score evaluation will be taken.*		

Test Result (including Screenshots, Photos etc.)

Expected result: yes

Drone based video streaming (step 1 - 5) – expected results:

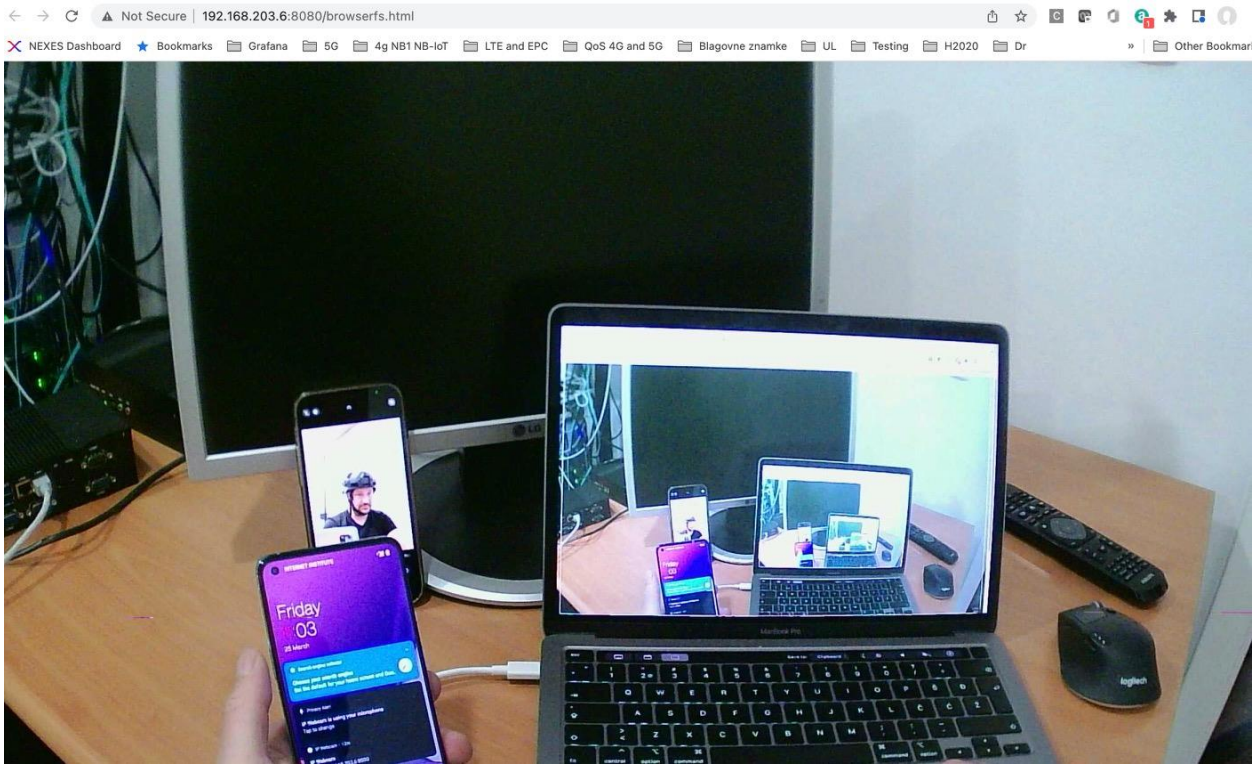


Figure 147: Streaming video from the body-worn camera

Error Description if test negative

Proposal Solution if test negative

Testprotocol Koper#12

Datum/Date: Dec 2021 – Jan 2022, Sept 2022 – Feb 2023

Test case type (): Pre-test, Trial

Tested by: VICOM, LK

Testszenario:

<table>
<tr><td colspan="2">Testcase: UC6-S8-1 (STORYBOARD_#8)</td></tr>
<tr><td colspan="2">Short description: People and vehicle detection in the controlled area</td></tr>
<tr><td colspan="2">App./Infrastructure: IaaS in Luka Koper</td></tr>
<tr><td colspan="2">Testcase Manager: Jurij Minrik, Andoni Cortés</td></tr>
<tr><td>Prerequisites</td><td>- Kafka server to transmit information between modules, listening on a topic
- Perception instance module for UC6 deployed
- 2d region of interest defined for the camera
-</td></tr>
<tr><td>Necessary test data</td><td>- Labeled video of the region of interest for detection models evaluation purpose</td></tr>
<tr><td>Aktivity</td><td>Steps
<table>
<tr><th>Step Name</th><th>Description</th><th>Expected Result</th></tr>
<tr><td>Step 1</td><td>Acquire Images from Video</td><td>Images acquired from video</td></tr>
<tr><td>Step 2</td><td>PI receiving video stream</td><td>Video Streaming received by the PI</td></tr>
<tr><td>Step 4</td><td>PI analyzes received image</td><td>Image analysis is performed</td></tr>
<tr><td>Step 5</td><td>PI sending results to kafka topic</td><td>Results of the PI published in the kafka topic</td></tr>
<tr><td>Step 6</td><td>Inference time of the detection algorithm is calculated</td><td>Inference time less than time to manually process</td></tr>
<tr><td>Step 7</td><td>Calculate the accuracy of the result comparing output to annotated labels. Different metrics will be calculated and sent.</td><td>If a container detected id matches with one in the provided list then accuracy is incremented.</td></tr>
</table></td></tr>
<tr><td>Expected result</td><td>Json with the following information:
- Object inside Region of Interest(type, bbox, confidence)
K-KPI20 - Model Inference Time
K-KPI19 - Model accuracy/reliability of the identification detection</td></tr>
</table>

Test Result (including Screenshots, Photos etc.)

Expected result: yes

Objects Visual detection:

Classes: Person, Motorcycle, Train, Car, Truck

Figure 148: Koper - Different perspective scenarios for Object detection

Error Description if test negative

Proposal Solution if test negative

ANNEX 2:

LL Athens

UC	Storyboard #	Test case ID	test case short description	Test case type	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April
5G Network KPIs	Storyboard #1a	#1A Based on Koper testcase id UC1-S4-1	5G NSA testing (n78 5G NR) exploiting ININ's monitoring system. Across LL testprotocol.	pre-test																	
		#1A Based on Koper testcase id UC1-S4-1	5G NSA testing (n78 5G NR) exploiting ININ's monitoring system. Across LL testprotocol	trial																	
5G Vehicle Driving test	Storyboard #1b	#1B Based on Koper testcase id UC1-S3-1	Initial 5G Drive test (n78 5G NR) exploiting ININ's monitoring system. Across LL testprotocol	pre-test																	
		#1B Based on Koper testcase id UC1-S3-1	5G Drive test (78 5G NR) exploiting ININ's monitoring system. Across LL testprotocol	trial																	
UC2	Storyboard #2	#7	Back end system test for localization multicast and video multicast to 3 devices.	pre-test																	
		#8	The basic scenario consists of 3 (or more vehicles) of which one is maneuvering. Performing 90 degree back turn often requires external human help or camera on the back side of the truck.	trial																	
UC3, UC4, UC5	Storyboard #4	#2	NFV-MANO platform testing for AI service orchestration at 5G edge computing nodes	pre-test																	
UC3	Storyboard #8	#2, #3	Initial test of the 5G&AI Enabled Rapid Alert System for collision avoidance	pre-test																	
			Trial test of the 5G&AI Enabled Rapid Alert System for collision avoidance	trial																	
UC4	Storyboard #5	#2, #4	Initial test of the 5G&AI enabled (far-)edge computing service for human presence detection	pre-test																	
			Trial test of the 5G&AI enabled (far-)edge computing service for human presence detection	trial																	
UC5	Storyboard #6	#2, #5	Initial test of the 5G&AI enabled (far-)edge computing service for container seal detection	pre-test																	
			Trial test of the 5G&AI enabled (far-)edge computing service for container seal detection	trial																	
UC7	Storyboard #7	#6	Initial pre-test for data collection validation of CAN-Bus sensors from 5G trucks	pre-test																	
			Trial for the predictive maintenance algorithm separated in two iterations.	trial																	

LL Hamburg

Test Case execution planning 5G Loginnov LL Hamburg

Date: 09.06.2022

Version: 1.06

Testcase setup

Storyboard #	#KPI & KPI Name	test protocols #	test case short description	CAT HH	App. / infrastructure
Storyboard #1	H-KPI1 Increase average truck speed single mode up to 5%	#1 - #11	single vehicle trip speed without application	Low/Medium	LCMM
	H-KPI2 Reduction of avg. acceleration activities single mode up to 5%		single vehicle trip acceleration without application	Low/Medium	LCMM
	H-KPI3 Reduction of stillstand time in single mode up to 5%		single vehicle trip stillstand without application	Low/Medium	LCMM
	H-KPI1 Increase average truck speed single mode up to 5%		single vehicle trip speed without application	Low/Medium	LCMM
	H-KPI2 Reduction of avg. acceleration activities single mode up to 5%		single vehicle trip acceleration without application	Low/Medium	LCMM
	H-KPI3 Reduction of stillstand time in single mode up to 5%		single vehicle trip stillstand without application	Low/Medium	LCMM
	H-KPI1 Increase average truck speed single mode up to 5%		single vehicle trip speed with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI2 Reduction of avg. acceleration activities single mode up to 5%		single vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI3 Reduction of stillstand time in single mode up to 5%		single vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI1 Increase average truck speed single mode up to 5%		single vehicle trip speed with apps	High	LCMM, GLOSA, tecly
	H-KPI2 Reduction of avg. acceleration activities single mode up to 5%		single vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly
	H-KPI3 Reduction of stillstand time in single mode up to 5%		single vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly
	H-KPI1 Increase average truck speed single mode up to 5%		single vehicle trip speed with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI2 Reduction of avg. acceleration activities single mode up to 5%		single vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI3 Reduction of stillstand time in single mode up to 5%		single vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI1 Increase average truck speed single mode up to 5%		single vehicle trip speed with apps	High	LCMM, GLOSA, tecly
	H-KPI2 Reduction of avg. acceleration activities single mode up to 5%		single vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly
	H-KPI3 Reduction of stillstand time in single mode up to 5%		single vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly
Storyboard #2	H-KPI4 Increase average truck speed platoon mode > 5%	#1 - # 1 + #12	platoon vehicle trip speed without application	Low/Medium	LCMM
	H-KPI5 Reduction of avg. acceleration activities platoon mode > 5%		platoon vehicle trip acceleration without application	Low/Medium	LCMM
	H-KPI6 Reduction of stillstand time in platoon mode with equipped vehicles		platoon vehicle trip stillstand without application	Low/Medium	LCMM
	H-KPI4 Increase average truck speed platoon mode > 5%		platoon vehicle trip speed without application	Low/Medium	LCMM
	H-KPI5 Reduction of avg. acceleration activities platoon mode > 5%		platoon vehicle trip acceleration without application	Low/Medium	LCMM
	H-KPI6 Reduction of stillstand time in platoon mode with equipped vehicles		platoon vehicle trip stillstand without application	Low/Medium	LCMM
	H-KPI4 Increase average truck speed platoon mode > 5%		platoon vehicle trip speed with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI5 Reduction of avg. acceleration activities platoon mode > 5%		platoon vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI6 Reduction of stillstand time in platoon mode with equipped vehicles		platoon vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI4 Increase average truck speed platoon mode > 5%		platoon vehicle trip speed with apps	High	LCMM, GLOSA, tecly
	H-KPI5 Reduction of avg. acceleration activities platoon mode > 5%		platoon vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly
	H-KPI6 Reduction of stillstand time in platoon mode with equipped vehicles		platoon vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly
	H-KPI4 Increase average truck speed platoon mode > 5%		platoon vehicle trip speed with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI5 Reduction of avg. acceleration activities platoon mode > 5%		platoon vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI6 Reduction of stillstand time in platoon mode with equipped vehicles		platoon vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly, Iot Box
	H-KPI4 Increase average truck speed platoon mode > 5%		platoon vehicle trip speed with apps	High	LCMM, GLOSA, tecly
	H-KPI5 Reduction of avg. acceleration activities platoon mode > 5%		platoon vehicle trip acceleration with apps	High	LCMM, GLOSA, tecly
	H-KPI6 Reduction of stillstand time in platoon mode with equipped vehicles		platoon vehicle trip stillstand with apps	High	LCMM, GLOSA, tecly
Storyboard #3	H-KPI7 Reduction of fuel consumption in single mode up to 10%	#1 - #9 + #12	single vehicle trip fuel/CO2 without application	Medium/Low	LCMM
	H-KPI8 Reduction of CO2 emission in single mode up to 10%				LCMM
	H-KPI7 Reduction of fuel consumption in single mode up to 10%		single vehicle trip fuel/CO2 with apps	High	LCMM
	H-KPI8 Reduction of CO2 emission in single mode up to 10%				LCMM
	H-KPI9 Reduction of fuel consumption in platoon mode up to 20%		platoon vehicle trip fuel/CO2 without application	Medium/Low	LCMM
	H-KPI10 Reduction of CO2 emission in platoon mode up to 20%				LCMM
	H-KPI7 Reduction of fuel consumption in single mode up to 10%		single vehicle trip fuel/CO2 with apps	High	LCMM
	H-KPI8 Reduction of CO2 emission in single mode up to 10%				LCMM
	H-KPI9 Reduction of fuel consumption in platoon mode up to 20%		platoon vehicle trip fuel/CO2 with apps	High	LCMM
	H-KPI10 Reduction of CO2 emission in platoon mode up to 20%				LCMM
Storyboard #4	H-KPI11 Increase value of 'KPI - cl per ton and km' up to 10% for vehicle trips	#1 -#9	KPI for all trips with LCMM	Medium/Low	LCMM
	H-KPI12 Increase value of API 'KWh per ton and km' up to 10% for vehicle trips			Medium/Low	LCMM
	H-KPI11 Increase value of 'KPI - cl per ton and km' up to 10% for vehicle trips		KPI for all trips with LCMM	High	LCMM
	H-KPI12 Increase value of API 'KWh per ton and km' up to 10% for vehicle trips			High	LCMM
	H-KPI11 Increase value of 'KPI - cl per ton and km' up to 10% for vehicle trips		KPI for all trips with LCMM	High	LCMM
	H-KPI12 Increase value of API 'KWh per ton and km' up to 10% for vehicle trips			High	LCMM
Storyboard #5	H-KPI13 Extended cellular bandwidth on urban roads by 5G network	#12 & #14	Measure 5G bandwidth	Medium/Low	Mobileum
	H-KPI15 Average signal latency in the 5G environment will be reduced thru Mobile Edge Computing (MEC) to 10 ms during vehicle trips		Measure avg. Signal latency	Medium/Low	Mobileum
	H-KPI16- 5G-NSA-Packed-Error-Rate		measure 5G Packed error rate	Medium/Low	Mobileum
	H-KPI13 Extended cellular bandwidth on urban roads by 5G network		Measure 5G bandwidth	High	Mobileum
	H-KPI15 Average signal latency in the 5G environment will be reduced thru Mobile Edge Computing (MEC) to 10 ms during vehicle trips		Measure avg. Signal latency	High	Mobileum
	H-KPI16- 5G-NSA-Packed-Error-Rate		measure 5G Packed error rate	High	Mobileum
	H-KPI13 Extended cellular bandwidth on urban roads by 5G network		Measure 5G bandwidth	High	Mobileum
	H-KPI15 Average signal latency in the 5G environment will be reduced thru Mobile Edge Computing (MEC) to 10 ms during vehicle trips		Measure avg. Signal latency	High	Mobileum
	H-KPI16- 5G-NSA-Packed-Error-Rate		measure 5G Packed error rate	High	Mobileum
Storyboard #6	H-KPI14 Positioning quality on urban road networks with 5G by 10 cm	#7, #8, #11, #15, #16	Precice Positioning	Medium/Low	Skylark
	H-KPI14 Positioning quality on urban road networks with 5G by 10 cm		Precice Positioning	High	Skylark
	H-KPI14 Positioning quality on urban road networks with 5G by 10 cm		Precice Positioning	High	Skylark

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UC	Storyboard #	Test case ID	test case short description	Test case type	December	January	February	March	April	May	June	July	August	Septembe r	October	Novembe r	December	January	February	March	April
UC1	Storyboard #1	UC1-S1-1	Inital 5G IoT System Deployment Automation	Pre-test																	
		UC1-S1-1	5G IoT System Deployment Automation	Trial																	
	Storyboard #2	UC1-S2-1	Initial Private 5G System Deployment Automation	Pre-test																	
		UC1-S2-1	Private 5G System Deployment Automation	Trial																	
	Storyboard #3	UC1-S3-1	Initial 5G Drive test (n7 5G NR, Macro CN)	Pre-test																	
		UC1-S3-2	5G Drive test (n7&n78 5G NR, Local CN/MEC)	Trial																	
		UC1-S3-2	5G Drive test (n7&n78 5G NR, Local CN/MEC)	Trial																	
	Storyboad #4	UC1-S4-1	Continous 5G NSA testing (n7 5G NR, Macro CN)	Pre-test																	
		UC1-S4-2	Continous 5G NSA testing (n7&n78 5G NR, Local CN/MEC)	Trial																	
		UC1-S4-3	Continous 5G SA testing (n78 5G NR, 5G CN, Mobile IaaS)	Pre-test																	
		UC1-S4-3	Continous 5G SA testing (n78 5G NR, 5G CN, Mobile IaaS)	Trial																	
UC5	Storyboad #5	UC5-S5-1	Conti IoT device data collection - Analytics in CONTI cloud	Pre-test																	
		UC5-S5-2	Conti IoT device data collection - Analytics in LK cloud	Trial																	
	Storyboad #6	UC5-S6-1	VICOM - Container OCR and Damage Detection	Pre-test																	
		UC5-S6-1	VICOM - Container OCR and Damage Detection	Trial																	
UC6	Storyboad #7	UC6-S7-1	Drone based video streaming	Pre-test																	
			Drone based video streaming	Trial																	
		UC6-S7-2	Body worn camera based video streaming	Pre-test																	
			Body worn camera based video streaming	Trial																	
	Storyboad #8	UC6-S8-1	VICOM - AI/ML based video analytics	Pre-test																	
		UC6-S8-1	VICOM - AI/ML based video analytics	Trial																	

REFERENCES:

D1.4 ‘Initial specification of evaluation and KPI’s’ version V1.7

D2.2 ‘Data collection and evaluation procedures’ V1.1

D3.1 ‘Trial methodology, planning and coordination’ V1.0

D3.2 ‘5G-LOGINNOV_D3.2_Testcases Planning V106-27062022.xlsx’