PracticAl and Effective tools to moNitor and Assess CommErciAl drivers' fitness to drive

Grant Agreement Number: 953426

D1.1: Use Cases

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Legal Disclaimer

Executive Summary

The current Deliverable (D1.1) has been prepared in the context of WP1: "Use Cases" of PANACEA project. WP1 aims to set the theoretical basis for all the specifications and implementation work of the project that will follow. In specific, WP1 aims:

- To perform desktop-based research to explore studies and projects focusing on the five impairment states that PANACEA is addressing (alcohol and (il)licit drugs use, fatigue, stress and cognitive (under/ over) load (A1.1).
- To explore alternative technologies in the pan-European context and identify key success and failure factors to be considered within PANACEA (A1.2).
- To identify the gaps in research and guidelines that we need to close and those that we can close within PANACEA (A1.3).
- To investigate the needs, wants, opinions through triangulated data collection with focus groups/ questionnaires, and interviews with drivers/ riders and stakeholders (A1.4).
- To distill the results of the previous Activities in WP1, map and categorise the PANACEA technologies and come up with a set of implementation/ demonstration Use Case scenarios (A1.5).

WP1 Activities (A1.1 – A1.5) were designed and executed in such a way to respond to the objectives above. D1.1 includes the outcomes of all Activities in a sound and coherent manner in order to prepare the project Use Cases scenarios:
Chapter 1 introduces the purpose of this document, the anticipated interrelations, and the target audience. **Chapter 2** describes the user/stakeholder – driven methodological approach that has been defined and applied for the formulation of the project Use Case scenarios and other key side results. **Section 2.2** summarises the current landscape. In specific, it refers in short to current research and studies that are relevant or interrelated to PANACEA (respective Milestones 1 and 3 reports)**. 44 studies and projects** were analysed. Additionally, an insight on the most important technologies in the field and the PANACEA is provided, closing with the PANACEA placement in the relevant market (**section 2.3;** Milestone 4). Existing gaps in legislation and developments have analysed and how they can be closed is summarised in **section 2.4** and discussed in Milestone 5. An analysis of current gaps in technologies and legislation was conducted and **section 2.5** summarises the high-level importance findings and requirements as identified through the consolidation of the collected information through: a) the conduction of focus groups across the three Use Case sites, b) the interviews, c) the post-questionnaires, d) the feedback during the UC scenarios workshop. These findings were taken into account for the development of the Use Case scenarios. This list will be revisited and turn to technical specifications in the context of WP2 work. Overall, **36 high-level considerations** have been reported. The in-depth results are included in Milestone 6 report, which also resides on the PANACEA website. In the same chapter, the key stakeholders of its value chain (Government/Authorities, Cities/ Regions, Transportation Provider, Technology Providers and professional in health services) as well as which are their key and alternative roles in the professional value chain are presented (**section 2.6**). **Chapter 3** describes the concept of the Use Cases, the Use Case scenarios and presents the templates used in the project to create the scenarios.
Chapter 4 describes the **28 Use Case scenarios (UCsc) and indicative scripts per each**, across the 3 main Use Cases (UCA, B, and C) defined in Appendix I template and having consolidated all feedback from the user/stakeholder needs and the market-driven needs recognition phases. The PANACEA technologies were defined in DoA as of primary and secondary importance to the PANACEA solution and are as follows:

CHTs and Technologies	Working shift flow	Administration, backend, and actors-oriented UC scripts
UCsc01: FitDrive (Primary) – DATIK UCsc02: Alcohol sensor (Primary)– SENSEAIR UCsc03: (Il)Licit drugs biosensor (Primary)- LEITAT UCsc04: - Smart Pulse Wave Analysis (PWA) device – AIT UCsc05: Steering wheel angle algorithm (SWA) and vehicle parameters (Primary)- ViF UCsc06: DBL index (Secondary) - DBL UCsc07: BACtrack Skyn (Secondary) – VTI and CERTH UCsc08: Fitbit wrist band (Secondary) – VTI UCsc09: Biomathematical model (BMM; Primary)– VTI UCsc10: ERGOS system (Secondary) – CERTH UCsc11: Cloud based Countermeasures' system (Primary) – CTLup	UCsc12: Baseline assessments UCsc13: Pre-Driving Assessment (incl. on-site) (ONPDA) UCsc14: During Driving Assessment (DDA) UCscr15: Roadside Assessment (RSA) UCscr16: off duty Assessment (ODA)	AII.1 UCscr17: Operators AII.2 UCscr18: Technology/ Service provider AII.3 UCscr19: WP5 Development Team Countermeasures' specialist (responsible for the content of CCS) AII.4 UCscr20: Enforcer AII.5 UCscr21: Administrator AII.6 UCscr22: Business rules AII.7 UCscr23: General actor registration/ authentication/ login (with failures) and creation of profile AII.8 UCscr24: Feedback module AII.9 UCscr25: Communication module among core actors (optional) AII. 10 UCscr26: Errors (as exceptions) handling (closely related to UC20 and this a system and not a business UC scenario- Diagnosis procedures)

In addition, 3 more Use Case scenarios, in the form of real event stories, were defined in Use Case D in order to investigate the transferability of knowledge and technologies among different transportation areas (**Chapter 5**). These Use Case scenarios do not describe user interactions with the PANACEA platform, but they are stories to be further evaluated in WP7. They will be evaluated as concepts only and not through the pilots (WP6), as it will happen with the rest of the 26 Use Case scenarios.
Chapter 6 concludes the Deliverable with the next steps that will follow its completion.
Finally, a series of Appendices are attached at the end of the document. **Appendix I** provides the *Use Case scenarios and scripts template*, **Appendix II** provides the *Use Case scripts for the administrative, actors-related other interaction and the backend*, **Appendix III** provides the *Use Case scenarios UML diagrams of Chapter 3 and Appendix III*, **Appendix IV** provides *static and dynamic user information parameters*. Last, **Appendix V** presents the PANACEA parts of the architecture and the data flows signifying the next steps of the project.

The **success criteria for WP1** have been reached as follows:

- At least 30 relevant literature sources thoroughly reviewed.
    - *PANACEA reviewed 44 sources for the addressed impairment states*.
- At least 20 different technologies will be thoroughly analysed and benchmarked against the PANACEA .
    - *58 technologies were found across the impairing states and were compared to the PANACEA solutions.*
- Conduct at least 3 focus groups with users and 30 interviews with users and stakeholders across UC sites. The methodology was slightly adapted to accommodate for data

triangulation in order to enrich data with questionnaires; therefore, the number of focus groups were doubled, the questionnaires were added, and the number of interviews were halved.

  - 6 focus groups were conducted (14 users and 14 stakeholders), 16 interviews (7 users and 9 stakeholders), 21 ex ante questionnaires were completed. *65 persons in total took part in A1.4 compared to 45 initially planned.*

- At least 18 use case scenarios agreed for implementation.
  - *29 main Use Case scenarios have been fully described and prioritized through an internal workshop with over 25 attendees.*

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List of Abbreviations

Abbreviation	Definition
Ad	Administrator
AI	Artificial Intelligence
AIA	American International Airways
An	Analyst
API	Application Programming Interface
ATCO	Air Traffic Controller Operator
BAC	Blood Alcohol Content
BD	Bus Driver
BDDA	Baseline During Driving Assessment
BMM	Biomathematical Model
BrAC	Breath Alcohol Content
BVLOS	Beyond Visual Line of Sight
CAN	Controller Area Network
CATO	Controller Assistance Tool
CCS	Cloud-based Countermeasure System
CD	Coach Driver
CHTs	Commercial Health Toolkits
CoE	Council of Europe
CS	Countermeasure Specialist
CSM	Customer Service Manager
CSR	Courier service rider

Abbreviation	Definition
CWP	Controller Working Position
DCBT	Driver CANbus Tester
DD	Dustbin Driver
DDA	During Driving Assessment
D/R	Driver and Rider (for all actors operating a vehicle regardless UC membership)
DMS	Driver Monitoring System
DSM	Driver Status Monitoring
DSS	Decision Support System
DUI	Driving Under the Influence
DWH	Data Warehouse
E	Enforcer
EC	European Commission
EDA	Electrodermal Activity
ECG	Electrocardiography
EEG	Electroencephalography
ELT	Emergency Locator Transmitter
EOG	Electrooculography
ETL	Extract, Transform, Load
EU	European Union
FO	First Officer
GDPR	General Data Protection Regulation
GIS	Geographic Information System

Abbreviation	Definition
GPS	Global Positioning System
GUI	Graphical User Interface
HMI	Human-Machine Interface
HR	Heart Rate
HRV	Heart Rate Variability
ICT	Information and Communications Technology
IoT	Internet of Things
ITS	Information Technology Services
KPIs	Key Performance Indicators
KSS	Karolinska Sleepiness Scale
LC-MS	Liquid chromatography–Mass spectrometry
ML	Machine Learning
MSL	Mean Sea Level
MS	Milestone
MSS	Main Success Scenario
NDIR-technique	Non-Dispersive Infra-Red
NFC	Near Field Communication
O	Operator
ODA	off duty Assessment
OEM	Original Equipment Manufacturer
OLAP	Online Analytical Processing
OMG	Object Management Group

Abbreviation	Definition
PP	PANACEA platform
PTW's	Powered Two Wheelers
PWA	Pulse Wave Analysis
QoS	Quality of Service
REM	Rapid Eye Movement
RFE	Recursive feature elimination
RFID	Radio Frequency Identification
SDLP	Standard Deviation of Lane Position
SGML	Standard Generalized Markup Language
SO	Shuttle Operator
RSA	Roadside Assessment
SSO	Single Sign-On
STCA	Short Term Conflict Alert
SWA	Steering Wheel Angle Algorithm
TAC	Transdermal Alcohol Content
TBD	To Be Determined
TCAS	Traffic collision avoidance system
TD	Taxi driver
TMC	Traffic Management Centre
TSP	Technology Service Provider
UAS	Unmanned Aircraft System
UC	Use Case
UML	Unified Modelling Language

Abbreviation	Definition
URL	Uniform Resource Locator
US	United States
VIF	Variance Inflation Factor
VRU	Vulnerable Road User
WP	Work Package

1 Introduction

1.1 Purpose of the document

This deliverable encompasses the outcomes of WP1: "Use Cases" and presents its results with emphasis placed on the Use Case scenarios (A1.5) that are primary actor-driven, meaning that they are based on the need, preferences, and requirements (A1.4) of main actors (drivers, riders, and operators) taking into consideration existing market (A1.3) and current trends and research/ experimental accomplishments (A1.1). The relevant actors that are considered as users and those as stakeholders are presented in section 2.6. In the scenarios we will focus on users which are the primary actors of PANACEA solution and ecosystem.

The initial project quantifiable success criteria have been all fulfilled and even surpassed; namely:

- At least 20 relevant literature sources thoroughly reviewed.
    - *PANACEA reviewed 445 sources for the addressed impairment states.*
- At least 20 different technologies will be thoroughly analysed and benchmarked against the PANACEA .
    - *58 technologies were found across the impairing states and were compared to the PANACEA solutions.*
- Conduct at least 3 focus groups with users and 30 interviews with users and stakeholders across UC sites. The methodology was slightly adapted to accommodate for data triangulation in order to enrich data with questionnaires; therefore, the number of focus groups were doubled, the questionnaires were added, and the number of interviews were halved.
    - 6 focus groups were conducted (14 users and 14 stakeholders), 16 interviews (7 users and 9 stakeholders), 21 ex ante questionnaires were completed. *65 persons in total took part in A1.4 compared to 45 initially planned.*
- At least 18 use case scenarios agreed for implementation.
    - *29 main Use Case scenarios and scripts have been fully described and prioritized through an internal workshop with over 25 attendees.*

Upon a specific methodological approach defined (and described in section 2 of this deliverable), the Use Case scenarios and scripts of PANACEA, being the final goal and reflecting the PANACEA solution conceptualisation, have emerged and are described in detail in chapter 4. The project's Use Case scenarios are going to serve as the reference point for the later design, implementation and demonstration/testing work that will follow.

1.2 Intended Audience

The nature of this Deliverable is public, meaning that it will be finally (upon approval by the EC) available through the web site of the project ("Library" section). Due to its various content layers, the interested audience may vary respectively, as follows:

Internal to the project:

PANACEA developers, including all those dealing with the specifications and implementation work of the PANACEA Platform (WP2 & WP3), the technologies to be integrated (WP4) and the development of the cloud-based countermeasures system of WP5, for whom the definition of the Use Cases scenarios and their justification from the stakeholders' needs and priorities side are crucial for their work.

- PANACEA partners dealing with the business modelling and exploitation aspects of the project (in the context of WP7 and WP8) that need to consider the priorities and restrictions imposed by the actors and stakeholders, as a basis for their respective work, as well as the competitive market and benchmarking results.

- PANACEA partners dealing with demonstration and testing (in the context of WP6) that will use the Use Cases and indicative interaction flow scenarios as the basis for the definition of the evaluation and experimental framework.

External to the project:

Researchers working in transport, mobility, ICT and fitness to drive sectors (and combination of them) who seek to find:

- Developers and engineers interested in the design of relevant multi-layer, poly-technological solutions.
- Technology, content, and service providers as well as transport operators that are potentially interested in the PANACEA solution and benefit from integrating their technologies to the PANACEA platform by fostering a health and wellbeing work environment for professional drivers/ riders.
- Unions, their representatives, professional drivers and riders in general.
- Health care professionals and coaching professionals and researchers interesting in the field of fitness to drive.
- Other actors described in section 2.6.

1.3 Interrelations

The current Deliverable encompasses in the form of Use Case scenarios and scripts the research outcomes of WP1 overall. A Use Case is here defined as the description of the technologies, the actors, the vehicles, and the tests that will take place in a pilot site. In addition, the Use Case scenarios mean the interactions of the actors with the PANACEA platform and scripts are scenarios that although they may work as independent scenarios, their value is greater as part of the scenarios, i.e., they supplement and enhance them. The stakeholders needs/preferences/priorities as well as the State of the Art in the fitness to drive field may be individually beneficial as feedback in a series of Activities of other WPs. Still, the key interrelation stands in the Use Case scenarios of the project, serving as the key reference point for the whole project from the moment of their release onwards. In specific, the Use Case scenarios will constitute the baseline for the System Architecture and specifications of WP2 and the later development in WP4 as well as for the Pilot scenarios in WP6. Due to the iterative nature -as depicted in the methodology section of the Deliverable (section 2)- the Use Cases and Use Case scenarios may slightly change as an outcome of the revisions that will emerge during the pilot rounds. Any updates will be reported respectively in D2.2 for M24.

1.4 Objectives

- Identification of needs and requirements for detecting, monitoring, and assessing Fitness o drive for any addressed health impairing dimensions. This will be done through literature reviews as well as existing short-term and long-term countermeasures, considering both user and expert feedback.
- Market research and benchmarking of cutting-edge technologies in each respective key area to identify key competitors.
- Analysis of research and technological gaps and determining the paths to close them.
- Improving the PANACEA Use Cases to drive technical and pilot activities based on four Use Cases and their evolution within WP1.

2 Methodology

2.1 Overview

A review of studies has been conducted. The focus was on previous European funded projects and research publications. The review provides a relevant insight of the state of art of user requirements and needs as gathered by several projects with the same target, i.e., looking at impairing states and technologies. Furthermore, a review of relevant articles and papers was conducted, and a benchmarking of relevant technologies and systems took place. In addition, any gaps in research and legislation were identified to ensure that they are considered in the development process. Next, we run focus groups, interviews and questionnaires with users and stakeholders across the UC sites (Greece, Spain, Sweden) to instantiate the findings on the user needs in terms of service functionality and personal expectations per location. The PANACEA Use Case methodology is described in Figure 1.

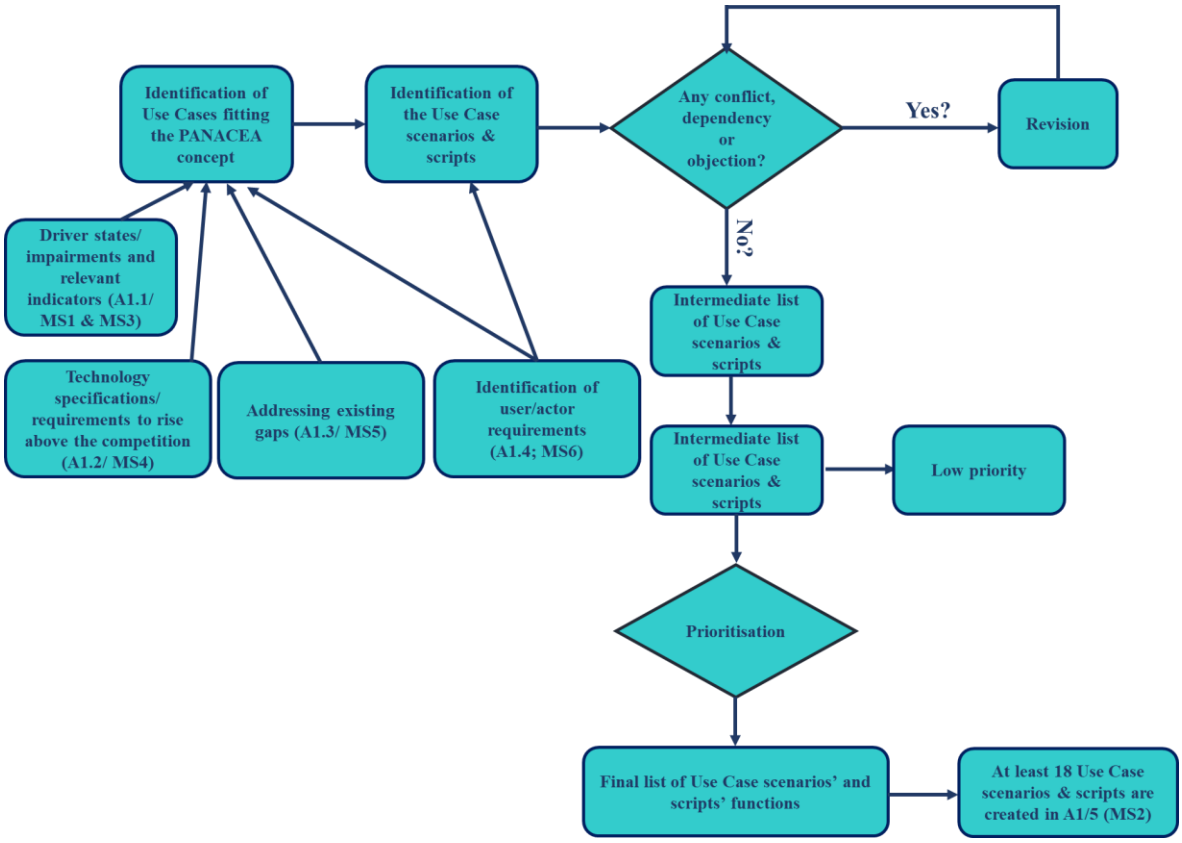

Figure 1. *The PANACEA Use Case scenarios methodology*

The Use Case scenarios are developed with consideration of the Use Cases technologies, actors and vehicles involved, testing plans and impairing states addressed. In UCA, bus drivers and shuttle operators will participate in WP6 pilots and use the technologies as shown for UCA in Table 1. UCA is led by VTI with the support of Transdev and situated in Linköping, Sweden. In UCB, taxi drivers and courier service riders will participate in WP6 pilots and situated in Thessaloniki, Greece is led by CERTH with the support of ACS and will use the technologies as shown for UCB in Table 1. Finally, in UCC, electric dustbin truck and coach drivers with the support of FCC and Autocares Cabranes companies and situated in San Sebastian, Spain will use the technologies as shown for UCC in Table 1.

Table 1. *Technologies per shift phase and UC*

WP3	WP4	Related technologies	Technologies to be used in each UC
3.1. Off-duty, lifestyle and recuperation	4.1 Pre-driving solutions implementation and integration	• BACTrack Skyn • FitBit, Oura or similar wearable • BMM to estimate fatigue level • AIT Smart PWA	**UCA** • BackTrack Skyn • FitBit • BMM
			UCB • BackTrack Skyn • AIT Smart PWA
			UCC AIT smart PWA
3.2. On-duty and ad hoc work	4.2. During driving solutions implementation and integration	• VIF Steering wheel algorithm (plus vehicle parameters like headway) • DATIK system • Senseair Go *(used during breaks/rest)* • AIT Smart PWA *(used during breaks/rest))* *Part of 24 hrs assessment:* • *BACTrack Skyn, FitBit, BMM (including time on task)*	**UCA** • DATIK System (Face camera) • DBL (A6.2 simulator study) • AIT smart PWA
			UCB • DATIK system (might without camera for PTW) • VIT steering wheel with vehicle parameters (additional to DoA) • ERGOS system (only in A6.2) • AIT Smart PWA • SENSAIR Go *Part of 24 hrs assessment:* *BACTrack Skyn (riders)*
			UCC • AIT smart PWA • SENSEAIR go • DATIK system
3.3. On-site assessment	4.1 Pre-driving solutions implementation and integration	• Senseair wall-mounted • LEITAT biosensor • DBL index (during driving in simulator; A6.2) • ERGOS system (during driving in simulator; A6.2) • DATIK fatigue pre-questionnaire • *Part of 24 hrs assessment:* *BACTrack Skyn, FitBit*	**UCA** • Senseair wall-mounted • DATIK fatigue pre-questionnaire • DBL (only A6.2) • LEITAT biosensor •
			UCB • Senseair wall-mounter • LEITAT biosensor • ERGOS system (only in A6.2) • DATIK pre-questionnaire • *Part of 24 hrs assessment:* *BACtrack Skyn*
			UCC Senseair wall-mounted
3.4. Roadside assessment	4.3. Enforcement measures	• Senseair portable • LEITAT biosensor	ROADPOL study (Norway)[1] • Senseair portable • LEITAT biosensor

[1] ROADPOL will be conducted by police officers; hopefully all UCs will be represented in the sample.

2.2 Literature review

Summaries of Milestones 1 and 3 follows. The reports can be found here.

2.2.1 Objectives

The main objective of A1.1 was to assess how the specified driving impairments (alcohol, licit and illicit drugs, fatigue/sleepiness, stress, cognitive load) could be effectively monitored and assessed using desk-based research methods. This resulted in two Milestone documents, MS1 and MS3. MS1 aimed to provide an overview of how the identified driving impairments could be effectively monitored and assessed by analysing at least 20 recent and relevant literature sources. Following this and based on the findings in MS1, MS3 aimed to provide an overview of the requirements and needs of the project technology used to measure each driving impairment and for the measurement or observation of driving behaviour.

2.2.2 Methodology

Systematic literature searches were conducted for MS1. The impairments were divided between three project partners (LOUGH, CERTH, LEITAT) who were responsible for conducting the review. The impact of certain impairments (alcohol, licit and illicit drugs, fatigue/sleepiness) on driving performance was additionally included, conducted by VIF. Prioritization was given to recent reviews and deliverables from previous EU projects, with a focus on monitoring the human rather than the vehicle. Once key literature had been identified, partners completed a shared table to aid with continuity of information. The information included author and year of publication, the source type (e.g., paper, project deliverable), the transport mode the publication focused on, the context (e.g., before/during driving, at the roadside), relevant indicators, the technical equipment used (if relevant) and the results/conclusions in the context of PANACEA. Additional information and diagrams were also included where relevant.

For MS3, the driving impairments and driving behaviour were divided between the four partners who completed the literature reviews for MS1 (LOUGH, CERTH, LEITAT, VIF). The aim was to review the requirements and optimal conditions of the project technology compared to the information provided in MS1. Aspects and features satisfied and not satisfied by the current technology were to be listed, along with any additional considerations. A table was completed including information about the name of the technology, the potential indicators, the needs/requirements for the technology to work both satisfied and not satisfied by the current project, and other considerations. Drafted tables were shared with the relevant technology partners to review.

2.2.3 Results

2.2.3.1 MS1

44 individual publications were reviewed for the five impairments, with some publications featuring multiple impairments. 15 experimental studies were reviewed for the impact of alcohol, licit/illicit drugs and fatigue/sleepiness on driving performance. The overall summary and completed tables can be found in chapter 3 of MS1. For alcohol detection, it was found that established tools are embedded within systems used to detect as well as inform authorities of driver impairment. Portable systems are useful, but a stable connection to cloud services would

be needed to inform authorities and prevent the driver from continuing. Overall, alcohol detection systems are reasonably easy to develop, with a variety of sensors on the market. For the detection of licit and illicit drugs, blood analysis and urine tests are the current, quantified tests accepted by courts as evidence. Saliva and on-site fluid drug tests offer potential, however further research is needed to increase reliability and sensitivity. For the detection of fatigue/sleepiness, EEG and EOG offer continuous and objective measurements, with ocular parameters being well established and used commercially, although HR and HRV are becoming increasingly popular. However, there are issues with driver acceptance, movement artifacts and real-world application. Multiple sensors would provide a more robust, accurate and reliable system, however individual differences are an important issue, so systems and algorithms may need to be personalised or trained. Non-intrusive measures (wearables, sensors) were recommended for real-world use. For stress detection, HR and HRV are extensively used. There is a strong correlation with stress and HR/HRV, EDA and respiration however consideration needs to be given to intrusiveness and practicalities of measurement. Again, multiple measures or hybrid detection systems are more robust and sensitive than one measure. Individual differences are important in terms of the influence on different measures and the variability in how measures align with each other. Consideration of contextual factors is important as they influence physiological responses. Cognitive load measurements mostly concern activity, size and position of the pupil. Finally in terms driving behaviour, impaired driving can be detected by observation of driving behaviour however sensitivity and specificity of true detections need further research. The most investigated measures were standard deviation of the lateral position, standard deviation of speed and lane keeping performance, with limited studies focusing on headway and steering wheel angle. Impairment due to alcohol, distraction, sleepiness, and other drugs can be detected in driving behaviour, however not all drugs impair driving behaviour, making them more difficult to detect. Studies were mostly conducted in driving simulators, with very few on road.

2.2.3.2 MS3

The main findings of MS3 are presented in 'look up' tables (chapter 3 of MS3), to be used as a project resource. Common considerations were found across the impairments including:

- Individualisation/personalisation, differences between drivers
- Driver acceptance / consent
- Loss of data (interference, noise, movement artifacts, compliance)
- Obtrusive nature of some of the sensors
- Pre-processing of data
- Influence of contextual factors (environment, driver state)
- Accuracy of detection, particularly for lower levels (e.g., sleepiness)
- Practical implementation, real-time processing
- Acquisition rate of data, time intervals
- Latency issues, rate of physiological response to an event (e.g., stress)

2.2.4 Conclusions

Overall, although it is possible to detect and monitor driver state using physiological signals, it is complex, with each indicator having several considerations that need to be addressed. Multiple sensors are likely to produce a more robust system, however individual differences and contextual factors need to be considered. In addition, the practicalities of combining

multiple sensors into a comprehensive impairment detection system needs to be considered, addressing issues relating to thresholds, interdependences and prioritisation of sensors and impairments.

2.3 Market Analysis & Benchmarking

A summary of Milestone 4 follows. The report can be found here.

The main objective of A1.2 was to identify technologies capable of monitoring and assessing driver impairments identified in the PANACEA project (alcohol, licit and illicit drugs, fatigue / sleepiness, stress and cognitive load) and benchmark those technologies. This resulted in Milestone document MS4. MS4 aimed to provide an overview of how technologies were identified and rated according to how well they perform their specific task and how they perform against the current market competitors.

2.3.1 Methodology

The impairments were divided between four project partners (SENSEAIR, LEITAT, AIT and DBL) who were responsible for conducting the analysis and benchmarking. The technologies to be benchmarked were identified based on input from A1.1, the PANACEA proposal/description of work and from input regarding current market-leading products and recent innovations. Input from ROADPOL was particularly helpful to identify products being used by Police forces today for roadside testing.

A template of a benchmarking table was developed and used by all partners conducting the benchmarking. Based on available information (most often published studies or product specifications for commercially available products), technologies were rated according to how well they perform their specific task and how the selected sensors and systems perform against the current market competitors. The results of the benchmarking were presented in tables and figures were produced to summarise all the benchmarking criteria that were evaluated based on numerical ratings.

2.3.2 Results

58 technologies were benchmarked across the five driving impairments. The benchmarking tables and figures plus a summary and market overview for each driving impairment can be found in MS4. For alcohol, there are many commercially available products for in-vehicle alcohol detection, but all are relatively costly and obtrusive. The infrared Senseair Go offers the key advantages of being mouthpiece-free and requires only a normal short breath. A mobile version of the Senseair Go is being developed for use in the project, to deliver the same benefits in the roadside testing setting. Testing before a work shift is possible with the Senseair Wall device. All depot-based solutions and interlocks currently have the disadvantage of providing only discontinuous data. The BACtrack Skyn, promises continual unobtrusive monitoring of any driver. While still unproven, it is very promising particularly for couriers / food delivery drivers using 2-wheelers.

The detection of licit and illicit drugs is possible during roadside screening using commercially available portable lateral flow devices with automated analysers for the detection of drugs in driver's saliva or fingerprint. These screen for 4-8 substances but require back to lab evidential testing using LC-MS. New portable / “fieldable” LC-MS devices promise rapid screening of a much greater number of substances but are bulky, expensive, and still unproven in the field. All technologies are relatively expensive, obtrusive, time consuming and offer discontinuous data.

There are many promising technologies within the consortium and externally, measuring a variety of physiological signals to monitor fatigue / sleepiness. A combination of different techniques would probably be the most promising solution. EEG-based approaches seem

effective but obtrusive. Camera-based approaches are promising but often raise data privacy issues.

A wide variety of mature technologies are available for monitoring stress, with assessment of heart rate measures most common as they can be assessed easily / cheaply / unobtrusively. Additional parameters would be useful addition if available unobtrusively (via a camera or embedded in steering wheels, seats or in wearables).

Cognitive load can be monitored via a range of physiological indicators, so using a combination of different techniques is probably the best solution. Eye tracking, (fixation time, pupillary dilatation, blink rate, etc.) are perhaps the most promising and can easily be supplemented with heart rate measures. Other parameters offer additional potential if they can be monitored in an acceptable way (sufficiently unobtrusive), including ECG and EEG.

2.3.3 Conclusions

Overall, there are many technologies available to measure and monitor the driver state to detect the identified driving impairments. The benchmarking helps indicate details of the diversity of alternatives overall but fails to highlight clear leaders. Implementing combination of sensors increases the reliability and robustness of a system, though consideration for personalisation and context of use is also important. The issues identified in A1.1 remain valid; considerations for thresholds, interdependencies and prioritisation of sensors and impairments are important for any complex impairment detection and assessment system.

A key challenge is the lack of an accepted gold standard to measure impairment and thus compare different technologies for individual impairment modes. In addition, there is a lack of clarity regarding how the various impairment modes interact in combination on a drivers' fitness to drive. For example, marijuana use is increasing and is typically the most frequently detected drug in traffic. Marijuana and alcohol both impair driving skills but not in the same way, meaning the combined use can result in a deeper level of impairment even at low doses of these drugs. Marijuana also slows the absorption of alcohol. While combined use of alcohol and drugs is common, more detailed research is required to better understand the increased risks associated with this. The further additive risk of mixing drugs / fatigue / stress/ cognitive load challenges is very poorly understood.

2.4 Gap analysis

A summary of Milestone 5 follows. The report can be found here.

2.4.1 Objectives

The main objective of A1.3 was to analyse the existing gaps in off-road, roadside and on road Fitness-to-Drive assessment and the enforcement measures. It aims to analyse the existing problems that should be solved to monitor the Fitness-to -Drive. According to the collected information a gap analysis diagram was drawn to estimate the existing gaps in current Fitness-to-Drive assessment. Technical, behavioural, operational, and legal gaps were systematically identified. Measures to close the gaps were discussed. This information was included in Milestone 5 document, "Analysis of gaps and suggestions for closing them (A1.3) taking into consideration the outcomes of A1.2"

2.4.2 Methodology

An analysis of existing Fitness-to-Drive assessment protocols, drug testing laws and regulations, institutions' protocols was conducted. The gaps were identified in collaboration with the following project partners: DATIK, SENSAIR, POLILET, ROADPOL and CERTH. The first task was to start with reviewing previous projects, literature, European legislations and laws, institutions' protocols, and the findings in relevant literature sources from MS1. This milestone also includes the outcomes from A1.2 and previous gap analysis from the Grant Agreement Section 1.1. All these results were divided into four different focus areas:

- Off-road Fitness-to-Drive was related to any activity that the driver/ rider performs that is not relevant to the professional driving/ riding task and is outside their shift. It includes Off-duty, lifestyle and recuperation/pre-driving shift-phases, also to on site assessment/cloud supported system
- Roadside Fitness-to-Drive: Performed when the driver/ rider is stopped by an enforcer and is asked to pull aside for a random check/test.
- On road Fitness-to-Drive was related to the actual driving task but also acute and momentary measurements that can be made at a traffic light stop or upon demand and the person does not have to go out / off the vehicle. It includes On-duty and ad hoc work/ During driving/Cloud support system
- Enforcement measures included all existing legislations and legal solutions related with driver and driving

After the review the main points were emphasized into the gap analysis table, and the main gaps were identified. According to all the information collected a gap analysis diagram was drawn to estimate the existing gaps in current Fitness-to-Drive assessment.

2.4.3 Results

After the analysis of existing Fitness-to-Drive assessment protocols, drug testing laws and regulations, institutions' protocols, deliverables from other projects and discussion with WP1 partners and outcomes from A1.2, the main findings were presented in chapter 3 of Milestone 5 report. In off-road Fitness-to-Drive assessment the evaluation of the driving capacity before driving was reviewed (which includes off-duty, on-site, lifestyle and recuperation/pre-driving), where it was observed that the driver's physical condition derives in various symptoms, and it is different for each person and situation. In addition, all relevant metrics are single-dimensional. Moreover, the majority of measurements to detect driver's fitness are not yet commercially available, still under development, with no "gold standard off-road test" and publicly available information is insufficient. The roadside fitness to drive assessment was mainly concentrated in alcohol and illicit-licit drugs measurements and the technical problems that exist to measure these analytes in the roadside. The following existing problems were identified: laborious and expensive lab analysis, no real-time monitoring, roadside analyses are not approved as evidence, point-of-testing not fully accepted, bad selectivity, lack of continuous and specific data of drives' impairments, "less-obtrusive" and more hygienic technology. The third focus area was the on-road fitness to drive assessment (including on-duty, ad hoc work) where the measure of both the operational (maneuvering) and cognitive aspects of driving problems were mentioned. It describes currently available testing devices; however, the unified detection system is still missing. Some detection techniques are like the off-road fitness to drive assessment. It was identified that no efficient monitoring the drivers' health and state during their day shift and no current system to detect if the driver drinks and/ or takes medication. The last focus area enforcement measures described the existing legislation to fitness to drive assessment and the problems faced by the police officers to measure the driver status. It was identified that there was no harmonization legislation for all EU countries, with different alcohol and drugs limits in each country. Also, the legal digital recorders such as Smart tachograph for the evaluation of professional drivers driving and resting times was presented however, they cannot measure driver fatigue, sleepiness, or stress.

The gap analysis diagram (Figure 2) depicts the required actions to close the gaps and how they were assigned to PANACEA project WPs. WP3 and 4 are mainly dedicated to close the identified gaps and could help to construct the final fitness to drive assessment monitoring in PANACEA project.

2.4.4 Conclusions

Overall, many gaps in fitness to drive assessment were identified in four different driving focus areas. The gap analysis diagram represents the existing gaps found in the different focus area, by the evaluation of the current state and desired future. The actions to close these gaps were also identified (Figure 2). PANACEA project will be able to close the ones addressed by targeted Activities and WPs, as shown in Figure 2, and to improve the monitorization of the driver's state and health on road and of road. Also, it will be able to improve enforcement measurement and the gaps in the roadside. The implementation of the holistic PANACEA solution and the creation of its zero population (i.e., the first actors who will use the solution), requires data transparency and a new legislative framework. The holistic PANACEA solution will include all the technologies integrated to the PANACEA platform and will address many impairing states and combinations of them. The fact that it will support the professional drivers and riders throughout all the shift phases and even when they will be off duty enables the PANACEA solution to be holistic.

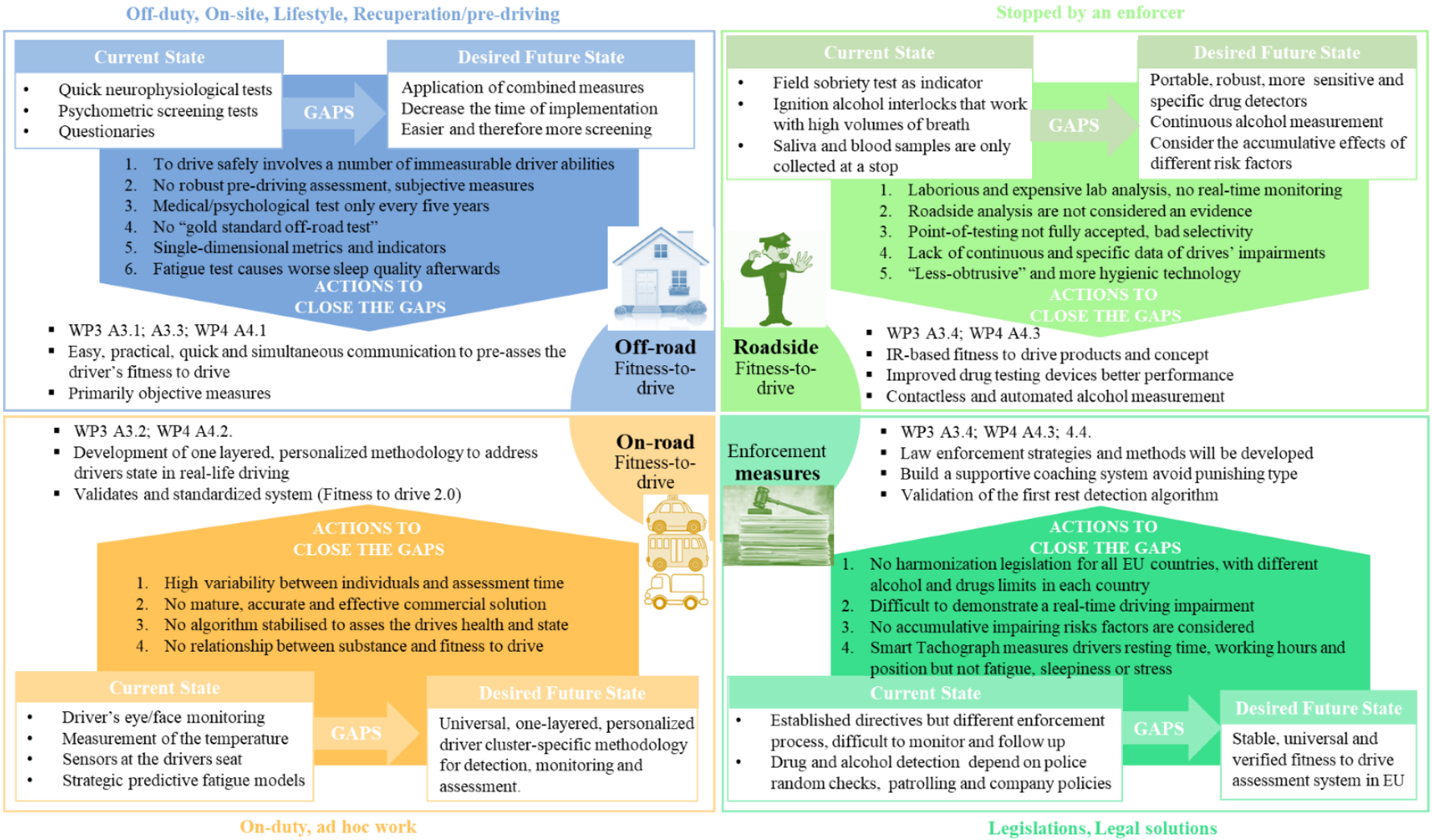

Figure 2. *Gap analysis diagram*

2.5 User needs and requirements

A summary of Milestone 6 follows. The report can be found here.

2.5.1 Objectives

The objective of this activity is to gather user and expert needs, wants, requirements, opinions, hesitations, and identify potential enablers and barriers for the implementation of the PANACEA Commercial Health Toolkits (CHTs). This was aimed to be achieved in A1.4 through:

- 3 (instead of 5 initially planned) interviews with stakeholders (operators, company management, enforcement personnel, policy makers, legislators, etc.)
- 3 (instead of initially 5 planned) interviews with drivers and riders per pilot site (Sweden, Spain, Greece)
- 2 focus groups (instead of 1) with drivers and one mixed with drivers and stakeholders at each pilot site.
- Completion of ex ante questionnaire from 21 participants (not initially planned) focussing on the characteristics of the PANACEA solution.

The composition of the groups of the attendees (focus groups), the interviewees (interviews) and the respondents (ex-ante questionnaire) as well as their occupations is presented in Table 2.

Table 2. *Number and occupation of participants per UC*

Actors	UCA	UCB	UCC
Focus groups			
Drivers/ riders	3 male & 1 female Autonomous Vehicle (AV) shuttle operators	3 male taxi drivers, 2 male delivery riders	5 male drivers (4 dustbin driver/ 1 coach)
Mixed (drivers/ riders and stakeholders)	3 male & 1 female bus operator representatives (Human Resource, planner, operational managers)	2 male taxi drivers, 2 males (operator, head of operators)	6 male stakeholders (Fleet operator, Human factors expert, Cognitive ergonomics leader from Garanada Universtity, Innovation Assistant, Sales responsable from OEM, Technical director, Technical Application Engineer)
Interviews			
Drivers/ riders	3 male shuttle operators	2 male taxi drivers, 1 courier service rider	1 male dustbin driver
Stakeholders	2 male managers (region and urban	4 male fleet operators, 2 heads of health and safety	1 male fleet operator

Actors	UCA	UCB	UCC
	operations), 2 male planers for Public Transport (PT)	department, 2 heads of operators' unit	
Ex-ante questionnaires			
Drivers/ riders	Shuttle operators: 7 (1 female – 6 male)	8 male drivers	6 male drivers (4 dustbin truck / 2 coach drivers)
Stakeholders	PT operator planner: 1 (male) PT operator HR: 1 (male) PT operator: operation manager/planner (1 female)	10 male stakeholders (2 operators, 2 police officers, 2 researchers in human factors, 2 taxi company board members, 1 health and safety manager, 1 municipality officer)	6 male stakeholders (Fleet operator, Human factors expert, Cognitive ergonomics leader from Garanada Universtity, Innovation Assistant, Sales responsable from OEM, Technical director, Technical Application Engineer)

2.5.2 Methodology

The process was based on an adapted requirements' analysis technique presented below (Figure 3). The first step (information gathering step 1) was to identify the key actors and stakeholders for the PANACEA ecosystem and then consider the aspects/ dimensions that are important for this Activity (identification of user and stakeholder aspects step 2) that will be addressed through the creating of personae and user stories for each Use Case pilot and evaluated through focus groups, interviews and ex ante questionnaires (Envisioning and evaluation step 3). The final step (requirements' specifications for the UC scenarios) will be distilling of the outcomes of the information that might be useful for the creation of the Use Case scenarios in A1.5.

2.5.3 Results

The diagram in Figure 4 presents the highlights of the emerging topics across each important dimensions per actor and UC and the resulting considerations for the Use Case scenarios creation and implementation. Holistic, coherence, communication, understanding of cultural aspects (related mostly to the culture of the professional drivers' groups rather the ones that are closely related to ethnicity and/ country, acceptance by users, data transparency) are vital for the next steps of the project. Drivers and riders are often fatigued and stressed. Drugs remain a difficult and seemingly unapproachable subject, but COVID has heightened the need for better health and wellbeing and how important it is in every aspect of our lives.

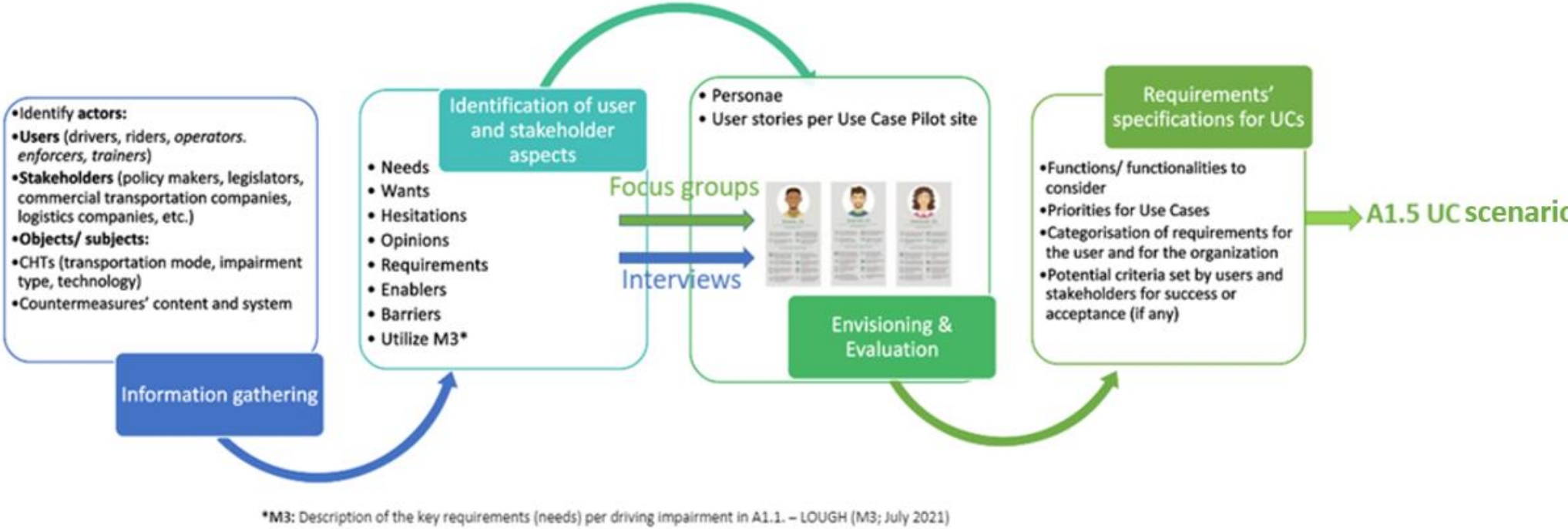

Figure 3. *Adapted requirements' analysis methodology*

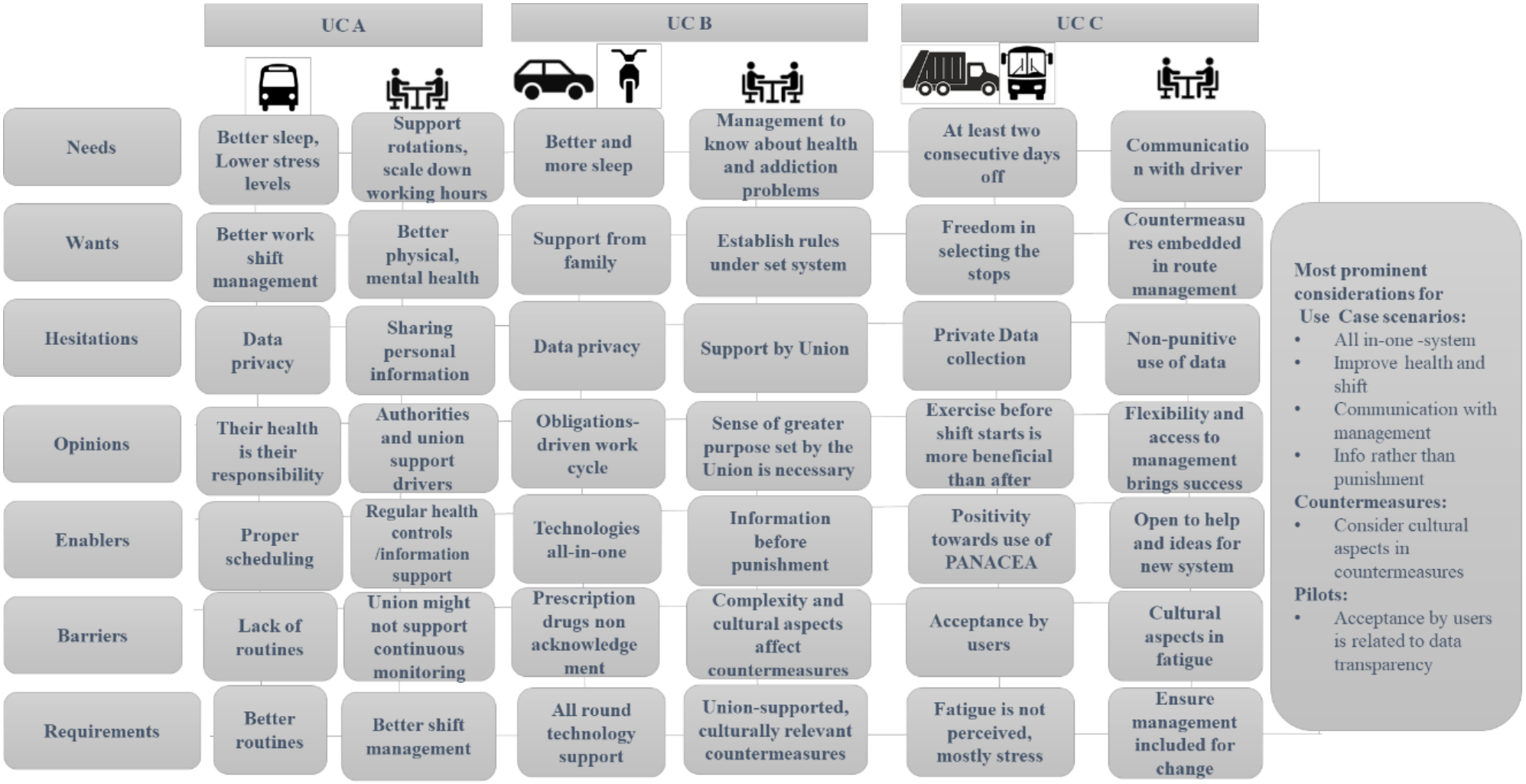

Figure 4. *Highlights from the adopted requirements analysis*

2.5.4 Conclusion

The holistic approach preference helped us shape the UCs around a flow of their shift (i.e., pre-driving, during, off-duty, etc.) that is common across the UCs with considering the differences in Commercial Healthcare Toolkits (CHTs) (i.e., the different combination of technologies per UC and per UC and work shift phase). The different CHTs are found in the last column of Table 1.

The importance of communication was considered by adding two optional Use Case scenarios for feedback provision and communication among the core actors through the PANACEA platform and, of course, depending on the nature of each Use Case scenario to consider communication as a potential step in its process.

Information over punishment is utilised in the way the countermeasures are considered in the Use Case scenarios as types (e.g., information text, advice, warnings), thoughtfulness towards the wellbeing of the actor and investing on behavioural change. However, although these aspects were considered in how countermeasures are portraited in the Use Case scenarios, the ones used in D1.1 are examples, and they will be further defined and developed in WP5.

2.6 The actors

The following table (Table 3) presents the main actors and stakeholders who we envisage to populate the PANACEA ecosystem. Where the actors are represented in one of the Use Cases, it is noted in the table.

Table 3. *The prospective users and stakeholders of PANACEA solution*

User[1]	Definition
Professional urban/ inter-urban bus driver (UCA)	Bus and shuttle driver working in private and/ or public company in a city area and its prefecture. municipality (e.g., Public Transport).
Shuttle safety operator (UCA)	Operators responsible for smooth operation of AV shuttles. Do not have to drive the shuttle but intervenes only on certain occasions or risky events.
Professional urban/ inter-urban truck driver (UCC)	Truck driver working in private and/ or public company in a city area and its prefecture. Municipality.
Professional long-haul truck driver	Driver of long-haul trucks, often cross-countries' journeys.
Professional delivery/ service driver/ rider (e.g., courier, food delivery services, taxi drivers) (UCB)	Driver/ rider often in urban areas with familiar and unfamiliar routes per day.
Fleet operators	Professional responsible for the smooth and successful operation of a company's fleet.

User[1]		Definition
Fleet analysts		Operators responsible for annotation and communication of events.
Fleet managers		Senior, supervise if there are more than operator. They manage a number of operators in a company.
Health and safety manager		Monitoring health and safety risks and hazards in the workplace and the appropriate and relevant protocols.
HR manager in company (logistics, transportation, etc.)		Manager responsible for the employee's working cycle in the company and their benefits. Responsible also for handling difficult and personal situations that are related to the employee's performance and behaviour that might affect their work outcomes and product quality as well their relationship with their employer company.
Enforcers/ Police/ Civil police		Road police officers responsible for enforcing legislation in relation to safe driving behaviour for every road user. The name and role of this user cluster might vary country-wise.
Driver instructors/ trainers		Professionals who train professional drivers/ riders.
Driver educational and/or rehabilitation programmes		Professionals who run drive rehabilitation courses/ programmes/ workshops, rarely actual centers, to enable offenders to re-obtain their license and become safe drivers. In the same category any training or raising awareness courses are relevant, as there is no consensus on how DUI offenders are treated across Europe, then in this category we add programmes, courses and workshops alike depending on alcohol levels, number and frequency of offences. The countermeasure specialist also belongs in this cluster and is the person or team of professionals who will be responsible for the development or adaptation of the countermeasures in the countermeasures cloud-based system.
OEM and transport/mobility operators	***OEM (Original Equipment Manufacturer)***	An industrial customer purchasing a product with the aim of integrating it into another product to be sold on another industrial market or to a final consumer. Example: Renault (OEM) buys tires from Michelin to be fitted on cars which it will then sell to an end user.

User[1]		Definition
	Transport/ Mobility operators and logistics companies	A mobility operator is a service provider to whom it is possible to subscribe. Following signature, a user who subscribes to a mobility operator will be able to access a mobility service. A user can also buy a ticket for occasional use of the service offered by operator. (e.g., public transport operators (all modes) • Vehicle (car/bike/...) sharing/pooling/rental service provider (public or private) • Parking operators • Road operators (tolls) • Taxi operators • Coach, buses, trucks, shuttles operators • Traffic Management operator)
Tier 1 suppliers, telecom operators, technology providers and services company	***Tier 1 Suppliers / Technology providers***	Tier 1 Supplier: Supplier who delivers directly to the company that produces, assembles, or finishes the marketed product. Technology provider: a company which for example provides 5G technology.
	Services companies	Company that carries out activities that add value to any product. It may also act as a service provider for a private individual or another company, in return for remuneration.
	Telecom operators	A telecommunications operator is an entity that offers remote communication services.
Research and academia		An establishment, laboratory or research and teaching organisation specialising in technological and human sciences. They may specialise in basic research or may be oriented towards applied research. They may be linked in partnership with universities, companies and ministries.
Passengers and other road users encompassing VEC		Passengers: relevant for professional bus/ shuttle, coach, taxi drivers. Other road users: All people who are not directly affected services' users but participate in the surrounding traffic and are affected by the presence or absence of PANACEA technologies.
Union/ Union rep		Representative from the appropriate driver Union
Families/ Social support system		Direct family members, spouses, children, partners, friends and other relatives that constitute the person's frequent support system and are affected positively and negatively by the user's behaviour.

User[1]		Definition
Umbrella associations/Non-profit organisations		An umbrella association is an association (often linked to a specific industry) of institutions that work together to coordinate activities or a set of resources. A non-profit organisation can be an association, a society or a club. The members of a non-profit organisation do not receive any financial benefit from it. Any profit made must be reinvested in the organisation.
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	***Road operators***	Entity with the mission to operate and maintain the road domain, which is assigned to the needs of land traffic.
	Policy makers	Persons who have the power to influence or determine policy and practice at the national, regional, or local level
	Legislators	Professionals or groups of professionals on governmental level who decide on amendments in existing legislation.
	Ministries	Administration, public services under the leadership of a minister. (e.g, Ministry of transportation • Transport agency • Road administration • Transport safety agency/authority)
	Cities and Municipalities	A municipality is the territorial administration of a communal-type entity that may include a single city or several agglomerations (villages, hamlets, localities, etc.). (e.g., Regional/local transport agency • The city and city planning (technical, traffic, ITS) department • Tourist agency or department)
	Municipality agency	An agency elaborating different programs of development in a specific field including the different investment funds on the national and international levels and certifications.
	Medical Health care professionals	Practitioners either work on company level or public workers who decide if a professional driver/ rider is fit to work or not.

User[1]		Definition
Other transport modes	***Users***	Drivers and operators of other transport modes (ferries, ships, train operators, air traffic operators, freights, airplanes, helicopters, drones' operators, etc.)
	Stakeholders	Airlines, freight, and train companies along with their OEMs and Tier companies.

3 PANACEA Use Cases

This section presents the three primary Use Cases (UCs) of the PANACEA project. Use Cases comprise the technologies, the actors involved, the vehicles they drive, and the impairments addressed at each of the three pilot sites (Sweden in UCA, Greece in UCB, Spain in UCC). A fourth UC is considered only conceptually with no technologies and pilot site, but with focus on the knowledge and systems that may be transferred across transportation modes. Therefore, the UC structure and presentation is separate and can be found in section 5. Below the target drivers and rider groups are presented across Use Cases.

Use Case (UC)	Target drivers
A	Bus/shuttle drivers
B1	PTW courier delivery riders
B2	Taxi drivers
C1	Coach driver
C2	E-truck driver (refuse/rubbish/garbage collection)

3.1 Use Case A: Bus drivers/ Shuttle operators in Linköping, Sweden

UC	Actors	Scenarios
UCA	Bus and Shuttle operator	**On-duty pre-driving** up to before entering vehicle (check for alcohol consumption previous night, drugs, insufficient sleep quantity and quality)
		During driving, includes entering the vehicle (fatigue, stress – during breaks)
		On-duty post driving, after exiting the vehicle (fatigue debrief based on the drive e.g., commute advice, receiving countermeasure advice ready for next shift)
		Off-duty, After shift (leisure and lifestyle choices) sleep issues taking anxiolytics to sleep (sleep, medication/drugs)
	PT Operator – Manager perspective including subgroups, see actors	**On-duty pre-driving**: (alcohol, drug testing, fatigue and health)
		During driving (fatigue/ distraction, stress)
		Off-Duty, After shift

1. Description
Bus drivers who are also safety operators for autonomous shuttles. The focus is on the safety during shuttle operation. Key considerations are the impact of shift work and the need to interact with VRUs. It is intended that the system will detect fitness prior to starting work as this is the priority to ensure people are fit to drive when starting work. In addition, it is necessary to appreciate that the task is very monotonous, so fitness (particularly alertness) needs to be maintained throughout shift. There is also a need to prepare drivers ahead of their future shifts. Priority: off-duty (lifestyle, to ensure fitness prior to starting shift), on-duty (pre-driving, the driver is at work and should be assessed before they are allowed in the vehicle), on-road (in the vehicle while driving as a guidance/assistance system). User stories demonstrating the personae of UCA drivers can be found in Appendix I of MS6.

2. Actors (with *grey* the groups that might be contacted offline and outside the PANACEA Platform (PP)
Professional urban/ inter-urban bus driver/ Shuttle safety operator: operate the vehicle (main actor).
Operator: Transdev, manage the service provision, they want safe and healthy drivers. The particular actor of interest is the manager who is responsible for shift planning, vehicle state and ensuring the service runs. Would have first contact with any drivers identified as not fit to drive.
Health and safety manager: monitor health and safety. Informed of cases if drivers have repeated problems (multiple occurrences, or serious e.g., illegal drug).
Driver instructors/ trainers: lifestyle coaching aspects will be of interest as this would be delivering some of the countermeasures. May also have interest from a national qualification of bus driving point of view.
Driver educational and/or rehabilitation programmes: Will be informed if drivers have repeated problems.
OEM (Original Equipment Manufacturer): possible actor if equipment is required in the vehicle e.g., integrated interlock system
Tier 1 Suppliers / Technology providers: Senseair, LEITAT and DBL as providers of the technology. There may be others
Union/ Union rep: Union to be provided with information which may help them to lobby for improved working conditions. Union will protect the drivers' interest if they choose to participate.

3. Priority
Fatigue/sleep/alertness Shift work Sleep disorders Light/social alcohol use Illegal drugs Legal drugs

3.2 Use Case B: Taxi drivers and courier service drivers in Thessaloniki, Greece

Description
Taxi drivers and courier service riders who work in the prefecture of Thessaloniki, Macedonia, Greece. Key considerations are the impact of stress, fatigue, alcohol, (il)licit drugs consumption. Fitness will be assessed across all shift phases with emphasis pre- and during the shift. It is very important to accommodate for both types of professionals with both working with unfamiliar and unstructured routes every day in often heavily dense urban environment and increase risks. Taxi drivers often collaborators and freelancers, whereas the courier service riders are employees, as it is the case with the other two Use Cases. User stories demonstrating the personae of UCB drivers and riders can be found in Appendix I of MS6.

* When readers see a gendered pronoun, they make assumptions about the gender of the person being described (Gastil, 1990; Moulton et al., 1978). APA advocates for the singular "they" because it is inclusive of all people and helps writers avoid making assumptions about gender. Therefore, the term singular ***they*** is used instead of ***his/ her***.

Actors: Taxi drivers/ riders, taxi/ courier service operator center (one or two persons), enforcer, countermeasures' specialist technical team member.
Vehicle: Taxi passenger cars (mostly owned by the taxi drivers), scooter/ PTW (mostly owned by the courier service riders)
CHT BTaxi technologies: The integrated technologies are: a) Primary: the DATIK fatigue detection system (without cameras for the riders), the SENSEAIR Go alcohol sensor (only for the taxi drivers), the steering wheel algorithm (only for the taxi drivers), the LEITAT sensor, and b) Secondary: ERGOS system, BACtrack skyn (mainly for riders). Research vehicle/ PTW parameters in ASCII file (timestamp sync.): headway (time/ space), lane departure (including standard deviation of lane departure (SDLP)), acceleration/ deceleration/ speed. Car/ motorcycle simulator parameters (timestamp sync.): lane departure, braking distance, headway (in distance), acceleration/ deceleration/, speed, reaction (others depending on scenario). **Data considerations per impairment state and technology used per shift phase can be found in Tables 9-11.** **PANACEA Platform** to collect all data and send notification back in several means. In order users to be assessed and monitored needs to be registered on the platform. Users have also to be subscribed on specific services. Registration and authentication are addressed in administrative UC scenarios (UCscr 17-26).
Road conditions: Mostly urban road infrastructure, high traffic volume during peak hours, mostly unknown daily routes, mostly familiar road context, rain, monotonous night driving.
Business rules: To consider if independent buyers and freelancers and not part of a fleet can be users of PANACEA solution.
UC scenarios: Pre-driving assessment, during driving assessment, onsite, roadside assessment, off-duty (this can be included in the pre-assessment for some of the scenarios).
Pre-driving assessment: Fatigued, stressed, Fatigued and intoxicated, under medication, under influence of drug replacement (these are primary scenarios; other combinations will be considered for secondary scenarios).
During driving: Intoxicated, Sleepiness, cognitive overload ((these are primary scenarios; other combinations will be considered for secondary scenarios)
Roadside: enforcer – intoxicated (these are primary scenarios; other combinations will be considered for secondary scenarios)
On site: Fatigued, stressed (these are primary scenarios; other combinations will be considered for secondary scenarios)
Off-duty: intoxicated and licit drugs intake (these are primary scenarios; other combinations will be considered for secondary scenarios)

3.3 Use Case C: Dustbin trucks and coach drivers, San Sebastian, Spain

1. Description
Truck and coach drivers that work in the San Sebastian and BCN area in Spain. Key considerations are the impact of shift work and different impairing states like stress and fatigue. It is intended that the system will detect fitness prior to starting work as this is the priority to ensure people are fit to drive when starting work. In addition, for coach drivers it is necessary to appreciate that the task is very monotonous, so fitness (particularly alertness) needs to be maintained throughout shift. For truck drivers, the task is carried out in night shift which means extra effort to keep alert. There is also a need to prepare drivers ahead of their future shifts. Urban, inter-urban and rural road conditions are experienced. Priority: off-duty (lifestyle, to ensure fitness prior to starting shift), on-site (pre-driving, the driver is at work and should be assessed before they are allowed in the vehicle), on-duty (in the vehicle while driving as a guidance/assistance system), User stories demonstrating the personae of UCC drivers can be found in Appendix I of MS6.

UC	**UCs**	**Scenarios**
UCC	Truck and Coach operator	**On-site** pre-driving up to before entering vehicle (check for alcohol consumption previous night, insufficient sleep quantity and quality – sleep, alcohol) Pre-questionnaire with subjective considerations about quality of rest, alertness level, fatigue experienced and expectations for the day)
		On-duty During driving, includes entering the vehicle (fatigue, distraction, stress – during breaks)
		On-duty post driving, after exiting the vehicle (fatigue, alcohol and stress)
	PT Operator – Manager perspective including subgroups, see actors	**On-site** Monitoring pre-driving events via PANACEA cloud: (alcohol, fatigue,) event monitoring
		On-duty Monitoring During driving via PANACEA cloud (fatigue/ stress)
		Off-Duty, After shift

2. Actors (with *grey* the groups that might be contacted offline and outside the PANACEA Platform (PP)
Professional urban/ inter-urban truck and coach driver: operate the vehicle (main actor)
Operator: Apaolaza Autobusak and FCC (Fomento Construcción y Contratas), manage the service provision, they want safe and healthy drivers. The particular actor of interest is the manager who is responsible for shift planning, vehicle state and ensuring the service runs. Would have first contact with any drivers identified as not fit to drive.
Health and safety manager: monitor health and safety. Informed of cases if drivers have repeated problems (multiple occurrences).
Driver instructors/ trainers: lifestyle coaching aspects will be of interest as this would be delivering some of the countermeasures. May also have interest from a national qualification of bus driving point of view.

Driver educational and/or rehabilitation programmes: Will be informed if drivers have repeated problems.
OEM (Original Equipment Manufacturer): possible actor if equipment is required in the vehicle e.g. integrated interlock system
Tier 1 Suppliers / Technology providers: Senseair, as providers of the technology. There may be others
Union/ Union rep: Union to be provided with information which may help them to lobby for improved working conditions. Union will protect the drivers' interest if they choose to participate.
Analyst: Operators responsible for annotation and communication of events.

3. Priority
Fatigue/sleep/alertness Shift work Sleep disorder Light/social alcohol use Cognitive load for truck drivers who need to manipulate specific recollection machines

4 The Use Case scenario concept

"Use cases" were initially presented by Ivar Jacobson in 1967 as "usage scenarios" and this is the term that will be used in this Deliverable to differentiate the interaction scenarios from the UCs A, B, and C. In the mid-1980s, Jacobson coined the Swedish term "användningsfall", which roughly means "situation of usage" or "usage case", but when publishing into English he translated it to use case (Jacobson, 1993).

A **Use Case scenario is** a sequence of interactions happening under certain conditions, to achieve the primary actor's goal, and having a particular result with respect to that goal. The main purpose of use case scenario is to present in a detailed and clear and easy-to-learn way, of the functional requirements of a system. The interactions start from the triggering action and continue until the goal is delivered or abandoned, and the system completes whatever responsibilities it has with respect to the interaction. Scenarios do not just refer to what the system can do, but also refer to those interactions that the system must be able to identify as invalid (e.g., error conditions and exceptions). They are used to describe the functional requirements of the systems under development. It uses graphical symbols and text to specify how users in specific roles will use the system (Jacobson, 1997).

The main purpose of use case scenario is to present in a detailed and clear and easy-to-learn way, of the functional requirements of a system. The use case scenarios can also be considered as a description of a system's behaviour, written from the point of view of a user who has told the system to do something particular.

The use case scenarios have the unique ability to help teams to understand the value that a system hopefully provides to its stakeholders (Bittner and Spence, 2006). Use case scenarios describe **who** is doing what and **when**, and **what is expected** from the system for each request. To this end, use case scenario comprise a powerful tool to capture functional requirements for software systems, to evaluate them (Cockburn, 1997).

Use case scenarios are made up of scripts. Scripts consist of a sequence of steps to achieve the UC scenario (or goal) and each step in a script is a sub goal of the use case. As such, each sub-goal represents either another use case scenario (subordinate use case scenario) or an autonomous action that is at the lowest level desired by the use case scenario decomposition. This hierarchical relationship is needed to properly model the requirements of a system being developed. In addition, it helps avoid the explosion of scenarios that would occur if we were to try to simply list all possible ways of interacting with the system. Scripts can be stand-alone, but they are more useful in combination with other scripts or under other scenarios.

The scenarios are detailed explanations of the followed steps that need to take place, so the scope can be realised. Additionally, the scenarios allow structuring the system requirements according to the user goals and provide the means to specify the interaction between a certain software system and its environment.

The starting point is that the primary actor has a goal; the system should help the primary actor to reach that goal. Each scenario contains a sequence of steps showing how the actions and interactions unfold. In each Use Case scenario, we often show ways (i.e., exceptions for example) that the goal can succeed or fail. A useful metaphor Cockburn (1997) uses to illustrate this is the striped trousers image (Figure 5), with the following principles:

- some scenarios end with success, some end with failure.
- we collect all scenarios and/ or scripts, success or failure.
- each scenario is a straight description for one set of circumstances with one outcome.
- use case scenario (stripes on the trousers) contains sub scenarios and/ or scripts and its steps.
- a step in a scenario does not care which stripe in the sub use case was used but only whether it ended with success or failure.

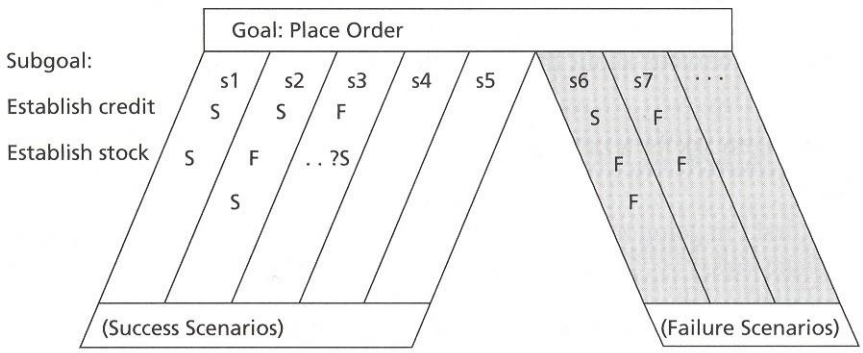

Figure 5. *Striped trousers scenarios succeed or fail*

There is often collection of related success and failure scenarios that describes actors using the system to support a goal. So, as the image reflects, a goal holds together all the scenarios (success and failure).
UC scenarios are clustered around the shifts, the technologies, and the actors. Administrative UC scenarios are already included, but only for consideration for WP2. Backend related UCs are part of the architecture to be addressed.
The text describes the use case scenario from the user's point of view; they do not describe how the system works internally or its internal structure or mechanisms. In general, use case scenarios contain the following:

- Actors (name, description, status, subclass, and associations)
- Use case scenarios steps and scripts (number, subject, business event, name, preconditions, associations, inputs, outputs)
- Associations between actors and uses case scenarios
- Relationships between use case scenarios
- Termination outcomes and conditions affecting termination outcomes
- Termination outcomes decision table
- System steps decision table
- Flow of events table

The combination of these elements provides an overview of the functional requirements.
The purpose of the use case scenarios is to establish the boundary of the proposed system and the functional capabilities to be delivered to users. Use case scenarios modelling also:

- Allow scheduling of common functionality early in development
- Allow scheduling of complex functionality later in development without changing existing code
- Provide a basis for defining test cases
- Provide a basis for identifying objects, functionality, interaction, and interfaces
- Provide a basis of communication between end users and system developers
- Provide the basis for defining the user interface requirements
- Provides a basis for producing materials, such as user documentation
- Serve as the basis for acceptance testing

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4.1.1 Use case scenario diagrams

Modelling is an essential part of a system development project. The OMG's Unified Modelling Language™ (UML®) is a Use Case scenario and script diagram that helps to specify, visualize and document models of software systems, including their structure and design. The use of UML allows analysing the future application's requirements and designing a solution that meets them. In this specific activity, we intend to represent the results with Use Case scenario UML diagrams.

The main purpose of a Use Case scenario diagram is to show which system functions are performed by each actor. One advantage of UML is being methodology-independent, i.e., regardless of the methodology that is used to perform the analysis and design, we can use UML to express the results.

UML are usually depicted as User Behaviour Diagrams including Use Case scenario Diagrams, used by some methodologies during requirements-gathering of a system, although, if necessary, it can be employed at any stage of the development lifecycle. In other words, these diagrams can be used at a very early stage, when the technological solution is a mere concept, but also after the architecture is set to include steps of the development (e.g., backend processes) that are not directly related to user behaviour.

According to the UML specification (OMG), a Use Case scenario Diagram is “a diagram that shows the relationships among actors and use cases within a system”.

The UML diagrams constitute the visualisations of the scenarios, but they will always be accompanied by the Use Case scenarios descriptions. High level UML diagrams (i.e., circles representing a Use Case scenario or script) were created for each of the three clusters of Use Case scenarios identified in this document (sections 4.3, 4.4, and 4.5. UMLs can be found in Appendix III).

4.2 Use Case scenarios functions’ prioritisation

An internal workshop was held on 3rd of December 2021 to prioritise the UC scenarios and their functions. In total 21 person participated in this internal workshop. The agenda included the introduction of the Use Case scenarios, their functions and the methodology applied to reach them. The discussion was split into three sessions: a) the prioritisation of the Use Case scenario related to the during driving assessment and its functions - (Figure 6) shows one Use Case scenario (left) and the prioritisation of its functions (right) by the attendees from low to high, b) discussion about needing more or other UC scenarios, and c) discussion about data protection and privacy as an aspect of the Use Cases and the PANACEA platform in general.

The objectives of WP1 were revisited and the objectives for the internal workshop were set (Figure 6). The numbering of UC scenarios presented in Table 4 differ from the ones presented in this Deliverable, as the scenarios were re-structured and expanded after the workshop. The UC scenarios 01-11 were initially part of the horizontal scenarios (UCsc17-26), and after the workshop were divided to create a separate cluster. However, almost all scenarios were important and functions were only prioritised.

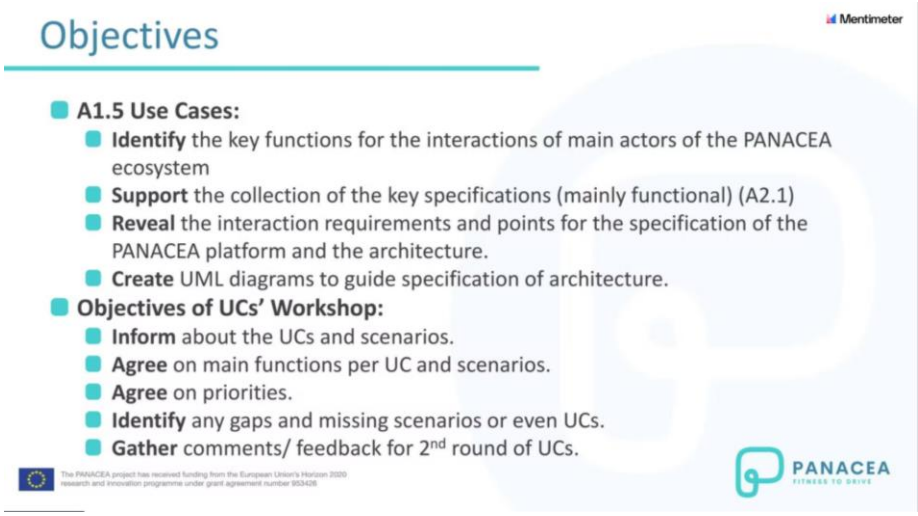


Figure 6. *A1.5 and workshop's objectives (from the workshop presentation)*

The scenarios were presented to the attendees along with the functions and they had to vote the scenario and its functions from low to high priority. In Figure 7, for the during driving assessment scenario (now it is UCsc14) shows the list of functions on the left and their prioritisation on the right. The assessment of the level of impairment and the assessment of fitness to drive are the most important scenarios. However, even the lower prioritisation functions were never too low. In most cases low was considered a function rated 2 out of 4.

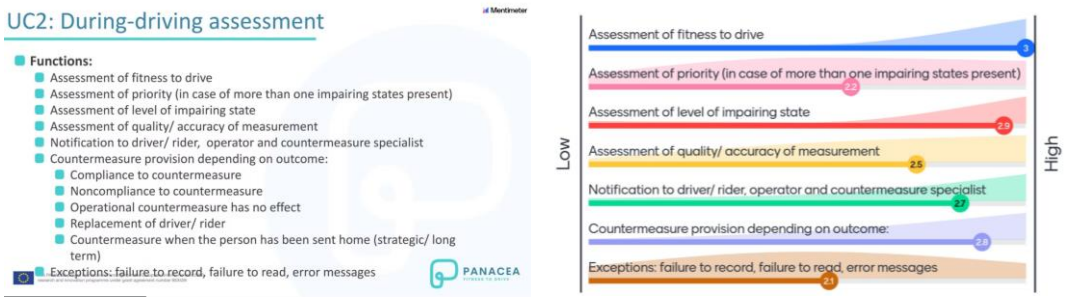


Figure 7. *UC scenario and functions (left) and prioritisation votes by attendees (right)*

The clusters of UC scenarios presented are shown below:

Table 4. *UC scenarios presented at workshop*

UCsc12: BASELINE ASSESSMENT UCsc13: PRE-DRIVING ASSESSMENT UCsc14: DURING DRIVING ASSESSMENT UCsc15: ROADSIDE ASSESSMENT UCsc16: OFF-DUTY ASSESSMENT UCsc17: OPERATORS UCsc18: TECHNOLOGY/ SERVICE PROVIDERS UCsc19: COUNTERMEASURES' SPECIALIST UCsc20: ENFORCER UCsc21: ADMINISTRATOR UCsc22: BUSINESS RULES UCsc23-26: ADMINISTRATIVE/ HORIZONTAL

The functions with highest and lowest priority are shown below. It is obvious that the actual measuring of the fitness –to-drive, data protection, quality of measurement, data access, etc. are the most important. There is variation of importance of function because the nature of the

scenarios differs. On the contrary, of lowest priority are considered the UC scenario that are handling the errors, which are of administrative nature and are basically the backend processes. These did not receive a true low priority (most where rated 2 out of 4), but they were rated lower than the rest. This is mostly because these are backend functionalities that will be probably handled by the PANACEA platform. The high and low priorities' functions presented in Table 5 have been adapted and presented to the final list of UC scenarios, as they are presented in this Deliverable. These are the prioritised functions. Hence, the Use Cases scenarios were defined and the functions for implementation were prioritised.

Table 5. *Highest and lowest priority functions per UC scenario*

HIGHER PRIORITY
UCsc12: Recording and storing of baseline assessment UCsc13: Fitness to drive assessment (pre-driving) UCsc14: Fitness to drive assessment (during driving) UCsc15: Countermeasures' provision UCsc16: Quality of measurement UCsc17: Notifications about driver's impairing state UCsc18: Access and visualization of data UCsc19: Feedback about countermeasures UCsc20: Use of alcohol and/ or drug device UCsc21: Actors/ data/ security and safety management (3) UCsc 22: View/ Feedback about business rules UCsc 23-26: Messaging the driver/ rider (operator)
LOWER PRIORITY
UCsc12: Deleting baseline assessment UCsc1: Alternative paths/ technologies to measurement UCsc2: Exceptions: Errors, misreading, etc. UCsc3: Exceptions: Errors, misreading, etc. UCsc4: Exceptions: Errors, misreading, etc. UCsc5: Menu preferences UCsc6: Exceptions: Errors, misreading, etc. and access to business rules UCsc7: Exceptions: Errors, misreading, etc UCsc8: Exceptions: Errors, misreading, etc UCsc9: Exceptions: Errors, misreading, etc UCsc10: Add business rule UCsc11: Exceptions: Errors, misreading, etc, creation of actors' profiles, language and UC selection

4.3 UC scenarios for the PANACEA technologies

The Use Case scenarios and scripts (Table 6 with cross-reference links to the scenarios and scripts) are divided in 3 categories: **a) CHTs and technologies:** the Use Case scripts for the technologies that will be integrated into the PANACEA solution (UC scripts 01-11; section 4.3, UMLs Appendix III), **b)** the **UC working shift flow scenarios**, where we demonstrate a real sequence of interactions across all shifts (i.e., from arriving to the company premises until they leave and go home) with the use of the holistic approach of PANACEA solution.; **c) Administration, backend, and actors-oriented UC scripts:** the Use Case scripts for the different actors interaction with the PANACEA platform (e.g. interaction with their profile), the registration, authentication, login in, in addressed in the project (UC scripts 12-26 in Appendix II and UMLs in Appendix III).

Table 6. *Overview of PANACEA Use Case scenarios & scripts*

CHTs and Technologies	Working shift flow	Administration, backend, and actors-oriented UC scripts
UCsc01: FitDrive (Primary) – DATIK UCsc02: Alcohol sensor (Primary)– SENSEAIR UCsc03: (Il)Licit drugs biosensor (Primary)- LEITAT UCsc04: - Smart Pulse Wave Analysis (PWA) device – AIT UCsc05: Steering wheel angle algorithm (SWA) and vehicle parameters (Primary)- ViF UCsc06: DBL index (Secondary) - DBL UCsc07: BACtrack Skyn (Secondary) – VTI and CERTH UCsc08: Fitbit wrist band (Secondary) – VTI UCsc09: Biomathematical model (BMM; Primary)– VTI UCsc10: ERGOS system (Secondary) – CERTH UCsc11: Cloud based Countermeasures' system (Primary) – CTLup	UCsc12: Baseline assessments UCsc13: Pre-Driving Assessment (incl. on-site) (ONPDA) UCsc14: During Driving Assessment (DDA) UCscr15: Roadside Assessment (RSA) UCscr16: off duty Assessment (ODA)	AII.1 UCscr17: Operators AII.2 UCscr18: Technology/ Service provider AII.3 UCscr19: WP5 Development Team Countermeasures' specialist (responsible for the content of CCS) AII.4 UCscr20: Enforcer AII.5 UCscr21: Administrator AII.6 UCscr22: Business rules AII.7 UCscr23: General actor registration/ authentication/ login (with failures) and creation of profile AII.8 UCscr24: Feedback module AII.9 UCscr25: Communication module among core actors (optional) AII. 10 UCscr26: Errors (as exceptions) handling (closely related to UC20 and this a system and not a business UC scenario- Diagnosis procedures)

The actors will primarily interact with the PANACEA platform through a web application (connected to the DATIK's iPanel for the operators) and an Android mobile application. The abbreviations used in the UC scenarios for the main actors can be found in the abbreviations list at the beginning of the document. In the main document, the UC flows are added with cross-references to the UMLs (Appendix III) and other connected UC scenarios and/ or scripts.

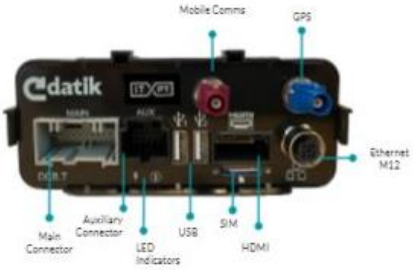
4.3.1 UCsc01: FitDrive (Primary) – DATIK

Relevant to all UCs (A, B, and C) for measuring fatigue. Related to UC scenarios 14, 17, 23, 25. Part of all CHTs.

1. Description

DATIK embedded system will be installed in the PANACEA demonstrators following instruction coming from the Installation Manual provided. The components of the DATIK system visible to drivers are shown below: a) DSM camera, b) Road camera/ ADAS, c) Mini Driver Display. Components that the driver cannot see are the following:

DCBT



EVENTS BOX

This system will work during driving which means that it is related to during driving (on-duty) phase.
Drivers switch on the engine, and they can see that all Fitdrive components are active and working (camera and display show their status is on). An image appears on display screen and camera shows it is functioning (e.g., it is possible to confirm with the mobile camera that infrared appears).

2. Actors

Driver: The drivers have to drive completing the service/s assigned. They must follow traffic and organisation rules. They take charge of status system communication, which means to know about ongoing system conditions to start driving. They will follow organisational instructions related to PANACEA system process (i.e., a protocol sheet). Riders (UCB) will not use the DATIK system.

Operator: The operators monitor the performance of the whole fleet and act accordingly following traffic and organisational rules. Their main aim is to complete the daily targets safely and successfully. They need to be aware of the system embedded and how PANACEA cloud system works in order to understand alarms, notifications and emails received or displayed. They will be constantly in touch with fleet drivers.

Analyst: The analysts will be aware of FitDrive functioning, they will follow instructions depicted on Analyst's Manual, which could change depending on the different aims pursued by organisation. The PANACEA platform with a 24h analyst service implies that the analyst team needs to achieve a 365 support with different operators around the clock.

3. Priority

Fatigue and Accident Risk Level based on fatigue and distraction parameters (recursive feature elimination (RFE), content (time, fatigue/distraction events, eco-driving performance).

4. Pre-conditions
• Engine on, connectivity, GPS and CAN access • Real time operating system • Time gap to DCBT functioning

5. Flow of Events		
Flow Identifier:	**UCsc01.1: FitDrive good performance**	
Step	**User Action**	**System Response (optional)**
1	D starts the vehicle.	All FitDrive components start functioning (real time functioning).
2	D starts driving the vehicle.	• The system displays different events and the risk level status depending on driver performance. • At the same time, the system displays the events registered through iPanel platform. These events are augmented with specific information attached and they can also be represented with a chart. • Depending on previous workflows configuration the system will automatically carry out different outcome possibilities: ○ SEND notifications and/or emails. ○ SHOW incidents. ○ REGISTER events.
3	O acts/manages consequently to safety information displayed.	PP adjusts the functioning in real time.
4	O acts/manages consequently to maintenance information displayed.	PP adjusts the proper functioning in real time.
5	D changes their behaviour considering information displayed.	PP adjusts the proper functioning in real time.
6	D turns off the vehicle.	PP registers the end of the service and display this on iPanel platform.

6. Exceptions		
Flow Identifier:	**UCsc01.2: FitDrive lost connectivity**	
Step	**User Action**	**System Response (optional)**
1	D behaves as in UCsc0.1.	• PP displays to D events related to safety, driving and maintenance. • PP displays the Risk Level status.
2		PP does not send information registered from FitDrive to the operators.
3		• Registered information is stored into the FitDrive embedded system and it and will be sent to iPanel. • Notifications and emails linked to events will then be sent.

Flow Identifier:	UCsc01.3: FitDrive lost CAN connection	
Step	**User Action**	**System Response (optional)**
1	D behaves as in UCsc0.1.	• PP displays safety and maintenance events PP displays Risk Level status on embedded display and on iPanel platform. • Eco-driving events are neither registered nor displayed.
2		PP sends all registered events.
3		Service-related vehicle status data are lost without CAN connection.

Flow Identifier:	UCsc01.4: FitDrive lost GPS signal	
Step	**User Action**	**System Response (optional)**
1	D behaves as in UCsc0.1.	• PP displays to D events related to safety, driving and maintenance. • PP displays the Risk Level status.
2		• PP does not display vehicle position on iPanel platform. • PP does not send position information related to events.

8. Post-Condition
End with the following post-conditions: • The CAN connection must be reviewed: 1.) remote checking protocol 2) physical checking protocol. • After a connectivity issue: 1) remote checking protocol (SIM card activation), 2) physical checking protocol. • After a GPS failure, a physical review (e.g., checking of the antenna) is recommended.

9. Business Rules
DATIK company existing business rules apply.

10. Special Requirements
1. This is a technology with various components; therefore a manual will be shared with partners for installation and mounting up. Consideration for EU and national guidelines for nomadic devices should be acknowledged and considered.

11. Artifacts
1. Protocol and instruction manuals. 2. Remote and physical checking protocol.

12. Notes and Issues
1. Considerations for physical integrations will be made for the PANACEA web application with the iPanel for the operators as well as the re-use of existing DATIK HMI elements to ensure homogeneity and coherence in user experience.

4.3.2 UCsc02: Alcohol sensor (Primary)– SENSEAIR

Related to All UCs (A, B, and C) for detecting alcohol consumption. Relevant to UC scenarios 12, 14-18, 20, 23. Part of all CHTs.

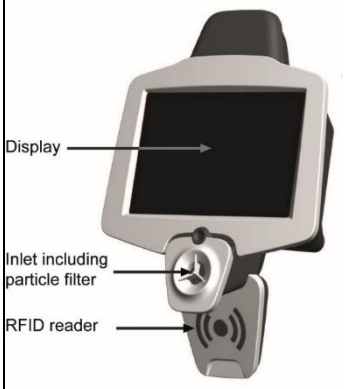
1. Description

The **Senseair Wall** alcohol sensor is used onsite (pre-assessment). Senseair Wall is a wall-mounted system that analyses the exhaled air to determine the concentration of alcohol. The exhaled test is performed without physical contact with Senseair Wall, i.e., the common mouthpiece used in breath analysers is not required. The recommended distance from the user to the device's inlet is approximately 3 cm. Individuals identify themselves using an RFID card.

Hand unit:

RFID reader:

Access box:



The **Senseair Go** public transportation adapter interlock is used On-duty pre-driving. Senseair Go interlock system, is comprised of a hand unit containing a RFID reader for identification of the user, an alcohol sensor based on NDIR-technique and an access box connected to internet. The hand unit provides visual and audible guidance for ease of use and to ensure the quality of the breath test. The alcohol breath analysis is performed without physical contact with the hand unit, i.e., the common mouthpiece used in breath analysers is not required.

Access box:

The **Senseair Go-Portable** is an alcohol breath analyzer **prototype** used in Roadside assessment. The system is a battery-powered handheld device that comprises a NDIR alcohol sensor and an HMI. The hand unit provides visual and audible guidance for ease of use and to ensure the quality of the breath test. The alcohol breath analysis is performed without physical contact with the hand unit, i.e., the common mouthpiece used in breath analysers is not required.

2. Actors

Driver/ Rider: Detection of alcohol consumption in pre- and during driving shift phase.

Enforcer: Detection of alcohol consumption by the enforcer (e.g., traffic police officer) at road assessment.

Operator: Informed about alcohol consumption in case of intoxication.

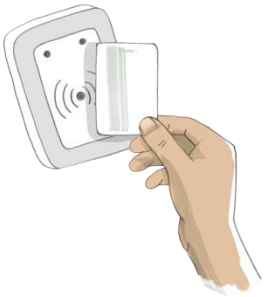
3. Priority

Alcohol

4. Pre-conditions

For reliable results, wait at least 20 minutes after ingestion of alcohol - or smoking - before performing an exhaled test. The time frame for the absorption and elimination of alcohol in the body varies greatly, which means that the blood alcohol level may continue to increase for 60-120 minutes after the last consumption of alcohol.

When eating candy containing alcohol, using mouth wash containing alcohol or drinking low alcohol beverages there will be an instant increase of alcohol levels in the mouth. The risk for a false positive result due to the mouth alcohol effect increases. Therefore, the users need to rinse their mouth with water or wait 20 minutes to clear the mouth of alcohol residue.

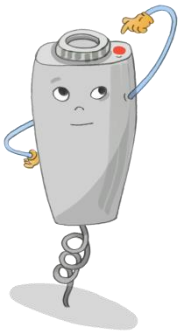
5. Flow of Events		
Flow Identifier: UCsc02.1: Senseair Wall - Test with an approved result		
Step	**User Action**	**System Response (optional)**
1	 Start: The driver identifies them themselves by placing the RFID card at the bottom of the Wall unit.	System initiation: The device prepares the system for measurements; the user must wait until indicated.
2	Exhale:  When the unit instructs you to breath. Exhale towards the inlet of the unit.	Result: The approved result is presented discretely on the screen.
Flow Identifier: UCsc02.2: Senseair Go - Start of vehicle, exhalation test with approved result		
Step	**User Action**	**System Response (optional)**
1	Start:  The vehicle is locked (the driver who has finished their work shift has locked the vehicle by scanning their ID card). 	Please wait: Wait a few seconds for the sensor to start up and the two green arrows to light up.

	Identify yourself on the vehicle by holding up your card against the RFID reader.	
2	Exhale:  Exhale when the two green arrows are lit.	Result:  Green lamp shine when the result is approved.
4		The vehicle is unlocked: The vehicle is unlocked when you exhale approved result. Period of validity: Approved exhalation test lasts for 3 hours (configurable).
5	Lock the vehicle: Scan your ID card again if you want to lock the vehicle.	Vehicle is locked.
Flow Identifier:	**UCsc02.3: Senseair Go-Portable (Prototype): Breath analysis administered by an enforcer**	
Step	**User Action**	**System Response (optional)**
1	Start: The Enforcer start the measurement by pressing a button on the handheld device and instructs the user to exhale into the device inlet.	Please wait: The system prepares for the measurement and the enforcer facilitates access to the user by approaching the devices or by handing over the device to the user.
2	Exhale: The system indicates a ready-to-exhale status and the user exhales into the inlet of the device	Result: After the analysis, the result will be shown on the device's display.
3	Annotation: The enforcer reports the result into PP	PP saves reported result.

6. Exception Flows		
Flow Identifier:	**UCsc02.4: Senseair Wall - Not enough test air to measure the alcohol concentration in the exhaled air**	
Step	**User Action**	**System Response (optional)**
1 - 3	Step 1-3 is the same as for test with an approved result.	
4		Not enough air: If the unit is unable to present a result, user is instructed to try again. No message will be sent to O (Configurable).
5	Exhale again:	Result:

	You might need to be closer to the inlet when exhaling. A suggestion is to exhale as you would create steam on a mirror.	The result is presented discretely on the screen.
Flow Identifier: UCsc02.5: Senseair Go: Insufficient sample amount (exhaled air) to be able to show a result from the exhalation test		
Step	**User Action**	**System Response (optional)**
1 - 3	Step 1-3 is the same as for test with an approved result.	
4		Insufficient exhalation: The orange lamp flashes in a couple of seconds and then the two green arrows are lit again: The unit cannot show a result. This will NOT give a signal to the traffic management! They need to repeat exhalation test.
5	Exhale again: D/R might need to be closer to the inlet when exhaling.	Result: Green lamp shine when the result is approved.
6		The vehicle is unlocked: The vehicle is unlocked when D/R exhale approved result.

7. Exception Flows		
Flow Identifier: UCsc02.6: Senseair Wall - Alcohol detected in test No. 1 and approved test result in test No. 2		
Step	**User Action**	**System Response (optional)**
1 - 3	Step 1-3 is the same as for test with an approved result	
4	D/R exhales on screen.	Result if alcohol is detected: • If the unit detects alcohol in their breath, the use will be notified discretely on the screen. • At the same time a message of the incident will be sent to the O (configurable).
5	Rinse mouth: Alcohol in the breath can for example come from the use of mouthwash.	The D/R is notified: Please rinse mouth thoroughly with water.
6		The D/R is notified: Please wait for 5 minutes: Please wait for 5 minutes (configurable) to be sure that all mouth alcohol has vanished.
7	Repeat step 1-4 as in Test with an approved result.	
8	**Exceptions Flow**	
Flow Identifier: UCsc02.7	**Senseair Wall: Alcohol detected in test No. 1 and in test No. 2**	
Step	**User Action**	**System Response (optional)**
1-6	Step 1-6 is the same as for Alcohol detected in test No. 1 and approved test result in test No. 2	

7	Repeat step 1-3 as in Test with an approved result.	
8	D/R breathes into device.	Result: • Alcohol is detected a second time. • If the unit detects alcohol in breath, it will be presented discretely on the screen. • At the same time a message of the incident will be sent to the O.
Flow Identifier: **UCsc02.8**	Senseair Go: Alcohol detected in exhalation test.	
Step	**User Action**	**System Response (optional)**
1 - 3	Step 1-3 is the same as for test with an approved result	
4	D/R breathes into the device.	If alcohol is detected:  • Red lamp lights: the unit detects alcohol in the exhalation. • An e-mail will be sent to the traffic management (O) that this has happened (configurable).
5		PP informs D/R to rinse their mouth: 'Alcohol in your breath can for example come from the use of mouthwash. Please rinse your mouth thoroughly with water.'
6	.	PP informs D/R to wait for 5 minutes: 'Please wait for 5 minutes (configurable) to be sure that all mouth alcohol has vanished.'
7	Repeat steps 1-3.	

8. Post-Condition
This use case can end with the following post-conditions: 1. D/R is found to be intoxicated. 2. D/R is not intoxicated

9. Business Rules
Any rules will be implemented through UCsc22.

10. Special Requirements
1. Use of the device. 2. Alcohol intake.

11. Artifacts
1. Readme files will be provided by SENSAIR to UNI and CHALMERS if needed.

12. Notes and Issues
1. Consideration of three different versions of this technology should be made for different shift phases.

4.3.3 UCsc03: (Il)Licit drugs biosensor (Primary)- LEITAT

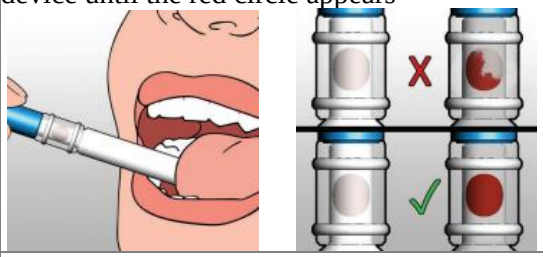
Related to UCs A and B. Relevant to UC scenarios 13, 15, 18, 20, 23. Part of CHTA and CHTB.

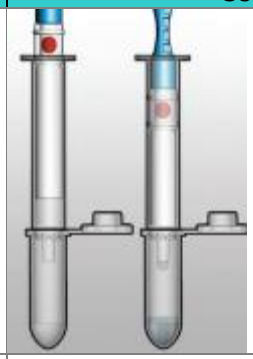
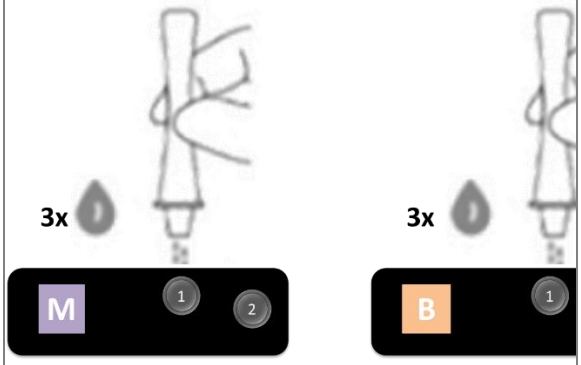
1. Description
LEITAT's drug biosensor is used on-site for pre-driving and roadside assessment of drugs. At least two different types of drugs will be detected on the driver's saliva sample: benzodiazepines and methadone. The device will be an optical sensor able to detect the concentration of drugs in saliva. The biosensor consists of a microfluidic chip specific for each drug and a spectrofluorometer integrated in the device for the fluorescence measurement of the samples.

2. Actors
Driver/ Rider: will be able to perform the saliva test themselves. This ensures the saliva samples are not manipulated.
Operator: will be there in case some help is needed (there is a possibility that the role of the Operator will be played by researcher/ experimenter). **Enforcer:** Police officer that stops the driver/ rider when a drug test will be performed.

3. Priority
Drugs: benzodiazepines (licit drug) and methadone (replacement of illicit drug).

4. Pre-conditions
• The first time that a drug can be detected in saliva samples and for how long it can be detected varies between drugs and within the person. • At least a few hours need to be passed for the presence of drugs in saliva, and they can be detected even some days after the consumption. • For the drug assessment a protocol will have to be followed by the driver and the results will be ready in less than 15 minutes. • A colour code will be used for identification of the chips and vials of each drug.

5. Flow of Events		
Flow Identifier: UCsc03.1: (Il) Licit drug measurement		
Step	**User Action**	**System Response (optional)**
1	D/R (or any other actor administering the test) turns the device on and identifies themselves by writing their ID into the screen.	The device will indicate "Charging" and will be auto calibrated.
2	Meanwhile the driver will fill the saliva collector device until the red circle appears 	
3	D/R will fill the drug vials with saliva to the mark (as many vials as drugs).	

5. Flow of Events		
Flow Identifier:	**UCsc03.1: (Il) Licit drug measurement**	
Step	**User Action**	**System Response (optional)**
		
4	D/R will put the lid and turn it up and down to mix 	
5	D/R will press the vial and introduce 3 drops on hall 1 of the corresponding chip (based on the colour code). 	
6	Wait 10 minutes for the sample incubation on the drug chips. 	
7	After 10 minutes D/R will add the buffer into hall 2. 	
8	Introduces the selected chip on the device.	

5. Flow of Events		
Flow Identifier: UCsc03.1: (Il) Licit drug measurement		
Step	**User Action**	**System Response (optional)**
9	On the screen, D/R select the drug that will be measured (based on colour code).	The device will give the option to measure different drugs.
10	D/R presses measure and waits for the result.	The device will say 'POSITIVE' and the concentration of drug or 'NEGATIVE' and zero concentration.
11	D/R repeats the same last 8-10 steps with as many chips as drugs they want to be detected.	

6. Exceptions		
Flow Identifier: UCsc03.2: Error related with the saliva sampling		
Step	**User Action**	**System Response (optional)**
1-3	Is the same as in UCsc03.	
4	D/R made an error during the saliva collection.	Chips are not covered on the screen.
5	If the amount of saliva is not enough for the chips more saliva will be taken from D/R.	
6-10	Then the same steps will be followed.	
Flow Identifier: UCsc03.3: Error related with the drug chip.		
Step	**User Action**	**System Response (optional)**
1-4	Is the same as in UCsc03.	
5	The error happens with the drug microfluidic chips, then another chip will have to be taken	
6-10	Same will be repeated.	

7. Exception Flows		
Flow Identifier: UCsc03.4: Error related with the device		
Step	**User Action**	**System Response (optional)**
1-8	Is the same as in UCsc03.	
9		The device gives and error when measuring the optical signal of the measurement.
10		The device will be reinitiated.
11		Calibration will be done again.
11	The same chip will be measured if the error is fixed.	Error is fixed.
12	D/R contacts LEITAT.	Error is not fixed.

8. Post-Condition
This UC scenario can end with the following post-conditions: 1. POSITIVE: Amount of drug detected≠0 2. NEGATIVE: Amount of drug detected=0

9. Business Rules
N/A. If any arise, they will be treated according to UCsc22.

10. Special Requirements
1. Procedure protocol should be followed.

11. Artifacts

1. Drug chips (as many as drugs with colour codes) (2 per D/R) 2. Saliva collector (1 per D) 3. Vials (as many as drugs with colour codes) (2 per D/R) 4. Buffer ampoule (1 per D/R)

12. Notes and Issues
1. This is a research device and for on-road assessment will complement the official drug test.

4.3.4 UCsc04: - Smart Pulse Wave Analysis (PWA) device – AIT

Related to UCs A and B for fatigue and stress. Relevant to UC scenarios 13-16, 18, 23. Part of all CHTs.

1. Description
D will use the smartPWA biosignal measurement device, which must be held with both hands like a gamepad, and a tablet computer with a dedicated App to record biosignals, in order to determine stress, alertness, or fatigue. 

2. Actors
Driver: Will use the smartPWA measurement Device and the App on the tablet.

3. Priority
Stress and Fatigue

4. Pre-conditions
• User must have a registered user-ID. • Baseline measurement that has to be stored in the PANACEA system. • Requires 5 minutes of uninterrupted time for the measurement. • Measurement device and tablet must be ready for use, i.e., batteries in device and tablet must be charged sufficiently. • Tablet must be started up. • Tablet must have connection to internet.

5. Flow of Events		
Flow Identifier: UCsc04.1: Standard smartPWA measurement		
Step	**User Action**	**System Response (optional)**
1	D opens App on tablet.	

2	D enters username and password for PP.	Verifies user credentials,
3	D switches on smartPWA device.	
4	D selects detected smartPWA device in App.	
5	D selects 'Measurement' in the App.	
6	D holds smartPWA device with both hands.	
7	D waits for measurement to finish.	
8	• D receives confirmation that measurement finished successfully. • They put the smartPWA device aside and switch it off, if applicable.	• App sends measurement data to PP • PP relates measurement data to baseline measurement and calculates stress and/or fatigue score.
9	• D receives confirmation that the measurement data were sent successfully. • They close the App and switch off the tablet.	

6. Alternative Flows		
Flow Identifier: UCsc04.2: Baseline smartPWA measurement		
Step	**User Action**	**System Response (optional)**
1	D opens App on tablet.	
2	D enters username and password for PP and checks the checkbox for baseline measurement.	Verifies user credentials.
3	D switches on smartPWA device.	
4	D selects detected smartPWA device in App.	
5	D selects 'Measurement' in the App.	
6	D holds smartPWA device with both hands.	
7	D waits for measurement to finish.	
8	• D receives confirmation that measurement finished successfully. • They put the smartPWA device aside and switch it off, if applicable.	App sends measurement data to PP and stores it as baseline measurement.
9	• D receives confirmation that the measurement data were successfully sent. • They close the App and switch off the tablet.	

7. Exception Flows		
Flow Identifier: UCsc04.3: Error in measurement: Signal quality insufficient		
Step	**User Action**	**System Response (optional)**
1-6	As in UCsc04.1.	
7	• D waits for measurement to finish.	

	• App detects insufficient signal quality and reports it to the D.	
8	D tries to adapt handling of the smart PWA device to produce better signal quality.	• If successful, system reports good signal quality. • Otherwise, see next exception flow.
9	D waits for measurement to finish.	
10	• D receives confirmation that measurement finished successfully. • They put the smartPWA device aside and switch it off, if applicable.	• App sends measurement data to PP. • PP relates measurement data to baseline measurement and calculates stress and/or fatigue score.
11	• D receives confirmation that the measurement data were sent successfully. • They close the App and switch off the tablet.	

7. Exception Flows		
Flow Identifier: UCsc04.4: Error in measurement: Signal not evaluable		
Step	**User Action**	**System Response (optional)**
1-7	As in UCsc04.1.	
8	D receives information that measurement was not evaluable.	App reports error to PP.
9	Driver has the option to retry measurement from step 5.	

7. Exception Flows		
Flow Identifier: UCsc04.5: Error in data transmission between App and PP		
Step	**User Action**	**System Response (optional)**
1-7	As in UCsc04.1.	
8	• D receives confirmation that measurement finished successfully. • They put the smartPWA device aside and switch it off, if applicable.	
9	D receives error message that the measurement data could not be sent to the PP.	
10	D reports technical problem to responsible staff.	App tries to send measurement data to PP, but it fails.

8. Post-Condition

This UC scenario can end with the following post-conditions:

1. Biosignal data uploaded to PP OR
2. User is stressed OR not stressed (decision made on PP) OR
2. Error report uploaded to PP OR
3. D reports error to staff

9. Business Rules

N/A. If any arise, they will be treated according to UCsc22.

10. Special Requirements

1. Measurement is taken when the vehicle is at stop.

11. Artifacts
1. Measurement data stored on the tablet and sent to the PP.

12. Notes and Issues
1. Stress management techniques exist that could be utilised by the cloud-based countermeasure system.

4.3.5 UCsc05: Steering wheel angle algorithm (SWA) and vehicle parameters (Primary)- ViF

Related to UCB for fatigue and cognitive load. Relevant UC scenarios are 12b,14, 18, 23. Part of CHTB.

1. Description
The ViF steering wheel algorithm utilizes steering as well as driver gaze behaviour to detect an abnormal driver state such as cognitive distraction, cognitive or other driver impairments. The algorithm measures the variability of specific driver behavioural markers and compares them with baseline data for the same driver. If abnormal behaviour is detected, it triggers an intervention to perform a physiological assessment to determine the cause for the observed abnormality.

2. Actors
Driver: there is no direct interaction between the driver and the technology, as this is not a technology but an algorithm and a selection of variables. Therefore, the data will be collected by the driver.
Operator: will receive the result about the impairment state if this is of certain risk for their safety and others.

3. Priority
Measure unusual driver behaviour (steering, gaze, ideally also fatigue, swerving, headway to traffic ahead) and trigger physiological measurements. A detailed context assessment could be beneficial.

4. Pre-conditions
• Access to CAN bus and receiving steering wheel information • Driver ID • Baseline driving data either in previous drive, (this is preferred) or during the current drive (if for the first time). During the baseline assessment it should be ensured that the driver is in a normal condition. The baseline drive should be as long as possible (exact duration is TBD), also baseline is measured continuously.

5. Flow of Events

Flow Identifier:	UCsc05.1: Baseline data available and driver shows normal driving behaviour	
Step	**User Action**	**System Response (optional)**
1	D gets into the car and identifies themselves by logging into the PP.	PP confirms successful identification.
2		• PP checks if baseline drive data is available: check is successful (baseline data available) • PP indicates to D that status is ok and they can start to drive.

3	The D is driving, attentive and under no influence.	The steering wheel algorithm calculates deviations from normal driving behaviour (baseline data): The deviations are within normal range and no countermeasures are needed.
4	The D reaches the depot after completing the drive.	Data is not uploaded to the cloud to protect privacy of the D.

6. Alternative Flows		
Flow Identifier:	**UCsc05.2: Baseline data available and driver shows abnormal driving behaviour with cause known**	
Step	**User Action**	**System Response (optional)**
1 - 2	As described in UC05.1	
3	Driver is driving but is fatigued.	• The steering wheel algorithm calculates deviations from normal driving behaviour (baseline data): The deviations exceed normal range. • PP checks other parameters (fatigue) to determine the cause. • Countermeasures are set according to the cause (e.g., if cause is fatigue) PP alerts D. • Information is sent to the O if D is often fatigued.
Flow Identifier:	**UCsc05.3: Baseline data available and driver shows abnormal driving behaviour with cause unclear**	
Step	**User Action**	**System Response (optional)**
1 - 2	As described in UC05.1.	
3	D is driving, but is impaired (e.g., under influence).	• The steering wheel algorithm calculates deviations from normal driving behaviour (baseline data): The deviations exceed normal range. • PP checks other parameters (fatigue) to determine the cause. • Cause is unclear: PP suggests a stop as soon as possible.
4	D stops.	PP suggests to use smartPWA device / alcohol test to determine driver state.
5	D conducts the suggested test.	Test result is uploaded in the cloud and countermeasures are set according to the test outcome (see relevant UC scenarios).
Flow Identifier:	**UCsc05.4: Baseline data not available**	
Step	**User Action**	**System Response (optional)**
1	D gets into the car and identifies themselves by logging into PP.	PP confirms successful identification.
2		PP checks if baseline drive data is available: check is not successful (baseline data not available).

3	D completes pre-questionnaire (DATIK). D completes the does alcohol test.	Data is sent to the cloud – everything is fine – the driver is in normal state; PP indicates that baseline data is missing and suggests recording the driving data of the following drive.
4	Driver accepts and is driving.	The steering wheel algorithm calculates the variability of behavioural markers, and a baseline profile is generated.
5	D reaches the depot after completing the drive.	PP indicates that driving data was successfully recorded. The baseline profile is uploaded in the cloud and stored with the driver's ID.

8. Post-Condition

This use case scenarios can end with the following post-conditions:
1. D can drive with no countermeasures needed.
2. D can continue driving after a break.
3. D needs to perform a test to determine whether they can continue driving.

9. Business Rules

No relevant are defined until now.
A policy needs to be developed when the O is going to be informed.

10. Special Requirements

1. CANbus measurements are required.

11. Artifacts

1. Any files related to the related h/w instrumentation, instalment and use will be provided by ViF.

12. Notes and Issues

1. We wanted to ensure maximum privacy of the D and minimize the upload of non-critical information to the O. O shall only be informed in clear safety-relevant cases.

4.3.6 UCsc06: DBL index (Secondary) - DBL

Related to UCA for fatigue and cognitive load. Relevant to UC12a, UC18, UC23. Part of CHTA.

1. Description

3.3. On-site assessment (part of pre-driving assessment)

4.1 Pre-driving solutions implementation and integration

This use case is considered to be run in a simulator.

The D will firstly undergo the individual calibration of the Neurometric Box, by wearing the Neurometric headset and performing a standard task (baseline) for approximately 15 minutes.

Once the calibration is done, D will drive the VTI simulator and, hence, will be exposed to a number of scenarios with different levels of complexity. The neurometric box will record in real time the neurophysiological data detecting the variation of the level of workload and

stress. At the end of the (simulated) shift, the D can analyse their reactions to the events and the environmental stimuli experienced during the driving and give feedback and opinions.

2. Actors
Professional urban/ inter-urban bus driver/ Shuttle safety operator: operate the vehicle (main actor, runs the simulation).
Operator: Transdev manages the service provision, they want safe and healthy drivers. The main actor of interest is the manager who is responsible for shift planning, vehicle state and ensuring the service runs. This primary actor has first contact with any drivers identified as not fit to drive. A secondary actor receives the cognitive state data analysis.
Health and safety manager: monitor health and safety. Informed of cases if drivers have repeated problems (multiple occurrences, or serious e.g., illegal drug). A secondary actor receives the cognitive state data analysis.
Tier 1 Suppliers / Technology providers: DBL as providers of the technology. Others may be included in a different installation.

3. Priority
Workload Stress Shift work

4. Pre-conditions
Calibration of the neurometric box (see above).

5. Flow of Events		
Flow Identifier:	**UCsc06.1: Driving the bus/shuttle**	
Step	**User Action**	**System Response (optional)**
1	D starts to drive/operate.	PP continuously monitors D.
2	D remains alert and attentive the entire drive.	PP detects that the driver is under/overloaded.
3	D reaches the depot after completing D.	PP records the neurophysiological data, and they are uploaded to PP.

5. Flow of events		
Flow Identifier: UCsc06.2: Driving the bus/shuttle with stressful events occurring and impacting the cognitive load of the driver.		
Step	**User Action**	**System Response (optional)**
1	D starts to drive/operate.	PP continuously monitors the D.
2	After a while, a series of stressful events (e.g., a car suddenly turning without light indicators, a cyclist that overcomes the bus just before one bus stop, a pedestrian that suddenly engages the zebra crossing, bad weather conditions, the narrowing a road due to road works, day/night shift, a malfunctioning of the traffic lights, etc.) are presented that can cause distraction, require focalised attention or increment the mental workload required by the task.	PP records the neurophysiological data and uploads them into the cloud.
3	The D reaches the depot after completing the drive.	PP uploads the driving data into the cloud.
4	Post simulation debriefing	

No alternative paths are available, so section 7 is not included.

8. Post-Condition

This use case scenario can end with the following post-conditions:

1. Cognitive under/ overload is detected and measured.
2. Stress is detected and measured
3. Baseline measurements are created.
4. Data are stored on PP.

9. Business Rules

No business rules are set now.

10. Special Requirements

1. It can be used only in simulator environment.

11. Artifacts
1. Instructions and training will be provided to UCA team. 2. DBL team will support the A6.2 pilots.

12. Notes and Issues
1. No foreseen issues.

4.3.7 UCsc07: BACtrack Skyn (Secondary) – VTI and CERTH

Relevant to UCA and UCB for alcohol consumption measured by sweat. Related to UC scenarios 09, 13-16, 18, 23, 26. Part of CHTA and CHTB.

1. Description
BACtrack Skyn is a wrist-worn device that measures transdermal alcohol content (TAC) continuously. Since it measures alcohol eliminated through the skin, there is a delay of about 30 minutes between alcohol intake and measurement. The Skyn device should be used by the D/R around the clock, 24h per day.    The device is synchronized with an IOs application and from there to the BACtrack Skyn cloud. Data will be transferred to PANACEA platform through the BACTrack Skyn cloud. The Skyn device is acting as a slave/data provider to the biomathematical model (UCsc09 in UCA), and as a source of continuous TAC measurements for the D/R. If the alcohol level in the morning is above zero the D/R is notified, and if above legal limits, the O is notified, too.

2. Actors
Driver/ Rider: Wears the device and makes sure it is charged.
Operator: Takes proactive action if the alcohol level is too high in the morning

3. Priority
Alcohol

4. Pre-conditions
The device is worn throughout the day (but not necessarily during night-time). Notifications should take the 30-minute delay from alcohol intake to reading into account.

5. Flow of Events		
Flow Identifier: UCsc07.1: Alcohol level is 0 in the morning		
Step	**User Action**	**System Response (optional)**
1	No action is needed	PP stores the results into D/R profile.

6. Alternative Flows		
Flow Identifier: UCsc07.2: Alcohol level is above 0 in the morning		
Step	**User Action**	**System Response (optional)**
1	D is wearing the wristband when they wake up.	PP notifies that the alcohol levels are above 0.
2	No other steps need to be taken.	
Flow Identifier: UCsc07.3:Alcohol level is above the legal limit in the morning		
Step	**User Action**	**System Response (optional)**
1	D/R is awake and wears the wristband.	PP notifies D/R about the measurement that is above legal limit.
	Steps 1-10 in UC13.1 scenario.	
2	D/ R may require performing the test with SENSAIR technology (UCsc02) if they do not believe that the result is accurate.	

8. Post-Condition
This Use Case scenario can end with the following post-conditions: 1. D/ R is fit to drive; 2. D/ R may not be fit to drive; 3. D/ R is unfit and must be replaced.

9. Business Rules
Not any so far.

10. Special Requirements
1. It must be worn for at least 30 minutes to get a reading. 2. TAC needs to be transformed to BAC and/ or BrAC. 3. This is a supplementary technology to SENSAIR devices.

11. Artifacts
1. Expected supporting files and documentation.

12. Notes and Issues
1. It has its own GUI interface and IOs application.

4.3.8 UCsc08: Fitbit wrist band (Secondary) – VTI

Related to UCA for sleep quality monitoring (through HRV). Relevant to UC scenarios 09. Part of CHTA.

1. Description

The Fitbit Charge 5 device should be used by the drivers around the clock, 24h per day. It is a health, fitness and sleep tracker that can monitor daily activities and sleep quality.

Fitbit estimates sleep stages using a combination of movement and heart-rate patterns. The device tracks the beat-to-beat changes in your heart rate, known as heart rate variability (HRV), which fluctuate as you transition between awake, light sleep, deep sleep, and REM sleep stages. When the device is synced in the morning, it uses the movement and heart rate patterns to estimate the sleep duration classified according to

these four types of sleep activity. Fitbit also estimates the activity level throughout the day and classifies activities as sedentary, light, moderate, or vigorous.

Sleep and activity data are synchronized from the device to a mobile phone and uploaded to the Fitbit cloud. Data are available via the Fitbit Web API. The Fitbit device is acting as a slave/data provider to the biomathematical model.

2. Actors

Driver: Wears the device throughout the day.

3. Priority

Sleep

4. Pre-conditions

The device must be charged about once a week. Recharging should be done when the participant is awake since sleep recordings are prioritized.

5. Flow of Events

Flow Identifier: UCsc08.1: Fitbit device provide sleep and activity data to the PP s (and subsequently the biomathematical model)

Step	User Action	System Response (optional)
1	The experiment leader sets up the device by entering gender, weight and height. This is done once.	Driver data are stored on PP.
2	D wears the device.	Data automatically synchronize with the Fitbit cloud from where it is read by the PP upon request.
3	If the battery is low, D charges the device.	

8. Post-Condition

This use case scenario can end with the following post-conditions:

1. HRV measurement appears on
2. HRV measurement is stored on the D's profile.

9. Business Rules

Not so far.

10. Special Requirements

1. Data will be extracted by FitBit cloud.
2. The technology requires manual setting up.

11. Artifacts

1. HRV reliability.

12. Notes and Issues

1. Not so far.

4.3.9 UCsc09: Biomathematical model (BMM; Primary)– VTI

Related to UCA for fatigue. Relevant to UC scenarios 07, 08, 14-18, 26. Part of CHTA.

1. Description

The biomathematical model estimate the current and future fatigue level of the driver. The model runs in the PP pulsing data from the Fitbit device (sleep), the BACtrack Skyn device (alcohol), and shift schedules. The implemented model is based on the sleep/wake predictor Åkerstedt, et al., 2008.) complemented with a time on task and task demand component (Peng

et al, 2018.). In the project, a component accounting for alcohol will also be added to the model. The main inputs are sleep/wake homeostasis and the circadian rhythm.
The biomathematical model will be used for two tasks. First, in the evening it will continuously predict next-day performance and send alerts to the participant when it is time to go to bed or to stop drinking. Second, in the morning it will predict performance in the upcoming shift and recommend extra breaks/naps or even driver replacement when needed.

2. Actors

Driver: The driver/shuttle operator receives alerts in the evening or in the morning if the predicted fitness level in the upcoming shift reaches dangerous levels. Since notifications are sent during off-shift hours, it may not be possible to require that the driver complies.

Operator: The operator is notified if the driver/shuttle operator is predicted to reach dangerous fatigue levels in the upcoming shift. Ideally this information is used to relax the schedule, facilitating a mid-shift nap, or similar.

3. Priority

Fatigue
Alcohol

4. Pre-conditions

Data from the Fitbit device, the BACtrack Skyn device and the shift schedule must be available in the PP. The PANACEA mobile app will show notifications to the driver is needed.

5. Flow of Events

Flow Identifier: UCsc09.1: Driver is predicted to be fit throughout the upcoming shift.

Step	User Action	System Response (optional)
1	D is wearing the FitBit wristband.	No fatigue or alcohol levels are detected and the information is transmitted from FitBit cloud to PP.
2	No action is needed.	PP send information to D and O that everything is ok.

6. Alternative Flows

Flow Identifier: UCsc09.2: D is predicted to reach dangerous fatigue levels at some point during the upcoming shift.

Step	User Action	System Response (optional)
1	D is wearing the FitBit wristband.	Fatigue levels are detected, and the information is transmitted from FitBit cloud to PP.
2	• O tries to add extra breaks to the shift, giving the driver the chance to recuperate. • UCsc13.1 describes in even more details the role of the impairment level measurements, the connection to the countermeasures and the role of other PANACEA actors.	• PP sends push notification to the D that they should act (if this is constructive, e.g., go to bed, or stop drinking). • Notifications are also sent to the O so that they can take preparatory actions.

Flow Identifier: UCsc09.3: Driver is predicted to reach dangerous fatigue levels throughout the upcoming shift

Step	User Action	System Response (optional)
1	Steps 1-2 are repeated but with different action by the O.	
2	O replaces the D with a backup D.	

8. Post-Condition
This use case scenario can end with the following post-conditions: 1. The driver is unfit and will not be able to drive. 2. The driver will be unfit and require extra breaks to drive safely throughout the shift. 3. The driver is and will be fit.

9. Business Rules
Those applicable to FitBit (commercial ones).

10. Special Requirements
1. It has no separate device; it needs the wristband.

11. Artifacts
1. Any artifacts related to the algorithms of the impairing states (fatigue, alcohol, sleepiness) that are related to BMM will be taken up in WP2 and mostly WP3.

12. Notes and Issues
1. No issues are anticipated.

4.3.10 UCsc10: ERGOS system (Secondary) – CERTH

Related to UCB for fatigue and stress. Relevant Use Case scenarios are 12, 14. Part of CHTB.

1. Description
The ERGOS system is a secondary system in PANACEA. It will be used in pre-testing and on-site assessment and during (on-duty) driving assessment. But the latter will happen only in simulated environment. ERGOS is a wearable fatigue detector system. The aim is to capture the relevant signals for fatigue, vigilance, and stress monitoring. This will be a streamlined montage consisting of: • sensors positioned horizontally across the forehead, to record frontal cortical signals relating to fatigue; • sensors positioned vertically above one eye, to record vertical eye-movements related to vigilance; • sensors over forehead to measure stress-related heart activity.

2. Actors
Taxi drivers and the delivery riders: measurement of fatigue and stress will happen only in laboratory conditions with both types of actors using the driving and riding simulators respectively at CERTH premises.
Researcher who will act as an operator: will receive the decision (through PP) about the condition of the driver and/ or rider in relation to fatigue and stress.

3. Priority
1. Fatigue 2. Stress

4. Pre-conditions
The system needs to be calibrated and cleaned before each use. User ID is necessary to be known in order to be correlated with other data in PP.

5. Flow of Events		
Flow Identifier: UCsc10.05.1: Calibration on pre-assessment and during driving assessment.		
Step	**User Action**	**System Response (optional)**

1	The researcher switches on the system and is on the company's premises.	System shows it is on and system shows it is connected to the PANACEA platform.
2	Researcher opens the ERGOS tab on PANACEA web application.	The ERGOS page is shown.
3	Researcher adds the driver's ID and other information about the driver, such as age, gender, age, weight, etc.	
4	Researcher saves the information on PANACEA platform.	PP sends notification that the data were successfully saved/ stored.
5	Researcher starts taking measurements from the 4 different data sources in a position agreed to reflect the pre-driving condition of the driver OR during driving the car/ motorcycle simulator.	Three consecutive sets of measurements are taken and when the calibration is finished, PP notifies the researcher that is complete and suggests when the next calibration should take place.
6	Researcher starts the measurements.	

5. Flow of Events		
Flow Identifier: UCsc10.5.2	**Measurement on pre-assessment and during driving assessment**	
Step	**User Action**	**System Response (optional)**
1	The researcher switches on the system.	System shows it is on and system shows it is connected to the PANACEA platform.
2	Researcher opens the ERGOS tab on PANACEA web application.	The ERGOS page is shown.
3	Researcher starts the measurements.	System shows with green line that each measurement is correctly being made.
3	Researcher saves the information on PANACEA platform.	PP sends notification that the data were successfully saved/ stored.
4	Research receives the notification about the driver's status.	System notifies the researcher that the driver is fatigued (please see UC X and X for notifications and countermeasures related to fatigue).
5.	Researcher saves the information on PANACEA platform.	PP sends notification that the data were successfully saved/ stored.

6. Alternative Flows	
Flow Identifier:	No alternative flows are feasible or relevant.

7. Exception Flows		
Flow Identifier: UCsc10.7.1: Calibration is forgotten		
Step	**User Action**	**System Response (optional)**
1	Researcher sets up the user and switches on system.	System shows that it is on. System shows it is connected with PP

2	Researcher starts the measurement.	System sends a message that the calibration needs to be completed first before measurement starts.
3	Researcher starts the calibration.	System starts calibration. System informs researcher the calibration has finished and now the system is ready to be used.
4	Researcher now enters the measurements.	Measurements are transferred to PP.
Flow Identifier: UCsc10.7.1: Error in measurement or calibration[2]		
1	Researcher sets up the user and switches on system.	System shows that it is on. System shows it is connected with PP.
2	Researcher starts the measurement OR calibration	System sends a message that the measurement is wrong and to retake the measurement
3	Researcher starts the calibration OR measurement again	This time the measurement/ calibration concludes successfully, and data are stored.
4	The researcher receives confirmation the measurement or calibration was successfully completed.	

8. Post-Condition

This use case scenario can end with the following post-conditions:
1. The result is shown on the PANACEA interface
2. All relevant parties have received the result

9. Business Rules

No relevant business rules. This is a research and experimental system. Data anonymisation is necessary.

10. Special Requirements

1. Calibration and cleaning are necessary.
2. Testing can happen only in controlled environment and a simulator
3. Testing session cannot be too long because band with the electrodes can become a burden.
4. Testing is better to happen in room temperatures. Bluetooth and internet connection.

11. Artifacts

1. There will be no need for technical instructions for setting up as it will be used only in CERTH premises.
2. If additional read.me files are needed, they will be prepared.

12. Notes and Issues

1. Nothing other that what was mentioned in 11.
2. Certain electrodes might need to be changed to improve measurements if they will be available during testing period.

[2] Errors in calibration and/ or measurement are addressed in ERGOS UC scenario because It is a secondary technology and error handling might not happen automatically in PP. Errors in general are handled by the administrative UC script in Appendix III (i.e., AII. 10 UCscr26: Errors (as exceptions) handling (closely related to UC20 and this a system and not a business UC scenario- Diagnosis procedures)).

4.3.11 UCsc11: Cloud based Countermeasures' system (Primary) – CTLup

Related to all UCs. Relevant to UCs 12-16, 17, 19, 20, 26. Related to all CHTs.

1. Description

The cloud-based countermeasure system (CCS) provides to the PP HMIs relevant input to be delivered to the D/R, the O and the E. The inputs are prepared by WP5 development team countermeasures specialist (CS) and represent suitable countermeasures at the strategic, tactical and operational level to be delivered if specific conditions apply.

The list of functions to be included in the PANACEA project are described in the following together with related actor(s).

In general, CCS

- Online web platform, probably linking to an app;
- Will have a "look up" feature, where a person (D/O and/ or E) can self-navigate through the countermeasures if they wish;
- Countermeasures' deployment will be triggered by the main PP when appropriate criteria are met.

2. Actors

WP5 development team Countermeasure Specialist (CS): can search for selected countermeasure(s)
Driver/Rider (DR): DR is the target of and can search for selected countermeasure(s).
Operator (O): is the target of and can search for selected countermeasure(s)
Enforcer (E): is the target of and can search for selected countermeasure(s)
Tier 1 Suppliers / Technology providers: CTLup as providers of the technology. It is responsible for the maintenance, updating and administration of the CSM.

3. Priority

- All PANACEA relevant impairment types are covered.
- Priority is tactical and strategic countermeasures (advice provided on deployment of operational countermeasures),

4. Pre-conditions

- As a "look up" - access to all PANACEA participants, available 24 hours a day.
- As a countermeasure deployment tool – precondition that impairment has been detected and communicated to the cloud-based countermeasures system.
- PP informs the CCS that a countermeasure trigger has occurred.
- Actors are registered in the PP, have login credentials and are logged in.

5. Flow of Events

Flow Identifier: UCsc11.1: Search for a specific countermeasure (all main actors)

Step	User Action	System Response (optional)
1	DR/O/E/CS navigates to the countermeasure search section in the system.	
2	DR/O/E/CS applies search filters to look for a countermeasure.	Search filters are available on the top of the page. Filters include: shift phase, specific impairment type, vehicle type, user type (DR, O, E) […].
3	DR/O/E/CS select a countermeasure from those available and accesses to the related contents.	Upon selecting an entry from the list of countermeasures the results page will appear including e.g., context of

		application of the measure (impairment type, vehicle type, …), short description of the countermeasure, procedure of application link(s) to other applicable countermeasures […].
4	DR/O/E accepts and applies (or not) the countermeasure.	PP records the acceptance.

5. Flow of Events		
Flow Identifier:	**UCsc11.2: Automatic event-based trigger of countermeasure (all main actors)**	
Step	**User Action**	**System Response (optional)**
1	A user (DR) is found with the minimum level of impairment state or higher.	The PP retrieves the historical data and relevant context info and request for a countermeasure for DR or O or E.
2	DR receives at the same time the recommended countermeasure through the PP HMI and accesses to the related contents. If the countermeasure is conditional on a certain time, the user is informed that an email will be sent at the set time.	The CSM search for a countermeasure for a DR or O or E applying the historical and contextual data provided. A countermeasure is found, and relevant countermeasure information is retrieved. If a conditional countermeasure is found, the PP schedules the delivery in the events list at the given time and send the link to access the contents by email. The CSM records the conditions and the related results (even in case of no countermeasure found).
3	DR accepts and applies the countermeasure.	PP records the acceptance

8. Post-Condition
This use case scenario can end with the following post-conditions: 1. countermeasure is deployed or accessed.

9. Business Rules
Might be created during CCS development within WP5.

10. Special Requirements
1. Provision of countermeasures occur through PP. 2. Countermeasures are presented to primary actors' GUIs.

11. Artifacts
1. Not at the moment. Might be created during the CCS development in WP5.

12. Notes and Issues
1. Users will be trained to use the CCS.

4.4 UC scenarios demonstrating the generic interaction flows per shift phase

We will demonstrate one flow to present the flow of interactions with the PANACEA platform (PP) across the different shifts. There are many commonalities across the Use Cases and in order to avoid repetition of information, we constructed one generic flow. However, the CHTs have common and different technologies as it is shown in

Table **1**. As such, in the second column of each UC scenario table, it is shown for which UCs the specific steps are relevant. In addition, separate UC scripts have been created to highlight other aspects of the interactions and they are mentioned and cross-referenced in the scenarios.

Parts 1-4 from the different UC scenarios are presented first to define the characteristics of each UC. Part 5 and onwards will be common.

In Appendix III, the separate actors-oriented UC scenarios are presented (UCsc17-26). They address secondary to the generic flow interactions with PP along with the interactions among themselves (optional UC scenarios). A shorter version of the UC scenario template is used to accommodate for the nature and requirements of these scenarios. There is no separate UC scenario for the D/ R, as the primary interactions are covered by UC scenarios 12-16. UC baseline and pre-assessment scenarios

4.4.1 UCsc12: Baseline assessments

Baseline assessment does not involve primary user/ actor interactions and ensure that the technologies work well and collect quality data according to the standards set by each technology and the PP. The baseline assessment process heavily depends on the data collection and the development in WP2 and WP3 and, as such, it does really directly involve the actual user. For this reason, at this stage, high level descriptions of the relevant UC scenarios are included. These will be re-visited in WP3 and will be reported in respective Internal Deliverables.

4.4.1.1 UCsc12$_a$: Pre-Driving Assessment (on-site; baseline) (ONBPDA)

A baseline UC scenario will include all baseline measurements required to be collected to create the baseline profile of each user (for those that they are required).

Brief Description
Baseline measurements in pre-driving will be collected for D/R on-site and will act as reference measurements for WP3 estimations, algorithms, fusion processes, and decision making about the state of the D/R. Baseline assessments are not required for: a) SENSEAIR Go device and alcohol consumption as well as the LEITAT measurements of consumption of benzodiazepines and methadone. Baseline assessments are required for a) fatigue (input indicators for the technologies mentioned as shown in Table 8), and b) stress (input indicators for the technologies mentioned as shown in Table 10). Baseline measurements will require at least 3 datasets each per individual. Baseline assessments for, example, for each level of the state (for example, Low: 1, Moderate: 2, High: 3) might emulated/ elicited in simulated environment with the

ecological/ face validity restrictions known to apply with choosing appropriate scenarios to elicit these conditions/ states. Only baseline estimates without any driving / riding task in a simulated environment are considered in the pre-driving assessment (onsite). Off-duty baseline measurements and assessment are available only in stress. The decisions on the will be made in WP3, especially about baseline data collection for A6.3 pilots (i.e., real-life tests). Baseline measurements will be stored in PP and will be available through the D/ R's profile.

4.4.1.2 UCsc12b: Baseline During Driving Assessment (BDDA)

Brief Description
Baseline measurements during driving will be collected for D/R on the driving and riding simulators, respectively and will act as reference measurements for WP3 estimations, algorithms, fusion processes and decision making about the state of the driver/ rider. Baseline assessments are not required for: a) SENSEAIR Go device and alcohol consumption as well as the LEITAT measurements of consumption of benzodiazepines and methadone. Baseline assessments are required for a) fatigue (input indicators for the technologies mentioned as shown in Table 8), b) stress (input indicators for the technologies mentioned as shown in Table 9), and c) cognitive load input indicators for the technologies mentioned as shown in Table 10). Baseline measurements will require at least 3 datasets each per individual. Baseline assessments, for example, for each level of the state (1, 2, 3) could be emulated/ elicited in simulated environment with the ecological/ face validity restrictions known to apply with choosing appropriate scenarios to elicit these conditions/ states. Baseline estimates without any driving / riding task in a simulated environment are considered in the pre-driving assessment (onsite and off-duty). The decisions on the aforementioned will be made in WP3, especially about baseline data collection for A6.3 pilots (i.e., real-life tests). These aspects are not much relevant to D1.1. Both WP2 and WP3 need to progress to be able to reach a decision on the baseline assessment procedures. Baseline measurements will be stored on PP and will be also available through the D/ R's profile.

4.4.2 UCsc13: Pre-Driving Assessment (incl. on-site) (ONPDA)

Pre-driving assessment is the assessment performed just before or at the beginning of the D/R's shift. Pre-assessment can be conducted remotely (i.e., BACtrack skyn shortly before the D/R arrives at the company premises), at the premises (i.e., on-site) or in the vehicle before the vehicle starts moving (i.e., the completion of the DATIK fatigue pre-questionnaire).

Brief Description
The D/R arrives at the depot centre to start their shift. This is their first shift of the day, and it will last for eight hours. They work for a company and as soon as they arrive at the premises of the company, they are asked to participate in the pre-driving assessment tests available at the company's premises.

Actors: Driver (D), Rider (R), operator (O).
Driver/ rider: they are assessed if they are fit to drive the company's vehicles before their shift starts.
Operator: The operator monitors and supports the Ds/Rs as well as provide information about their trips. They will receive the status report about the driver's fitness to drive.

3. Priority
To ensure D/R is fit to drive before the shift starts.

4. Pre-conditions
D/ R to be at the premise. The D/ R is at the beginning of the shift and is registered and authenticated to the PANACEA platform (PP) and mobile app (registration, authentication and login are handled by the administrative UC scenarios, i.e., UCsc23). The D/R has login credentials for the PANACEA platform as a D/ R. An operator is responsible for this D/R and has access to their profile. Pre-assessment technologies are integrated and exist in the PANACEA platform. Technologies are available and technologies work properly. Internet connection is required. For some Bluetooth connection is also necessary.

5. Flow of Events			
Flow Identifier:		**UCsc13.1: Pre-driving assessment to ensure D/R is fit before they drive.**	
Step	**UC**	**User Action**	**System Response (optional)**
1	A, B	The D/R enters the company's premises and logins on the PP.	Nil
2	A, B	The driver logs in / enters their credentials to the PP. Use Case script 23 is about the registration, login and authentication of all main actors	PP authenticates the credentials and logs the D/R.
3	A, B	D/ R provides a saliva sample for the LEITAT biosensor to check for drugs in the saliva. UC script 03 script describes how the LEITAT technology works.	• PP receives the results by the LEITAT technology and sends the concentration along with fitness to drive decision to the D/R and O.

4	A	• D/R receives a notification (no drugs detected) and they are ready to start their shift. • O receives the measurement result on their panel that the D/R does not have drugs in their system.	• The result is saved to the D/R's profile (accessed by the O and, thus, by the employer).
5	A, B	D/R breathes on the wall mounted SENSEAIR alcohol sensor device. UCscr02 scripts demonstrate the use of the SENSAIR technologies and UCscr12a impairment alcohol demonstrate the process of countermeasures' activation depending on the detected alcohol level.	• PP computes and registers the results • PP gets the result on the screen of the device (No alcohol detected), and they are ready to start their shift. • The O receives the measurement result on their panel that D/ R is not intoxicated.
6	A, B		PP saves the result of this pre-driving alcohol assessment to the driver's profile.
7	A, B	D/ R enters the vehicle/ gets on the PTW.	Nil.
8	A, B	D/R enters their credentials to the PP.	• PP authenticates the credentials and logs the D/ R. • The DATIK fatigue pre-questionnaire appears on the screen of the mobile app.
9	A, B	D/ R completes the questionnaire and submits the questionnaire.	• PP provides confirmation that the user successfully completed the pre-questionnaire. • PP informs the user that they are alert and score and its meaning. • PP sends the result and score of this D/ R to the O.
10	A, B	O views the result on D/ R's profile.	Nil
11	A, B	The operator sends confirmation to the D/ R that they can start their shift.	PP receives the confirmation and forwards it to the D/ R.

12	A, B	D/ R acknowledges the beginning of the shift.	• PP logs the beginning of the shift. • PP informs the O the D/ R's shift has started.

5. Flow of events			
Flow Identifier: UCsc13.2: Alcohol detection			
Step	**UCs**	**User Action**	**System Response (optional)**
1-2	A, B, C	Description same as step 1 – 2 of UCsc13.1.	Description same as step 1 – 2 of UCsc13.1.
3	A, B, C	D/R breathes into the wall mounted SENSEAIR device.	Alcohol is detected. The information is logged and sent to the O. Countermeasure is triggered.
4	A, B, C	If D/R is deemed fit to drive, the description would continue as per step 6 of UCsc13.1.	If D/R is deemed fit to drive, the description would continue as per step 6 of UCsc13.1.

Use Case Script 13.2a: Alcohol intoxication[3]		
Main success scenario (MSS): Detection of intoxication at legal limit is 0.02% (BrAC 0.10 mg/L)		
UCs	**Actor**	**PANACEA Platform (PP)**
A, B, C	**Sequence of numbered steps:** 1. The D/ R breathes on the wall mounted SENSEAIR device. 2. The D/ R receives a warning (mobile phone/ tablet) that they are intoxicated and cannot drive. 3. The D/ R receives some advice, for example[4], to hydrate and abstain from driving for the next 2 hours. 4. The O views the notification received about the D/ R and calls another D/ R to take up their shift. 5. The CS developer receives a notification that the advice was taken/ implemented. 6. The D/R breathes to the wall mounted SENSEAIR device. 7. The reading is zero. 8. O informs D/ R that they can start this part of their shift. 9. D/R is ready to start their shift.	1. The reading on the SENSEAIR device's screen is 0.02% (BrAC 0.10 mg/L). 2. The reading is sent to the O. The result is stored to the driver's profile. 3. The PANACEA platform sends an auditory warning and an intoxicated face icon to the D/ R's mobile app and the operator. 4. The type of suggested countermeasure is stored to the D/R's profile. 5. Acceptance of countermeasure is stored of the D/ R's profile. 6. After 2 hours PANACEA platform sends a notification to do the SENSEAIR breathing test again. 7. The PP sends the reading to the D/ CSR's mobile app and to O and the reading is stored to D/ R's profile.
		Differences:

[3] The alcohol levels used are valid in Greece and Sweden and this categorization is used only to serve the implementation of the UC as an example. WP3 will define the levels and the thresholds. WP5 will define the content and delivery method of countermeasures.

[4] The countermeasure has been added as an example and serves the purpose to demonstrate the required steps.

5. Flow of events		
Flow Identifier: UCsc13.2: Alcohol detection		
A, B, C	**Extensions:** Other scenarios (successes or failures) *A condition:* **Legally intoxicated: >0.10 mg/L above legal limit** 1. The O receives the same warning. 2. The warning is saved to their D/R's profile. 3. The D/R receives advice to hydrate, do not drive and ask someone to drive them home. 4. The D/R leaves with someone else driving them back to their place. 5. The D/ R receives lifestyle change advice about alcohol consumption, effects on health, etc. *The content, HMI and delivery time will be decided by WP5 (HMI within A4.6).*	1. The reading and warning are sent to D/R's mobile phone that they cannot drive this shift on their mobile app. 2. The reading and warning are sent to O mobile phone that they cannot drive this shift on their mobile app. 3. The reading and warning are sent to the CCS along with any other information need for intoxication on this level. 4. The D/ R receives the reading and a danger warning to their mobile phone that they cannot drive this shift. 5. The O receives the reading and a danger warning to their panel. 6. The O allocates this shift to another D/ R. 1. PP sends advice to hydrate, do not drive/ ride and ask someone to drive them home.
A, B, C	**Precondition:** The D/ R needs to be in the company's premises, the D/ R needs to have a profile (account) with credentials with the O and the countermeasures' specialist development team to have access to the profile. (D/R's compliance is necessary).	
A, B, C	**Guarantee:** Ensures detection of alcohol level. Ensures the D/ R does not drive. Ensures that the D/R receives the appropriate countermeasure.	
A, B, C	**Trigger:** D/R arrives to the premises and their shift is about to start.	

5. Flow of events			
Flow Identifier: UCsc13.3 Drug detection			
Step	**UCs**	**User Action**	**System Response (optional)**
1-2	A, B	Description same as step 1 – 2 UCsc13.1.	Description same as step 1 – 2 UCsc13.1
3	UA, B	D/ R provides a saliva sample for the LEITAT biosensor to check for drugs in the saliva.	The system detects drugs in the driver's system. Information is logged and sent to the O.
4	A, B	The D/R receive the countermeasure and O is also informed.	Depending on the thresholds, countermeasure is administered/action taken, e.g., speak to operator, unable to drive etc.
5	A, B	If driver is deemed fit to drive (depending on country legislation, drug type and concentration levels), then steps 7-12 of UCsc13.1 follow.	If driver is deemed fit to drive (depending on country legislation, drug type and concentration levels), then steps 7-12 of UCsc13.1 follow.

UCscr13.3a: Consumption of (Il)licit drugs		
Main success scenario (MSS): Concentration of benzodiazepine and/ methadone under Greek legislation (as an example of implementation).		
UC	**Actor**	**PANACEA Platform (PP)**
A, B	**Sequence of numbered steps:** 4. Steps 1-3 of UCsc13.1. 5. O allocates another D/ R to this shift. 6. The O replaces the D/ R. 7. D/ R leaves the premises and the shift.	4. The reading on the screen is a certain high concentration. 5. The reading that that they are under the influence of a drug, with a certain concentration and cannot drive along with the message that they have to report to their O and medical doctor for further advice. is sent to D/ R's mobile app. 6. PP sends the same message to O that the D/R has a certain concentration of benzodiazepine and/ or methadone and the D/ R cannot drive/ ride until further notice.
A, B	**Precondition:** Actors are registered and have login credentials and are logged in. No failures occur. D/R is at the premises and have been maximum number[5] days since they consumed a certain[6] dosage of benzodiazepines and/or number days since they have consumed certain dosage of methadone.	
A, B	**Guarantee:** PP guarantees that D/ R who consumed a certain and/or certain methadone will not drive until they are being examined by a medical professional.	
A, B	**Trigger:** D/R arrives at premises. A licit/ illicit drug measured is made with the LEITAT biosensor technology and a positive reading is obtained (on technology, on D/ R's mobile app, on O's panel and communicated to the CCS through PP).	

5. Flow of events			
Flow Identifier: UCsc13.4: (in)sufficient sleep detection			
Step	**UC**	**User Action**	**System Response (optional)**
1-2	A	Steps 1-2 of UCsc13.1.	
3	A	D selects to send their sleep quantity and quality data from Fitbit wearable through its mobile application to PP. D receives the countermeasure. *Respective UC scripts follow that present the different countermeasure delivery depending on level of fatigue. These are merely used an example to support the work of WP3 and WP5 in terms of functional requirements. The decisions of thresholds, fatigue levels remain with WP3 and the decisions on the content and delivery method of countermeasures remain with WP5, respectively.*	Wearable information indicates the driver has obtained (in)sufficient sleep. Depending on fatigue level detected, then the relevant countermeasure will be triggered to be sent to the D. *Examples:* Total sleep time <4h driver not fit to drive. OR Sleep time 4h-6h countermeasure system triggered, driver provided with countermeasure advice (e.g., caffeine and nap) and able to continue with shift, but O will frequently monitor them. Information is logged and sent to the O.

[5] The number of days that each substance will be defined, i.e., the range will be defined in WP3.
[6] The dosage will be provided along with the fitness to drive decision.

4	A	If D is deemed fit to drive, the description would continue as per step 6-12 of UCsc13.1.	If D is deemed fit to drive, the description would continue as per step 6-12 of UCsc13.1
5. Flow of events			
Flow Identifier: UC13.5: Fatigue detection			
Step	**UC**	**User Action**	**System Response (optional)**
1-7	A, B, C	Description same as step 1 – 7 of UCsc13.1.	
8	A, B, C	The D/R completes the DATIK fatigue pre-questionnaire on the mobile app and submits the questionnaire. A decision is made about D's/ R's fitness to drive based on the fatigue risk score and its meaning. The UC scripts that follow provide in detail the interaction steps for several possibilities of fatigue detection at different levels[7].	PP provides confirmation that the user successfully completed the DATIK fatigue pre-questionnaire. PP informs D that they are (not/too) fatigued and also sends to them the score and its meaning. Depending on the thresholds, the appropriate countermeasures will be triggered (e.g., level 1 would trigger an advice the D/ R to have a break in an hour, with caffeine and a nap and level 3 notifies the D that they are unfit to drive. PP sends the fatigue risk score and its meaning to the D an O.

UCscr13.5a: Fatigue		
Main success scenario (MSS): a) No fatigue is dedicated and b) Fatigue level is detected and respective countermeasure is communicated to involved actors (for each level).		
UCs	**Actor**	**PANACEA Platform (PP)**
A, B, C	**Sequence of numbered steps:** 1.The D/R completes the DATIK pre-questionnaire via the dedicated mobile app. 2.D/R leaves the premises.	1.PP detects no fatigue (level 1: normal) and a message is sent to the D/R, O, CCS that the person shows no signs of fatigue and D/R can start their shift. 2.PP registers the beginning of D/R's shift.

[7] A unified threshold methodology per impairment state will be adopted to enable detection, monitoring and assessment of fitness-to-drive coming from different technologies that might measure the same impairment construct. The levels of fatigue used in UC script 13.5a accommodate the needs of the Use Case scenarios and not the final thresholds; those will be defined/ set in WP3. However, they will be represented in scale/ levels and those are used here as examples to highlight relevant functionalities.

UCscr13.5a: Fatigue		
A, B, C	**Extensions: Levels of fatigue 2 (successes)** 1.The D/R completes the DATIK pre-questionnaire via the dedicated mobile app. 2.allocates another D/R to this shift. 3.D/R complies with the message. 4.D/R starts their shift.	1. PP detects increased fatigue (level 2: increased) and a message is sent to the D/R, O, CCS that the person show some signs of fatigue and D/R cannot immediately start their shift. 2. PP (CS) sends a message to D/R to have a beverage and a walk in the fresh air for 20 minutes. 3. PP (CS) sends the same message to O. 4. PP sends to D/R, O and CS the information that fatigue reached now normal levels (level: 1) and D/R can start their shift. 5. PP (CS) sends a positive message to D/R. 6. PP registers the beginning of D/R's shift
A, B, C	**Extensions: Levels of fatigue 3 (successes)** 1.The D/R completes the DATIK pre-questionnaire via the dedicated mobile app. 2.allocates another D/R to this shift. 3.D/R complies with the message. 4.D/R starts their shift.	1. PP detects high fatigue (level 3: high) and a message is sent to the D/R, O, CS that the person show some signs of fatigue and D/R cannot start their shift. 2.PP (CS) sends a message to D/R to take a nap and/ or rest because they are not in a position to start their shift right now. 3.PP (CS) sends the same message to O. 4. PP sends to D/R, O and CS the information that fatigue reached now normal levels (level: 1) and D/R can start their shift. 5.PP (CS) sends a positive message to D/R. 6.PP registers the beginning of D/R's shift.
A, B, C	**Extensions: Levels of fatigue 3 (after application of countermeasure)** 1. The D/R completes the DATIK pre-questionnaire via the dedicated mobile app. 2. allocates another D/R to this shift. 3. D/R complies with the message. 4. D/R leaves the premises.	1. PP detects high fatigue (level 3: high) and a message is sent to the D/R, O, CCS that the person show some signs of fatigue and D/R cannot start their shift. 2. PP (CCS) sends a message to not take up their shift and take some time off to recuperate. If they continue to feel tired, they could be advised to discuss it further with their GP. 3. PP (CCS) sends the same message to O.
A, B, C	**Extensions: Levels of fatigue 2 from 3 (after application of countermeasure)** 1. The D/R completes the DATIK pre-questionnaire via the dedicated mobile app. 2. allocates another D/R to this shift. 3. D/R complies with the message. 4. D/R leaves the premises.	1. PP detects increased fatigue (level 2: increased) and a message is sent to the D/R, O, CCS that the person show some signs of fatigue and D/R cannot start their shift. 2. PP (CCS) D/R to have a beverage and a walk in the fresh air for 20 minutes. 3. PP (CCS) sends the same message to O.

UCscr13.5a: Fatigue		
A, B, C	**Extensions: Levels of fatigue 1 from 2 (after application of countermeasure)** 1. The D/R completes the DATIK pre-questionnaire via the dedicated mobile app. 2. allocates another D/R to this shift. 3. D/R complies with the message. 4. D/R starts the shift.	1. PP detects normal fatigue (level 1: normal) and a message is sent to the D/R, O, CS that the person show no fatigue and D/R can start their shift. 2. PP (CCS) sends a positive message to D/R. 3. PP registers the start of the shift.
Precondition: Actors are registered and have login credentials and are logged in. D/R is at the premises and fatigue levels are measured/ estimated.		
Guarantee: PP guarantees that D/R who were fatigued were identified and appropriate countermeasures were suggested and followed.		
Trigger: D/R arrives at premises. Fatigue is detected by a subjective measurement (All UCs; DATIK pre-questionnaire) available through their mobile app.		

6. Alternative Flows			
Flow Identifier:	**UCsc13.6: BACTrack over SENSEAIR**		
Step	**UCs**	**User Action**	**System Response (optional)**
1-2	UCA, B	Steps 1-2 are the same as in UCsc13.1.	Steps 1-2 are the same as in UCsc13.1
3	UCA, B	D/R check the current BACtrack measurement through their mobile phone and that they are not intoxicated.	• PP stores the current BACtrack measurements to the D/R's profile. • PP (CCS) sends a positive message to D/R. • PP informs the O that the user is not intoxicated.
4-11	UCA, B	Steps are the same with steps 6-12 in UCsc13.1.	Steps are the same with steps 6-12 in UCsc13.1.

7. Exception Flows			
Flow Identifier: UC13.7: Failure in alcohol reading			
Step	**UCs**	**User Action**	**System Response (optional)**
1-2	A, B, C	Steps are the same with steps 1-2 in UCsc13.1.	Steps are the same with steps 1-2 in UCsc13.1.
3	A, B, C	The wall-mounted SENSEAIR device cannot get a good reading.	• PP informs D/ R and O that a reading failed to be recorded. • PP presents information on the LCD screen about how D/ R should use the device. • PP asks the user to try again.
4	A, B, C	D/ R tries to use the device for the second time. If failure on 3rd attempt, D/ R cannot continue with their shift.	• A reading is provided about the alcohol level being zero. • If the system fails to get a reading on the third attempt, then an error message is sent automatically to the O and the A. ○ Manual use of the technology is advised.
5-12	A, B, C	From now on description is the same as per steps 5-12 of UCsc13.1.	From now on description is the same as per steps 5-12 of UCsc13.1.
Flow Identifier: UC13.8: Failure in il(licit) drug reading			
Step	**UCs**	**User Action**	**System Response (optional)**
1-2	A, B	Steps are the same with steps 1-2 in UCsc13.1.	Steps are the same with steps 1-2 in UCsc13.1.
3	A, B	The LEITAT biosensor cannot get a good reading	• PP informs D/ R and O that a reading failed to be recorded. • PP presents information on the LCD screen about how D/ R should use the device. • PP asks the user to try again.

7. Exception Flows			
4	A, B	D/ R tries to use the device for the second time. If failure on 3rd attempt, D/ R cannot continue with their shift.	• A reading is provided about the drug measurement being zero. • If the system fails to get a reading on the third attempt, then an error message is sent automatically to the O and the A. ○ Manual use of the technology is advised.
5-12	A, B	From now on description is the same as per steps 5-12 of UCsc13.1.	From now on description is the same as per steps 5-12 of UCsc13.1.

7. Exception Flows			
Flow Identifier: UC13.9: Failure in fatigue reading			
Step	**UCs**	**User Action**	**System Response (optional)**
1-2	A	Steps are the same with steps 1-2 in UCsc13.1.	Steps are the same with steps 1-2 in UCsc13.1.
3	A	The Fitbit wearable has no sleep information / was not worn.	• PP informs D/ R and O that a reading failed to be recorded and there is no sleep information about the D. • Fatigue will be measured by the DATIK fatigue pre-questionnaire in step 6 of UCsc13.1.
7-12	A	From now on description is the same as per steps 7-12 of UCsc13.1.	From now on description is the same as per steps 7-12 of UCsc13.1.

8. Post-condition
This use case scenario can end with the following post-conditions: 1. The D/ R has successfully completed the pre-driving assessment. 2. D/ R can start their shift.

9. Business Rules
This is relevant to Ds/ Rs who work in a company with an overseeing operator or team of operators and analysts. This is partially relevant to self-employed D/Rs (e.g., taxi drivers). Each user will have a unique ID. D/ R owns an Android mobile phone. Each measure will be stored, and this will be a decision of the team of Os.

10. Special Requirements
1. For the alternative path UC scenario, D/ R needs to have only iOS app and the cloud app for BACtrack skyn. It Is not available in Android. Other examples are *legal and regulatory requirements; application standards; quality attributes of the system, including usability, reliability, performance, and supportability; operating systems and environments; compatibility requirements; and design constraints.*

11. Artifacts
1. User logs, device logs, app logs. Examples are *requirement specification documents, design documents, source code, and executables. Artifacts are sources of facts about the system.*

12. Notes and Issues
1. Descriptions of the parts of the PP are not included. PP is regarded as a 'black box' in this description. Backend UC scenarios will further be addressed in WP2 and D2.2. 2. Countermeasures are only examples. Final countermeasures will be defined and created in WP5.

4.4.3 UC scenarios for during driving assessment

During driving assessment involves the active shift where the driver is actually driving/ riding the professional vehicle and completes work tasks. It also involves any short breaks to use certain technologies (e.g., smartPWA device).

4.4.3.1 UCsc14: During Driving Assessment (DDA)

Brief Description
D/ R is ready; has successfully completed the pre-assessment and ready to start their shift. This is their first shift of the day, and it will last for eight hours. They are already logged in PP.

Actors: Taxi driver/ Courier service rider, operator.

D/ R: is assessed if they are fit to drive during their shift.
Operator: The operator monitors and supports the D/ R as well as provide information about their next trips. They will receive the status report about the D/ R's fitness to drive.

3. Priority
To ensure the TD/ CSR is fit to drive throughout the duration of the shift.

4. Pre-conditions
The D/R is registered and authenticated. The D/R has passed the pre-driving assessment. The D/ R has the PANACEA solution installed on their vehicle and have the PANACEA app installed on their Android mobile phone. Internet connection is required. They have checked that all technologies are connected and on (green light on PANACEA GUI interface). The PANACEA solution identifies them, and their profile is selected, and the system starts to detect their level of fatigue and cognitive load (for UCA and UCB). On board is also the stress technology (AIT SmartPWA) to be used during breaks to get feedback on stress levels.

5. Flow of Events			
Flow Identifier		**UCsc14.1: Driving/ Riding/ operating with the vehicle/ PTW (DDA)**	
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B, C	The D/R starts to drive/ride/ operate.	PP continuously monitors the D/R.
2	A, B, C	D/R remains alert and attentive the entire drive.	D/R detects that the driver is alert and attentive. No countermeasures are needed.
3	A, B, C	D/R reaches the depot after completing the drive.	PP uploads the driving/ riding data into the cloud.

5. Flow of Events			
Flow Identifier		**UCsc14.2: During rest/ break (DDA)**	
Step	**UCs**	**User Action**	**System Response (optional)**

5. Flow of Events			
1	A, B_{Taxi}, C	The driver stops for a break and puts the PP in break/rest/waiting mode.	PP asks D to perform a stress measurement.
2	A, B_{Taxi}, C	The driver starts the SmartPWA device (UCsc04) and performs a measurement.	PP detects stress within the normal range and sends feedback to the D. The outcome of the test is sent to the O.
3	A, B_{Taxi}, C	D receives feedback on normal stress level. D is fit to drive after their break.	

5.Flow of events			
Flow Identifier:	**UCsc14.3: During rest/break – increased stress**		
Step	**UCs**	**User Action**	**PP Response (optional)**
1	A, B_{Taxi}, C	The D stops for a break and puts the PP in break/rest/sleeping mode.	The PP is in sleeping mode during a break. The PP asks the D to perform a stress test.
2	A, B_{Taxi}, C	The D starts the smartPWA device and performs a measurement.	The PP detects increased levels of stress and activates a countermeasure.
3a	A, B_{Taxi}, C	The D performs the countermeasure after receiving feedback on stress levels.	PP records compliance to countermeasure. O and CCS are informed.
3b	A, B_{Taxi}, C	The D refuses to engage with the suggested countermeasure (e.g., rest break, breathing exercises etc).	PP records non-compliance to countermeasure and O and CCS are informed.
5	A, B_{Taxi}, C	The countermeasure is effective, and the D remains alert the remaining drive.	PP (through the SmartPWA technology; UCsc07) detects that the D is alert. No further countermeasures are needed.
6	A, B_{Taxi}, C	The D reaches the depot after completing the drive.	The PP uploads the driving data into the cloud.

5. Flows of events			
Flow Identifier:	**UCsc14.4 During rest/break stress measurement – unable to get a measurement**		
Step	**UCs**	**User Action**	**PP Response (optional)**
1	A, B_{Taxi}, C	The D stops for a break and puts the PP in break/rest/sleeping mode.	The PP is in sleeping mode during a break. The PP asks the D to perform a stress measurement.
2	A, B_{Taxi}, C	The D starts the smartPWA device (UCsc04) and performs a measurement.	• The PP fails to perform the measurement. • The PP sends an error message to Ad and asks the D to re-start the device.
3	A, B_{Taxi}, C	The D re-starts the device.	

5. Flows of events

5. Flow of Events			
Flow Identifier:		**UCsc14.5: During rest/break; D switches off PANACEA solution**	
Step		**User Action**	**PP Response (optional)**
1	A, B_{Taxi}, C	The D turns off the vehicle and the PP.	PP sends of a message to the D's mobile app that data collection and health monitoring will not be available if PANACEA solution is switched off.
2a	A, B_{Taxi}, C	D decides nevertheless to switch off the PANACEA solution.	PP switches off the solution. Stress measurement reminder will be sent out when the D switches the PANACEA solution again.
2b	A, B_{Taxi}, C	D leaves PANACEA solution in sleeping mode.	PP can collect data. Steps 2-3 of UCsc14.4 will follow.

5. Flows of events			
Flow Identifier:		**UCsc14.6: Fatigue detection**	
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B, C	D/R starts to drive/operate.	PP continuously monitors the D/R.
2	A, B, C	After a while, D/R experiences increasing fatigue.	PP identifies a D/R fatigue event. PP activates the fatigue countermeasure HMI when it happens.
3	A, B, C	The countermeasure is effective, and the D/R remains alert the remaining drive.	PP detects that the driver is alert. No further countermeasures are needed.
	A, B, C	D/R reaches the depot after completing the drive.	PP uploads the driving/ riding data into the cloud.
UCsc14.7: Driving the vehicle with fatigue events detected – ineffective countermeasure			
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B, C	The D/R starts to drive/operate.	The PP continuously monitors the D/R.
2	A, B, C	After a while the D/R experiences increasing fatigue events.	• The PP identifies a fatigue event. • The system displays new risk score based on the registered event. • The PP activates the fatigue countermeasure HMI when it happens.
3	A, B, C	The countermeasure is not effective, and the D/R is still very fatigued.	• The PP identifies another fatigue event and activates the fatigue countermeasure HMI. • The PP sends an alarm to the O – traffic management.

			• The PP informs the D/R that traffic management has been informed and that it is time for a break.
4	A, B, C	The D/R stops for a break and informs the passengers they need a rest. The D/R stops the PP.	
5	A, B, C	The countermeasure is effective, and the D/R remains alert the remaining drive.	The PP detects that the D/R is alert. No further countermeasures are needed.
6	A, B, C	The D/R reaches the depot after completing the drive.	The PP uploads the driving data into the cloud.

UCsc14.8: Fatigue detection: Change in levels

Step	UCs	User Action	System Response (optional)
1	A, B, C	D/R enters their credentials (this will happen either with a PIN, NFC, or simple login process). Further on this in UCsc23.	PP authenticates D/ R.
2	A, B, C	D/R leaves the premises and starts their shift.	PP detects Fatigue level 2 (increased fatigue) and notifies the D/R and the O.
3	A, B, C	D/R receives the Fatigue level 2 warning (icon and audio warning) through mobile app.	PP advises the D/R to take a break and rest for 20 minutes. PP sends this notification also to O.
4	A, B, C	D/R accepts the advice and stops and rests parking space for almost half an hour and has caffeinated drink.	PP notifies O about the acceptance.
5	A, B, C	D/R starts the vehicle/ PTW.	PP sends a request to complete the pre-driving fatigue questionnaire through the mobile app.
6	A, B, C	D/R completes the pre-driving fatigue assessment questionnaire on their mobile phone and submits it.	PP sends the Fatigue level 1 notification to their mobile app (icon and vibration) that they are “OK to drive!” to D/R and O (to their panel web app).
7	A, B, C	D/R continues with their shift to their next stop.	

5. Flow of Events

Flow Identifier UCsc14.9: Stress detection – Change in Levels			
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B_{Taxi}[8], C	Step 1 is the same as step 1 in UCsc14.1.	Step 1 is the same as step 1 in UCsc14.1.
2	A, B_{Taxi}, C	The D is stuck in traffic, and they get frustrated, their heart rate is rising (only in A6.2 tests[9]).	PP detects higher (Stress level 2) than normal (Stress level 1) and notifies D to stop, if possible, during the next five minutes to relax and play the stress relief game.
3	A, B_{Taxi}, C	D receives the message on their mobile app and complies. Stops at the next safe stop / rest area. D plays the stress game on their mobile app.	PP detects stress levels returned to normal (Stress level 1) and empowers D for completing the stress relief game by sending them the following message: "*Take a deep breath and you are ready to continue your journey*."
4	A, B_{Taxi}, C	D receives the stress level notification (icon and audio warning) and the message on their mobile phone app and starts the vehicle.	
5. Flow of Events			
Flow Identifier UCsc14.10: Alcohol detection without trigger (DDA)			
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B, C	Step 1 is the same as step 1 in UCsc14.1.	Step 1 is the same as step 1 in UCsc14.1.

[8] Stress will be measured by AIT SmartPWA unit which will be tested only by taxi drivers in UCB.
[9] Heart rate and heart rate variability are indicators measured by the ERGOS (UCsc10) and the AIT SmartPWA ((UCsc04) technologies, which both can be used during driving only in the A6.2 simulation studies. In addition, stress can be detected with any other indicators shown in Table 10. We will not show in the scenarios all the possible indicators, as they do not affect the user-platform interactions.

2	A, B, C	The D has to stop to take breath sample for alcohol detection.	PP processes the data and depending on the verdict steps 3 and 4 follow.
3	A, B, C	The flow is identical with UCsc13.1, steps 5-7.	PP receives data from the SENSEAIR Go instead of SENSEAIR wall-mounted device for all Ds and from the Backtrack skyn wristband for the Rs.
4	A, B, C	The flow is identical to UCsc13.2.	PP receives data from the SENSEAIR Go instead of SENSEAIR wall-mounted device for all Ds and from the Backtrack skyn wristband for the Rs.
Flow identifier:		**UCsc14.10: alcohol detection by another trigger (DDA)**	
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B, C	Step 1 is the same as step 1 in UCsc14.1.	Step 1 is the same as step 1 in UCsc14.1.
2	A, B, C	D/R is driving towards their next stop.	PP detects a **trigger**[10] for potential alcohol and/ or substance use to high (e.g., >2 x SDLP (Standard deviation of Lateral Position). Substance use cannot be tested during driving nor alcohol. PP sends a notification to D/R to stop at a safe/ rest area to perform an alcohol test.
3	A, B, C	D accepts the suggestion and stops at a rest area and uses the SENSEAIR Go technology to measure their BrAC.	PP does not detect any alcohol consumption by the SENSEAIR Go (D) or the BAC Track skyn wristband (R) and notifies D/R through their

[10] Trigger is a change in an indicator that demands further investigation for an estimation and/ or measurement that is not continuous and requires human intervention and/ or initiation, e.g., SDLP, steering rate, centerline and road edge crossings, speed variation, driver facing camera (FitDrive; DATIK).

		R wears BAC Track skyn wristband and measurement is continuous. D/R receive the notification (icon and vibration) and the positive message.	mobile app: "No alcohol was detected!". PP sends the same notification to O. A positive message (CCS) is sent to the D/R.
5. Flow of Events			
Flow identifier: UCsc14.11: Cognitive overload – event triggered			
Step	**UCs**	**User Action**	**System Response (optional)**
1	B_{Taxi}	Step 1 is the same as step 1 in UCsc14.1.	Step 1 is the same as step 1 in UCsc14.1.
2	B_{Taxi}	*The following flow of events apply only to TD and taxis/ cabs.* TD talks on the phone and abruptly turns the steering wheel because they are involved into another task whilst driving. TD receives the visual and auditory warning through their mobile app. TD receives a message that 'Talking on the phone while driving is prohibited by law!". TD is no longer overloaded. TD receives the positive message on their mobile phone app.	PP (SWA is described in UCsc05) detects that TD is overloaded [11] from Level 1 to Level 2 (increased cognitive overload). PP notifies the TD that they are distracted with a visual and auditory warning send to their mobile app. PP informs O that TD is distracted to Level 2. PP sends distraction event-targeted information to TD. PP detects that overload Level 2 changed to Level 1 and sends a positive message to TD.
3		TD's shift has ended and they logout PP. *TD has always the option to continue being monitored by the PANACEA solution during their off-duty time and take advantage of the offered support. This function of pre-assessment (off-duty not the onsite) is optional.*	PP logs out TD and informs O that TD has finished their shift.

[11] Cognitive load is detected in UCB by the steering wheel algorithm and deviation in selected vehicle parameters (ViF) and validated by the video data (driver -facing camera) from FitDrive (DATIK).

5. Flow of Events		
Flow Identifier: UCsc14.12: Post driving advice (on-site)		
Step	**User Action**	**System Response (optional)**
1	The D/R exits the vehicle after their driving shift.	PP collates information about the fatigue and other events that occurred during the drive.
2	The D/R checks their app that they received an email with a debrief that will be available on their personal profile (available through the web application).	• The D/R receives a debrief based on their drive. • The information details the number of fatigue and/ other impairing-related events that occurred. • The D/R is provided with advice about: o The commute home and countermeasure advice for driving (caffeine/nap); o Preparing for the next shift (sleep, countermeasure advice or even alcohol intake, drugs and medicines, etc.) o Information about cognitive load (under/ over) and driving
3	The driver signs off duty	Nil.

7. Exception Flows			
Flow Identifier: UCsc14.13: Failure of reading, failure of compliance to countermeasure, failure of countermeasure, more than one states at the same time.			
Step	**UCs**	**User Action**	**System Response (optional)**
1	A, B, C	D/ R is in any of addressed states (level 2 and above; alcohol, fatigued, stressed, mentally under/ overloaded).	PP fails to read any input data that is related to the measurement of any of the addressed states, then: • If the use of the technology is trigger-based (i.e., SENSEAIR Go), then a second attempt is requested by PP to D. PP also informs O and Ad.
2	A, B, C	D tries a second to use the technology, e.g., SENSEAIR Go while being parked at a rest area.	PP sends the reading to D, O and Ad. Next steps are identical to the UCsc14, depending on impairment type.

7. Exception Flows			
3	A, B, C		PP fails to read any input data that is related to the measurement of any of the addressed states, then: • If the technology uses more than one data source input, like fatigue, stress, cognitive load (see Tables Table 8-Table 10), then it moves to the next input until it finds one that it does not fail to provide reading[12]. • PP informs A about the issue(s). • PP detects level of T/ R state and informs D/ R and O. From here on, the steps follow as shown to the aforementioned UCsc14, depending on impairment type.

8. Post-Condition
The D/R has completed a shift supported by the PANACEA solution and has received the appropriate countermeasures and complied to them with no issues. 1. The D/R is more well prepared to avoid fatigue. 2. The D/R gets more aware of stress levels and mitigate them. 3. The D/R has successfully signed out of their vehicle. 4. The D/R is considered fit to go home. 5. The D/R feels confident that the Traffic Management Centre (TMC) know and support him for a break when needed.

9. Business Rules
Each user will have a unique ID. Each measure will be stored, and this will be accessible to drivers and Transdev (i.e., the operators). Collected data (not off-duty data) can be used in discussions with managers. For some TDs, working as freelancers, compliance to certain countermeasures. Compliance off-duty needs to be discussed and agreed upon. Other Ds are employees and, thus, the above case does not apply. Monitoring off-duty needs to be discussed. Certain business rules might apply that are not considered here, but the business rules part of the architecture might be able to handle. Aspects are related to data access, login and shifts, countermeasures compliance.

[12] This assumption is based on the fact that in WP3, it will be decided that even one data source/ input will suffice to reach decision for detection of fatigue, stress and/ or cognitive and any other driver/ rider states that more than one data sources/ inputs exist.

10. Special Requirements[13]
For the alternative path UC, the user might need to have only iOS app for BAC Track. PANACEA mitigation will depend on openness of technology: It Is not available in Android. We will try to get the data from the web portal and direct them to the Android application, so the participant does not have to: a) use a separate application (that is iOS and a separate device) and b) use technology outside PANACEA.

11. Artifacts [14]
User logs, device log, app log. Will be defined, if known, at this stage by the architecture and the technology teams.

12. Notes and Issues
1. This description does include random occurrences of impairing states (i.e., everything happens in sequence). It is presenting a simple flow of events with all addressed states into considerations. Not all exceptions are reported. 2. Descriptions of the parts of PP are not included. PP is regarded as a 'black box' in this description. The descriptions and diagrams in Appendix V will present the workings and flows of the components of the PP architecture and the data flows on a high and generic level to demonstrate the interrelation and the utilisation of the work performed in this Deliverable to WP2 and WP3, respectively. 4. No countermeasures are included, as they are not available yet. Indicative countermeasures are described in the scenarios to follow to reveal any functions and functionalities that might be required to be considered.

4.4.4 UC scripts for roadside assessment

Roadside assessment is conducted by enforcers, e.g., traffic police and vehicles are often randomly stopped to be checked and drivers / riders to be assessed. Roadside assessment in PANACEA entails only assessment of alcohol and (il)licit drugs consumption.

[13] Other examples are *legal and regulatory requirements; application standards; quality attributes of the system, including usability, reliability, performance, and supportability; operating systems and environments; compatibility requirements; and design constraints.*

[14] Examples are *requirement specification documents, design documents, source code, and executables. Artifacts are sources of facts about the system.*

4.4.5 UCscr15: Roadside Assessment (RSA)

Brief Description
A separate UC scenario description is not necessary as the roadside UC as it does not satisfy a shift pattern of the driver/ rider but a part of the road safety enforcement, monitoring and assessment. Scripts are scenarios that can be stand-alone, but they are shorter, and they are often dependent on the actual scenarios. Scripts are supportive and do not determine alone the role of the main actor (e.g., driver/ rider). For this reason, roadside and off-duty are only described as scripts. There is no need for baseline assessment. Measurements are made by the enforcer and not adjustment to any actors personal physiological and/ or other driving performance/ profile characteristics are required. Calibration of the LEITAT technology might be required, but this should be considered in the administrative UC scenarios' section. These scenarios are not related to a specific UC, but the roadside testing that will be conducted in Norway, within A4.3.

Actors: Taxi driver/ Courier service rider, operator.
Enforcer (E): Often the police officer who randomly test D/R at the side of the road to assess if they are fit to drive or not. They will also assess the ability of D/R in case of an accident.
D/ R: is assessed if they are fit to drive during their shift.
Operator: The operator monitors and supports the D/ R as well as provide information about their next trips. They will receive the status report about the D/ R's fitness to drive.

3. Priority
To ensure the D/ R is fit to drive when the enforcer stops and tests them.

4. Pre-conditions
The D/R is registered and authenticated. The D/R has passed the pre-driving assessment. The D/ R has the PANACEA solution installed on their vehicle and have the PANACEA app installed on their Android mobile phone. Internet connection is required. They have checked that all technologies are connected and on (green light on PANACEA GUI interface). The PANACEA solution identifies them, and their profile is selected, and the system starts to detect their level of fatigue and cognitive load (for UCA and UCB). On board is also the stress technology (AIT SmartPWA) to be used during breaks to get feedback on stress levels.

UCscr15.1: Alcohol intoxication
Main success scenario (MSS): Detection of intoxication at legal limit is equal or above 0.02% (BrAC 0.10 mg/L-0.40 mg/L) TD/ CSR are on-duty and during driving. If TD/ CSR are off-duty, then in business rules, they have agreed to be monitored during off-duty and the data to be shared with the PANACEA platform.

Prerequisites: Both are registered to PP. Enforcer is already logged in.	
Actor	**PANACEA Platform (PP)**
Sequence of numbered steps: 1. The D/R needs to stop / park after the enforcer asked to do so. 2. D/R scans their employee PANACEA enabled card on the enforcer's tablet. 3. The D/R breathes on the SENSEAIR portable device. 4. The operator views the notification received by the D/R and calls another D/R to take up their shift. 5. The D/R will not come back to their shift for the day. 6. The D/R receives the message to the mobile app. 7. The D/ R leave their shift and go home. 8. Th CCS receives the message that a countermeasure has been sent and schedules to get in contact with the O and the D/R to discuss further actions to support them.	1. The enforcer signals the D/ R and asks them to stop at the side of the road. 2. The enforcer accesses their web application page. 3. The enforcer asks the D/R to scan their card on the enforcers tablet. 4. Their form is now pre-filled with D/R's required data. 5. The enforcer asks the D/R to breathe on the SENSEAIR portable device. 6. The reading on the SENSEAIR device's screen is 0.02% (BrAC 0.18 mg/L) 7. The enforcer informs the D/R about the 100 Euros fine and 7 points credited in their point system. 8. The CS sends a countermeasure message and advises them to seek help and support. 9. PP informs the CCS that a countermeasure message was sent out.
Extensions: Other scenarios (successes or failures) *A condition:* Legally intoxicated: >0.41 mg/L above legal limit 1. Sequence of numbered steps: 2. The D/R needs to stop / park after the enforcer asked to do so. 3. D/R scans their employee PANACEA enabled card on the enforcer's tablet. 4. The D/R breathes on the SENSEAIR portable device. 5. The O views the notification received by the D/R and calls another D/R to take up their shift. 6. The D/R will not come back to their shift for the day. 7. The D/R receives the message to the mobile app. 8. The D/R leave their shift and go home. 9. Th CCS receives the message that a countermeasure has been sent and schedules to get in contact with the O and the D/R to discuss further actions to support them.	*Differences:* 1. The enforcer signals the D/R and asks them to stop at the side of the road. 2. The enforcer accesses their web application page. 3. The enforcer asks the D/R to scan their card on the enforcers tablet. 4. Their form is now pre-filled with D/R's required data. 5. The enforcer asks the D/R to breathe on the SENSEAIR portable device. 6. The reading on the SENSEAIR device's screen is BrAC 0.45 mg/L 7. The enforcer informs the D/R about the fine and the potential imprisonment. 8. The CS sends a strategic countermeasure message and advises them to seek help and support. 9. The CS informs the CCS that a countermeasure message was sent out.

Extensions: Other scenarios (successes or failures) *A condition:* <0.10 mg/L less than legal limit or no alcohol intoxication. 1. The D/R needs to stop / park after the enforcer asked to do so. 2. D/R scans their employee PANACEA enabled card on the enforcer's tablet. 3. The D/R breathes on the SENSEAIR portable device. 4. The O views the notification received by the D/ R and is ready to continue with their shift. 5. The D/R receives the positive message to the mobile app if no alcohol is detected. 6. The D/R receives the information to their mobile app if alcohol is detected within legal limits.	*Differences:* 1. The enforcer signals the D/R and asks them to stop at the side of the road. 2. The enforcer accesses their web application page. 3. The enforcer asks the D/R to scan their card on the enforcers tablet. 4. 5. Their form is now pre-filled with D/R's required data. 6. The enforcer asks the D/R to breathe on the SENSEAIR portable device. 7. The reading on the SENSEAIR device's screen is 0 mg/L 8. The enforcer informs the D/R that they can continue their shift. 9. PP informs the O and CCS. 10. PP sends a positive message to the D/R if no alcohol is detected. 11. If alcohol (within legal limit is detected), then a message is sent with information about potential effects of drinking and driving even at low levels and how to counterbalance effects (e.g., drinking water and not driving before a certain number of hours have passed since last drink).
Precondition: The D/R needs to be on their shift, the D/R needs to have a profile (account) with credentials with the O and the countermeasures' specialist development team to have access to the profile. The D/R's compliance and consent is necessary.	
Guarantee: Ensures detection of alcohol level. Ensures that the D/R does not drive when it is illegal to do so. Ensures that the taxi driver/ courier service rider receives the appropriate countermeasure.	
Trigger: D/R driving performance deteriorates.	

UCscr15.2: Consumption of licit/ illicit drugs	
Main success scenario (MSS): Greek legislation (no tolerance on licit and illicit drugs)	
Actor	**PANACEA Platform (PP)**
Sequence of numbered steps: 1. The TD/ CSR pulls over as requested by the enforcer. 2. TD/ CSR scans their employee PANACEA enabled card on the enforcer's tablet. 3. TD/ CSR performs the saliva test. 4. TD/ CSER receives the message with the X concentration on their mobile app 5. O allocates another TD/ CSR to this shift. 6. TD/ CSR follows the enforcer for further investigation. 7. After X hours, TD/ CSR receives the informative message.	1. The enforcer stops the TD/ CSR for a random test. 2. The enforcer accesses their web application page. 3. The enforcer asks the TD/ SCR to scan their card on the enforcers tablet. 4. Their form is now pre-filled with TD/ CSR's required data. 5. The enforcer asks the TD/ CSR to perform the saliva test with the LEITAT biosensor. 6. The enforcer places the LEITAT sensor into the reading device. 7. The reading on the screen is X concentration.

	8. The enforcer asks the TD/ CSR to follow them for further investigation. 9. The reading that that they are under the influence of X drug, X concentration is sent to TD/ CSR's mobile app. 10. PP sends the same message to O that the TD/ CSR has an X concentration of benzodiazepine and/ or methadone and the driver cannot drive until further notice. 11. After X hours, a countermeasure in the form of an informative message (lifestyle management oriented) is sent to the D/R's mobile app, about using the specific drug , the current legislation, effects, etc.
Extensions: Failure of reading. *A condition:* when the LEITAT reading fails for either the licit or illicit drug or both. If reading is successfully obtained the second time, then the aforementioned steps are taken. If reading is again failed, then manual reading is performed by the enforcer. The enforcer enters the result to PP and based on the result any of the aforementioned steps will be taken.	*Differences:* If reading fails, a failure message is sent to the D/R, O and Ad 'Failed to read. Please retry'. Manual initiation of the process is advised by PP (i.e., measuring outside PP and entering manual the results). PP administrator receives an error log.
Precondition: Actors are registered and have login credentials and are logged in. No failures occur. TD/ CSR is stopped by the enforcer during their shift and have been maximum X days since they consumed X dosage of benzodiazepines and/or X days since they have consumed X dosage of methadone. In other words, the consumption should happen between the set minimum and maximum days and concentrations to be detectable by the LEITAT biosensor.	
Guarantee: PP guarantees that D/R who consumed X and/or X methadone will not drive until they are being examined by a medical professional.	
Trigger: D/R is on their shift, during driving and are stopped for a random drug test by an enforcer (traffic police employee- legal authorities in this case. A licit/ illicit drug measured is made with the LEITAT biosensor technology and a positive reading is obtained (on enforcer's tablet or other device / technology, on D/R's mobile app, on O's panel and communicated to the CS; everything happens through the PP).	

4.4.6 Scripts with combinations of impairments[15]

Alcohol and (il)licit drug

UCscr 15.3: Alcohol intoxication and (il) licit drugs – Roadside assessment[16]	
Main success scenario (MSS): Detection of intoxication at legal limit is .02 % (BrAC 0.10 mg/L) and consumption of benzodiazepines and/or by enforcer in roadside assessment. The driver and the enforcer are both registered to PP. This scenario is held in a country were both legal and illegal drugs consumption is accepted under certain and clear (e.g., Norway), where the real roadside tests (WP4) will be conducted.	
Actor (Enforcer in roadside assessment)	**PANACEA Platform (PP)**
Sequence of numbered steps: 1. Driver/ rider is stopped by E during driving their bus shift. 2. E enters their own credential on the PP platform. 3. E switches on and uses the LEITAT device with the driver/ rider. 4. Enter creates a new 'Event'. 5. E enters the driver ID to the 'Event' page and the measurement appears on the page. 6. The benzodiazepine level is X. 7. Prescription is available at driver/ rider's profile.17 8. E switches on and uses the portable SENSEAIR device with the driver/ rider. 9. The intoxication level is at legal limit (02%). 10. The alcohol level is ok (Technology result alone is Pass). 11. E receives the note on the Event page and implements the fine and makes a note on the Event that the fine and the legal implication have been implemented. 12. E saves the Event on E's PP dashboard. 13. E shares the Event with the Operator and the cloud-based countermeasures system via email, app or online platform.	1. PP login of E is successful. 2. PP confirms that the device is active on PP and ready for use. 3. The new 'Event' page is open. 4. The measurement of benzodiazepine appears in the Event page as soon as the driver ID is added (Driver ID in the Event page is connected with the Driver ID in the technology/ sensor data source). 5. The measurement of alcohol appears on the same Event page and is Pass. 6. Another note appears on the Event page that alcohol consumption is not allowed when taking benzodiazepines and the X fine and X legal implication have to be implemented. 7. PP notifies E that the Event was successfully shred via email with the O and CS. 8. PP (CCS) sends out a long-term countermeasure advice to the D/R. 9. PP (CCS) informs the O and E and any other core actor that has been selected to access countermeasures, that the D/R received the specific countermeasure.

[15] This scenario also accommodates the needs of other combination like fatigue and (Il) licit drugs, alcohol and fatigue, stress and fatigue, stress and (il)licit drugs, stress and alcohol, although not all combinations will be tested within PANACEA, as not all combinations of technologies will be tested in the different sites. The steps do not differ; thus, no different scenarios need to be described.

[16] UC2.1 can be conducted in other UCs. The priority of implementation is UC2.1 which involves potentially direct legal implications.

[17] This step depends on the driver/ rider. If they have selected to share their profile with the other actors of the PP, then the information about the prescription will be made available to E, if not, then it will not be.

UCscr 15.3: Alcohol intoxication and (il) licit drugs – Roadside assessment[16]
Precondition: Benzodiazepine is consumed as part of prescription and this scenario is valid only for countries where consumption of benzodiazepines is legal with doctor's notice. However, consumption of alcohol, even in legal limit in conjunction with the prescription makes it illegal.
Guarantee: Ensures detection of alcohol level. Ensures the driver/ rider does not drive. Ensures that the driver/ rider receives the appropriate countermeasure.
Trigger: Both assessment needs to driver/ rider to stop to execute. In this occasion, both are conducted on roadside.

4.4.7 UC scripts for off-duty

Off-duty refers to the driver's/ rider's state outside their working shift during their own private time (e.g., leisure, family time).

4.4.8 UCscr16: off duty Assessment (ODA)

The BAC Track skyn wearable and the AIT smartPWA technology are selected that are detecting and measuring alcohol consumption and stress, respectively. In this phase, the D/R is not working and can be engaged in any other activities. In addition, D/ R are not obligated to use the technologies offered by the PANACEA solution. They need to have three options in their driver profile: a) to have the technologies always activated or always deactivated, b) select which technologies are activated in off duty phase, c) be able to activate/ deactivate when they want, and d) activate the night before their shift. They will receive recuperation and lifestyle changing support from CCS mostly during this phase and if their connection to PP is not active, then they will not be able to exploit the full extent of the assistance and support of CS. This should be made clear to the drivers and riders through a disclaimer in their profile. Access to CCS without access by the O would be also desirable.

UCscr 16.1: Alcohol intoxication	
Main success scenario (MSS): Detection of intoxication at legal limit is > .02 % (BrAC 0.10 mg/L). MSS requires that technologies are activated in their profile. Access is granted. Related to All UCs	
Actor	**PANACEA Platform (PP)**
Sequence of numbered steps: 1. D/ R is out with friends at a concert, and they are having drinks. 2. The D/R receives, for example, an advice to hydrate and abstain from driving/ riding for the next X hours or arrange for their designated break right now! 3. The countermeasures' specialist receives a notification that the advice was taken/ implemented.	1. The reading on the BAC Track skyn wristband device's screen is > .02% BrAC 0.10 mg/L) 2. The reading on the PANACEA mobile app is >0.02% (BrAC 0.10 mg/L) 3. The PANACEA platform sends an auditory warning and an intoxicated face icon to the D/R's mobile app and the CCS (optional if access to O is granted). 4. Acceptance of countermeasure is stored of the driver's profile.
Precondition: The D/ R is off duty and need to have profiles (account) with credentials with the operator and the countermeasures' specialist to have access to the profile. The D/R's compliance.	
Guarantee: Ensures detection of alcohol level. Ensures the taxi driver/ courier service rider does not drive. Ensures that the taxi driver/ courier service rider receives the appropriate countermeasure.	

UCscr 16.1: Alcohol intoxication
Trigger: Continuous assessment. Ensures that TAC is transformed to BAC or BrAC.

UCscr16.2: Alcohol intake, drugs intake 7 days (last day it is traceable)	
Main success scenario (MSS): Detection of combination of alcohol and drugs, where drugs were taken almost a week before. Related to UCB	
Actor	**PANACEA Platform (PP)**
Sequence of numbered steps: 1. D/ CSR is out with friends at a concert, and they are having drinks. 2. The TD/ CSR receives, for example, an advice to hydrate and abstain from driving/ riding for the next X hours or arrange for their designated break right now! 3. The countermeasures' specialist receives a notification that the advice was not taken/ implemented and not implemented. 4. Enforcer stops TD/CSR and performs an alcohol and drug test (described in UC15). 5. E creates and new Event (shown I n UC 15) with all relevant pieces of information. 6. E shares the Event with the O and CS via email. 7. TD/ CSR receives the countermeasure. 8. E and O also receive the information about the countermeasure sent out by CS18.	1. The reading on the BAC Track skyn wristband device's screen is > .02% BrAC 0.10 mg/L) 2. The reading on the PANACEA mobile app is >0.02% (BrAC 0.10 mg/L) 3. The PANACEA platform sends an auditory warning and an intoxicated face icon to the TD/ CSR's mobile app and the CCS (optional if access to O is granted). 4. Non-acceptance of countermeasure is stored of the driver's profile. 5. The cloud-based countermeasures system is informed about non-compliance. 6. Measurement is positive for alcohol and drugs with the SENSEAIR and LEITAT sensors. 7. Results are shown on the E's device and on the TD/ CSR's profile. 8. PP confirms saving of the Event. 9. O and CS receive the information. 10. CS sends another countermeasure to TD/ CSR with information about mixing alcohol with drugs.
Precondition: The TD/ CSR is off duty and need to have profiles (account) with credentials with the operator and the countermeasures' specialist to have access to the profile. The TD/ CSR's compliance.	
Guarantee: Ensures detection of alcohol level. Ensures the taxi driver/ courier service rider does not drive. Ensures that the taxi driver/ courier service rider receives the appropriate countermeasure.	
Trigger: Continuous assessment. Ensures that TAC is transformed to BAC or BrAC.	

UCscr16.3: Stress level	
Main success scenario (MSS): Detection of stress level (1, 2, 3). MSS requires that technologies are activated in their profile. Access is granted. Related to all UCs.	
Actor	**PANACEA Platform (PP)**

[18] Any information about the driver/ rider is sent out only after they consent about sharing these pieces of information in their driving profile.

UCscr16.3: Stress level	
Sequence of numbered steps: 1. The D/ R is at home and feels agitated even at rest and after an enjoyable morning. 2. The stress level score is sent also to the D/ R's mobile app. 3. The D/R receives an advice to try out the smartPWA stress relief exercises. 4. The D/R plays the balloon game on their mobile phone, and they feel better already. 5. CCS receives a notification that the advice was taken/ implemented. 6. D/ R checks the information they receive on their mobile app and spends some time in the afternoon reading them.	1. Uses the smartPWA device to measure their stress levels. 2. The stress level is shown to be increased from level 1 (normal) to level 2 (increased). 3. The PP sends out a message to TD/ CSR about playing the stress relief exercise. 4. The smartPWA measurement is taken again, and the stress level dropped from level 2 to level 1(normal). 5. PP informs the D/R that their stress level is now normal. 6. PP informs the CCS that the advice was taken, and the implementation was successful. 7. PP sends information about stress during the weekend and activities, lifestyle options that can help alleviate and control it.
Precondition: The D/R is off duty and need to have profiles (account) with credentials with the operator and the countermeasures' specialist to have access to the profile. The D/R's compliance.	
Guarantee: Ensures detection of increased stress. Ensures the taxi driver/ courier service rider does not drive. Ensures that the taxi driver/ courier service rider receives the appropriate countermeasure.	
Trigger: Only the D/R can decide to measure their stress levels. Based on the available technologies, the only trigger is the person's subjective change of stress levels.	

UCscr16.4: Off-duty, after shift	
Main success scenario (MSS): Detection of stress level (1, 2, 3). MSS requires that technologies are activated in their profile. Access is granted. Related to UC A.	
Actor	**PANACEA Platform (PP)**
Sequence of numbered steps: 1. The D commutes home 2. The D wears the Fitbit wearable and the BACTrack Skyn when off duty. 3. During leisure time, off duty, the driver is provided with advice and information based on the Fitbit and Skyn data through their mobile app. 4. D updates their personal information to note any new medications.	1. The wearable tracks the drivers sleep quality and quantity. 2. PP (CCS) provides the D with advice on sleep from their past sleep history, preparing for the next shift. 3. Escalated alerts will notify the D if they are staying up too late to get enough sleep before tomorrow's shift. 4. D and O will be notified in the morning if the sleep quality was so poor that it will affect performance in the upcoming shift. 5. The D is also provided with advice on lifestyle choices. 6. The D is also provided with advice on alcohol use. 7. Escalated alerts will notify the dD if BAC levels that will affect next-day performance are reached. 8. The D will be notified in the morning if BAC levels are >0. If BAC > legal limit the operator will be notified.
Precondition: The D is off duty and need to have profiles (account) with credentials with the operator and the CCS to have access to the profile. The D/R's compliance.	

UCscr16.4: Off-duty, after shift
Guarantee: Ensures detection of poor sleep quality and when it is related to alcohol consumption the previous night. Ensures that D does not drive when they are not fit to the next day. Ensures that the D rider receives the appropriate countermeasure.
Trigger: Only the D can decide to measure their fatigue and alcohol levels.

4.5 UCscr17-26: Administrative, backend and actors-oriented scenarios

The driver/ rider depending on phase and driver type will allow access to data storage or not through their profile. Consideration should be made for those who are employees (e.g., bus drivers/ shuttle operators – part of contractual agreement, agree once) and those who are freelancers (e.g., taxi drivers – either once or case-by-case).

For example, to use an NFC card that the user can scan with their mobile phone and the person logins. We need to know/ set the NFC structure, e.g., username:pavlos&password:Spanidis. We need to know how these elements are stored in the NFC, so we can isolate them and compare them with the ones in the user database.

Decision will be on access through the following options:

1. Key/ NFC card
2. Code number
3. Biometrics (face/ thumb)
4. Traditional login (email/ username and password)

Finally, there are also some generic UC scripts that cover the system administration from the user's side, i.e., all the elements the user must introduce in the system that can be managed at any time. This includes personal user data, such as age, gender, health status, etc., so the system can create the user's profile. These UC scripts are listed below:

- Register
- Login
- Manage user's profile
- Change account details
- Log out
- Unregister
- Messaging driver/ rider/ operator (not enforcer or countermeasures' specialist development team member).
- Administration of PANACEA solution (backend administration – editing of business rules – for the company – the final end user).
- User feedback exploitation.

These generic UC scripts fall in a separate category, as they don't represent users' goals, but steps to be carried out by the users to allow an optimal use of PANACEA services. Therefore, these are not described in detail, as the rest in these UCs, but they will be included in a separate section, as they are not UC-specific. A data privacy disclaimer will be added in both the web and the Android app. The actor should be able to select their native language. At least English, Swedish, Spanish and Greek should be available. All terms will be sent out to the UC teams for translation (e.g., through Notepad ++ files).

There is no separate driver's/ rider's actor in the administrative Use Case scenarios because in the rest of the scenarios, they have the direct role and thus the relevant functions are revealed. Those related to the driver's/ rider's profile are presented in UC23. In Appendix II, UC scripts 17-26 can be found. The respective UMLs reside in Appendix III.

5 Use Case D: Knowledge and technology transferability across transportation modes

Three UC scenarios/ stories were selected based on real life events related to other transportation modes (i.e., aviation; pilot, traffic controller, remote drone controller) to explore in order to further investigate the transferability potential of know-how and/ or technologies among road and other transportation modes. The feasibility of the latter will be evaluated in WP7 and specifically A7.4 ; Cross- modal transferability impact assessment and exploitation' with the conduction of interviews, surveys, and workshops and the conduction of a literature review. A first selection of relevant topics could include, among others:1) sustainability, 2) automation, 3) inclusion and user-centredness, 4) security and safety and 5) smart mobility.

Use Case D - Story 1 Aircraft Pilot	
Structure	**Content**
Actor	Cargo Flight Pilot
Real Event	American International Airways Flight 808
Persona	Captain James Chapo;
User Story	Pre-during-post shift
Type of Impairment	Fatigue, workload
Solution	/
Countermeasure	/
Use Case D - Story 1 Aircraft Pilot	
Actor: The pilot protagonist of the event was the pilot and captain James Chapo from the American International Airways (AIA) Flight 808, a cargo flight operated by American International Airways (now Kalitta Air) that crashed in 1993 while attempting to land at Leeward Point Field at the Guantánamo Bay Naval Base in Cuba. All 3 crew members on board survived with serious injuries[19].	
Real event: The aircraft involved was N814CK, a McDonnell Douglas DC-8-61(F) manufactured in December 1969. Originally configured for passenger service, in 1991 it was sold to AIA and converted into a freighter. The aircraft had accumulated 43,947 flight hours and 18,829 flight cycles at the time of the crash. It was powered by four Pratt & Whitney JT3D-3B engines.	

[19] https://en.wikipedia.org/wiki/American_International_Airways_Flight_808

Aircraft and crew: 54-year-old Captain James Chapo had joined AIA on February 11, 1991, and had 20,727 flight hours. They previously flew for Eastern Air Lines from 1966 to 1991.

The flight to Atlanta was supposed to be the end of the crew's shift. Flight 808 was originally scheduled for a separate crew in Miami.

Crash: The flight took off from Norfolk at 14:13 EST. It was transporting mail and perishable food to the Guántanamo Bay Naval Base as per AIA's contract with the US Navy. The crew first made radio contact with air traffic control at 16:34. The controller reported instructions for approaching the airport and also stated to use Runway 10. The crew requested for this to be changed to Runway 28, to which the controller accepted and issued further landing instructions. However, at 16:42, the crew requested again for the runway to be switched back to 10, which was also accepted.

The plane had begun the turn too late, requiring it to make a steeper bank to align with the runway. At 400 feet above ground level, they increased the Angle of Bank to at least 60 degrees to make the runway and still overshooting. At 200-300 feet above ground level, the right wing stalled. The nose pitched down as the wings rolled toward 90 degrees, and at 16:56, the aircraft struck level terrain 1,400 feet from the end of the runway. The plane was destroyed by the impact and post-crash fire, and none of its cargo was salvaged. The cockpit had separated from the main wreckage and slid across the ground, coming to rest inverted with all 3 crew members alive inside, but with serious injuries.

Investigation: The cockpit voice recorder revealed that the flight crew had decided to land on Runway 10 and planned to go-around and land on Runway 28 if they missed. During the approach to Runway 10, the air traffic controller told the crew to remain within the airspace designated by a strobe light mounted on the Cuban border fence, unknown to the controller, this strobe light was inoperative on the day of the crash. The captain became fixated on trying to locate the strobe light, which led him to begin the turn too late, and failed to maintain his airspeed during the steep turn despite warnings from his other crew members.

Having been on duty since midnight, Captain Chapo had been awake for 23.5 hours. The **crew members' sleep patterns in the 72 hours previous the crash revealed that all 3 had accumulated large sleep debt from working over long shifts.** In the 3 **days before the crash, Captain Chapo slept for a total of 15 hours, First Officer Curran for 18 hours, and Flight Engineer Richmond for 21.5 hours.** Most of the **crew's shifts were done at night, requiring them to attempt to sleep in the day, which disrupted their circadian rhythm.** This aggravated the effects of fatigue on the crew, with **Captain Chapo observed suffering from various symptoms**, including **impaired judgement** with his decision to land on Runway 10, his **cognitive fixation** on trying to locate the strobe light, the **poor communication** with his crew about their decreasing airspeed, and his **slow reaction time** in avoiding and recovering from the stall. **The impaired judgement, decision-making, and flying abilities of the captain and flight crew due to the effects of fatigue** influenced the captain's ability to properly assess the conditions for landing and maintaining vigilant situational awareness of the airplane while manoeuvring onto final approach.

User Persona	Persona variables	Type of User	Type of Journey	Perform task
James Chapo is a 54 years old cargo flight pilot with many years of experience on his shoulders.	James knows that their job has high demanding task performances where they need	Cargo flight pilot	They work night shifts. They accept working night shifts, seeing the job typology and	James has been doing night shifts for years now. They cannot choose their shifts and working

They accumulated a total of 20,727 flying hours. They work night shifts and is forced to rest and sleep during the day. They have long shifts arriving not to sleep for 24 hours.	to be lucid and concentrated. They have several years of experience in these types of flights, and they got used to these shift schedules. To stay awake for more than 20 hours a day they drink coffee before and during flights. They are a social individual and has developed good relationships with his crew members. Especially with the FO they alternate and support each other. Their job is really demanding and when it happens to spend days sleeping few hours, they can't wait to have rest days.		requirements. They would prefer not to work at night, but after all they appreciate the calm and scant air traffic.	days. With their crew they have to follow strict and precise procedures but seeing the built relationship with his crew they decide in autonomy how to manage the tasks and activities as in the limit of possibilities.

User Story:

PRE-SHIFT

1. The Airline pilot works for a cargo airline company
2. Drives an Airbus A320 for commercial continental flights
3. Last night they arrived in Charleroi (Brussels) and spent the night in a hotel.
4. They are in a foreign airport and with the First Officer they spent the late-night sharing stories and information and drank a couple of beers. (How does it work for Blood alcohol level?)
5. Early in the morning of the day after, they need to go back to Charleroi airport to fly to Fiumicino Airport with another cargo.

SHIFT

1. The Captain and the FO study the plan of the day: the route flight plan, the quantity/volume of fuel needed, meteorological conditions etc.
2. The captain and the FO participate in a short briefing.
3. As captain they need to assure safety and operations, the safety of all crew members and passengers and they need to assure aircraft safety and commands taking actions to secure safety.

4. The communication is fundamental: intra-cockpit, cockpit-cabin, cockpit-ATC and cockpit-ground.
5. The captain communicates, aviates, and navigates.
6. The captain and the FO start setting up the aircraft and start communicating with the control tower.
7. They check the instrumentations, fuel levels, and communicate with ground control operators.
8. They assess all instruments are correctly working and they are ready to flight
9. The captain greets all passengers.
10. They initiate engine start procedure and proceeds to taxi to the departure runway holding point.
11. As soon as they receive clearance for departure, they initiate the take-off procedure
12. Critical phase of taking off
13. In flight: calculate fuel levels, evaluate the weather of alternate airports on the route, communicate with ATC to move from one control sector to another and perhaps obtain clearance to shorten parts of the route. Especially when flying cargo at night.
14. Critical phase of landing
15. Checklists

POST SHIFT

1. At the end of the night shift, back in Rome, the Captain, having days off, decides to meet some friends to relax and have a drink after the flight he had that day.

Type of impairment:

Night shifts, lack of sleep, alcohol intake, change in workload levels for tasks > fatigue

Attention, concentration, distraction > workload

Use Case D - Story 2 Air Traffic Controller Operator (ATCO) - ATC	
Structure	**Content**
Actor	ATCO
Real Event	Uberlingen crash
Persona	Peter Nielsen
User Story	Pre-during-post shift
Type of Impairment	Workload, Stress, Fatigue
Solution	/
Countermeasure	/
Use Case D - Story 2 Air Traffic Controller Operator (ATCO) - ATC	

Actor: The flight controller protagonist of the event was called Peter Nielsen, who worked at the control center in Zurich of the Swiss company Skyguide. Under the agreements in force at the time, Skyguide was not only responsible for the airspace over Switzerland, but also for a small part of the German airspace, which included the area in which Uberlingen is located[20].

Real event: July 1st, 2002, 23:35. **A passenger plane of the Russian company Bashkirian Airlines and a cargo plane of the DHL company collided in the sky** at a height of 34890 feet above the town of Uberlingen, in southern Germany. The Russian plane was a Tupolev Tu-154 coming from Moscow and bound for Barcelona. It was carrying 9 crew members and 60 passengers, including 45 children. The plane of the DHL express courier was a Boeing / 57 on which only the two pilots were traveling. They had departed from Barhain, had made a stopover in Bergamo, Italy, and were headed for Brussels. Minutes before the disaster, the two planes were both traveling at an altitude of 36,000 feet and were on a collision course. Unfortunately, the ATCO in charge of the specific airspace only realized the imminent danger 40 seconds before the collision, because they were working at two stations simultaneously. The first station was the one from which they controlled the so-called overflights (planes passing over his airspace), the second was instead a station to control arrivals at the local Friedrichshafen airport. Normally they would not have to work alone, but due to a practice that had consolidated in their control center, a colleague who was supposed to help them had gone to rest. The reason for this practice, not foreseen by official procedures, was that normally at that time (eleven in the evening) the workload was very low and there were no landings or take-offs.

The controller spent a lot of time managing Aero Loyd's A320 flight which had asked to land 9 minutes before the disaster having to contact the airport control tower, but the communications system was not working properly. When they returned to focus their attention on the other position, they realized what was happening. They told the Russian company to immediately go down 1000 feet. The Russians began the descent but at the same time, they received from the TCAS (Traffic collision avoidance system) the signal to rise in altitude. The procedures should have led the pilot to ignore the ATCO and follow the system. The pilot, however, confirmed the decision to carry out what the ATCO asked for. At the same time, the TCAS system on the DHL flight instructed the crew to descend, precisely to avoid colliding with the other aircraft. Only the DHL, however, followed the instructions of the TCAS and both planes dropped in altitude. The controller had no information that the system had activated in both planes and had insisted a second time on asking the Russian plane to accelerate its descent. Not only that, they had given the Tupulev's crew an indication of where the other plane was, but this indication turned out to be incorrect. By the time the two crews were finally able to see each other on sight it was too late and a final attempt by Tupulev to rise in altitude was completely useless. All 69 passengers of the Tupulev Tu-154, including crew members, died in the accident. The same fate befell the two pilots of the Boeing 757.

To complicate things slightly, Friedrichshafen airport is in Germany and, although very close to the Swiss border, it is managed by a control tower belonging to a company other than Skyguide. Nielsen was responsible for controlling both the airspace between Switzerland and Germany dedicated to passing aircraft, and another sector dedicated to arrivals at the airport. In this second sector, they had to maintain contact with the planes as long as they were in flight and accompany them until landing, coordinating in advance with the control tower of the German airport. **Normally there were no arrivals at the airport**

[20] https://en.wikipedia.org/wiki/2002_%C3%9Cberlingen_mid-air_collision

at that time and therefore this second task was considered undemanding and perfectly manageable at the same time as the other sector, where traffic was very limited during the night. This is why for several years the practice of letting one of the two people on duty rest during their nights had been established at the control center in Zurich.

Just that night, however, an A320 had arrived. Nielsen noticed that the telephone system on his station had been deactivated following maintenance. Before they knew it, they had used the phone 3 times to try to contact the airport. They then decided to get in direct contact with the plane via radio, giving them an indication to get in touch with the airport. With his colleague present, they would have spent much less time and resources to perform these functions, being able to concentrate fully on the other position, from which they controlled the sector of airspace where the other two planes were about to collide. Not only they had to divide their attention between two different operational situations, physically moving from one location to another, but they had to work with radar systems that were not entirely efficient, since they were using a fallback system due to the failure of the first. This backup system had many limitations such as the absence of the STCA (short term conflict alert). That night they could not see it activate and prevent the conflict between the two planes. They could perhaps have heard the beep (but it is not clear what the volume was), but without being able to interpret it correctly without visual feedback and that in the meantime he was intent on landing the A320.

That evening, affecting the conductor's performance was an impressive series of flaws in the defence systems that were randomly combined with each other.

User Persona	Persona variables	Type of User	Type of Journey	Perform task
Nielsen is 45 years old, worked in ATC for the last 15 years. In the last year they have been moved from the day shift to night shift. They are married with 1 adolescent daughter and 2 dogs. They accepted the night shift to bring home some more money in order to pay for his daughter's education.	Nielsen knows that for their job they need to be lucid. For that reason, they never drink during the week. They allow themself a small glass of wine during the weekend and when they are far from shifts. Their job requires a lot of cognitive effort and activation. They refer to be often stressed and fatigued after their long shifts.	They are an Air traffic controller operator	They work night shifts. They prefer working those shifts, seeing the calm and few presences of airplanes, but for his personal life it is difficult to make things match.	They have somewhat stable shifts and works 5 evenings and nights a week. They cannot manage their schedule alone, but they can decide with their collaborator who can rest and who can work. They spend their shifts controlling the above airspace for passing flights and communicating with the airport for landing planes.

User Story:

PRE-SHIFT

- This month the Air Traffic Controller is doing the night shifts. (there can be morning, afternoon or night shifts). Night shifts are volountary and they decided to them to raise some more money.
- They know that at the end of the day they will have two days off and can't wait to enjoy some well-deserved rest.
- They slowly wake up in the late morning, and at lunch hour they have breakfast.
- They start doing some activity to wake up and to prepare for the long night sitting at their position.
- In the afternoon they enjoy some leisure time and gets ready to go to work.
- Arriving at their workplace with their vehicle they get a coffee before starting the shift.

SHIFT

- Tonight, in the (Malpensa) Airport (which is one of the most if not the most trafficked Italian airport) there is an honest aircraft traffic. We are far from festivities and the traffic management is reduced from normal. As often it happens, the ATCO is going to manage more than only his position staying at the ATCO's CONTROLLER WORKING POSITION (CWP)
- They keep constant communication with the other ATCOs.
- They have to teamwork if they want to succeed in their activities.
- With their colleague they decide how to organise the shift; who will rest first and who will rest second.
- Having merged to sectors, due to the low night traffic, they decide to work with a 200NM resolution.
- They manage the incoming and exiting aircrafts.
- They make some separation and conflict detection & resolution, when possible, airplanes are near to a conflict.
- They interact and communicate with different captains with the shared standard procedures.
- They interact and communicate with all the other actors working at the airport: with Flight information service, Alerting Service, Aerodrome Control Tower, ATCOs.
- They give headings, directions and positive feedback and signals to the pilot to ascend / descend.
- The main activities are resumable to: monitor, control, issues, transfer, inform and alert.
- They mainly use the apron radar and the tower radar, the electronic strips and the meteorological display. They use the CATO (controller assistance tool) to get advice for decisions; and the STCA (short term conflict alert) as a safety tool to anticipate future collisions.
- **POST SHIFT**
- Extremely tired after the night shift, as the sun is rising, he gets back to his car and goes back home to get some rest.

Type of impairment:

Attention, concentration, distraction on different position and tasks > workload

Night shift for 2 working positions > fatigue

Critical situation > stress

Use Case D - Story 3 UAS Remote Pilot	
Structure	**Content**
Actor	UAS Remote Pilot
Real Event	unmanned MQ-9A Reaper; NY 2020
Persona	Drone Pilot Charles Morgenstern
User Story	Pre-during-post shift
Type of Impairment	Fatigue, cognitive load
Solution	/
Countermeasure	/

Use Case D - Story 3 UAS Remote Pilot
Actors: 108th Attack Squadron from the 174th Attack Wing > UAS Remote Pilot[21]
Real event: A Reaper drone crashed at the end of a New York runway because the operators mixed up the levers on the control panel. The unmanned MQ-9A Reaper quickly lost power and hit the ground about a minute after its take off from Hancock International Airport in Syracuse, N.Y. The UAS (unmanned aircraft system) was assigned to the 174th Attack Wing and operated by the 108th Attack Squadron's Launch and Recovery Element out of Hancock Field Air National Guard Base. The incident happened on a clear Thursday afternoon June 25, 2020, after a crew launched the drone with plans to swap control to another crew once it reached military airspace at over 18,000 feet after take-off. But the Reaper lost all engine power in 44 seconds, at about 150 feet MSL (Mean Sea Level) and was significantly damaged when it struck the end of the runway, crashing into runway lights and spinning 180 degrees before stopping. **The loss of engine power was due to the pilot misidentifying the Flap Lever.** Instead of pushing the Flap Lever forward to reduce the flaps, the pilot pulled the Condition Lever backward which resulted in the fuel supply to the engine being cut off stopping the engine. The two levers were an inch apart but had very different functions. The flap lever controls the orientation of the wing flaps. The condition lever controls the fuel shutoff valve, engine, and the pitch of the propeller blades. When it's fully forward, the engine operates normally,

[21] https://www.airforcemag.com/app/uploads/2021/04/25-June-20-ACC-Syracuse-Hancock-Intl-Airport-MQ-9A-AIB-Report.pdf

but at the midpoint, the fuel valve and engine shut off, and at fully back it stops the propeller blades.

The pilot continued to misidentify the levers after the engine lost power, mistakenly pulling the wing flaps all the way back, which pushed the aircraft down instead of letting it glide.

The **UAS Remote Pilot** had logged hundreds of hours of flight time, but the board found that the UAS Remote Pilot, in the BVLOS (beyond visual line of sight) became fixated on the heads-up display during take-off, which led to the lever mix-up.

The design of the ground control station console contributed to the crash, including the lack of a safety guard on the condition lever. Despite being right next to each other, both have black handles and are unmarked or differentiated by colour, the report said: "**These levers could easily be mistaken by an inexperienced, fatigued, or confused crewmember**"

User Persona	Persona variables	Type of User	Type of Journey	Perform task
UAS Remote Pilot Charles. They worked in the military squadron for the last couple of years. They are young yet they sum up to 1000 flight hours and have a lot of experience. They are in the process of obtaining their final license finishing the courses and training on safety and rescue, as well as the medical visits necessary for the abilitation.	They drink energy drinks to stay awake during the long shifts. They are aware of the high cognitive effort required in their tasks. They are aware of the need for collaboration within the squadron and other operators and the importance of being able to assertively communicate. They know how important is to properly train future drone pilot students.	Drone pilot	They work during the day. They divide their work activity between theoretical (aviation theory concepts and notions) and practical (simulation and full simulations) training; courses for safety and rescue lessons; drone pilot matters; alternating those activities between morning and afternoons.	The UAS Remote Pilot is part of the 108th Attack Squadron's which is a training unit that produces newly qualified aircrew, launch, and recovery aircrew. They train new pilots; They interact with other sector squadrons.

User Story:

PRE-SHIFT:

1. Being military, they have strict schedules. They wake up in the morning by 6am and need to be ready in a few minutes.
2. They assist the Flag raising
3. They have their morning training
4. They are having breakfast before shift
5. The Squadron altogether moves to the base thanks to the military shuttle
6. They arrive to the base and prepare for the operations

SHIFT:

1. Before arriving to the control room, they go the drone hangar to speak with the Safety Manager and the technicians to ensure that the UAS can fly safely
2. They meet with young future pilots and do some theoretical trainings
3. After the morning lectures, the trainees will have some trials in the simulators for their practical training.
4. The drone pilot has a pre-training briefing with the students
5. They assist the trainees while flying drones in the simulators, giving orders and advice
6. After the practical training they have a debrief with the trainees
7. After the morning lectures and training they have lunch
8. In the first afternoon they join again the squadron
9. Arriving to the control room they start looking at the checklist of the day
10. They have a briefing regarding the operations of the day
11. Today they have to fly a UAS and a few other UAS will transit their sector
12. They organize the control room
13. Passing of information is done with the Remote Flight Crew
14. They ensure and check the take-off site and the weather conditions.
15. The UAS Remote Pilot have a quick briefing for the day, sharing some issues and perplexities regarding the job and how it could be improved
16. They have a last check of the UAS from the Safety Manager
17. To ask the clearance of flight the squadron Captain ask the Commander of the Army the authorization request to fly
18. They ensure safe operations in the sector communicating with other squadrons monitoring the airspace, accepting and/or Handover UAS from other squadrons etc.
19. After the operations they land the UAS.
20. They compile the logbook for the day.
21. They work until dinner time

POST-SHIFT:

1. They are particularly stressed and fatigued from the day
2. They resolve some minor military matters, such as checklists
3. They have dinner with the squadron
4. They enjoy some leisure time among the squadron
5. They take part to the flag lowering
6. Lights out

Type of impairment:

Fatigue which leads to distraction and levers misinterpretation.

6 Conclusions and next steps

The current Deliverable (D1.1) has achieved to set all the theoretical basis for the work to follow in the next WPs of the PANACEA project. Specifically, it has reviewed and discussed the State of the Art and the strategic priorities in the field; it has recognised the impairment types addressed and the prominent technologies to detect, monitor and assess them; it thoroughly discusses the acceptability, view, concerns, priorities, needs and preferences of the stakeholders involved in its value chain through a user/stakeholder centric approach that encompasses focus groups, interviews, questionnaires and a workshop; and finally, it has turned into requirements and Use Case scenarios the key findings of the work conducted in WP1: "Use Cases" matching them with the original anticipations of the project workplan.

As such, **28 prioritised Use Case scenarios** are described in the current Deliverable that are going to guide the specifications (WP2), implementation (WP3, WP4 and WP5) and evaluation work (WP6) of the project. The Use Cases reflect the functions of the PANACEA platform that will be developed in the project and will be the key tangible outcome of the project along with the CHTs and respective technologies. If there will be a need for updates and revisions in the Use Case scenarios, then they will be included in the architecture Deliverable (D2.2). A first step towards the visualization of the backend processes to implement the Use Case scenarios and a description of data flows from one shift phase to the next is made and presented in Appendix V.

In addition, the literature, workshops and surveys conducted are providing valuable input of the market status, the strategic priorities in the field, the emerging business models, the practices that have been applied successfully or not so far and the key success and failure factors for PANACEA solution's deployment and penetration. This work will feed the work to be realised in the context of WP7: "Impact Assessment" and the exploitation part of WP8: "Dissemination, Exploitation, Standardisation and Policy actions", whilst part of it will help towards defining the reference case for the pilot plans in WP6: "Pilots".

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Appendix I: The Use Case scenario and script templates

AI.1 Use Case scenario definition

Description

Provide a brief description of the reason for and outcome of this use case scenario, or a high-level description of the sequence of actions and the outcome of executing the use case scenario.

Actor

An actor is a person or other entity external to the software system being specified who interacts with the system and performs use cases to accomplish tasks. Different actors often correspond to different user classes, or roles, identified from the customer community that will use the product. Name the actor(s) that will be performing this use case.

Priority

Select the priority impairing states to measure.

Pre-conditions

List any activities that must take place, or any conditions that must be true before the use case can be started. Number each precondition. Examples:

1. User's identity has been authenticated.
2. User's computer has sufficient free memory available to launch task.

Flow of Events

Provide a detailed description of the user actions and system responses that will take place during execution of the use case under normal, expected conditions. This dialog sequence will ultimately lead to accomplishing the goal stated in the use case scenario's name and description.

Alternative Courses

Document other, legitimate usage scenarios that can take place within this use case separately in this section. State the alternative course and describe any differences in the sequence of steps that take place.

Exceptions

Describe any anticipated error conditions that could occur during execution of the use case scenario and define how the system is to respond to those conditions. Also, describe how the system is to respond if the use case scenario execution fails for some unanticipated reason.

Post-conditions

Describe the state of the system at the conclusion of the use case execution. Number each post-condition. Examples:

1. Document contains only valid SGML tags.
2. Price of item in database has been updated with new value.

Business Rules

Identify business rules captured or referred to in this use case scenario. The business rules are about the logic and business and the reasoning (business rules' repository). For example, in our case, if the person is driving and alcohol level is above the legal, then they must stop driving.

Special Requirements

Identify any additional requirements, such as non-functional requirements, for the use case scenario that may need to be addressed during design or implementation. These may include performance requirements or other quality attributes.

Artifacts

List and describe any artifacts created by the system. System artifact is a tangible document created through the system development process. Examples are requirement specification documents, design documents, source code, and executables. Artifacts are sources of facts about the system.

Notes and Issues

List any additional comments about this use case, any remaining open issues, or TBDs (To Be Determined) that must be resolved. Identify who will resolve each issue, the due date, and how it will be resolved.

AI.2. Use Case scenario table

1. Description
Provide a brief description of this use case

2. Actors
Actor 1: describe the role of this actor
Actor 2: describe the role of this actor

3. Priority

4. Pre-conditions

5. Flow of Events		
Flow Identifier: Enter the flow name and brief descriptor		
Step	**User Action**	**System Response (optional)**
1		
2		
3		
4		

6. Alternative Flows		
Flow Identifier:		
Step	**User Action**	**System Response (optional)**
1		
2		
3		
4		
Flow Identifier:		
Step	**User Action**	**System Response (optional)**
1		

2		
3		
4		

7. Exception Flows		
Flow Identifier:		
Step	**User Action**	**System Response (optional)**
1		
2		
3		
4		

8. Post-Condition
This use case can end with the following post-conditions: 1. 2.

9. Business Rules

10. Special Requirements
1. 2.

11. Artifacts
1. 2.

12. Notes and Issues
1. 2.

AI.3 Use Case Script table

Use Case Script
Main success script (MSS):
Sequence of numbered steps: • **A step:** an interaction between an actor and the system • Simple statement stating who carries out the step • Intent of the actor and not how it is done on the GUI

Extensions: Other scenarios (successes or failures)
• *A condition:* when should we deter from the MSS?
• *Differences:* what should be different?
• *Questions to ask:*
  ○ How could MSS go differently?
  ○ What could MSS go wrong?

Precondition: what should be ensured before the system allows the UC scenario to begin
Guarantee: what the system will ensure at the end of the UC scenario
Trigger: specifies the event that forces to UC scenario started

Appendix II: Administrative, backend and actors-oriented scripts

In this section, all the remaining horizontal, i.e., administrative, backend and those related to different types of actors scripts are described. Bullet points instead of steps are used because the order of presentation is not definite/ restrictive of order of occurrence. In other words, the order they are presented in the scripts does not define when they happen/ occur.

AII.1 UCscr17: Operators

Operator interactions (with PP and other actors)	
The operator's main application will be the iPanel with a PP layer for the connection between the ipanel and the web application of the project. The ipanel Help Center describes all existing functions that are available but are not necessarily relevant to PANACEA project. The functions that will be re-used are in *italics*. Those that will be new or need adaptation are presented as normal. Not many italics will be used, however, as the functions that are already available will not be repeated in the steps that follow, only if they are necessary for the described flow. The Operator can be an analyst, a health and safety operator and other posts according to the organisation's structure.	
Actor (operator, mainly fleet monitoring and management)	**PANACEA Platform (PP)**
Operator, Analyst (monitoring for events, incidents) [22]	**Impairment level and compliance with countermeasure**

• The Operator receives a notification that the X5678 is on fatigue level 2, along with their location and their shift phase.
• The Operator receives the notification that X5678 received the warning and the advice to find a rest area and has a caffeinated beverage and/ or 20-minutes' rest.
• The Operator is notified that the driver followed the countermeasure.
• The Operator checks the driver's status:
  ○ Driver is temporarily checked out for rest.
  ○ Vehicle is stopped and engine is off.
  ○ Driver is not on the seat (checking the camera).
  ○ Driver is in a designated resting area (GPS localization).
	• PP notifies the operator that X5678 driver/ rider is fatigued level 2 and that they have been informed about their status.
	• PP notifies the operator that X countermeasure was sent.
	• PP notifies the operator that the driver complied with the countermeasure.

Operator(s)	**Shift phase**

[22] **Operator:** This cluster can include more than one type of employee, depending heavily on company structure and type. The main role taken up and this is the priority UC to be implemented, is fleet operator than manages and monitor the drivers/ riders' daily routes.

Operator interactions (with PP and other actors)	
• The Operator notices that Driver X59345 is on shift and *checks their schedule, delivery points*, shift duration, technologies active (i.e., CHT active).	• Driver X59345 status from off (red) changed to during driving (green) on the operator's dashboard.
• **Exception 1:** Driver/ Rider does not comply to countermeasure. ○ Operator receives notification on their dashboard about X59345 being not compliant to countermeasure sent on 09.45 today because they were fatigued. ○ The Operator checks where the driver/ rider is right now on their route, so to ensure they can safely talk. • **Exception 2:** The driver receives a call from the operator. ○ The driver agrees to comply with the countermeasure. ○ The accept the countermeasure.	• **Exception 1: Notification of non-compliance is sent to the operator.** ○ PP notifies the Operator that the Driver/ Rider is not complying with countermeasure. ○ The *exact location of the driver/ rider is shown on the map along with current route, speed, and remaining time to reach their destination*. ○ It is shown that the vehicle is stopped, and the driver/ rider is not driving/ riding. • **Exception 2: Notification of emergency** ○ The operator receives a flashing notification for a certain driver. ○ The operator opens the driver's profile and receives a notification that they fatigue level is 3, steering and lane departure is extremely variant, and the driver does not comply with the suggested countermeasure for the past hour. ○ The operator calls the driver and they answer. They are asked to comply with the countermeasure. ○ The operator receives the notification that the driver complies with the countermeasure. ○ The operator makes a note of this event and shares it with the countermeasures' specialist and the analyst operator. ○ The cloud-based countermeasures system also has access to this event. ○ The countermeasures' specialist receives the notification that the driver complies with the countermeasure.
Operator(s)	**Menu preferences (apart from the ones already available in ipanel)**
• The operator selects to receive separate types of notifications for the following: ○ Impairment type and Level – auditory notification and push information. ○ Countermeasures sent– auditory notification and push information.	• PP asks the operator if they want to store the preferences. • PP stores the preferences. • PP asks the operator if they want to store the preferences. • PP stores the preferences. • PP asks the operator if they want to store the preferences.

Operator interactions (with PP and other actors)	
○ Countermeasures (non) compliance – auditory notification. ○ Communication in chatbox – auditory notification. ○ Incident – auditory notification and push information. ○ Event – auditory notification and push information. • The operator changes their mind and wants to receive push notification with the content for any communication in the chatbox. • Select to view 'Vehicles' per 'Type' • Select to view per UC	• PP stores the preferences. • PP asks the operator if they want to store the preferences. • PP stores the preferences.
Operator(s)	**Access to fleet**
• The Operator selects to view the number of vehicles and types of vehicles per fleet. • The Operator selects to view on the map the whole fleet (position, speed, issues, incidents, events, impairments, countermeasures, on shift, off shift) ad hoc. • The Operator wants to visualize some of the information provided for the last two weeks and only for the drivers who showed fatigue level 2 during their shift. • The Operator selects to create a report based on these visualisations and the selection criteria.	• PP presents on the operators' dashboard these pieces of information based on their selection. • PP presents the charts and the visualisations for the selected aggregated data. • A report is created for this visualization and is stored on the 'Reports' tab of the dashboard.
Operator(s)	**Access to actors (mainly drivers/ riders)**
The operator communicates with the other core actors through the communication module as described in UC13.	
Operator(s)	**Creation/ Access to reports**
• The operator goes to the Reports tab. • The operator searches for a past report. • The operator wants to create a report on alcohol consumption, illegal drugs events from roadside and pre-assessments for the last six months. Fields for creating a Report that are relevant o PANACEA are: ○ Impairment type and level ○ Countermeasures' compliance or not	• PP creates the Report based on the request made by the operator. • The Report is created and opens for the operator. • PP asks the operator if they want to save the Report.

Operator interactions (with PP and other actors)	
○ Incidents and Events ○ Vehicle Type ○ UC ○ Driver ID ○ Shift phase • The operator views the report and saves it under the Reports tab for future reference.	
Operator(s)	**Notification of events and incidents**
Apart from the ones already available in 'Incidents' tab. • The operator receives a notification about Driver X5431 under the influence of illegal drugs during their shift at route X by enforcer S. Drugfinder on time, date. ○ This information is also available on the iPanel as an incident and it is highlighted with red and it is of High significance. • The operator confirms to the Enforcer that they received the message. • The operator contacts Driver X5431 through the communication module to ensure they are ok and verify the situation. • The operator searches on the dashboard for the nearest driver. • The operator can see this driver's type of vehicle, their route for delivery and their exact location. • The operator asks the driver if they can go and bring the other vehicle back to the hub after they finish with their route. • Driver agrees to do so. • The operator sends the location and the vehicle type to the driver to pick it up at the end of their shift. • Driver confirms to do so. • This information is added to the incident report.	• PP sends a push notification from Enforcer that Driver X5431 was found to be under the influence of illegal drugs (*name, content*) and will have to follow the enforcer team at the nearest police station for further investigation and blood testing. • PP sends confirmation to Enforcer that the push notification has been received by the operator. ○ This piece of information can be also shared with the countermeasures' specialist, the Driver and other core actors. • PP searches for the nearest driver and finds one 3.5 km away.
Operator(s)	**Access to drivers'/ riders' profiles (optional)** *Only if and for those parts that it is granted by the profile owner and/ or administrator in case of emergency.*

Operator interactions (with PP and other actors)	
• The operator has accessed the health report and wellbeing preferences set by the driver/ rider on their profile space. • During the pre-assessment, the driver was found to be under anxiolytic medication, which for the country the person lives and works, it is legal, but they have to determine the content and the amount they take on a weekly basis in order to verify that this is the case for this driver. • To do so, the operator accesses their health record from their profile. • The operator makes a note of this information to their dashboard about this Driver (Driver's tab in operators' dashboard).	PP opens up the health record of this Driver with information on their prescribed anxiolytic medication, which they take for the last six months, and it is legal.
Operator(s)	**Telematics (Live,** Diagnosis, Activity**)**

Apart from the ones already available in 'Live' tab of iPanel.
• The Operator views in live mode information about the:
  ○ Technologies active (CHTs active)
  ○ Shift phase of drivers
• The operator selects to view information about selection of these pieces of information.
• The operator selects to view these pieces of information for certain routes, day, weeks, months.
• The operator selects to visualise the information on the map.
• The operator selects to visualise the information on the map.
• The operator selects to share the information with another operator.
• The operator selects to extract the
• The operator selects to refresh the page.
	PP presents the pieces of information selected by the operator.
	PP visualizes the information on the geographical map.
	PP shares the information with the operator chosen by this operator via email.
	PP visualizes the information per week and months with two graphs and a pie chart.
	PP extracts the information either in csv and/ or pdf files.
	PP refreshes the page and new information is available.

Operator(s)	**Telematics (**Live, **Diagnosis**, Activity**)**
Apart from the ones already available in 'Diagnosis' tab of iPanel. The following information is available to the operator per driver/ rider and per fleet: • Baseline assessment • Calibration performed • Current fitness to drive (ad hoc)	• The 'Diagnosis; tab is open on the 'Telematics' menu of the operator's dashboard. • Any selection made on the left-hand side appears on the dashboard per driver and/ or aggregated, depending on the operator's selection.

Operator interactions (with PP and other actors)	
○ Thresholds reached ○ Thresholds passed • Fitness to drive per phase ○ Pre-driving (on-site) ○ During driving ○ Roadside ○ Off-duty • Countermeasures sent • Countermeasure compliance • Countermeasure's non-compliance • Countermeasures applied; no change observed • For the past week • Month • 6 months • The operator views in real-time all the above information and create visualizations for them. • The operator saves the visualisations under the 'Report' tab in a pdf format (choices of at least pdf and csv are available). • Then these visualizations along with the reports they are shared with the operators' team currently at site.	• The visualization is created and open in a separate window. • The visualization is stored in pdf format under the 'Report' tab. • The visualizations and the weekly current report are shared via email with the other 4 operators who are now on shift.
Operator(s)	**Telematics (**Live, Diagnosis, **Activity)**
Apart from the ones already available in 'Activity' tab of iPanel. ○ Average speed ○ Shift phase and shift duration (e.g., 60% of phase is completed) ○ Current route ○ Traffic Management ™ info: ▪ Weather conditions ▪ Traffic congestion (yes/no) ▪ Anticipated delays ○ Next stop (bus, delivery, drop-off and rest) ○ vehicle parameters related to the technologies	• Any selection made on the left-hand side appears on the dashboard per driver and/ or aggregated, depending on the operator's selection. • The visualization is created and open in a separate window. • The visualization is stored in pdf format under the 'Report' tab. • The visualizations and the weekly current report are shared via email with the other 4 operators who are now on shift.
Precondition: The actor is already logged in to the web application and/ or the iPanel. There is a dedicated operator profile space.	
Guarantee: The operator has access to fleet, event, incident management as well as monitoring and detecting of impairment, its levels and countermeasures administered to company drivers/ riders.	

Operator interactions (with PP and other actors)
Trigger: Incidents, events, issues, errors impairments, etc. detected.

AII.2 UCscr18: Technology/ Service provider

Technology/ service provider (TSP)	
The technology/ service provider can access the PP through the PP (technology/ service registration module), using any device with an Internet connection.	
Actor	**PANACEA Platform (PP)**
TSP	**Technology/ service registration module**
	Registration/ Authentication/ login
The TSP accesses the registration page of the PANACEA web application and selects to register by adding an email address and selecting a password. TSP enters the email address and the password to the respective fields.	PP prompts the TSP to re-enter the password (at least 8 alphanumeric digits, at least one cap letter, at least one number, and at least one symbol) and strength of selected password is shown. PP redirects TSP to the login page. PP authenticates the credentials and grants access to TSP to PP.
Exception 1	**Failure to register (wrong credentials)**
TSP enters a password that does not satisfy all requirements.	PP informs TSP about the requirements that was not satisfied, i.e., a number was not used.
TSP selects a password with a number.	PP confirms registration and re-directs TSP to login page.
TSP enters the credentials.	PP registers TSP.
TSP enters the credentials and logins.	PP authenticates TSP.
Exception 2	**Failure to login**
TSP enters the wrong email address or wrong password. TSP receives the email and accesses the url in the email and creates a new password, which is asked to add twice. TPS enters the new credentials (either email and/ or password) and logins to PP.	After 3 wrong attempts, PP asks to enter their email address to create a new password. PP authenticates the change of password and re-directs TSP to login again.
Alternative	**Login with code**
TSP is issued by their company with a unique 4 digits code which they add in the field.	PP authenticates TSP and grants access to PP.
Exception 1	**Failure to login**
TSP is issued by their company with a unique 4 digits code which they add in the field.	PP cannot authenticate TSP and informs them that this is the wrong code and that they have to contact the Administrator. PP informs A about failure to login with the unique code.

Technology/ service provider (TSP)	
TSP uses the new code received via SMS and logins to PP.	A issues a temporary code or resends the code to TSP's preferred medium (e.g. mobile phone and/ or email).
	TSP Profile/ preferences (optional)
TSP enters their own profile where they have the following options: Personal • Add a picture • Change picture • Change email address • Change picture • Add address • Add mobile phone Technology/ service • Add technology/ service • Edit technology/ service • View existing technologies/ services • Adding / editing business rules Access data (Optional: to select per technology/ service type) • Data (raw) • Visualizations • Events ○ Impairment type • Metadata • Other QoS indicators • Set by WP2, WP3 and WP4 Communication • Administrator • Other technology providers (optional)	
	Adding a technology/ service
• The TSP selects the option from the TSP profile menu to add a technology/ service.	The Add a technology/ service opens with several fields to be completed about the

Technology/ service provider (TSP)	
• The TSP adds the necessary information for the fields shown in the right-hand side. • The TSP saves the information added.	characteristics of the technology/ service. The following is an indicative list: • **Name:** The name of the technology • The **impairment/ driver state** it addresses • **Vehicle type:** The vehicle type it is used on • **Location and UC:** The location (city) where the technology will be tested • **Business rules:** General, business rules of the service that may affect the drivers, but also the operators, companies, etc. • **API availability:** The availability of an existing web API • **API type:** The response type (JSON, XML or both) of the web API • **API URL:** The base URL of the web API • **Comments:** Additional comments/remarks of the technology/ service provider in relation to the operation of the technology/ service.
	Editing a technology/ service
• The TSP selects the field with the API url. • The TSP deletes the previous url and adds a new one in the field. • The TSP saves the information.	• The PP presents the field with the existing API url information. • The PP asks the TSP if they want to save the information. • The PP confirms that the information has been saved.
	View existing technologies/ services
• The TSP selects to view the other technologies added to PP.	• PP presents the Technologies/ services for which the completed forms exist.
	Adding/ editing business rules (this is presented in UCsc22)
The information added in this part, it is described in detail in UC10, but here only a high-level description of the business rules for specific technology/ servicer are required.	
Precondition: The TSP has at least one technology/ service registered and integrated to PP.	

Technology/ service provider (TSP)
Guarantee: TSP is registered. TSP has access to their profile and technologies' information and status.
Trigger: Need to access the PP and control, monitor, improve, rectify the PP related processes and workings, communicate with the actors of the PANACEA solution (be part of its ecosystem).

AII.3 UCscr19: WP5 Development Team Countermeasures' specialist (responsible for the content of CCS)

Interaction between the WP5 development team (CS), the cloud based countermeasures system and PP (CS Actor)[23]	
Actor	**PANACEA Platform (PP)**
Countermeasures' Specialist developers (CS)	**Add a countermeasure**
To add a countermeasure to cloud-based countermeasures system • WP5 development team CS is already logged in the countermeasures system • CS selects 'Shift phase'. • CS selects During Driving. • The CS selects the 'Impairment Type' option. • CS selects impairment type 'Stress'. • CS selects stress level 2. • CS selects 'Vehicle Type' and then the vehicle. • CS selects the vehicle 'Taxi'. • CS selects the 'Add countermeasure' button • CS selects to add text in the countermeasure. • CS selects to accompany the text with an auditory warning. • CS sets the level of sound and the duration of the sound (if appropriate). • Changes the text type, size, colour, makes the text bold • CS selects to upload the text and the accompanying sound (if appropriate). • CS names the countermeasure. • CS saves the countermeasure.	• The following shift phases are available: Pre-driving, During Driving, Roadside and off-duty. • The impairment types options appear to CS: Licit Drugs, Illicit Drugs, Alcohol, Fatigue, Stress, Cognitive Load (underload/ overload). • The 'Vehicle Type' options are: Bus, Shuttle, Taxi, PTW, Truck, and Coach. • The text editor appears with basic formatting options. • Auditory warning options appear: a) Sound level, b) frequency of appearance, c) duration of appearance, d) when it appears after detected event, e) Repetitions.

[23] The interactions with the countermeasures' system will be further investigated and discussed in A5.5 and D5.2 and its update D5.3.

Interaction between the WP5 development team (CS), the cloud based countermeasures system and PP (CS Actor)[23]	
	Change/ update countermeasure
• To change/ update a countermeasure within the cloud-based countermeasures system • CS selects the 'Stress for Taxi drivers'. • CS selects to remove auditory from 'Stress level 1' in 'Off-duty' for all 'Vehicle Types'. • CS selects 'All vehicle Types' • CS selects 'Off-duty' • CS selects Stress level 1 • CS deselects auditory warning. • CS saves the changes made in current selection. • CS saves the changes.	• The countermeasures' menu opens. • PP asks CS if they want to Save' the changes with the same name or different. • PP confirms changes are saved.
	Delete countermeasure
• To delete a countermeasure within the cloud-based countermeasures system • CS selects to delete the countermeasure with name 'Fatigue for shuttle drivers. • CS confirms deletion. • CS selects 'No'.	• PP asks CS if they are sure they wish to delete the countermeasure with this name. • PP informs that this countermeasure is deleted and asks if CS wants to create a new one. • PP redirects CS to the main landing page of countermeasures.
	View countermeasure use (compliance/acceptance) (aggregated/ per driver type/ per person)
• To view countermeasure use recorded by PP • CS selects to view the compliance percentage for coach and truck drivers the last two months and also for driver X5678.	• The analytics dashboard presents that 15 coach and truck drivers followed the suggested countermeasures and that this mounts to 72%. • Driver X5678 was compliant 75%.
	View countermeasure non-use (non-compliance/ non-acceptance)
• To view countermeasure non-use recorded by PP • CS selects to view the 25% of times Driver X5678 was not compliant. • CS flags the driver as a potential follow up . • CS flags the operator as a potential follow up . • CS checks if there any restrictions set by the driver/ and/ or operator about the	Driver X5678 was not compliant when they were off duty.

Interaction between the WP5 development team (CS), the cloud based countermeasures system and PP (CS Actor)[23]	
communication and finds out, there are none.	
	Communicate with driver/operator/enforcement officer
• The cloud-based countermeasures system sends an automatic notification through the chat box, that a relevant countermeasure is available. • •	The chat box opens The driver/operator/enforcement officer appears active right now. • The operator receives the message with the suggested countermeasure . • The operator accepts or rejects the countermeasure suggestion.
	View feedback about countermeasures
CS selects to view feedback by coach drivers for CHT C the last week.	• Feedback by 4 coach drivers is provided for week 48. • Open-ended comments are provided online with information about time and day of the comment, the driver who commented (if the driver has added their name), related UC, vehicle type and the actors who have access to this file.
Precondition: CS is registered to PANACEA platform and the countermeasures' system and is logged on the system. These steps describe the functions that are needed to be in place in order to succeed interaction and sharing of countermeasures with the PANACEA platform.	
Guarantee: Countermeasures are online and available to be delivered to the vehicle user.	
Trigger: Set by WP5 for any available countermeasure. The trigger might be the activation of events.	

AII.4 UCscr20: Enforcer

Enforcer	
Actor	**PANACEA Platform (PP)**
Enforcer (E)	**Add an Event**
• E is already logged on to the enforcer's profile. • E adds a new 'Event'. • E adds 'Country'. • E selects UC (optional). • E selects 'Vehicle type' • E selects Driver ID. • The E selects the 'Impairment Type' option. • E selects impairment type 'Alcohol'. • E views the 'Alcohol measurement'. • E accepts the measurement to be save on the new Event.	• PP opens the new 'Event' page. • PP 'Alcohol' level is presented on the screen with the accompanying text mentioning the legal implication (or not) of this measurement, e.g. 'Alcohol level is X and Driver X is not intoxicated.' Driver X is fit to drive'. • PP asks the E to save this alcohol measurement to the 'Event'. • PP confirms the creation of a New Event with name: Drive ID_IMPAIRMENT TYPE_DATE.

Enforcer	
• E accepts to save the new Event with this name.	
Exception 1: Alcohol level with legal implication • E views the 'Alcohol measurement' and the alcohol level is above the legal limit. • E accepts the measurement to be saved on the new Event. • E accepts to save the new Event with this name. • E shares the new Event with the driver and the operator via email. **Exception 2: Licit/ illicit drugs with legal implication** • E views the 'Licit (Illicit) Drug measurement' and the alcohol level is above the legal limit. • E accepts the measurement to be saved on the new Event. • E accepts to save the new Event with this name. • E shares the new Event with the driver and the operator via email.	• PP opens the new 'Event' page. • PP 'Alcohol' level is presented on the screen with the accompanying text mentioning the legal implication of this measurement, e.g., 'Alcohol level is X and Driver X is intoxicated.' Driver X is NOT fit to drive'. The fine is X.' • PP asks the E to save this alcohol measurement to the 'Event'. • PP confirms the creation of a New Event with name: Drive ID_IMPAIRMENT TYPE_DATE. • PP opens the new 'Event' page. • PP 'Licit (Illicit) Drug' level is presented on the screen with the accompanying text mentioning the legal implication of this measurement, e.g., 'Licit (Illicit) Drug level is X and Driver X is under influence.' Driver X is NOT fit to drive'. The fine is X.' • PP asks the E to save this alcohol measurement to the 'Event'. • PP confirms the creation of a New Event with name: Drive ID_IMPAIRMENT TYPE_DATE.
	Add to an existing Event/ Change/ update
• E selects from the Events menu the latest event appears on the screen. • E selects to add 'Notes' to the Event description. • E adds a 'Note' about the state of Driver X and the condition of the examination and measurement. • CS saves the changes.	• The Events menu opens. • The latest event appears, and it is the 'Drive ID_IMPAIRMENT TYPE_DATE'. • The 'Notes' section opens. • PP confirms saving the updated version of this Event.
	View/Delete Event
• E selects to delete the countermeasure with name 'Drive ID_IMPAIRMENT TYPE_DATE'. • E confirms deletion. • E selects 'No'.	• PP asks E if they are sure they wish to delete the Event with this name. • PP informs that this Event is deleted and asks if E wants to create a new one. • PP redirects E to the main landing page of the Events page/ tab.
	Share Event

Enforcer	
• E selects to view the Events related to this Driver for the past 3 years. • E views that the previous Event happened 14 months and it was a random drug test which was also negative. • E selects to share via the chatbox. • E shares this event with the operator. • O receives the event and confirms it to E.	• 2 Events appears on the screen. • PP asks E to select the way to share the event (email, chatbox, other).
	Communicate with operator and other core actors
• E enters the chat box on their profile. • E selects to contact the operator responsible for the coach driver X4567H during the afternoon shift 3.00-9.00 to ask them a few things about any events happening to investigate a licit drug's event. • E sends a message with their query. • E receives information about specific query of the driver's profile and health record and sends a thank you message to the operator. CS closes the chat box.	The chat box opens The operator O34359 appears active right now. • The operator receives the message with the E's request. The operator shares only the requested information to E. based on agreement with driver on which parts of their profile are shareable and with whom through the secure chatbox and sends a goodbye note to E.
E communicating with coach driver (UCC, as an example)	**Communicate with driver/ rider**
• E uses the chat box to communicate with the coach driver. • E asks the coach driver about the DUI seminar they have to attend. • E thanks the coach driver and asks if they can share this information with the operator. • E informs the coach driver that will not happen, as this is their wish and asks them to contact them if they have any issues, worries and/or even questions about the countermeasures.	• CD receives the message from E. • CD replies to E's message and shares information about the DUI, as well day and time of the seminar. • CD kindly asks ECS to do not share this piece of information with the operator. • CD thanks for getting in touch and informs E that they will do so, if they feel they want to contact them.
	View feedback about enforcement
• E selects to view feedback by coach drivers for CHT C the last week.	• Feedback by 4 coach drivers is provided for week 48. • Open-ended comments are provided online with information about time and day of the comment, the driver

Enforcer	
	who commented (if the driver has added their name), related UC, vehicle type and the actors who have access to this file.
Precondition: E is registered to PANACEA platform and is logged on PP. These steps describe the functions that are needed to be in place to succeed interaction and sharing of the event with the PANACEA platform and respective core actors.	
Guarantee: The alcohol and (licit/ drug) measurement is taken, and the legal action (if necessary) is taken, and driver/ rider remains safe.	
Trigger: Enforcer initiates measurement. The trigger might be the activation of events.	

AII.5 UCscr21: Administrator

Administrator role (Overall platform operation/functional aspects)	
This UC is specifically related to WP2, as it relates to the backend workings. Management of different parts of the PP can be separately granted depending on the security protocols, the level of access granted and the role of the administrator. The overall PP administrator has access to all the management roles mentioned in this UC scenario. The steps of the workings will be further defined in WP2, as they related to the FIWARE architecture and not the user-facing interactions.	
Administration/ actor with administration rights	**PANACEA Platform (PP)**
	Create an administrator/ an actor's profile/ grant access
	Registration
• When the actor attempts to login, a query (query profile) is sent to technology/ service orchestrator, the authentication/ authorization module and another to the user data repository and the person is authenticated. • The same query process is followed for the password. • An alternative path is requested if the person enters the wrong username and/ or password.	Authentication and authorization • The PP must provide support for authentication and authorization • The PP authentication system must be compliant with standard of Single Sign-On (SSO) • The PP authentication system has to support the recovery and change of password
• An alternative to the above is the failure of login in because of wrong password or wrong username. • The admin. controls the submission, and display of updated profile after it has been saved in technology orchestrator	

Administrator role (Overall platform operation/functional aspects)	
and data repository and returns the profile to the actor[24]	
• The admin. selects to grant access to other actors, as general administrators and/ or actors. • The admin. selects an operator to have full administrator access to the platform	**Grant access rights/ make other administrators** • Authentication and authorization must be managed by the Administrator
• Grant access to actors • Control access to actors • Create an actor's profile • Manage an actor's profile • Monitor an actor's profile • Delete an actor's profile	**Actors' Access management** • Actors' profiles have to be managed and monitored by the Administrator.
• PP (backend)	**Content management**
	Technology/ service/ sensor management

• Add/ edit/ remove technology to CHT (UCA, UCB, UCC)
  ○ Select scenario for integration (in collaboration with Technology/ service provider
• Add/ edit/ remove technology specifications/ requirements
• Create/ edit/ remove a dataset/ repository
• Test/ verification of data collection
• Calibration/ edit/ update of data collection
  ○ Temporal
  ○ Per vehicle
  ○ Per shift
  ○ Create baseline
• Finalise integration of technology to PP
• Grant/remove access to selected actors to use the technology alone and/ or within the respective CHT through PP.
	• The PP has to provide support for creating, publishing, sharing, distributing and deleting datasets

PP (backend)	**Communication and supporting content management**
• Add/edit/ delete of artefacts, explanatory notes, read me files for technologies, CHTs, datasets	

[24] Returning can be to the Android application and/or the web application and/ or the countermeasures' system, depending on the actor.

Administrator role (Overall platform operation/functional aspects)	
• Add/ edit/ delete of standards and rules for adding and removing • Add/edit/delete communication protocols and standards • Add/ edit/ delete training material for administrators, administrator support and other actors wherever this is deemed necessary	
PP (backend)	**Data management**
• Share datasets • Create datasets from different data sources • Create datasets from the same data sources • Create datasets per vehicle type • Create datasets based on timestamp, week, month, year, specific dataset setting. • Create a dataset based on queries and/or rules defined in WP3 and WP6. • Run quality check to data (remove empty cells, remove unreal measurements/ non-existing, identify outliers) • Create visualizations and basic analytics • Share datasets • Share aggregated results • Share visualisations and analytics • Select data per person • Select data per impairment type • Select data per impairment type level • Select data for a combination of impairments • Select data for a combination of levels of impairments • Select data per shift level • Select data for shift level, impairment type, impairment combinations and impairment level. • Select datasets on vehicle type layer • Select datasets on UC (i.e., CHT) layer • Select data based on custom queries/ rules	• (The PP has to provide support for creating, publishing, sharing, distributing and deleting datasets) • The PP has to be capable to provide data navigation, selection and filtering • The PP has to provide support to perform queries and access to the results • The PP has to be capable to allow developers to access data (according to data ownership and privacy) and process them • The PP has to be capable to implement data analytics including predictive models, statistical analysis, etc. using Rstudio and/or Python The PP must be capable to allow users to perform data visualization and create Dashboards

Administrator role (Overall platform operation/functional aspects)	
• Grant access to dataset(s) • Control access to dataset(s) • Create a dataset(s) • Manage a dataset(s) • Monitor a dataset(s) • Delete a dataset(s) • Share a dataset(s) • Extract a dataset(s) • Anonymise a dataset(s) • Pseudonymise a dataset(s)	**Data access management** • The PP has to provide support for creating, publishing, distributing and deleting datasets • Data owners have to be capable to extract and finalize an own dataset for publication • The PP has to be capable to implement data transformations such as: transcoding, data gathering, anonymizing, stream processing, loading and storage, typically by means of ETL and ELT programming, as well as visual programming tools. • The solution has to be capable to use the same data processing paradigm for business logic definition of data rendering
• GDPR implementation • National legislation implementation • PANACEA ethical and data privacy policy implementation • UC and pilot site ethical and data privacy implementations • Terms of Use, Privacy disclaimer, Cookies statements implementations • Security protocols implementation • Security mechanisms and s/w implementation • Security standards implementation • Manage threats/ attacks protocols, s/w, reporting implementation • Safety protocols and standards implementation	**Security and safety management** • The Data Access must be managed according to GDPR • The solution must provide: Terms of Use, Privacy policies, Cookies statements implementation • The PP has to be compliant with security levels of standard Penetration Tests
• Administrator and actor(s) granted access to visualization and analytics	**Visualization and Analytics (incl. QoS) management (Knowage real-time display)**
• Perform different big data analyses • Static reports • Maps • Network views • Interactive cockpits • Data/Text mining models • Reports • Multidimensional analysis (OLAP)	• The PP has to perform different kinds of Big Data analytics and multidimensional analysis • The PP has to be capable of representing results on visual analytic tools and Dashboards • The PP has to support geo-referenced and location-based services (e.g., GIS) and data visualization on maps

Administrator role (Overall platform operation/functional aspects)	
• Data exploring with drag & drop query builder. • Simple but also advanced and complex visualisations • Enterprise reporting • Plot data over maps, vectorial pictures, space, etc. • deliver insight with mash-up techniques without moving data to plot business data over a map, over a space, over a schema, over a vectorial picture without moving data between GIS system and DWH environments; • Define strategic scorecards • measure and evaluate performances through thresholds and from different point of views • alerting for critical issues • giving facilities to make the reaction possible soon; • Perform advanced processing using data mining techniques for forecasting and prescriptive purposes. • Simulate an action, evaluating its effects on different and related assets. • Run analytics and perform business intelligence functions on the current and historic contextual data managed in smart applications. • Historical analyses performed querying the context data storage system. • Evaluation of Key Performance Indicators (KPIs). • Notifications/ alarms sent to technologies, web and mobile applications.	• The PP has to perform analysis on historical and contextual data • The solution has to enable the creation of predictive models and simulations for producing early warnings, alert and notifications, supporting decision-making processes • The PP has to enable evaluation of Key Performance Indicators (KPIs)
• Add/ Edit/ delete business rules • Verification of business rules implementation	**Business rules' management** • The PP has to be capable to manage business rules via visual programming tool (e.g., Node-Red – IoT App)
• Manage feedback box operation • Monitor feedback box operation • Collect open feedback box	**Feedback**

Administrator role (Overall platform operation/functional aspects)	
• Add close-ended question items • Create report of feedback based on user-selected queries • Create visualisations of close-ended question items • Store feedback • Add/ update security protocols • Share feedback with actors	• The PP has to be capable to collect, manage and report feedbacks from users
• Dataset reports • Actors' logging reports • Errors and (no) solutions reporting • Exceptions' reporting • Add/ edit/ delete artefacts	**Reports and exception management (incl. artefacts)** • The PP has to produce reports for the different actors' activities: logging, operations, errors etc.
Precondition: Administrator has complete access to different parts.	
Guarantee: Ensure healthy, efficient, and safe operation and use of PP.	
Trigger: N/A use of PP requires the administrator role and work is established; prior any UC can be materialised/ operationalised.	

AII.6 UCscr22: Business rules

Business rules	
Actor (relevant for administrator, service/ technology provider and potentially an operator)	**PANACEA Platform (PP)**
• Admin. Selects the SENSEAIR Go technology and sees that three business rules have already been added and wants to add a fourth one.	**Select technology** The PP has to be capable to manage business rules via visual programming tool (e.g., Node-Red – IoT App)
• Admin. selects to add a business rule • Admin. adds a brief description of the business rule and its name. • Admin. edits the validity times (shift phases) and or other (pre-) conditions necessary for the technology to work. • Admin updates the Terms and Conditions of the technology • Terms and Conditions of CHTs • Terms and Conditions of combination of technologies. • Privacy disclaimer. • Possible combinations with other technologies/ services/ sensors offered through the same CHT or different via PP.	**Add/ edit/ update/ delete business rule**

Business rules	
These are standard examples: The exact type and content of the business rules will be provided For the CHTs, the decisions will be made in WP4 in collaboration with UNI, CHALMERS and CERTH (technical and data manager of the project.	**Standard examples: Adding Terms and Conditions**
	Standard examples: The privacy policy and access conditions
	Standard examples: The pricing and taxation policy (not relevant currently, but might in the future, when it will be a product)
	Standard examples: The restrictions and principles for service composition – connection
	Standard examples: Application of technical and operational measures
Precondition: Technology, service and/ or sensor has been integrated and business rules exist.	
Guarantee: Business rules will be included and will ensure smooth and meaningful operation of the technology through PP.	
Trigger: -	

AII.7 UCscr23: General actor registration/ authentication/ login (with failures) and creation of profile

General actor registration/ authentication/ login (with failures) and creation of profile	
Main success scenario (MSS): The actor will be able to create an account as a first step and then log-in and authenticate as a registered user. In particular, a new user will be provided with the option to create an account by entering a username and a password. An already registered user will be offered the option to login by providing the right credentials. This User Register/Login/Authentication activity is the starting point of the user interaction with PP and the prerequisite step before the user will be able to set up his/her profile.	
Actor	**PANACEA Platform (PP)**
New/unregistered Actor **Sequence of numbered steps:** The new/unregistered actor selects to register The **Actor** adds their email address The **Actor** adds a password The **Actor** re-enters a password They select their occupation from a drop-down menu: Bus driver, shuttle operator, taxi driver, courier service rider, truck driver, coach driver, operator, enforcer, countermeasures specialist developer and other. The Actor accesses the email to their email box and follows the url to activate their account. **Login logout:**	The PP web app landing page is common for all actors. An option to register or login appears on the page. The **Actor** is prompted to add their email address The **Actor** is prompted to add a secure password that contains eight characters, at least one cap letter, one small letter, at least one number and at least one symbol. The strength of the selected password will be shown to the **Actor**. PP will give the option to the Actor to mask/ unmask the password whilst entering it (i.e., eye icon in password field). PP sends confirmation to the **Actor's email address that they have successfully registered to the PANACEA solution and to follow the url to activate their account.** **PP shows a message on the screen that the account has been successfully created and returns the Actor to the login page.**

General actor registration/ authentication/ login (with failures) and creation of profile	
The **Actor** enters the credentials and successfully logs in. The **Actor** after finishing with the web app or their profile, they select to log out from this session. *Until here the whole process is common for all Actors.*	The newly created user details are stored in the database. PP returns to the landing page. PP shows that they are logged out.
Registered Drivers/ Riders **Sequence of numbered steps:** A registered D/ R enters their email address and password. D/R accesses their profile. The D/R reads and signs (ticks the box) and accepts to share the data that will be requested. The D/R selects all the user profile static parameters from Table 7 (these are indicative, and they be further refined based on WP2, WP3, WP4 and WP5 needs and requirements and presses the submit button. *Alternative login, through swiping their NFC employee card to their mobile phone.*	PP receives the credentials of the TD/ CSR and authenticates them. The privacy disclaimer explaining the reasoning for asking these pieces of information pops up. PP opens the TD/ CSR profile page where the optional and required user profile creation static parameters are presented. PP informs the that their choices have been recorded and that they can change them whenever they want. O and Administrator are informed as well.
Registered Operators (from various categories in the company) (login – logout) **Sequence of numbered steps:** A registered O enters their email address and password. O accesses their profile. The O reads and signs (ticks the box) and accepts to share the data that will be requested. The O selects all the user profile static parameters from Table 7((these are indicative, and they be further refined based on WP2, WP3, WP4 and WP5 needs and requirements and presses the submit button. *Alternative login, through swiping their NFC employee card to their mobile phone.*	PP receives the credentials of the O and authenticates them. The privacy disclaimer explaining the reasoning for asking these pieces of information pops up. PP opens the O profile page where the optional and required user profile creation static parameters are presented. PP informs the that their choices have been recorded and that they can change them whenever they want. The administrator is informed as well.
Registered Countermeasures' specialist (login – logout) **Sequence of numbered steps:** A registered CS enters their email address and password. CS accesses their profile.	PP receives the credentials of the CS and authenticates them. The privacy disclaimer explaining the reasoning for asking these pieces of information pops up.

General actor registration/ authentication/ login (with failures) and creation of profile	
The CS reads and signs (ticks the box) and accepts to share the data that will be requested. The CS selects all the user profile static parameters from Table 7 (these are indicative, and they be further refined based on WP2, WP3, WP4 and WP5 needs and requirements) and presses the submit button. *Alternative login, through swiping their NFC employee card to their mobile phone.*	PP opens the CS profile page where the optional and required user profile creation static parameters are presented. PP informs the that their choices have been recorded and that they can change them whenever they want. The O and the administrator are informed as well.
Registered Enforcers (login – logout) **Sequence of numbered steps:** A registered E enters their email address and password. CS accesses their profile. The E reads and signs (ticks the box) and accepts to share the data that will be requested. The E selects all the user profile static parameters from Table 7 (these are indicative, and they be further refined based on WP2, WP3, WP4 and WP5 needs and requirements) and presses the submit button. *Alternative login, through swiping their NFC employee card to their mobile phone.*	PP receives the credentials of the E and authenticates them. The privacy disclaimer explaining the reasoning for asking these pieces of information pops up. PP opens the E profile page where the optional and required user profile creation static parameters are presented. PP informs the that their choices have been recorded and that they can change them whenever they want. The O and the administrator are informed as well.
Registration Failure The new/unregistered **Actor** tries to create an account by entering an email address that has already been used before. The **Actor** will have to choose a different email address and repeat the process.	Registration will fail and an error message will appear to the **Actor**, indicating that the specific address is not available.
Authentication/ Login failure The Actor tries to log-in by entering a wrong email address or password. The Actor will have to retry by logging in by providing the correct credentials.	Authentication fails and PP sends a message to the Actor that the email address and/ or the password is wrong and to try again. An option to change the password should be available. The PP successfully logins the actor.
Alternative Registration (Optional) The Actors to be able to register through Facebook or Google accounts. The Actor selects the Facebook or Google registration buttons. The Actor enters the Facebook or Google credentials. The Actor is successfully logged in.	PP redirects the Actor to the respective platform to login with their Facebook or Google credentials. The PP sends a confirmation message to the Actor's screen that the registration was successful.

General actor registration/ authentication/ login (with failures) and creation of profile
Precondition: No other Use Case as a prerequisite since this is the first interaction step between the user and the system. However, the user should have a mobile device supporting Android and a network connection available.
Guarantee: The user will be registered.
Trigger: -

AII.8 UCscr24: Feedback module

Feedback to platform	
Actors (Administrators, operators, drivers, riders, countermeasures specialists, enforcers)	**PANACEA Platform (PP)**

• The rider is on their own profile page and wants to add feedback about their experience with the BAC skyn wristband.
• They can rate the following:
  ○ The technologies
  ○ The CHTs
  ○ The whole PANACEA solution
  ○ The effect the use of solution has on them.
  ○ The UC experiences
  ○ The countermeasures
  ○ The vehicles
  ○ The other actors
  ○ Their health and wellbeing
  ○ Other
  ○ They can leave open-ended feedback and comments.
	Add feedback (per professional type)
	• The PP has to be capable to collect, manage and report feedbacks from users
	• The PP has to be capable to collect, manage and report ratings from users

• The actor wants to change the rating of one of the technologies and returns to the feedback from on their driver's profile dashboard. • They rated the experience with one of the technologies with 3 stars (out of five) and wants to change it to 4 (out of five). • Selects last	**Change/ Delete feedback (per professional type)** The PP has to be capable to collect, manage and report ratings from users
In this example, is CS, but it can be any of the core actors who may have (or granted administration rights) to the feedback module	**Select feedback (per professional type, per period, per feedback type)**
• CS wants to view only the feedback only for the fatigue-related countermeasures for level 2 and during driving for the truck drivers in UCC and selects these options on their dashboard. • CS selects to save this as a report on their profile (i.e., dashboard) with the name: 'Fatigue2_trucks_UCC'.	• PP presents on the dashboard a table with all the results in the form of a report (xlsx, csv, pdf). • PP saves the report and a message on screen appears to confirm saving of the report with that name.

Feedback to platform	
CS (as elaborated above)	**Visualize feedback (analytics)**
• CS wants to visualise some of the results, to make it easier to communicate them. • CS selects to create a bar chart with countermeasures' compliance per impairment, shift phase for UCC for the last three months. • CS changes the colours of the bar chart, adds axes' titles and a legend. • CS saves the bar chart with the name: 'Fatigue2_trucks_UCC 3M'	• PP creates and presents to the CS the bar chart with the data they have selected. • The bar chart now appears with the changes selected by CS. • CS saves the bar chart in the CS' profile (i.e., dashboard).
CS (as elaborated above)	**Share feedback**
• CS wants to share feedback with the company executive responsible for the CS programme. • CS selects only the ratings for the fatigue-related countermeasures for level 2 and during driving for the truck drivers in UCC. • CS selects to share the feedback report and the visualizations via email.	• PP shows the different modes they can use to share the report and the visualisations. The modes are communication module (for actors with access to PP), email and Viber**.**
Precondition: Each actor has already set a profile on PP and they have registered and are currently authenticated.	
Guarantee: Feedback is received, prioritised and utilised.	
Trigger: Core actors leave feedback.	

AII.9 UCscr25: Communication module among core actors (optional)

Communication among core actors **Notifications are shown as received also outside the chatbox (push notifications, but without the content of the message). The UC presents the default. In preferences, this could be altered)**	
Actors (Administrators, operators, drivers, riders, countermeasures specialists, enforcers)	**PANACEA Platform (PP)**
• Any core actor (above), but, as an example, rider.	**Initiate conversation – End conversation (open/ close chatbox)**

• The rider is on their own profile page and wants to communicate with their operator.
  ○ They open the PP chatbox and select to send a message to the operator.
  ○ The rider acknowledges the messages and closes the conversation.
• The rider closes the chatbox.
	• The operator receives the message with an auditory notification.
	• The operator views the message.
	• The operator replies to the message.
	• The operator closes the chatbox.

• **Extension 1:** As the rider is riding now, they will not receive the notification until they stop.	• The operator sends a message to the rider.

Communication among core actors **Notifications are shown as received also outside the chatbox (push notifications, but without the content of the message). The UC presents the default. In preferences, this could be altered)**	
• The rider stops for a delivery and receives the notification from the chatbox. • The rider replies to the operator's message. • The rider closes the chatbox.	• The operator receives a message on the chatbox that the rider is riding now and will be notified about their message when they will be safely at stop. • The operator views the message and replies to confirm the answer. • The operator closes the chatbox.
Same as above.	**Chat (add/ delete)**
The rider and core actors	**Group Chat**
• The rider sends a message to the operator. • The rider sees the operator 2 was added in this chat.	• The operator receives the message and believes another member of the operators' team should participate in reply to the rider's request. • The operator adds operator 2 in this chat.
Extension 1:	
	Voice/ Call
• The rider opens the chatbox. • The rider selects to call the operator. • The rider calls the operator. • The rider talks with the operator. • The rider hangs up. The call has ended.	• The operator receives a call through the operator dashboard and the embedded chatbox. • The operator answers the call and talks to the rider. • The call has ended.
• **Extension 1:** Operator does not answer. • As the operator did not answer, the rider sends a message to the chatbox as they want their question to be answered by the operator as soon as it is possible. • The rider closes the chatbox. • The rider receives notification that the operator sends a message. • The rider opens the chatbox to read the message. • The rider closes the chatbox. • 30 minutes receives the call and answers it. • The discussion between the rider and operator is held. • The rider closes the chatbox after the end of the discussion.	• Operator is busy and does not take the call. • The operator receives notification that the same rider sends them a chat message. • The operator opens the chatbox and reads the message. • The operator sends a message to the rider that will call in 30 minutes. • The operator closes the chatbox. • 30 minutes later opens the chatbox and calls the rider. • The operator hangs up and closes the chatbox after the discussion finishes.
Rider (as elaborated above)	**Share content through chat**
• CS wants to share feedback with the company executive responsible for the CS programme.	• PP shows the different modes they can use to share the report and the visualisations. The modes are

Communication among core actors **Notifications are shown as received also outside the chatbox (push notifications, but without the content of the message). The UC presents the default. In preferences, this could be altered)**	
• CS selects only the ratings for the fatigue-related countermeasures for level 2 and during driving for the truck drivers in UCC. • CS selects to share the feedback report and the visualizations via email.	communication module (for actors with access to PP), email and Viber**.**
Precondition: Each actor has already set a profile on PP and they have registered and are currently authenticated.	
Guarantee: Communication is open among core actors.	
Trigger: Core actors have a reason to communicate.	

AII. 10 UCscr26: Errors (as exceptions) handling (closely related to UC20 and this a system and not a business UC scenario- Diagnosis procedures)

Communication among core actors **Notifications are shown as received also outside the chatbox (push notifications, but without the content of the message). The UC scenario presents the default. In preferences, this could be altered)**	
The main purpose of it is to address the main categories of problems and that their categorisation will not be ad hoc. Some of them, will be, but not the main issues. It servers to guide the connection between the system errors (internal only; administrator awareness) and those that will be aware also to the other core actors (external; administrator and other actors awareness).	
Actor (System Administrators and those granted access to this part of architecture)	**PANACEA Platform (PP)**
General/ Error (undefined)	Internal/ external steps. Those with external steps, will have a user facing error coding and guide users towards resolving or communicating with the system administrator.
Incorrect/ no reading problem/ failure (incl. computational, data issue, I/O and file problems)	Internal/ external steps.
Notification reception problems	
PP failure (incl. return-value problem: function or procedure call)	
Database connection problems	
Technology/ service failure (incl. null pointer and memory problems)	
Use error (incl. external user/client problem)	
Hardware/ device problem/ failure	
Error/ issue proritisation	
Thread/ memory exhaustion problem	
Binary corruption problem	
Deprecated functionalities	

Communication among core actors **Notifications are shown as received also outside the chatbox (push notifications, but without the content of the message). The UC scenario presents the default. In preferences, this could be altered)**	
The main purpose of it is to address the main categories of problems and that their categorisation will not be ad hoc. Some of them, will be, but not the main issues. It servers to guide the connection between the system errors (internal only; administrator awareness) and those that will be aware also to the other core actors (external; administrator and other actors awareness).	
Errors addressed, stored, reported, and stored.	
Data calibration	Internal/ external steps.
Data quality check (QoS indicators) aligned to WP3 data quality indicators	• The PP has to collect logs for each platform module • The Administrator has to be able to access to logs • Developers (Technological Partner) have to be capable to access to errors returning from wrong developing statements and/or conditions (database failure, access failure, missing data etc.)
Precondition: Each actor has already set a profile on PP and they have registered and are currently authenticated. There is an error handling component / part addressed in the architecture. There will be a taxonomy for errors classification and handling.	
Guarantee: Problems are addressed, stored and reported.	
Trigger: Any error, problem that disrupts the flow.	

Appendix III: Use Case scenarios and scripts diagrams (UMLs)

Based on naming and numbering in Chapter 4, the following UMLs have been created that each circle represents a scenario and/ or a script.

AIII.1 UCsc01-11: Technologies

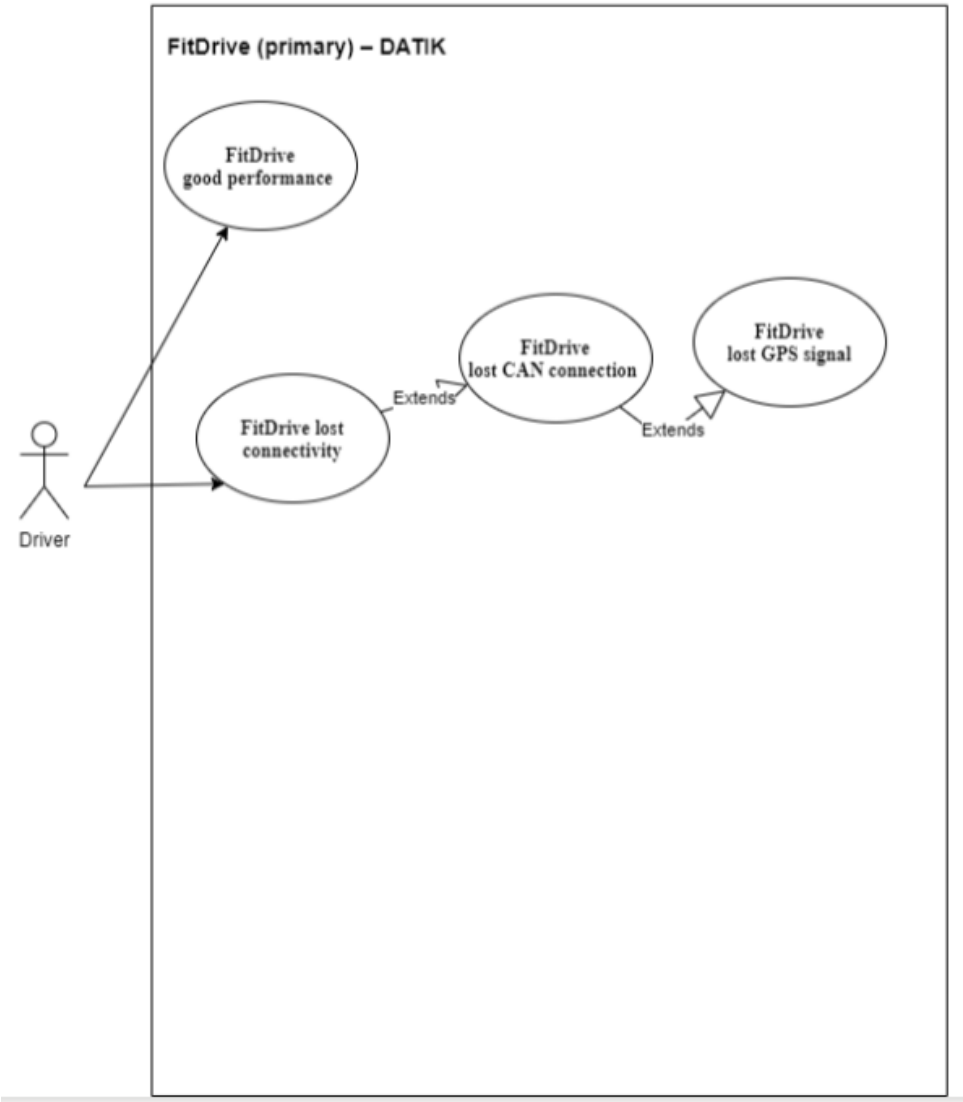

Figure 8. *UCsc01: FitDrive (Primary) – DATIK UML*

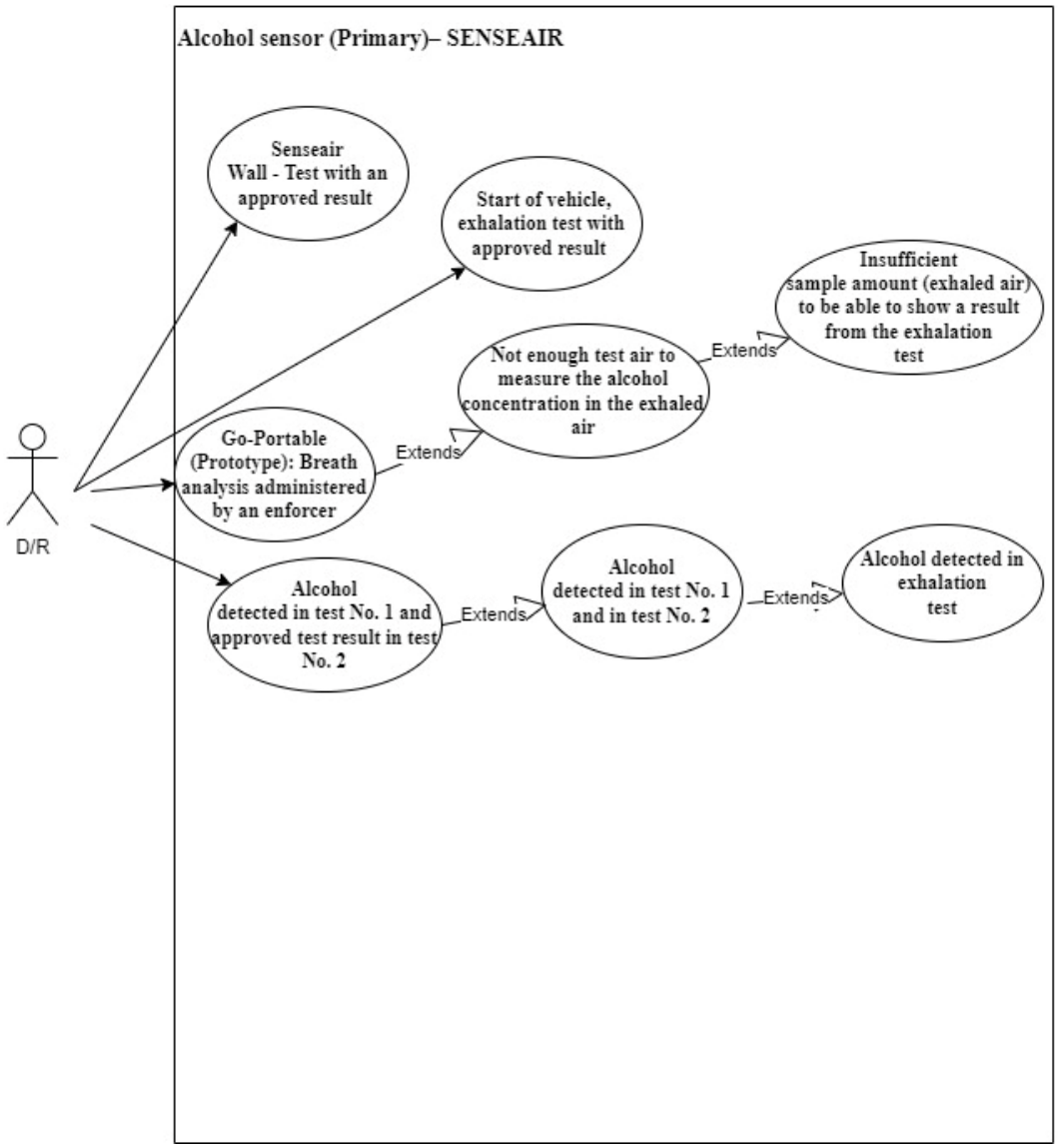

Figure 9. *UCsc02: Alcohol sensor (Primary) – SENSEAIR UML*

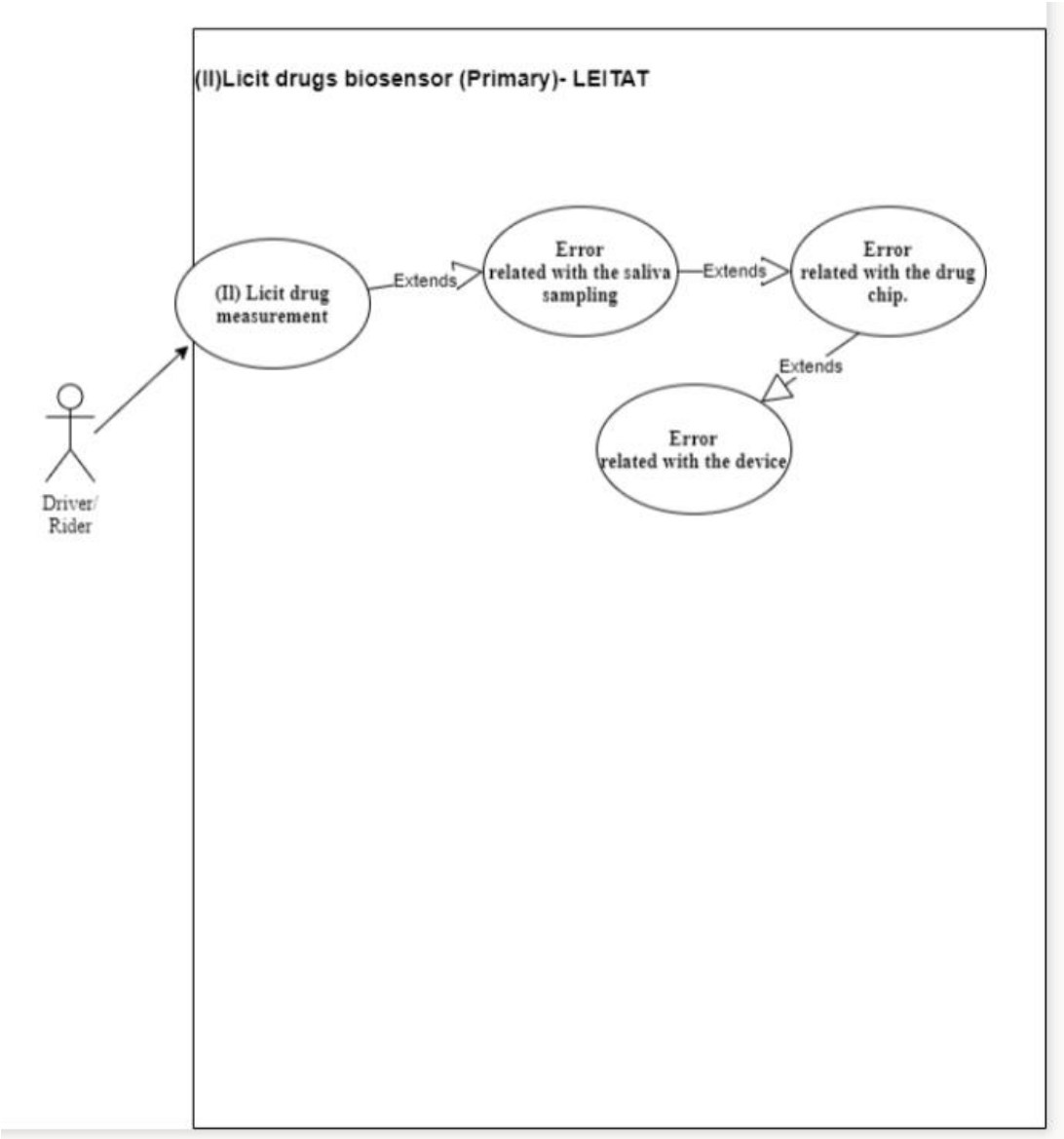

Figure 10. *UCsc03: Il(licit) drugs biosensor (Primary) – LEITAT UML*

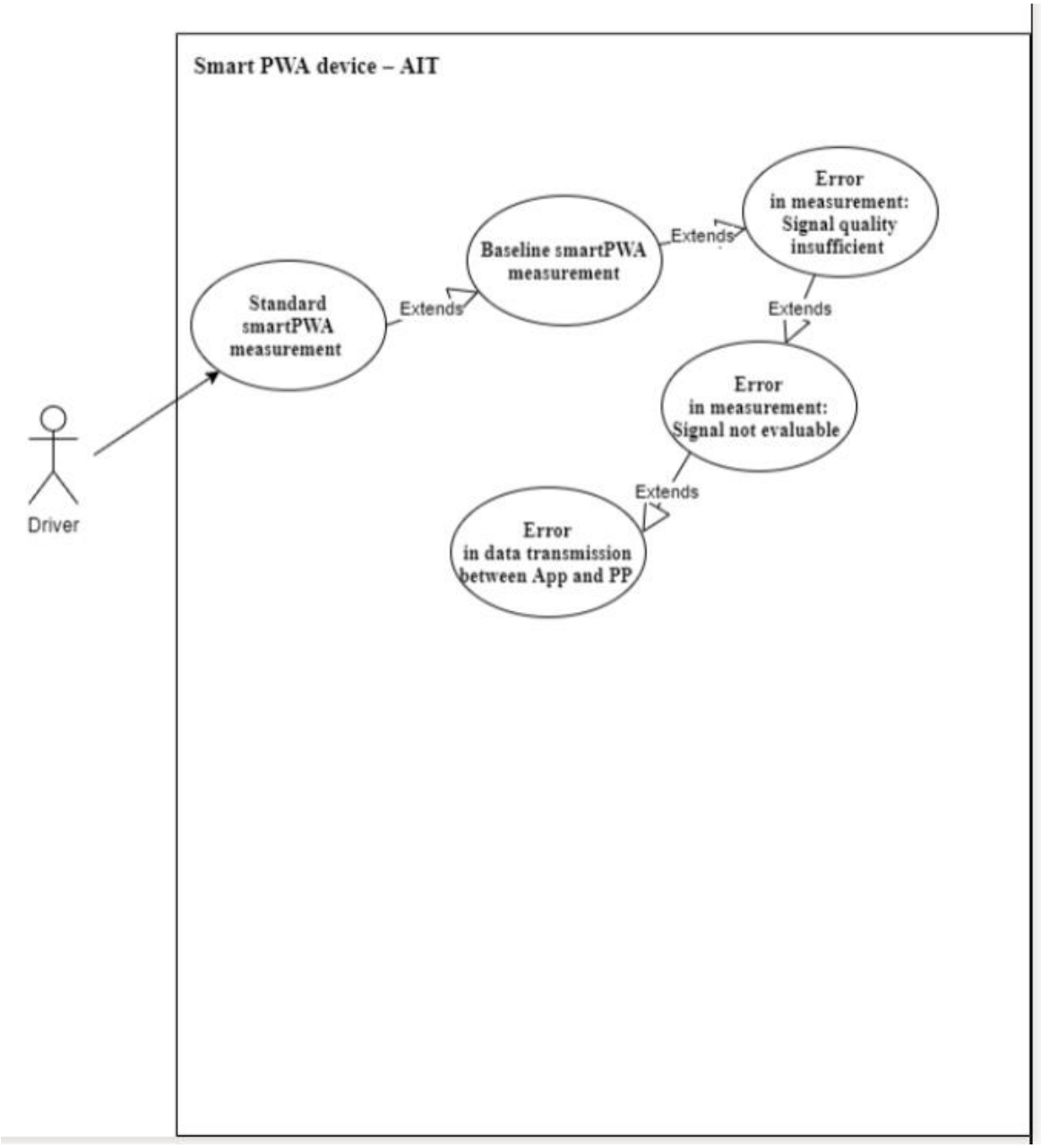

Figure 11. *UCsc04: Smart PWA device (Primary) – AIT UML*

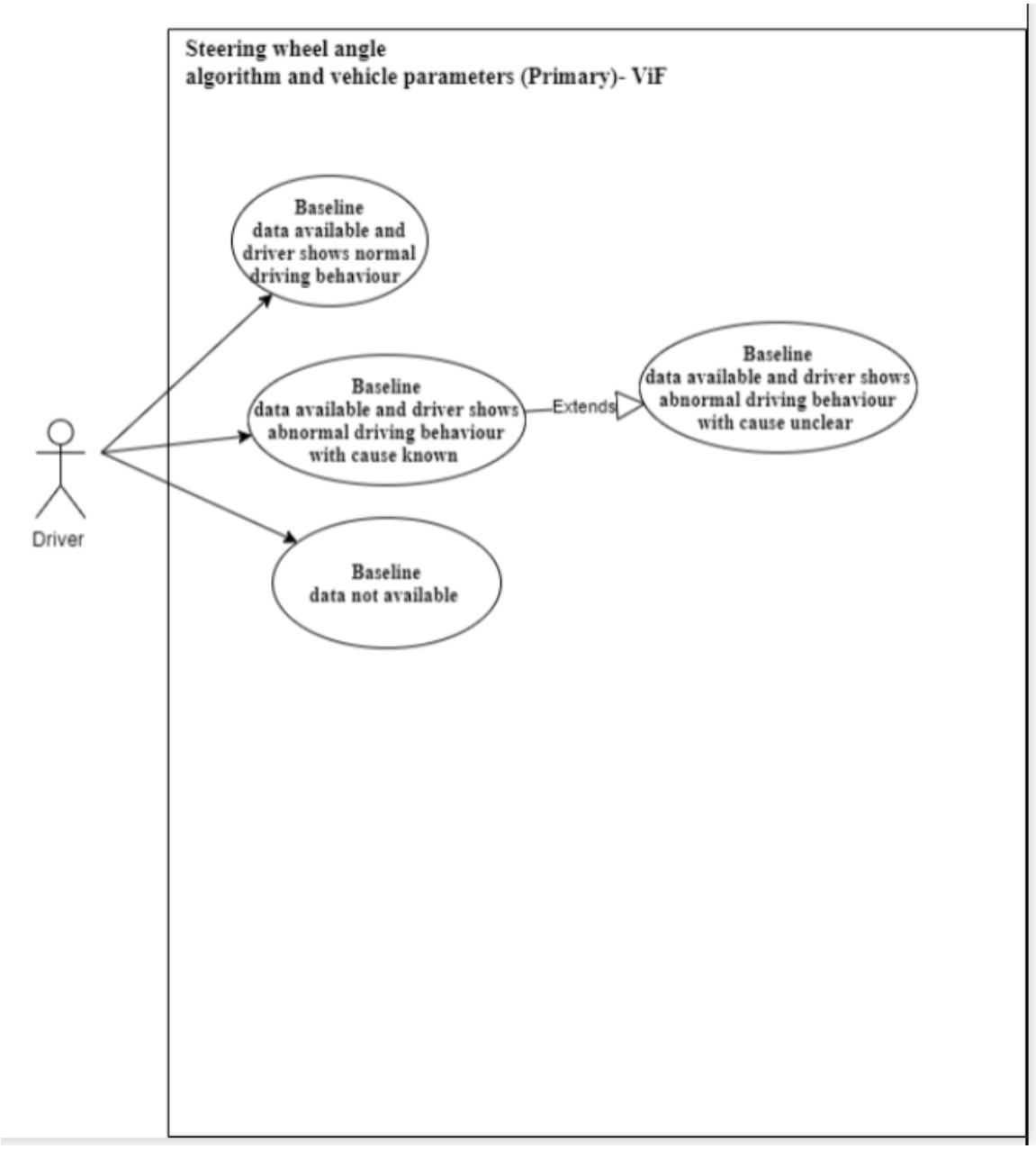

Figure 12. *UCsc05: SWA algorithm and vehicle parameters (Primary) – ViF UML*

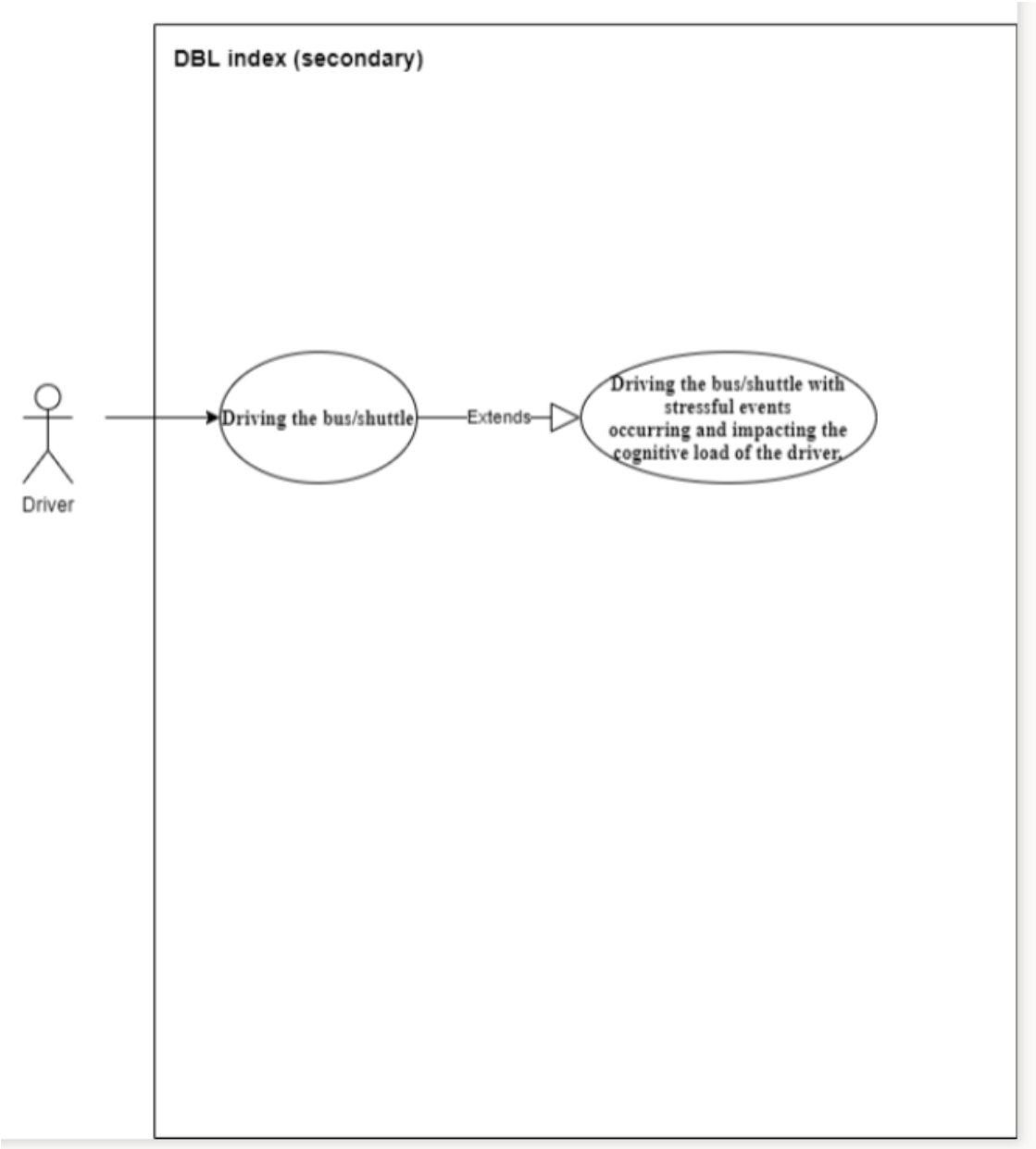

Figure 13. *UCsc06: DBL Index (Secondary) – DBL UML*

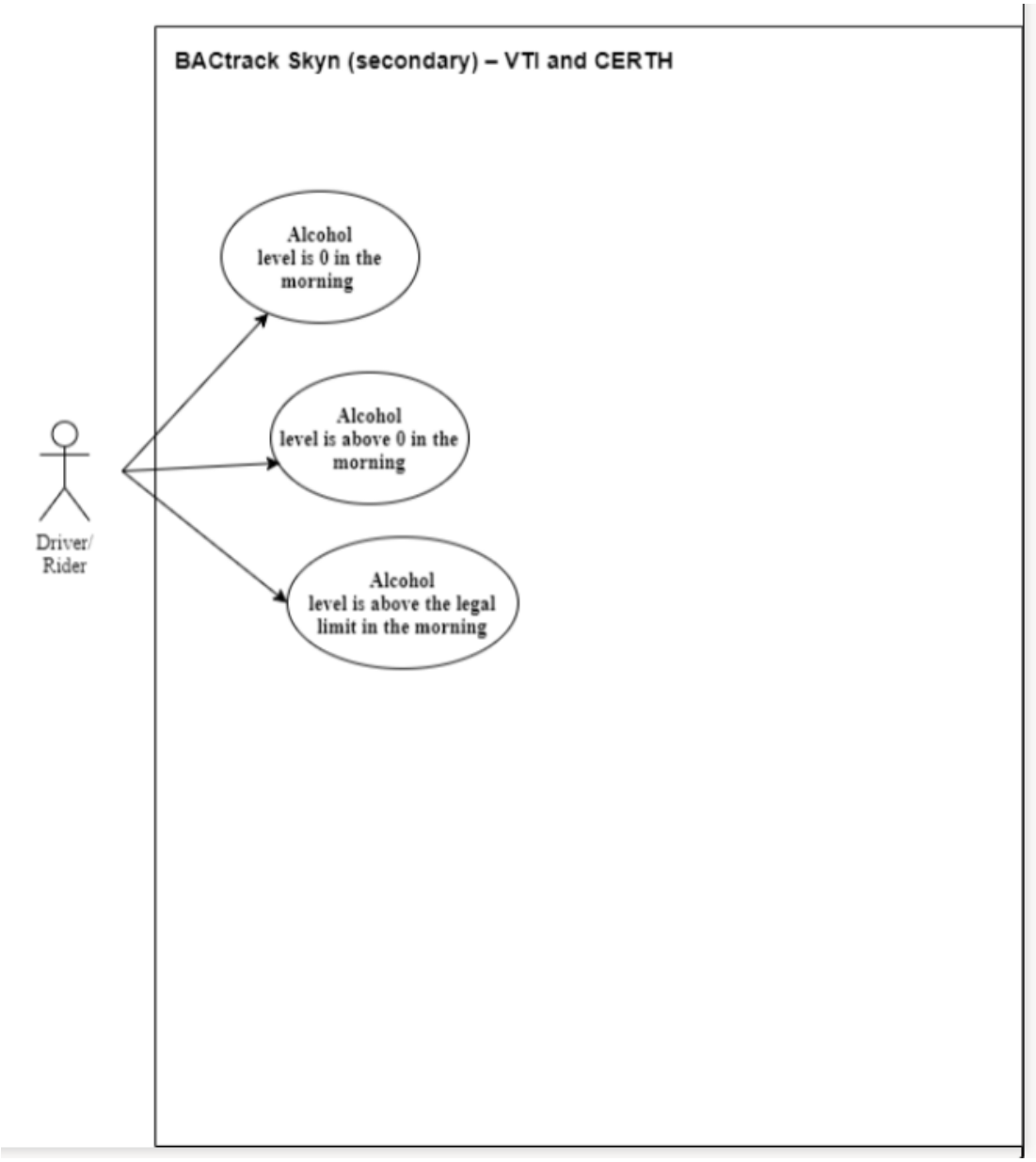

Figure 14. *UCsc07: BACtrack Skyn wristband (Secondary) – VTI and CERTH UML*

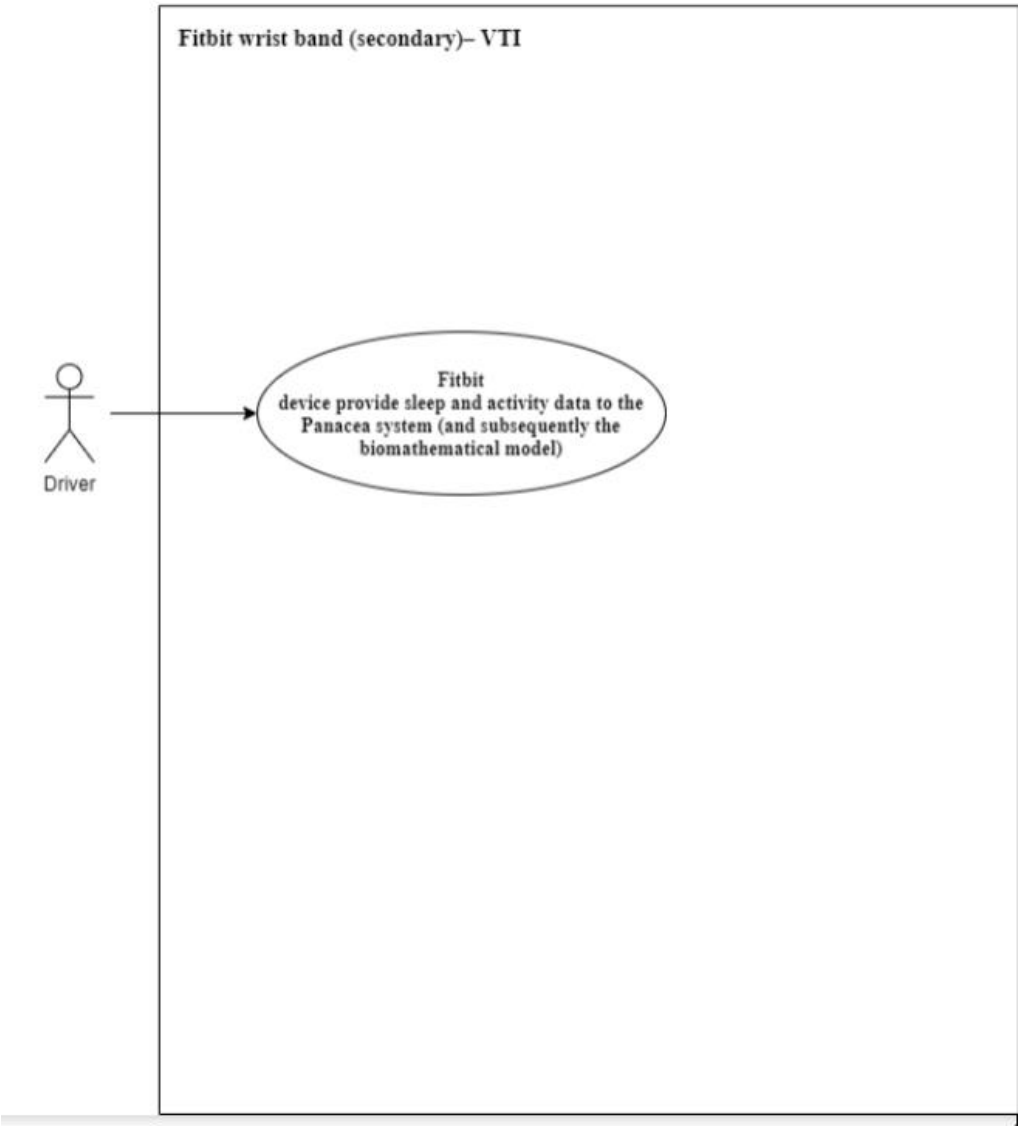

Figure 15. *UCsc08: FitBit wristband (Secondary) – VTI UML*

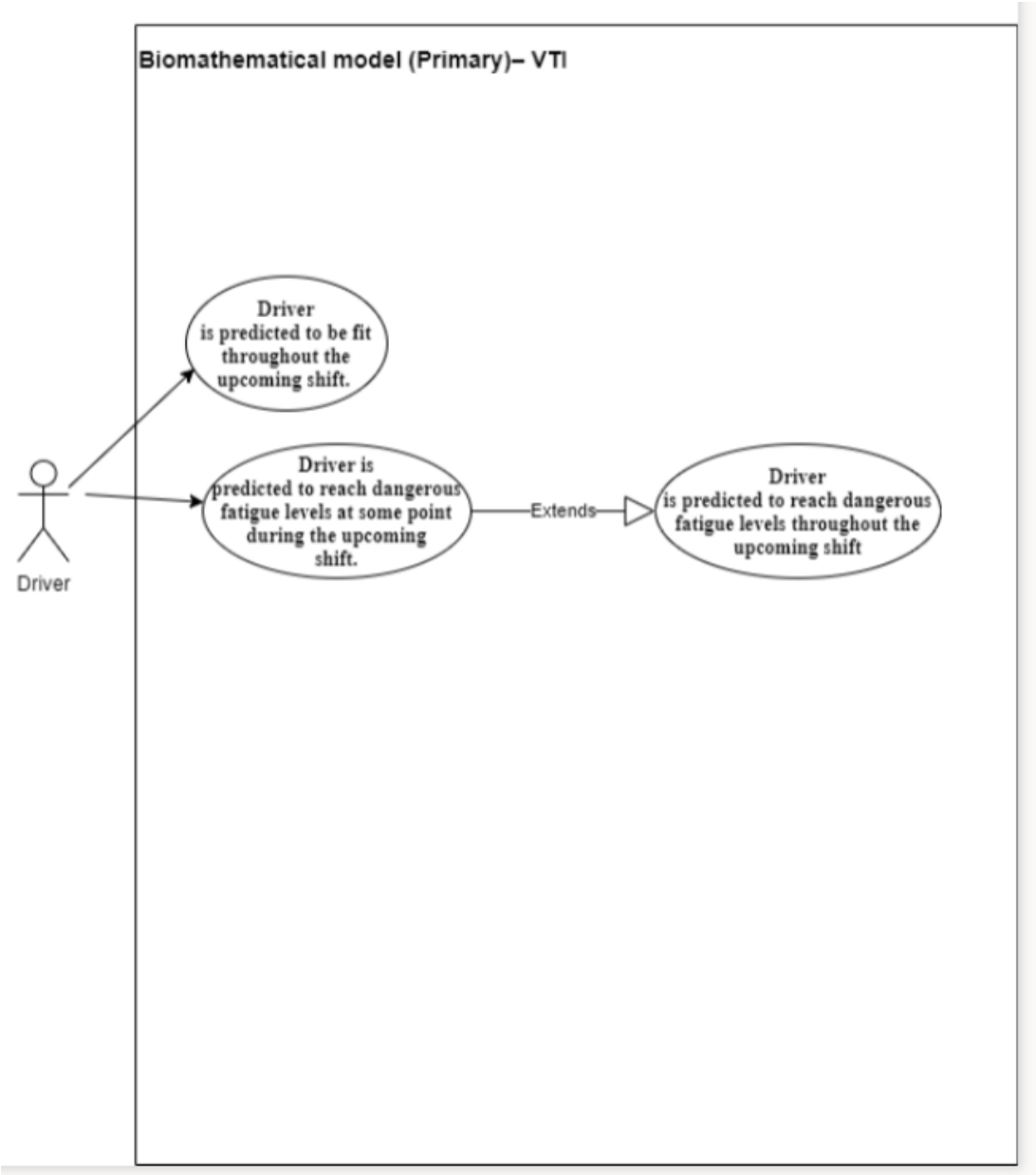

Figure 16. *UCsc09: BMM (Primary) – VTI UML*

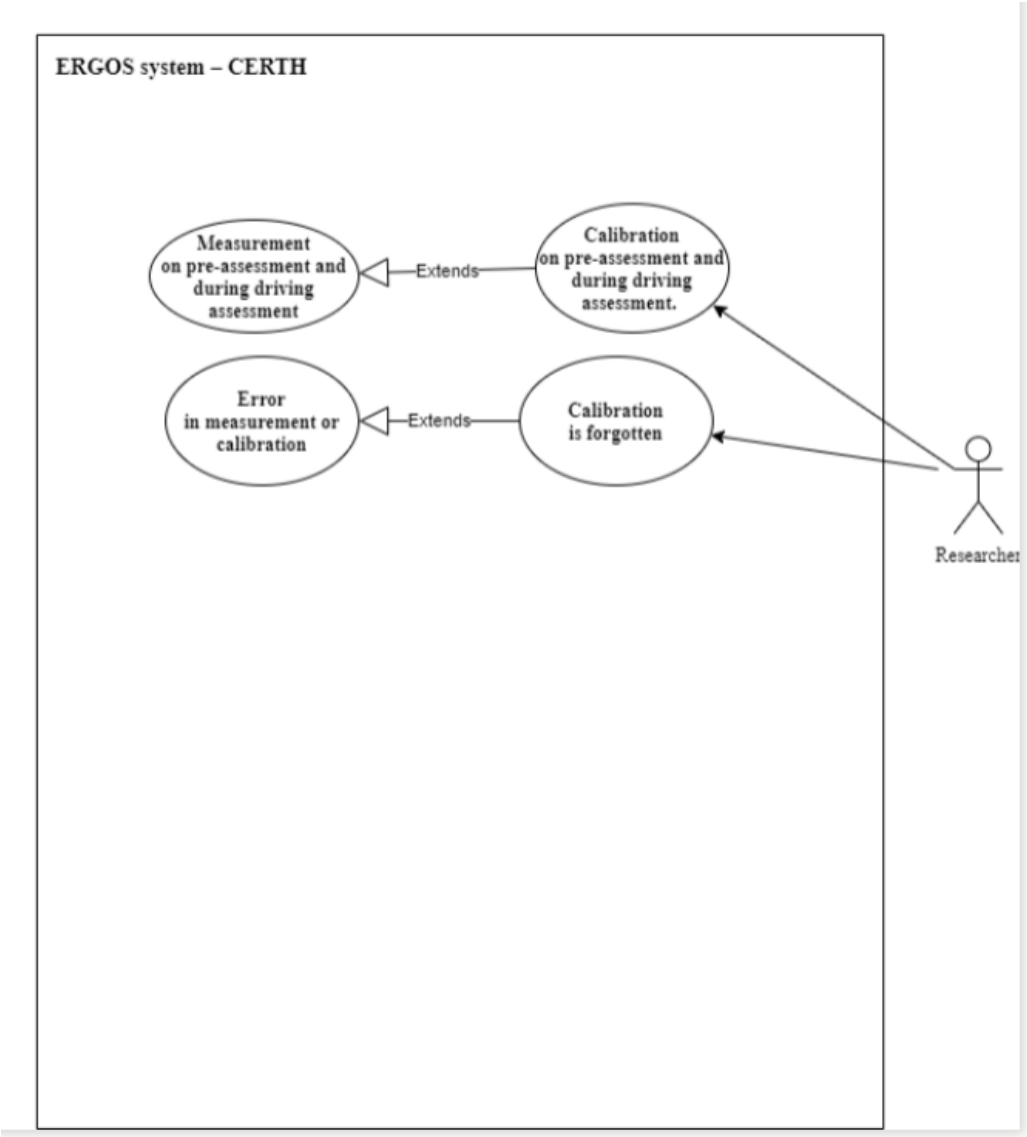

Figure 17. *UCsc10: ERGOS system (Secondary) – CERTH UML*

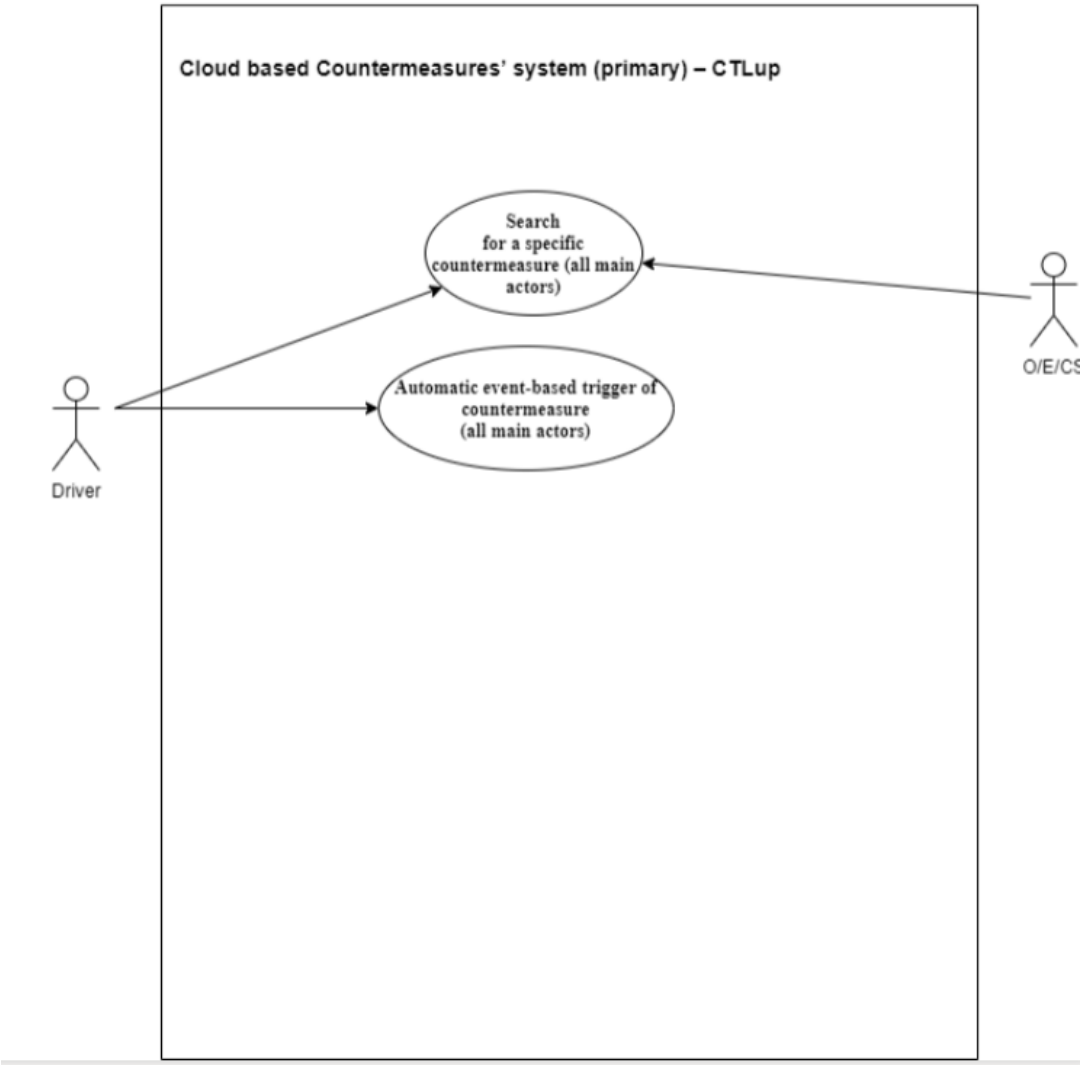

Figure 18. *UCsc11: Cloud-based countermeasures' system (Primary) – CTLup UML*

AIII.2 UCsc12-16: UC scenarios for interaction flow

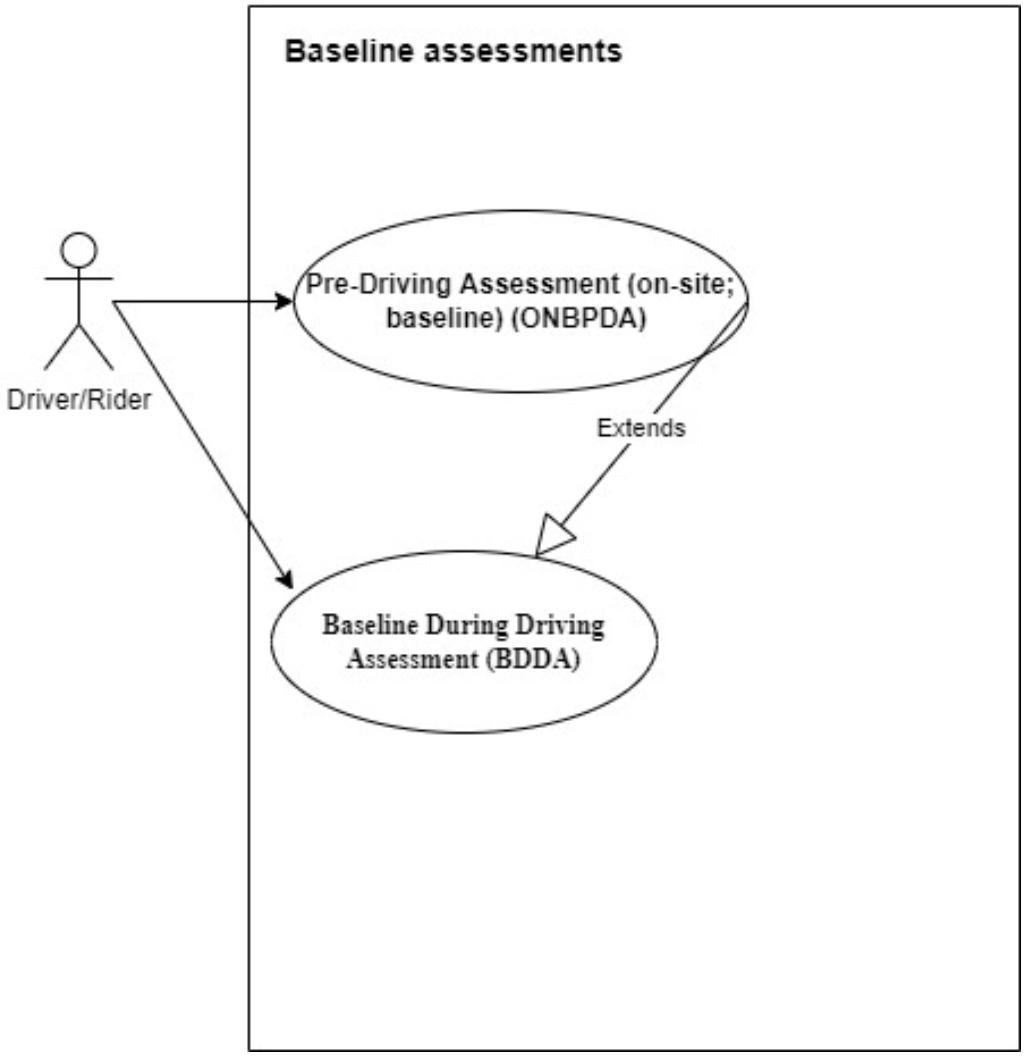

Figure 19. *UCsc12: Baseline assessments UML*

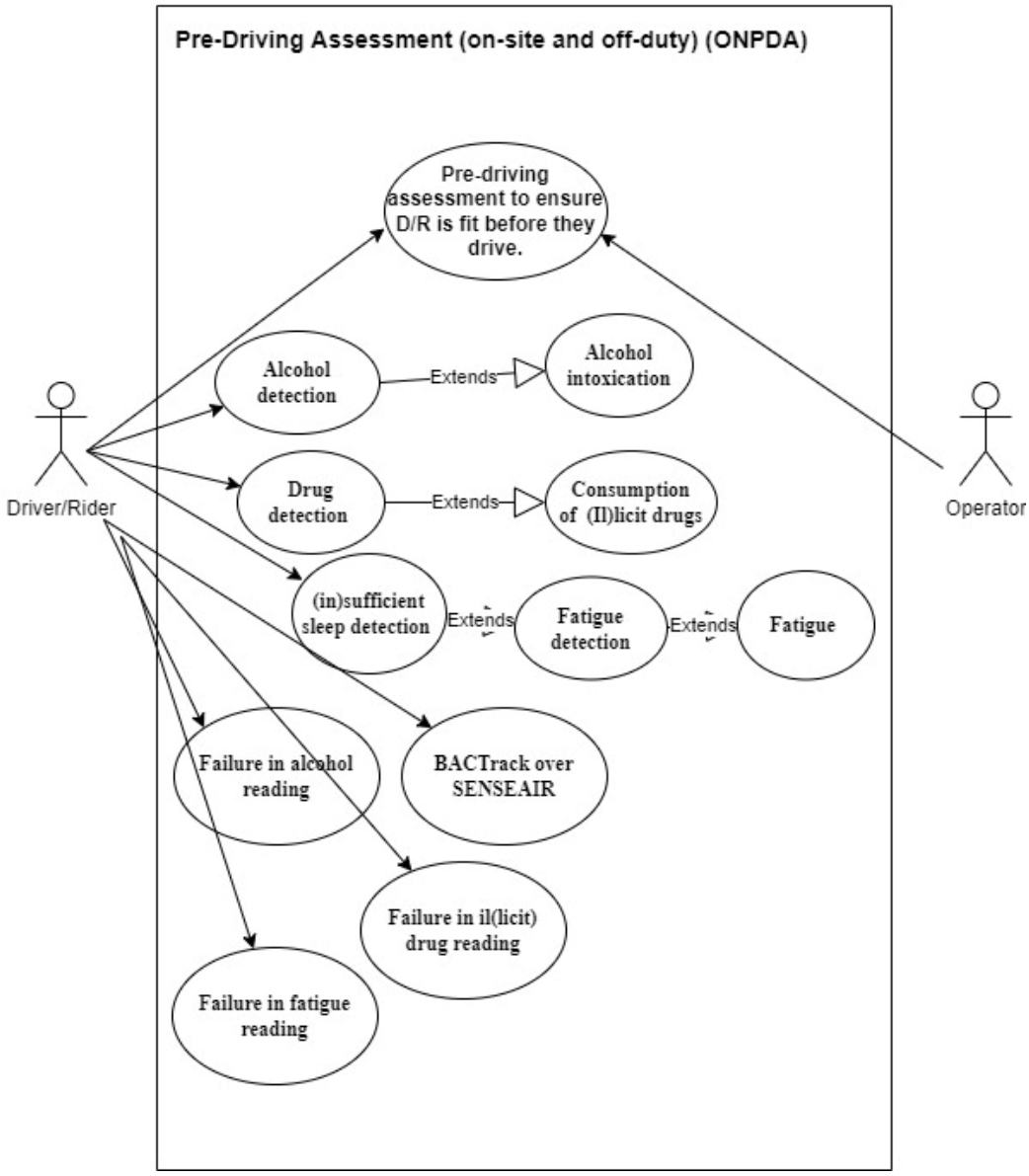

Figure 20. *UCsc13: Pre-driving assessment (PDA) UML*

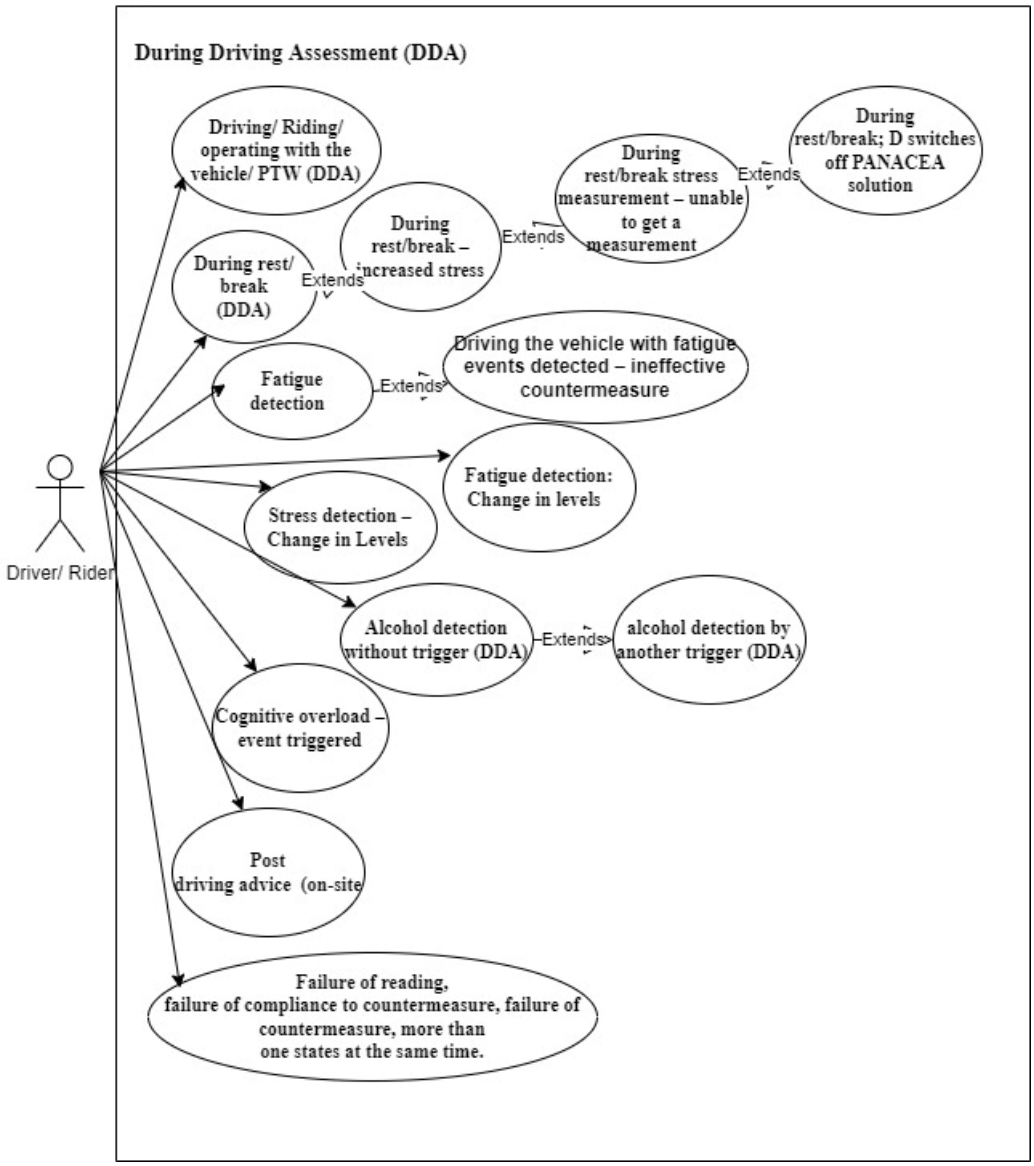

Figure 21. *UCsc14: During driving assessment (DDA) UML*

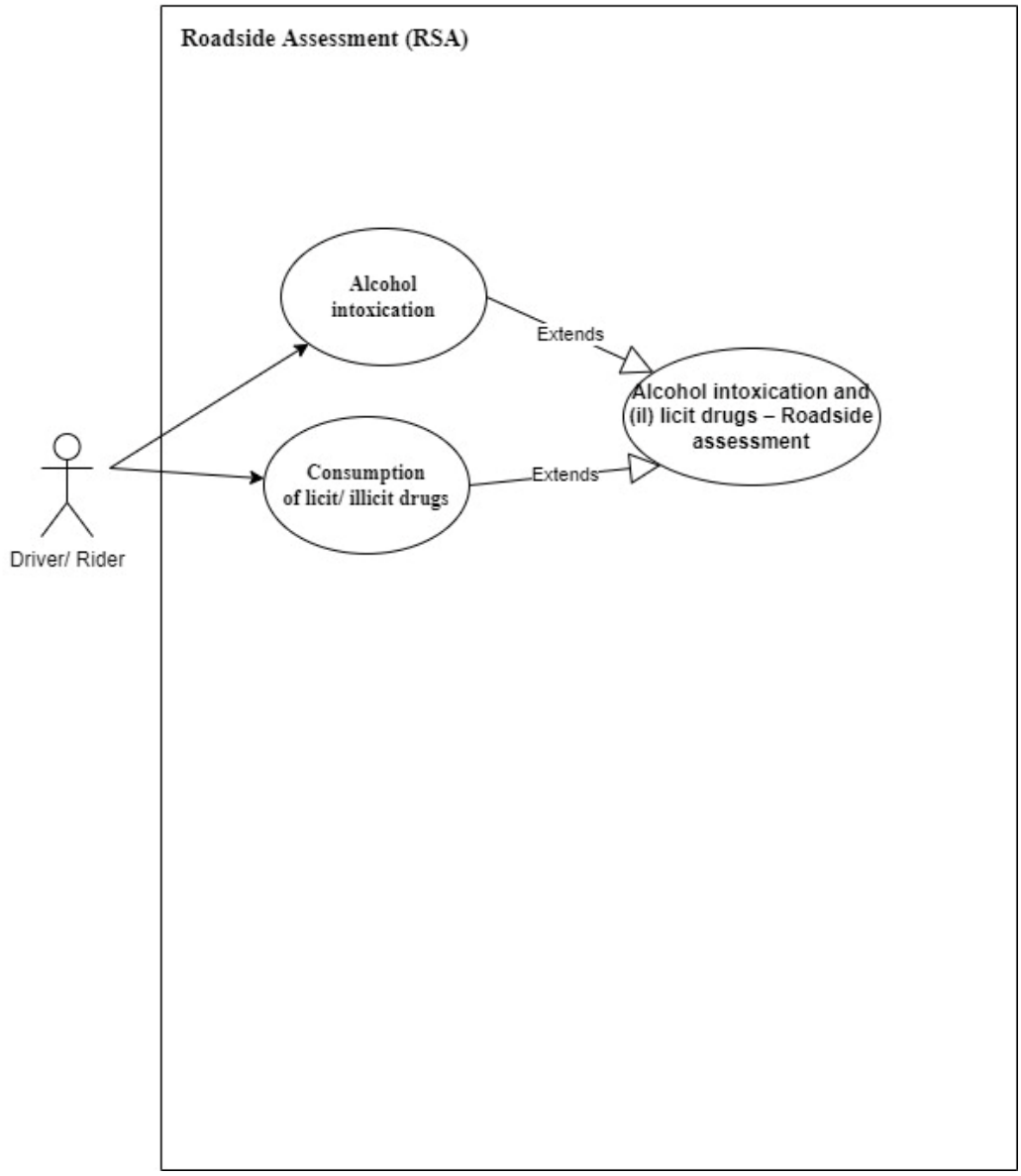

Figure 22. *UCscr15: Roadside assessment (RSA) UML*

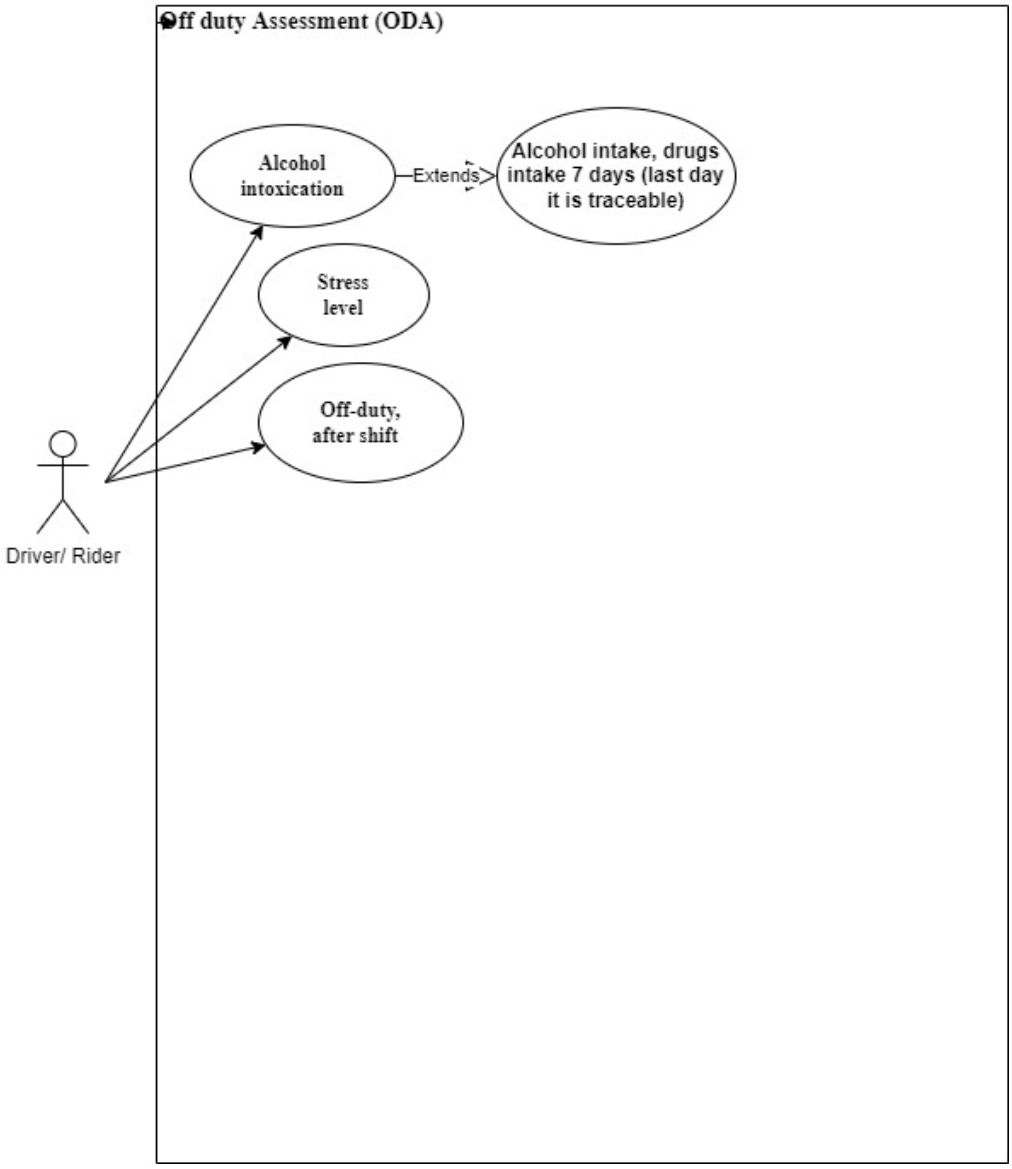

Figure 23. *UCscr16: Off-duty assessment (ODA) UML*

AIII.3 UCscr17-26: Administrative, backend and actors-oriented

The UMLs presented in this section correspond to the UC scripts discussed in section 4.5 and presented in Appendix II.

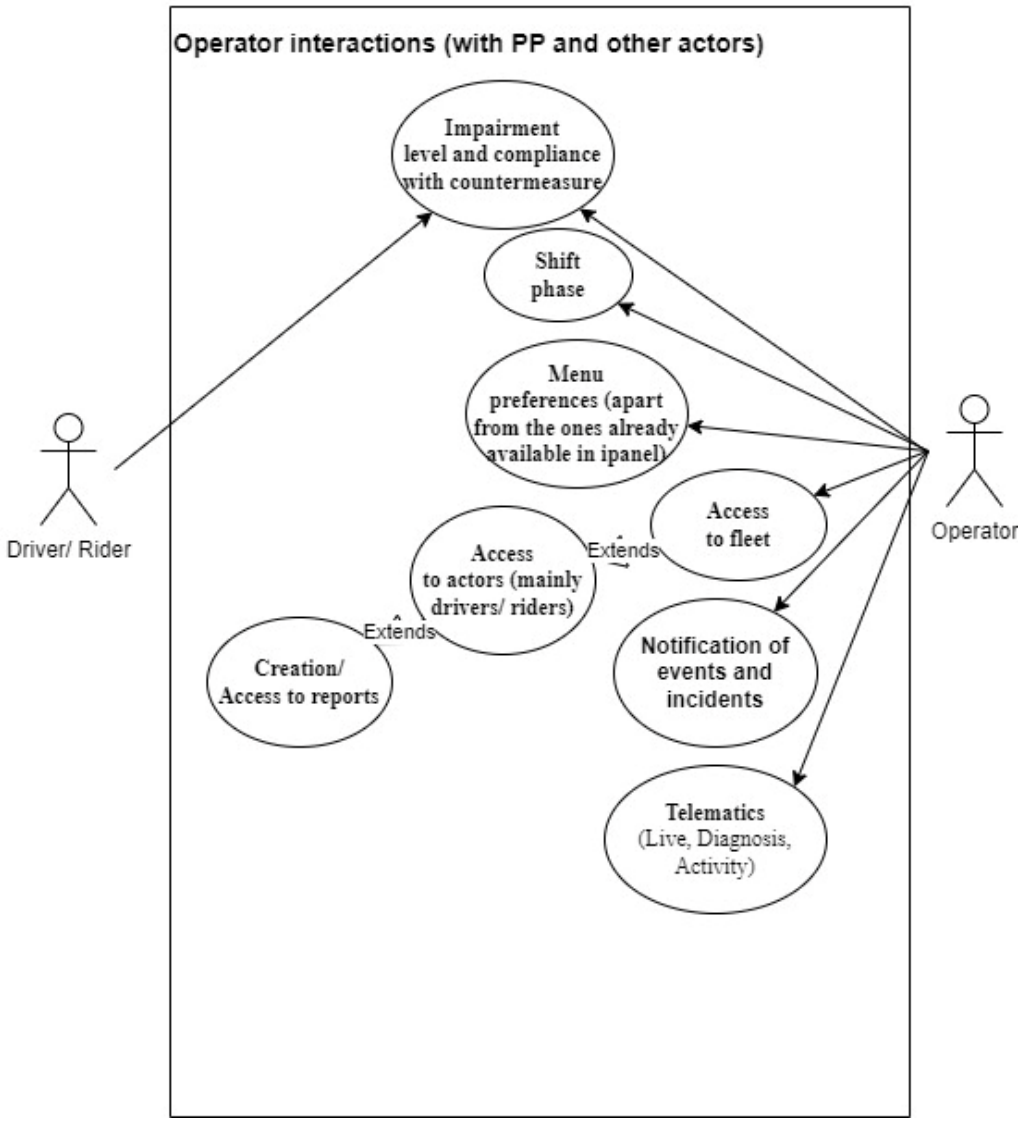

Figure 24. *UCscr17: Operator UML*

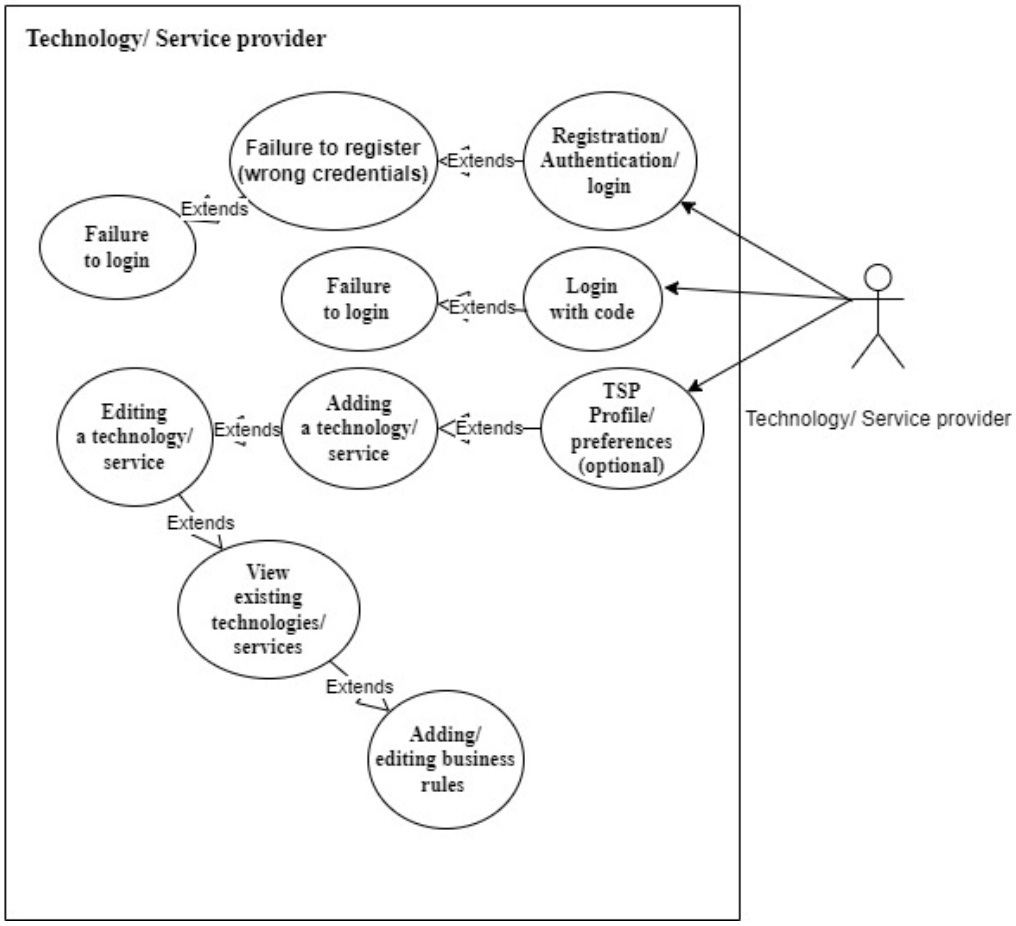

Figure 25. *UCscr18: Technology Service Provider UML*

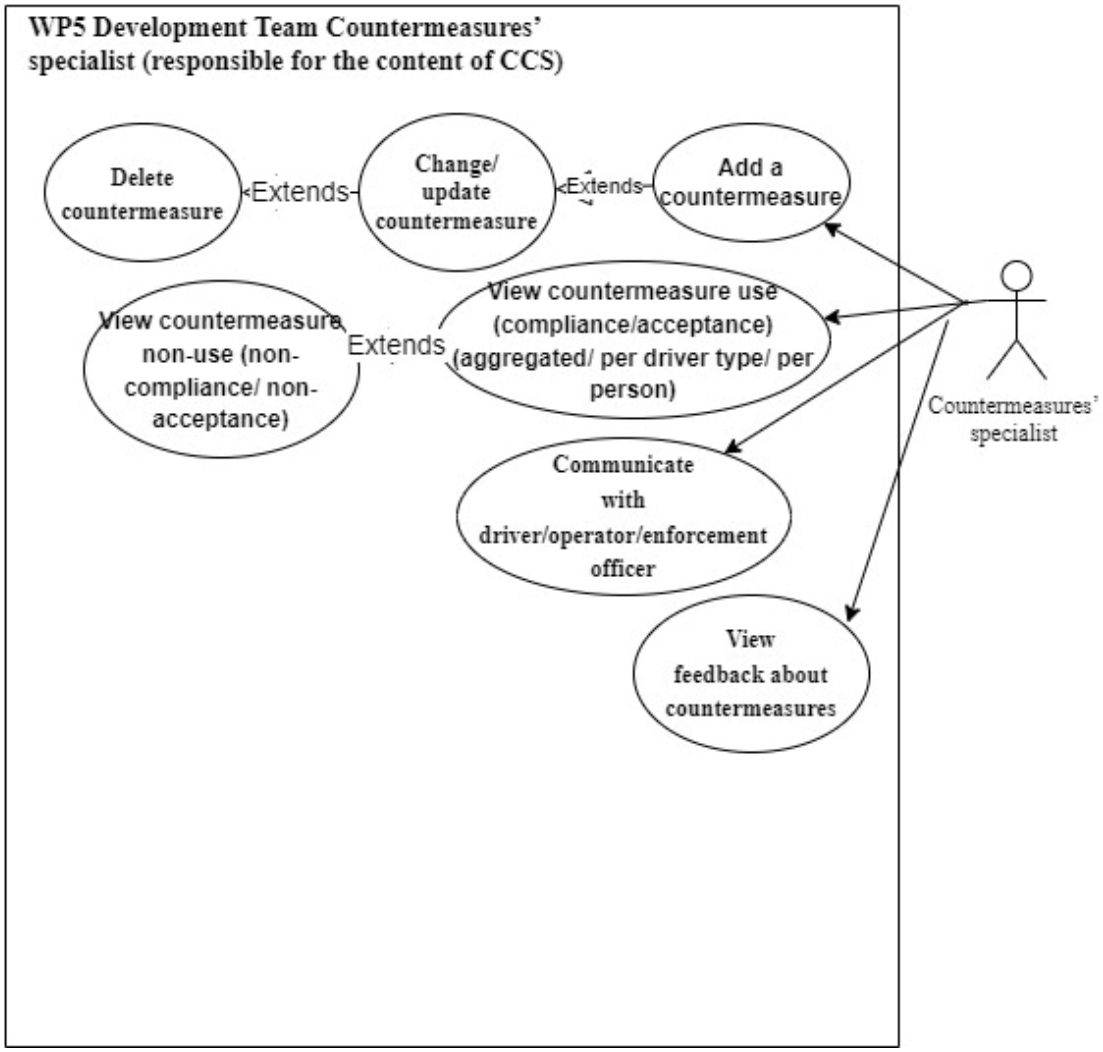

Figure 26. *UCscr19: Countermeasures' specialists (development team) UML*

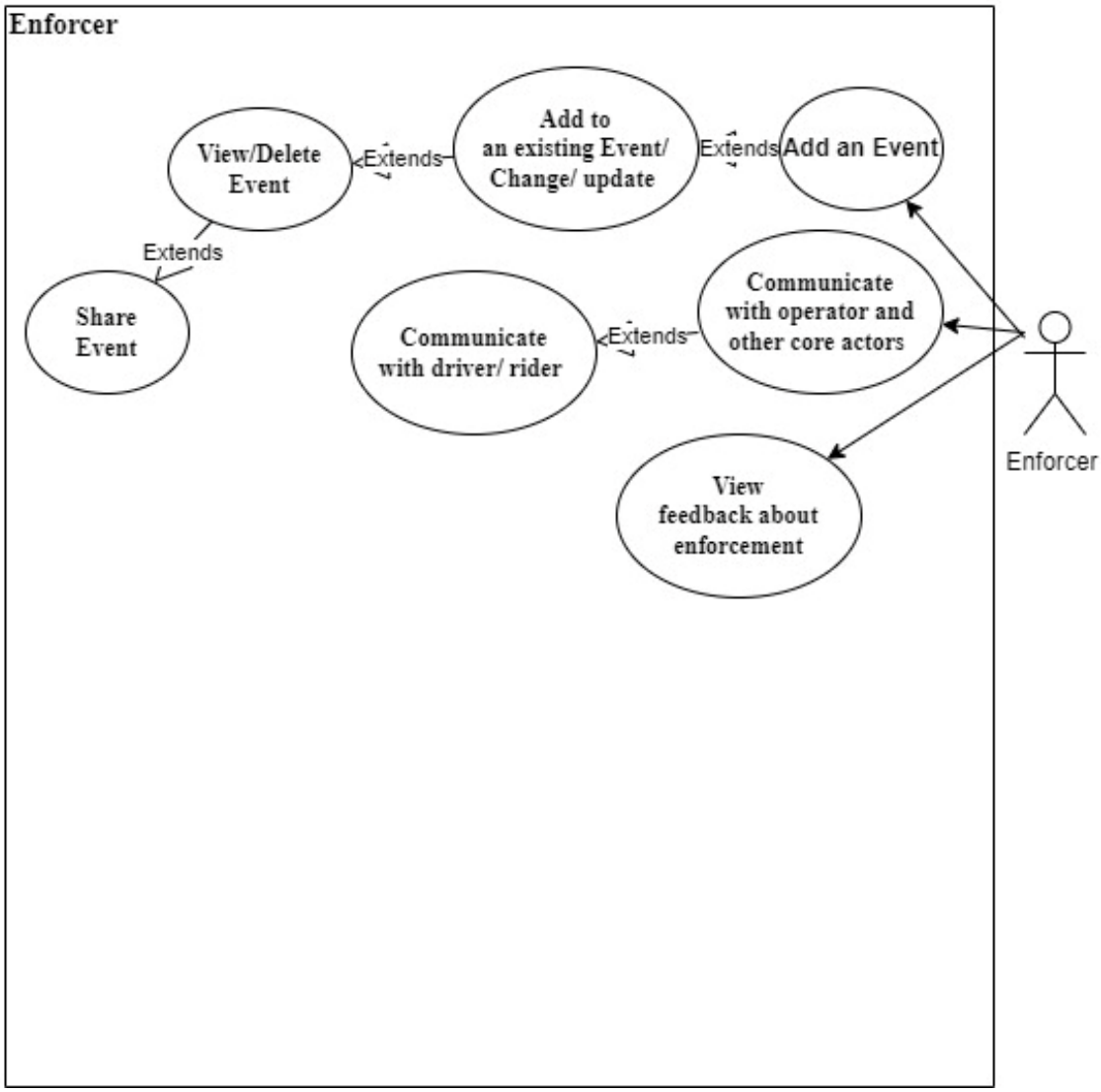

Figure 27. *UCscr20: Enforcer UML*

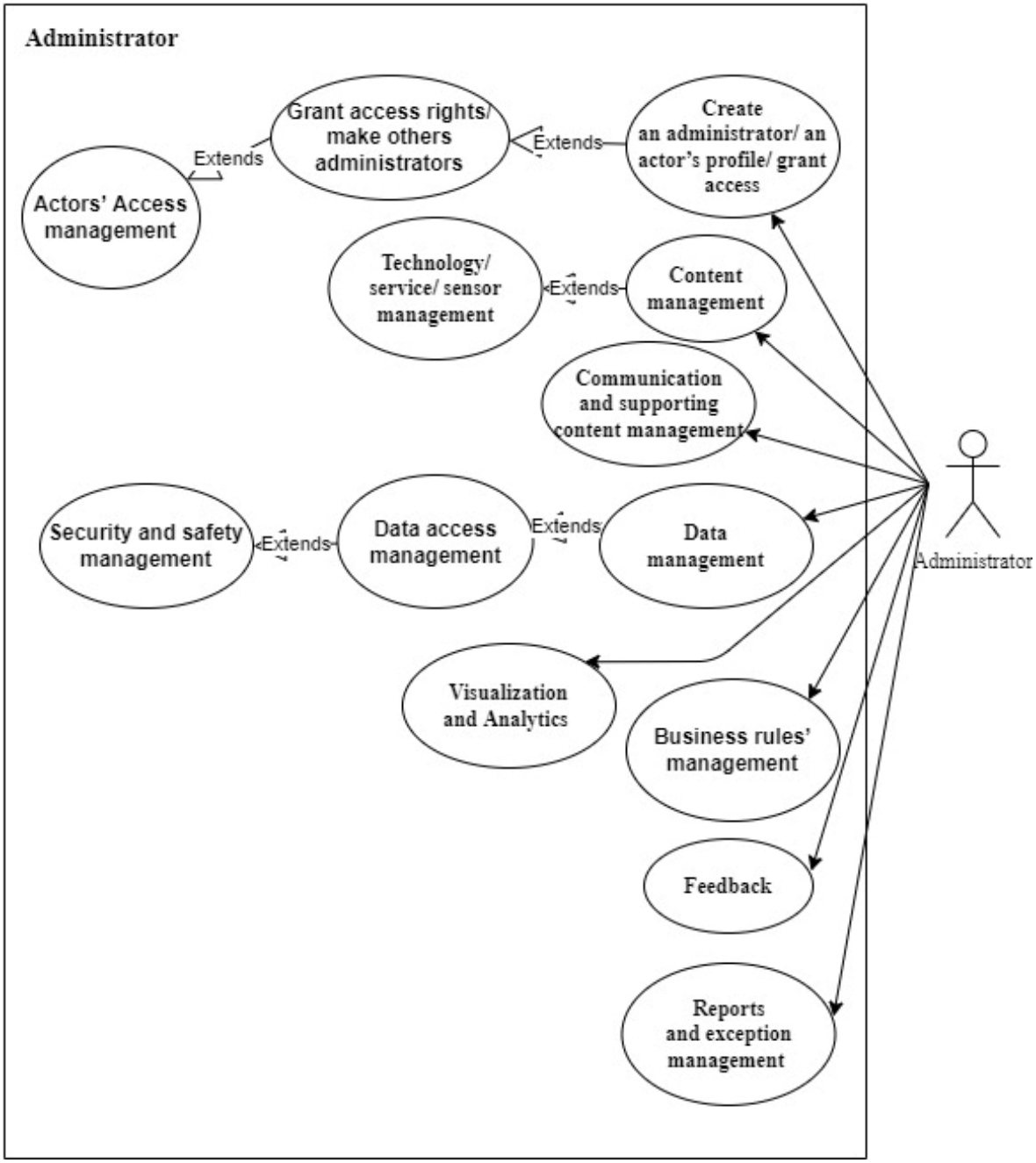

Figure 28. *UCscr21: Administrator UML*

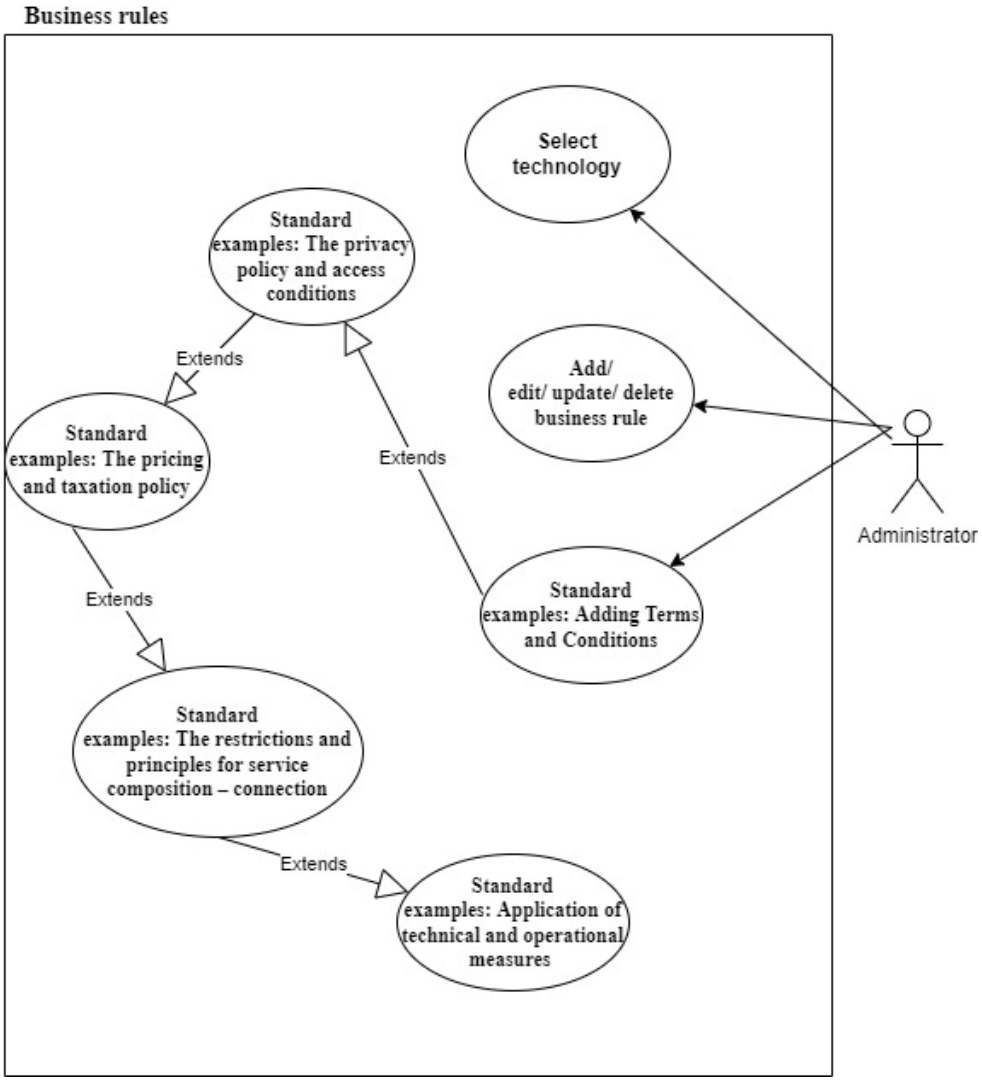

Figure 29. *UCscr22: Business rules UML*

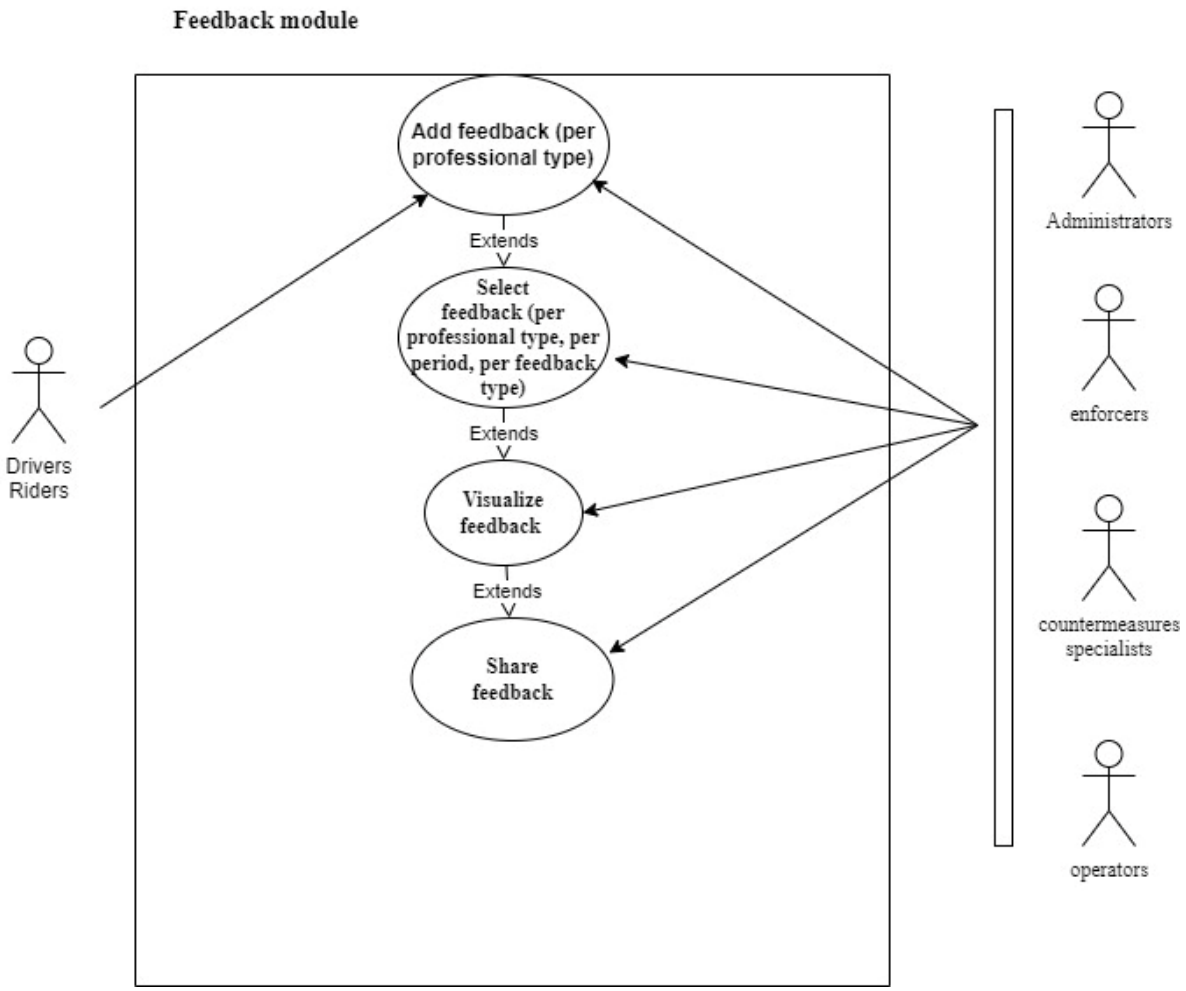

Figure 30. *UCscr24: Feedback module UML*

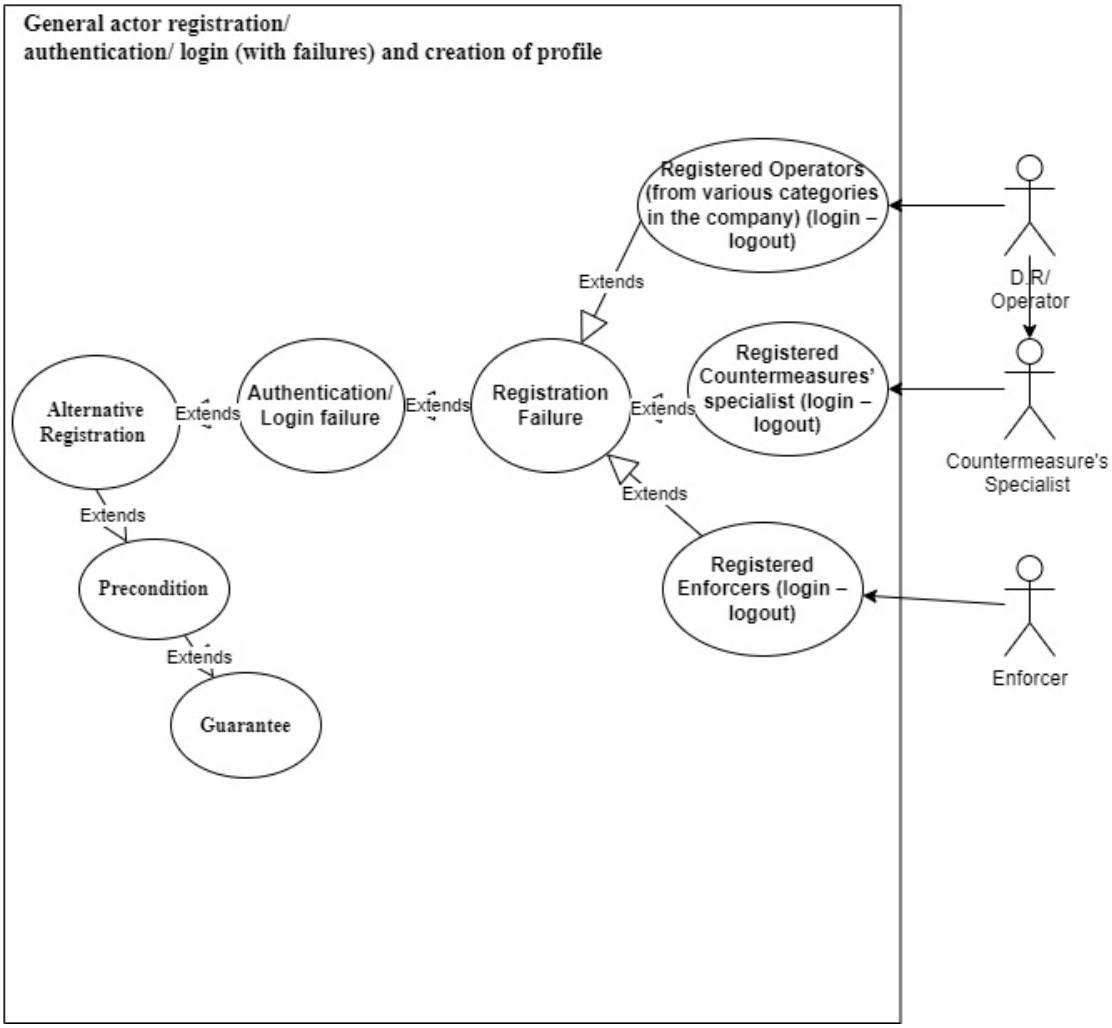

Figure 31. *UCscr23: Generic registration/ authentication/ login UML*

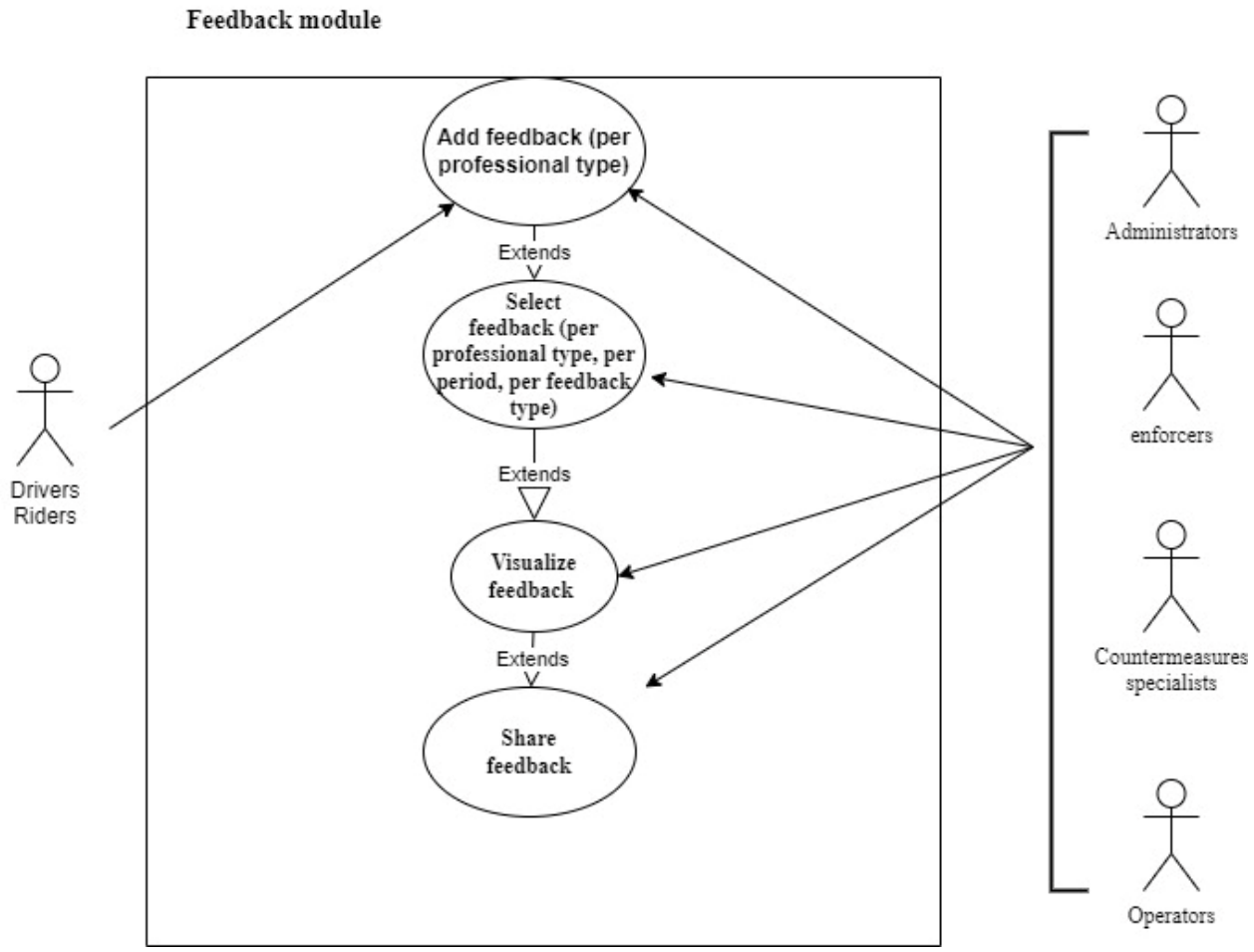

Figure 32. *UCscr24: Feedback module UML*

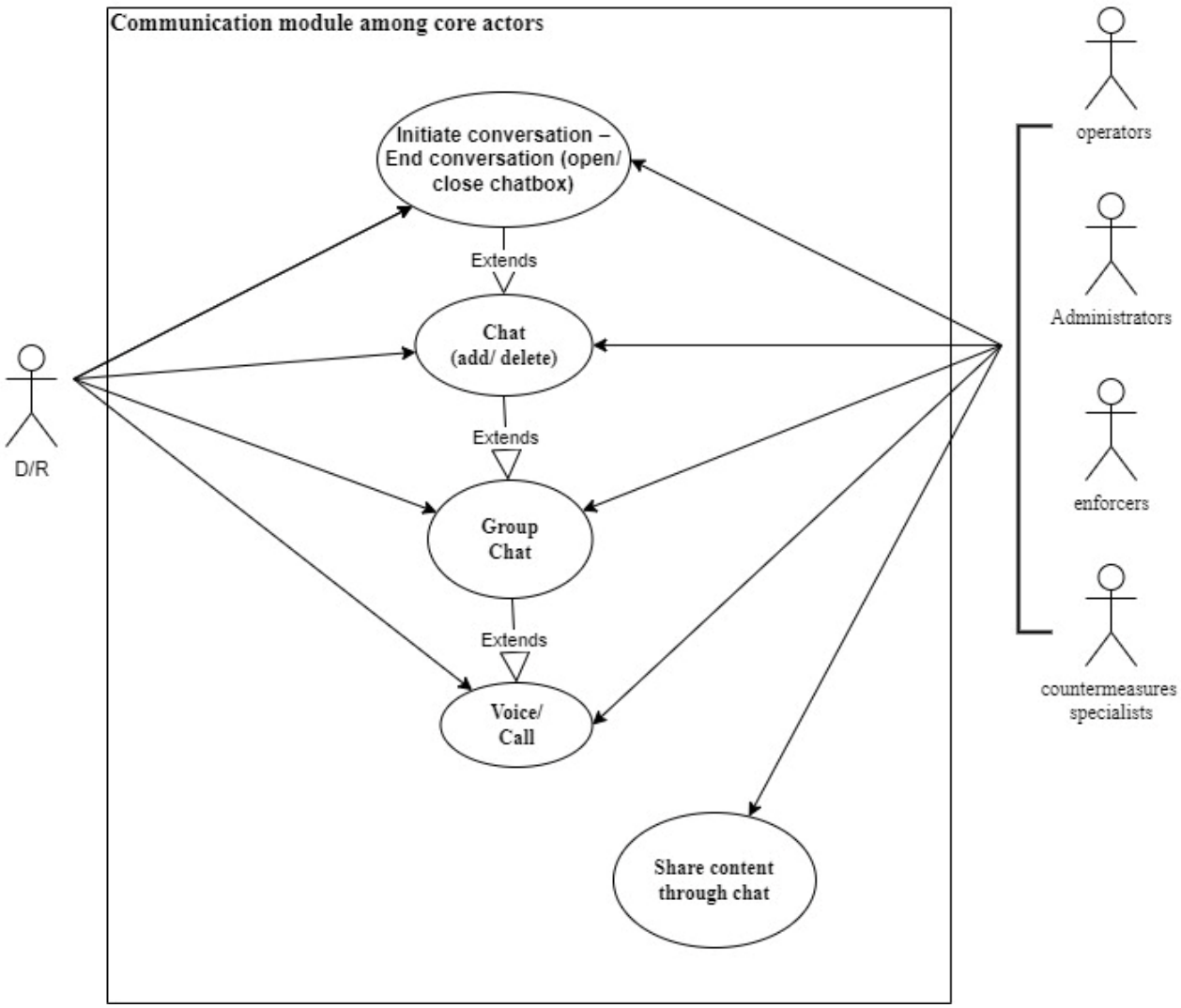

Figure 33. *UCscr25: Communication module UML*

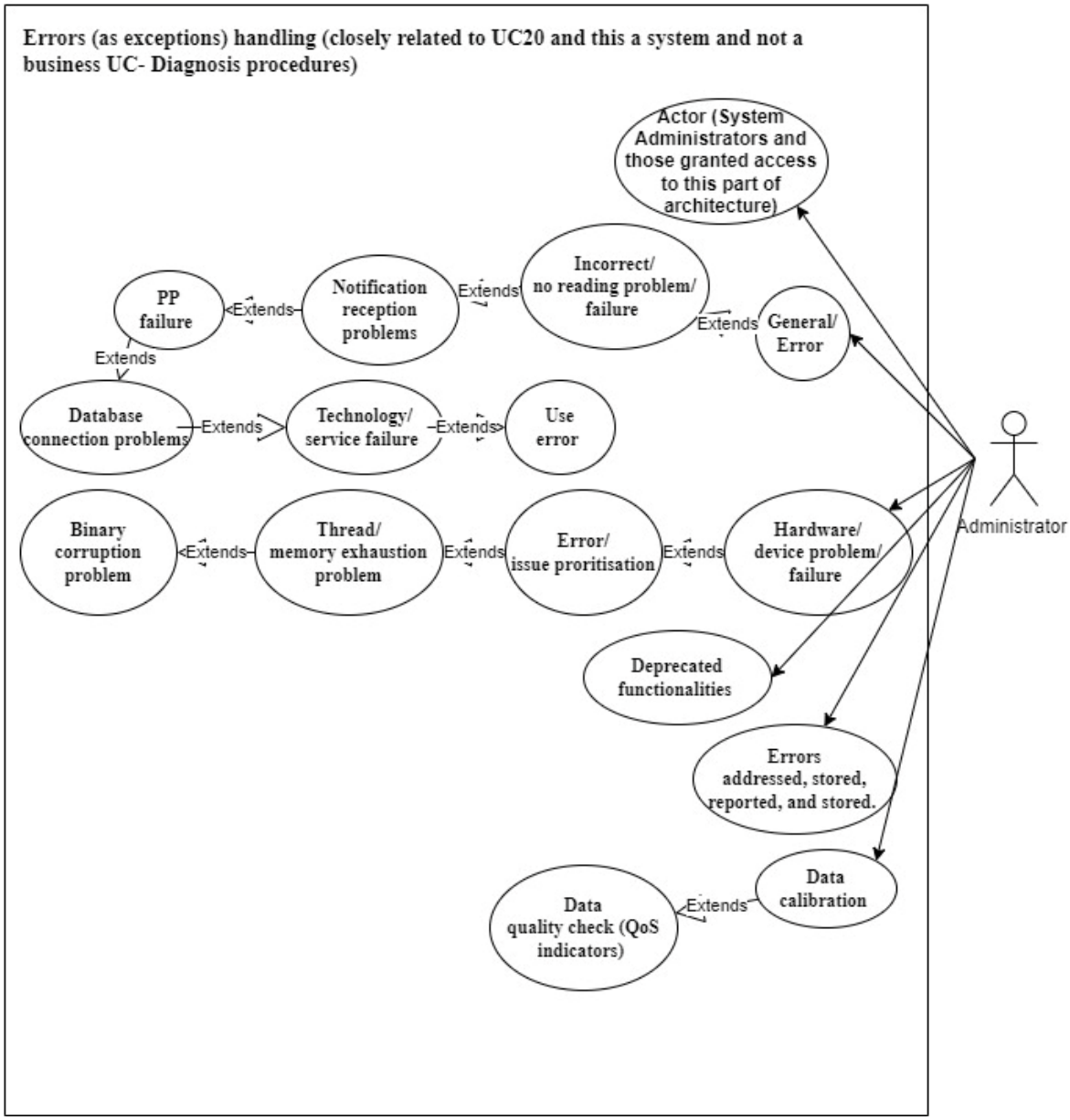

Figure 34. *UCscr26: Errors' handling UML*

Appendix IV: Static & Dynamic user information parameters

The following table includes static user information that could be available (mostly interactive) as part of each actor's profile. This is an indicative and preliminary list. The contribution of WP2, WP3, WP4 and WP5 teams is necessary to further elaborate them.

Table 7. *Static user information parameters*

Parameters	Options
Email	
Password	
Username (optional)	
Gender	
Age	
Profession	• Administrator (A) • Technology/ Service Provider (TSP) • Operator (O) (here all possible sub-categories for the operator may be considered, depending on the entities' structure). • Bus Driver (BD) • Shuttle Operator (SO) • Taxi Driver (TD) • Courier Service Rider (CSR) • Countermeasures' Specialist (CS) Enforcer (E)
Language	At least English, Spanish, Swedish, Greek.
City (for PANACEA purposes only)	Linkoping (UCA; Sweden), San Sebastian (UCC; Spain), Thessaloniki (UCB; Greece)
Medical conditions Share with core actors ▢All ▢ Those with prescribed medication ▢ selected ▢ None Share only with Enforcer and only in case of an incident ▢All ▢ Those with prescribed medication ▢ selected ▢ None	▢ Heart condition Prescribed medication: Yes/ No ▢ Diabetes Prescribed medication: Yes/ No ▢ Hypertension Prescribed medication: Yes/ No ▢ Hyperlipidaemia

Parameters	Options
	Prescribed medication: Yes/ No ▢ Weight (under/ over) Prescribed medication: Yes/ No ▢ Chronic backpain problems Prescribed medication: Yes/ No ▢ Mental health problems (e.g., depression, anxiety) Prescribed medication: Yes/ No ▢ Sleep problems (e.g., sleep apnoea, insomnia) Prescribed medication: Yes/ No
Lifestyle choices (optional)	▢ Drinking coffee ▢ Drinking energy drinks ▢Drinking wine or other alcohol beverages to unwind after work ▢ Smoking ▢ Drugs ▢ Nutrition: Vegetarian/ Lactose intolerant/ Other ▢ Exercise (frequency Likert) Leisure activities (from a selection)
Shift phase	▢ Pre-driving ▢ During driving ▢ Off duty ▢ Roadside (option for enforcers only)
TDs/ CSRs	
Vehicle identification	▢ Vehicle plate number
Personal identification	▢ Personal ID ▢ Personal credential
Operators	

Parameters	Options
	☐ Name ☐ ID ☐ UC ☐ Vehicles ☐ Shift level: ☐ Role:
Countermeasure Specialists	
	☐ Name ☐ ID ☐ UC ☐ Vehicles ☐ Shift level: ☐ Role:
Enforcers	
	☐ Name ☐ Position ☐ UC ☐ Area ☐ Impairment type and level ☐ Vehicle type ☐ Shift on/off
Others from DATIK, WP2, WP3, WP4, WP5 and technology providers	

Table 8. *Fatigue related indicators per relevant technology and suggested impairment state levels.*

Type	FATIGUE Data Parameters
Inputs	**Video (Driver) (for TD only)**

Type	FATIGUE Data Parameters
	• Head movement • Gaze direction • Eyelid opening (Blinks) • Yawning
	AIT PWA ECG: • Heart rate (HR) • Heart rate variability (HRV)
	Real Time Clock: • Time
	Simulators and instrumented vehicles and steering wheel algorithm Kinematics: • Speed • Acceleration • Steering wheel angle • Braking
	Lane keeping
	Global Positioning System: • Longitude and Latitude
Outputs	Fatigue state level of severity: • Normal: 1, Increased: 2, High: 3
	(Optional) Quality factor of fatigue estimation: (CoE) • Confidence level (0-100%)

Table 9. *Cognitive load related indicators per relevant technology and suggested impairment state levels.*

Type	Cognitive load (under/ over) Data Parameters
Inputs	Video • Gaze direction • Head rotation

Type	Cognitive load (under/ over) Data Parameters
	Driving performance: • Steering wheel angle • Steering wheel angle rate • Vehicle speed (lat., long.) • Vehicle acceleration (lat, long) • Braking • Throttle pedal position • Yaw rate
	Kinematics • Braking • Acceleration
	Environment: • GPS coordinates • Upcoming intersections • Traffic intensity • Surrounding vehicles position • Etc.
	ECG/PPG: • Heart rate • Heart rate variability
	Real Time Clock: time
	Video (exterior): Video in front of the vehicle
	Video (interior): In cabin video
Outputs	Levels of distraction state: 1, 2, 3
	Quality factor of distraction estimation: Confidentiality level (CoE)

Table 10. *Stress related indicators per relevant technology and suggested impairment state levels.*

Type	STRESS Data Parameters
Inputs	Video (Driver): • Dilated pupils • Tunnel vision • Head rotation • Eye movements • Blink duration
	ECG waveform • Heart rate • Heart rate variability
	PPG waveform
	Electro dermal Activity: (EDA) Phasic and tonic activity
	Personal data: • Gender • Age • Driving experience • Defective vision
	Vehicle data: • Steering wheel angle • Steering wheel angle rate • Vehicle speed (lat., long.) • Vehicle acceleration (lat, long) • Braking • Throttle pedal position • Yaw rate
Outputs	Levels of stress state: 1, 2, 3
	Quality factor of rest estimation: Confidentiality level (CoE)

Appendix V: PANACEA Architecture components and data flow activities

This Appendix includes the main core architecture components of the PANACEA Platform (PP) with the respective sequence diagrams about monitoring & assessment of the derived measures. The core components of the Panacea Platform are the following:

AV.1 Main core architecture components

The main core components are the following:

- **IOT Broker**: this covers the "Gateway" features for data collection and data brokering from technological partners, devices or third parties and redistributes them to related Panacea solution components (i.e., the Decision Support System; DSS) according to their protocol communications.
    - **IOT Apps**: this covers a set of processes and rules for data management (i.e., Rule Engine component), transformation, and the like., which can work systematically, on-demand, and/or in an event-driven manner to respond to actions and events in the PANACEA platform.
- **Data Storage:** this component manages context information at large scale deriving from IoT devices (i.e., smartwatches technological partners (FitbitCloud), and other public and personal data source provided in a uniform approach and aligned to the Panacea Data Modelling**.**The specific component should be involved the following:
- **Data Analytics** this component covers a large set of common solutions processes & tools to be used by PANACEA Researcher /Business Expert across the Panacea data storage in order to cover different business needs as following:
    - **Data Analytic Processes,** to enforce smart behavior, support decision making, compute future conditions and thus make strategies ,and analyzing performances.
    - **Data Analytics development tools:** to permit the Panacea Data Analysis, which could improve Panacea's data management and add new ways to make deductions as well as to generate new knowledge and services from data and contexts, included 3rd parties' sources; if this is needed.
    - **Visual Analytic processes**: to visualise the business logic, business intelligence. The visual analytics offers direct connection with the respective interfaces, including dashboards ,applications, and Mobile applications if needed.
- **Dashboard (Presentation layer)**: to covers services bidirectionally with the Panacea's components via the External/Internal Interoperability component (i.e., SmartDriver Api). It may have direct connection with the Data Analytics and with IoT Applications for realizing: Detect , Monitoring & Assessment monitoring ,Business Intelligence tools, for dynamic routing, for deep drill down on data, what-if analysis tools, etc. via Web & Mobile Application.
- **Authentication and Authorization** – to provides authenticated access and the right authorisation to the different roles of users and devices according to the roles, profiles, ownerships, delegations.
- **External Interoperability Interface (API)** :This component should be offering services as Open API for exchange info with technical Partners or any other 3rd parties' external interface. The component is usually exploited by Dashboard (Presentation layer).
- **Administration Module: to** offer features/services to handle the **management** of content, users, processes, device healthiness, notification, and alert mechanism etc.
- **Internal Interoperability Interface (API)**: allows the Panacea solution component (i.e., BMM, DSS) to access and interoperate with the Knowledge and Data Storage via IoT App. This component is also responsible to guarantee that: (i) additional applications can be

developed and plugged into the architecture without creating a vendor lock-in, (ii) legacy solutions can interoperate with the Knowledge and Data Management.

A.1.2 Monitoring Management

Figure 35 captures the flow of detection samples from edge layer & monitoring them with their Dashboards throughout the PANACEA solution component.

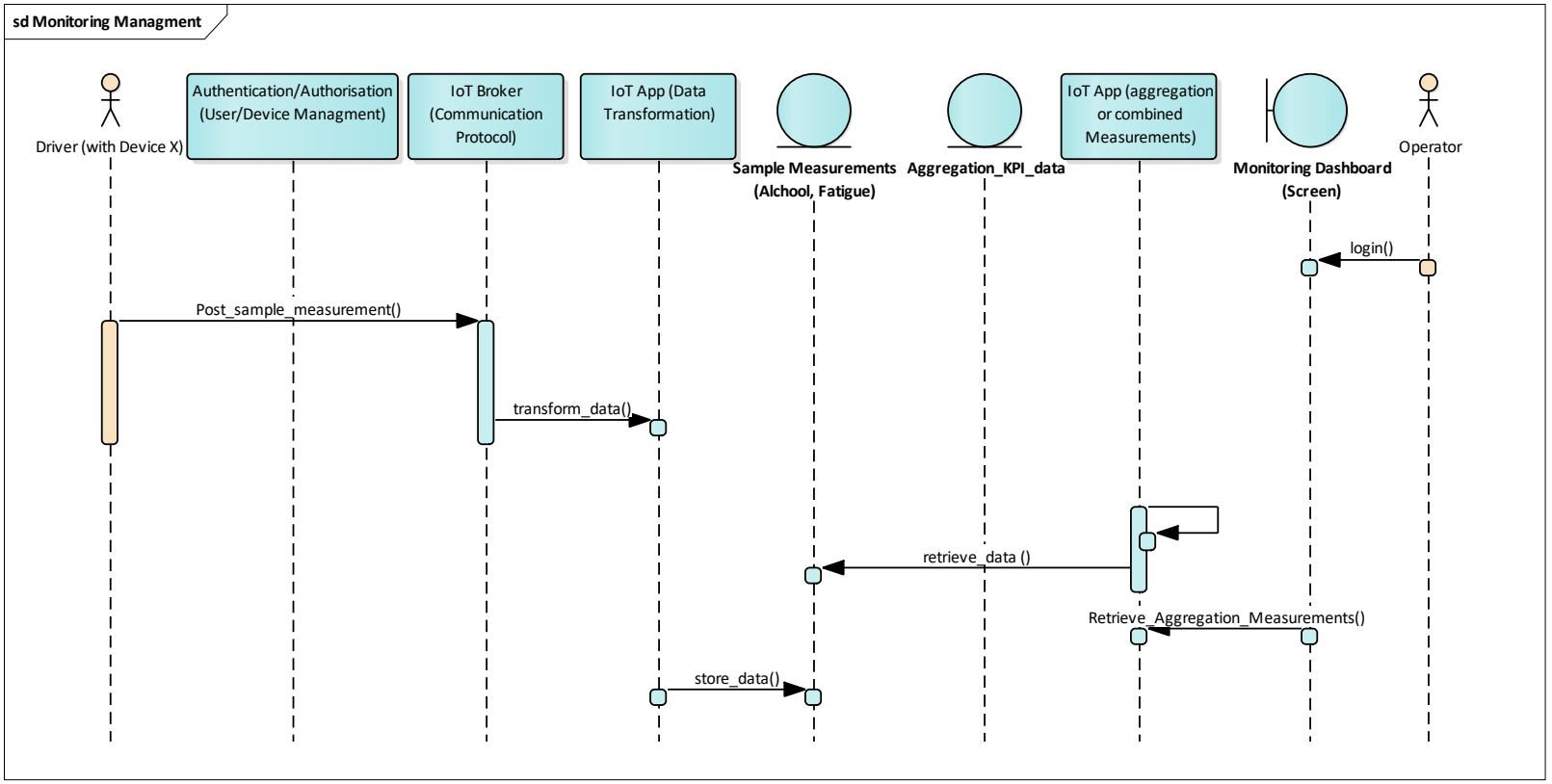

Figure 35. *Monitoring management in PANACEA platform*

A.1.3 Assessment Management

Figure 36 captures the assessment flow of samples throughout the PANACEA solution components.

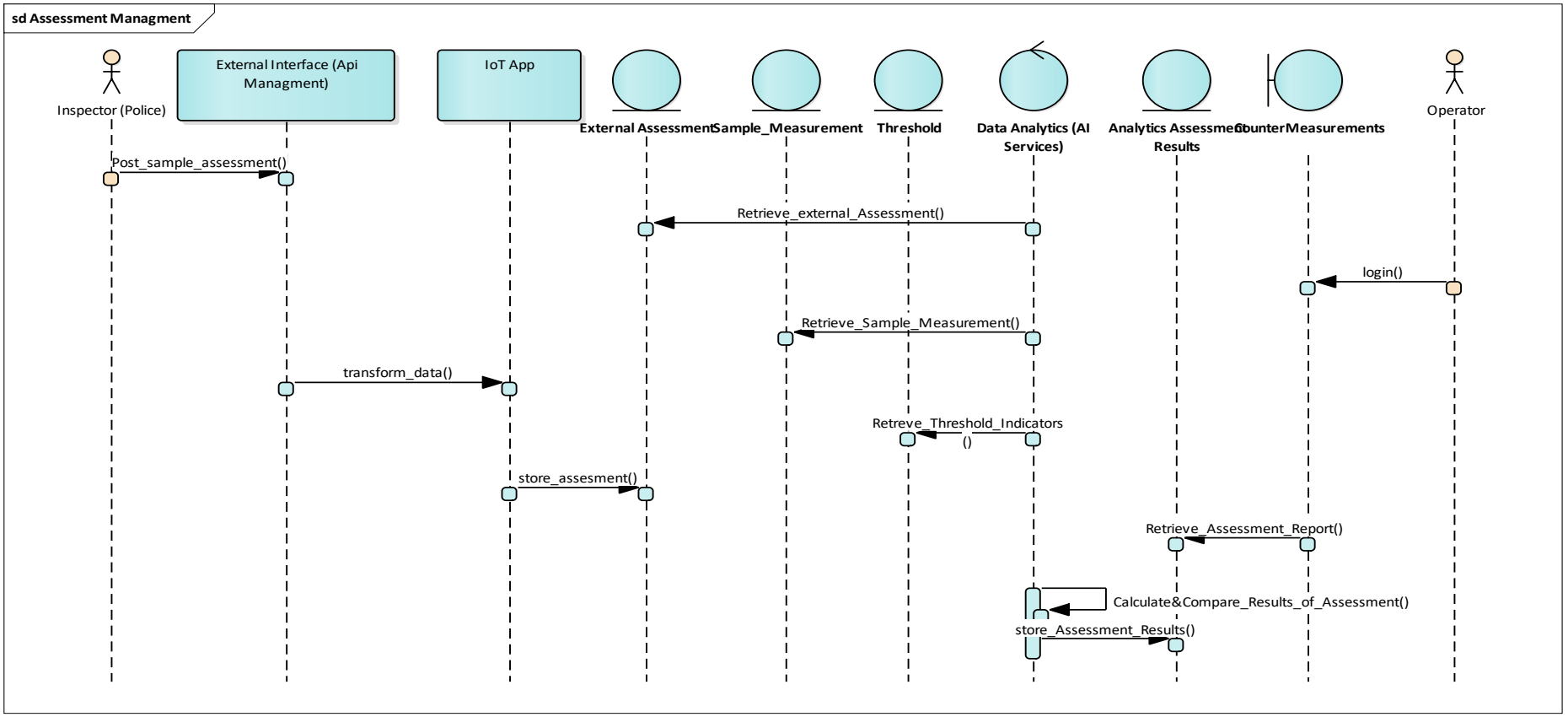

Figure 36. *Assessment management in PANACEA platform*

A.1.4. Threshold Management

The Threshold Management contains the following sequence diagrams:

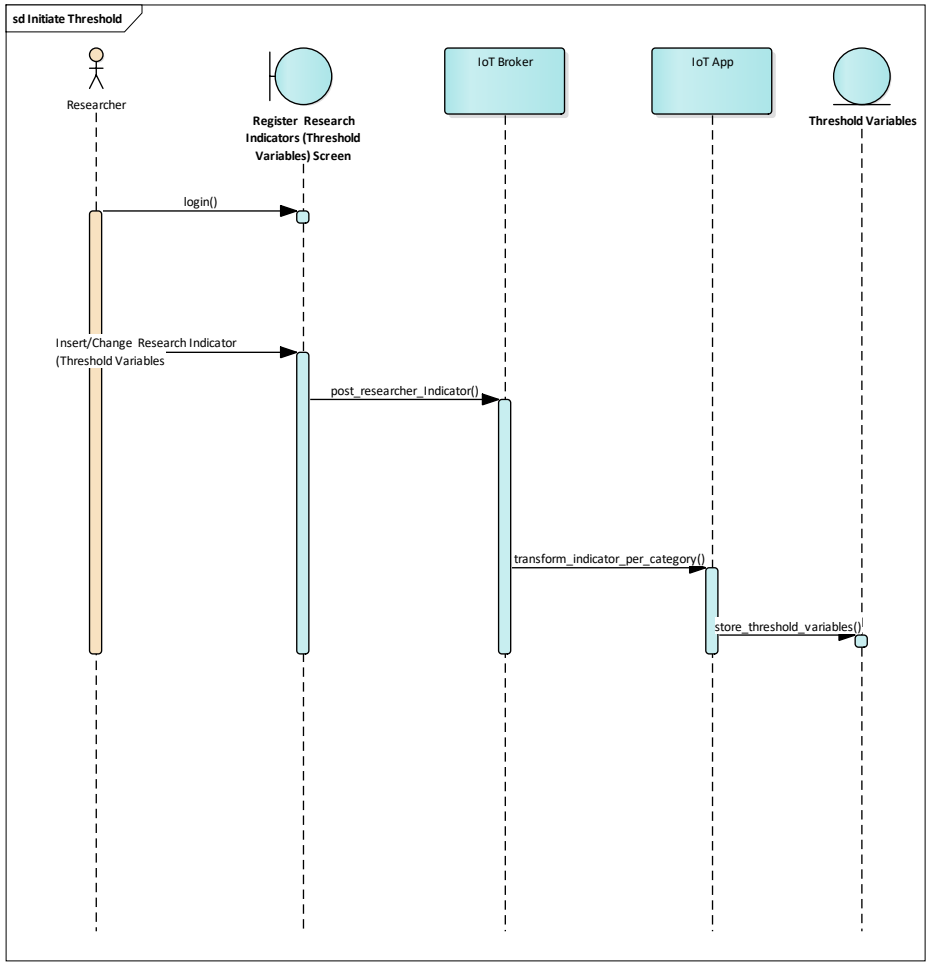

Figure 37. *Initiation of threshold in PANACEA platform*

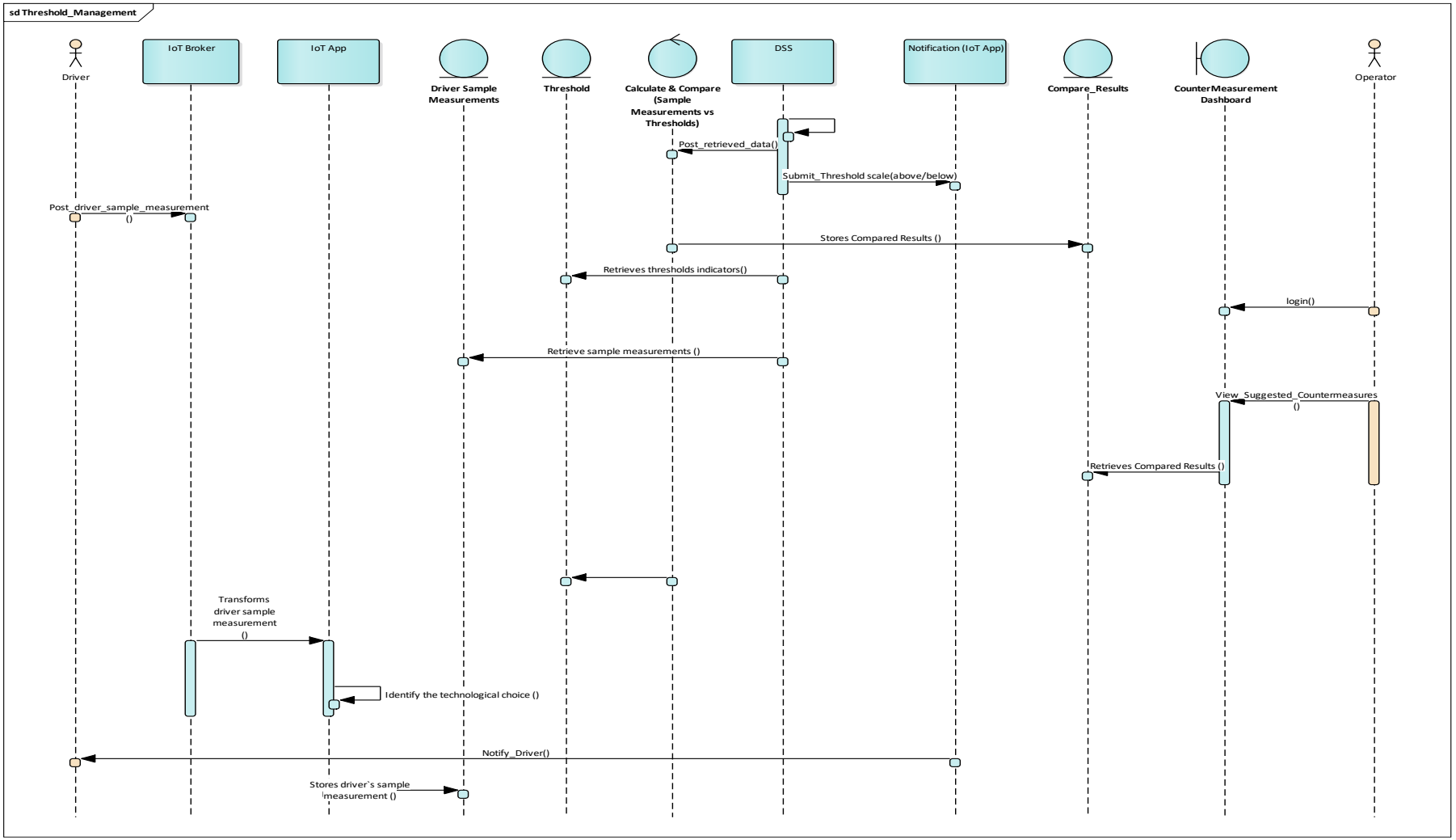

Figure 38. *Threshold management in PANACEA platform*

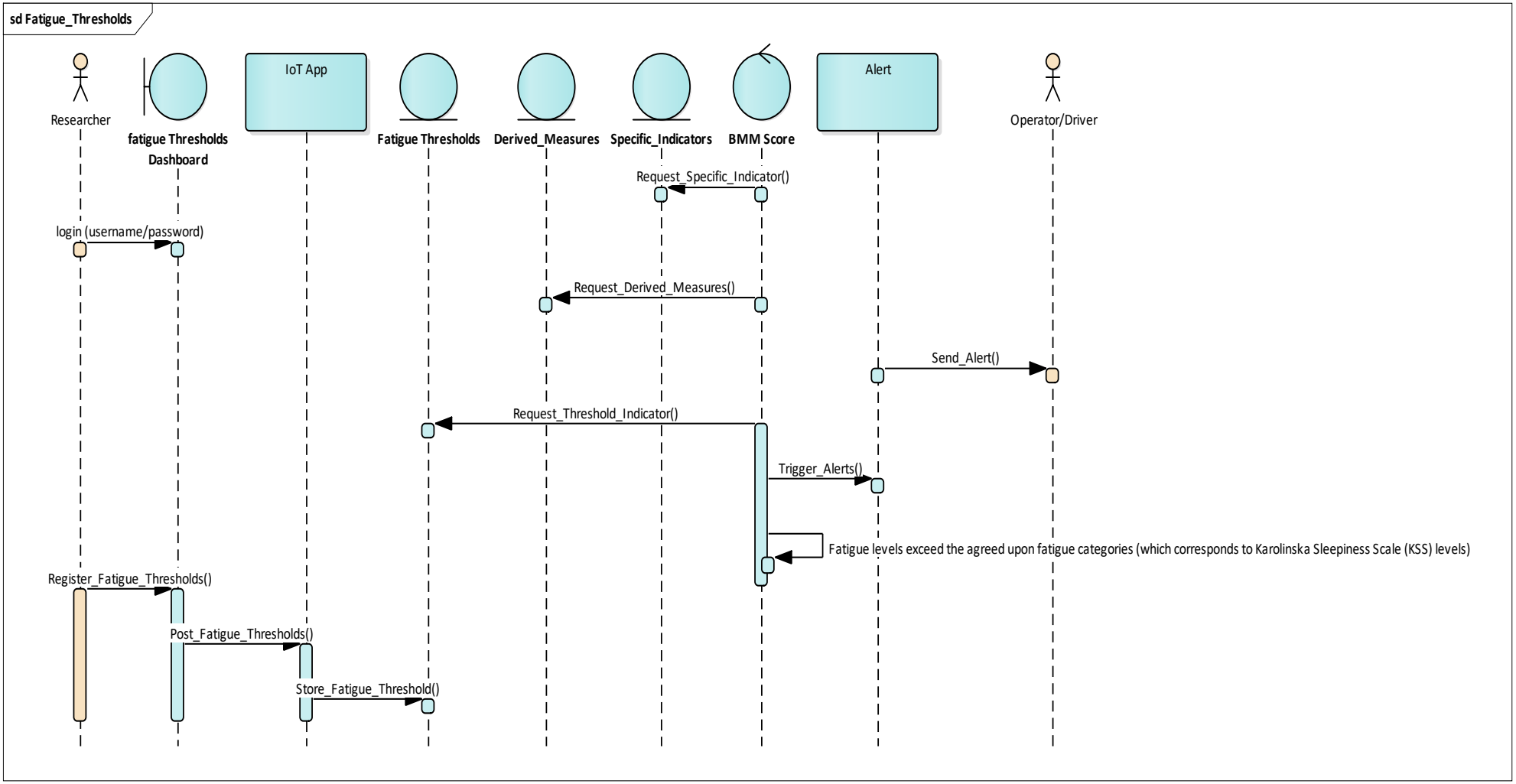

Figure 39. *Fatigue thresholds in PANACEA platform*

Initiate Research Framework
Actor: Researcher
Executive Tasks

- Logins in the Research Indicator Dashboard
- Registers indicators values (i.e., Threshold)

Component – IoT Broker

- Get/Retrieve data from Front-End Layer

Component – IoT App (Transformation Service)

- Transforms Researcher Indicators aligned to PANACEA Data Dictionary
- Stores the Researcher Indicators in the associated Entity on the Panacea Data Storage. The Threshold indicators should be stored in scale format.

AV.2 Driver`s/ Rider's Sample Management

The following diagram depicts the process of managing the Driver`s/ Rider's sample against the existing Thresholds.

- **Actor** – Driver / Rider
- **Device** –sample intake
- Post the driver/ rider sample measurement to Panacea Platform via IoT Broker

Component: IoT App (Service Transform sample measurement)

- Identify the technological choice (Main or Secondary) on the specific device model
- Transforms driver sample measurement based on specific device model specification
- Stores driver`s sample measurement and results to driver's profile on the associated Panacea entity.

Component: DSS (Decision Support System) – Trigger by the sample

- Retrieves sample measurements for specific driver profile based on predefined technological choice
- Retrieves thresholds indicators
- Calculate & Compare sample measurements vs Thresholds
- Store Compared Results on the associated entity of Panacea Data Storage

Component: Notification – Trigger by DSS (above or below Threshold scale)

- Notify actor accordingly (i.e., Driver, Operator etc.)

Component: Counter Measurement (Dashboard)

- Retrieve Compared Results (Classification Case)
- Suggest countermeasures according to classification case

Actor – Operator

- Login to the associated Counter Measurements Dashboard (Role based permissions)
- View only Suggested countermeasures for respective drivers/ riders
- Takes Actions

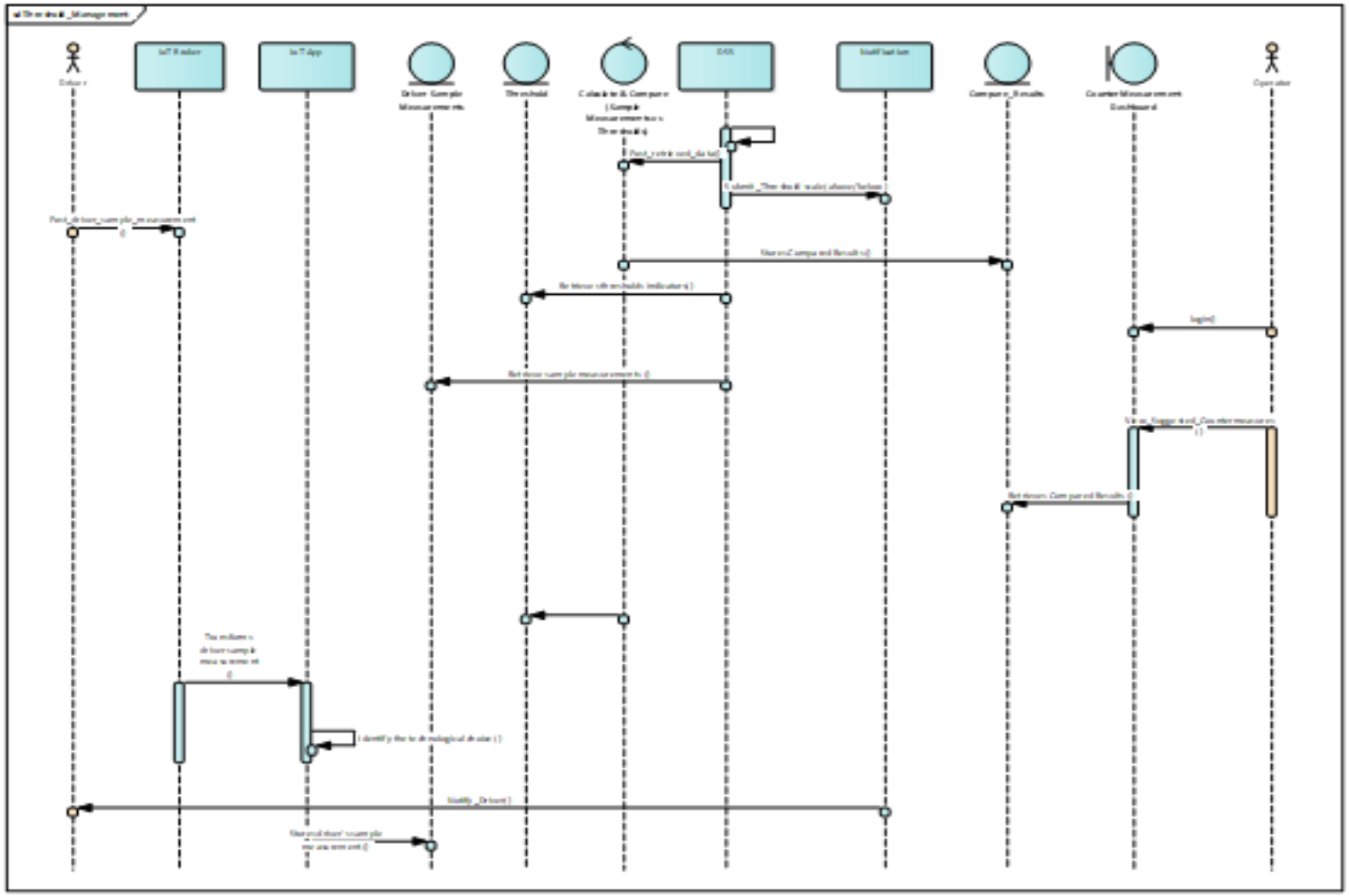

Figure 40. *Driver's / Rider's sample management*

AV.3 Data flow across difference measurement instances

Flow for 24h measurements (UCA at least)

Bus drivers and shuttle operators use Fitbit and BACtrack Skyn for 24h monitoring and assessment of sleep quality and alcohol consumption (TAC), respectively. Raw data from the system will first be logged in the provider's cloud system. PANACEA system will request data to a provider's cloud system every 5th minute for Fitbit and every 15th minute for BACtrack Skyn. This raw data will then be processed by a biomathematical model (BMM) implemented within the PANACEA system to create aggregated data (derived measures and/or indicators) which will then be used to estimate the current and future BMM score. The after-effects of alcohol consumption due to deteriorated sleep are also included in the BMM score. If the predicted fatigue levels exceed the agreed upon fatigue categories (which corresponds to Karolinska Sleepiness Scale (KSS) levels) at any time in the upcoming work shift, the driver and the operator will be alerted (Figure 38).

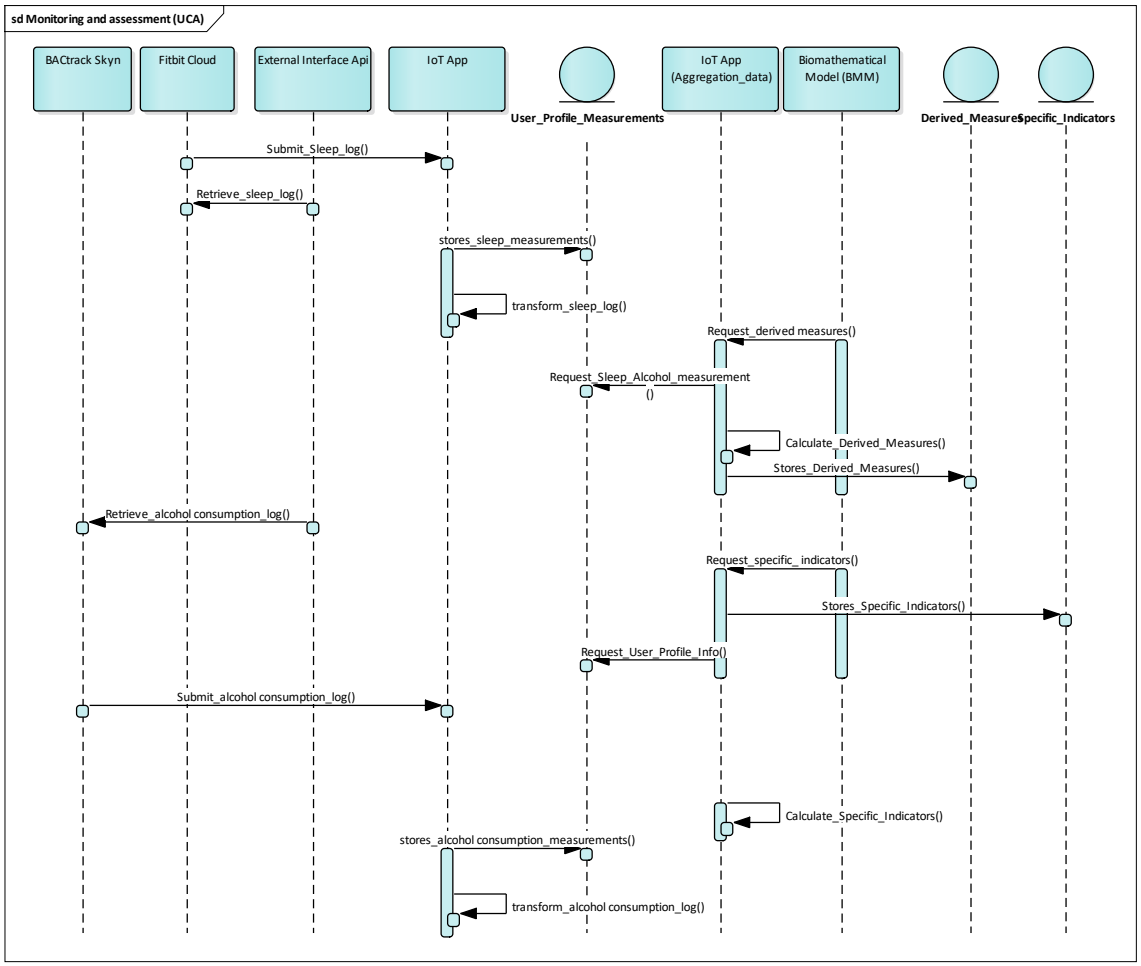

Figure 41.*Monitoring & assessment in UCA (example)*

Flow for measurements done at on-site assessment for alcohol and drugs

Drivers give breath sample to Senseair wall mounted sensor and/or saliva sample to LEITAT sensor. The sample is processed directly in the device and result is presented to the drivers via the device and at the same time a more detailed result is also sent to provider' cloud system. Every time data from PANACEA drivers arrives to the provider's cloud system, that data will also be sent to the PANACEA platform. Once arrived in the PANACEA platform, the data will be:

1. Used to make a notification to the operator

2. Combined together with data from other sensors and sent to DSS and countermeasures system. **See above Threshold Management**

Data flow for measurements from DBL system during simulator experiments (covers both on-site assessment and on-duty)

Drivers use DBL system during simulator experiments. DBL system continuously collect data while being used. Raw data will first be collected in the device or in the provider' cloud system and then the raw data will be analysed to create some neurometrics in the provider's cloud system. The neurometrics data will be copied to the PANACEA platform. Once the data is available in the PANACEA platform, the data will be processed to create scores that can be matched with the threshold mapping to the agreed stress categories and cognitive load categories.

Data flow for measurements from ERGOS system during simulator experiments (covers both on-site assessment and on-duty)

Drivers use ERGOS system during simulator experiments. ERGOS system continuously collect data while being used. Raw data will first be collected in the device or in the provider' cloud system and then the raw data will be copied to the PANACEA system. Once the data is available in the PANACEA system, the data will be processed to create aggregated data (derived measures and/or indicators) which then be used to create score(s). The score(s) will then be matched with the threshold mapping to the agreed fatigue categories and stress categories.

Data flow for measurements from AIT SmartPWA at on-site assessment, or at certain time while off-duty, or at resting time during on-duty

Drivers use AIT smartPWA system at certain times during the data collection period (not while driving in real traffic). Raw data will first be collected by the smartPWA device and streamed via Bluetooth to a mobile device (tablet or smartphone). At the mobile device, the AIT smartPWA app is installed, which processes the raw data and sends aggregated data to the Panacea platform once the measurement is finished. In the Panacea platform, the aggregated data will be combined with the aggregated data from the baseline measurement to create some score(s). Note that the aggregated data from the baseline measurement should already be stored in the PANACEA platform. The score(s) will then be matched with the threshold mapping to the agreed fatigue categories, stress categories, and cognitive load categories.

Data flow for measurements done at roadside assessment (those that are part of PANACEA test).

Drivers give breath sample to Police's own alcohol-sensor and/or saliva sample to Police's own drug-sensor. Result of measurement is shown to the drivers by the Police following their procedure and the result will be sent by the Police to the PANACEA platform somehow. Drivers who are willing to participate give breath sample to Senseair's portable device and/or saliva sample to LEITAT's device. Sample is processed directly in the device and result is presented to the police via the device, but result shall not be presented to the drivers. When one or both of PANACEA's devices is/are used then the Police shall send the measurement results from the PANACEA's device(s) and the corresponding Police's own sensor(s) to the PANACEA platform somehow. Such data will be used to check for level of agreement between PANACEA's devices and the commercial devices currently in used by the Police for roadside assessment.

Data flow for measurements from DATIK face camera while driving during on-duty

Drivers will be monitored all the time by DATIK face camera and their steering behaviour will be processed by VIF Steering wheel algorithm while they are driving on-duty. For DATIK system, raw data will be logged and processed onboard the vehicle to create events. Further the events and other data or parameter (e.g., timestamp and time of day) will be fused onboard to calculate a risk score/ level, which will be matched with threshold mapping to fatigue categories and

stress categories. The events and the risk level are sent to the DATIK's cloud system and be made available via DATIK iPanel platform to be available for the fleet operators. At the same time, the data will also be shared with the PANACEA platform (iPanel sends data to PANACEA whenever the data arrives in the iPanel). Within the PANACEA platform, the data will be aggregated with other data and be sent to the cloud-based countermeasure system to trigger appropriate countermeasures (Figure 42).

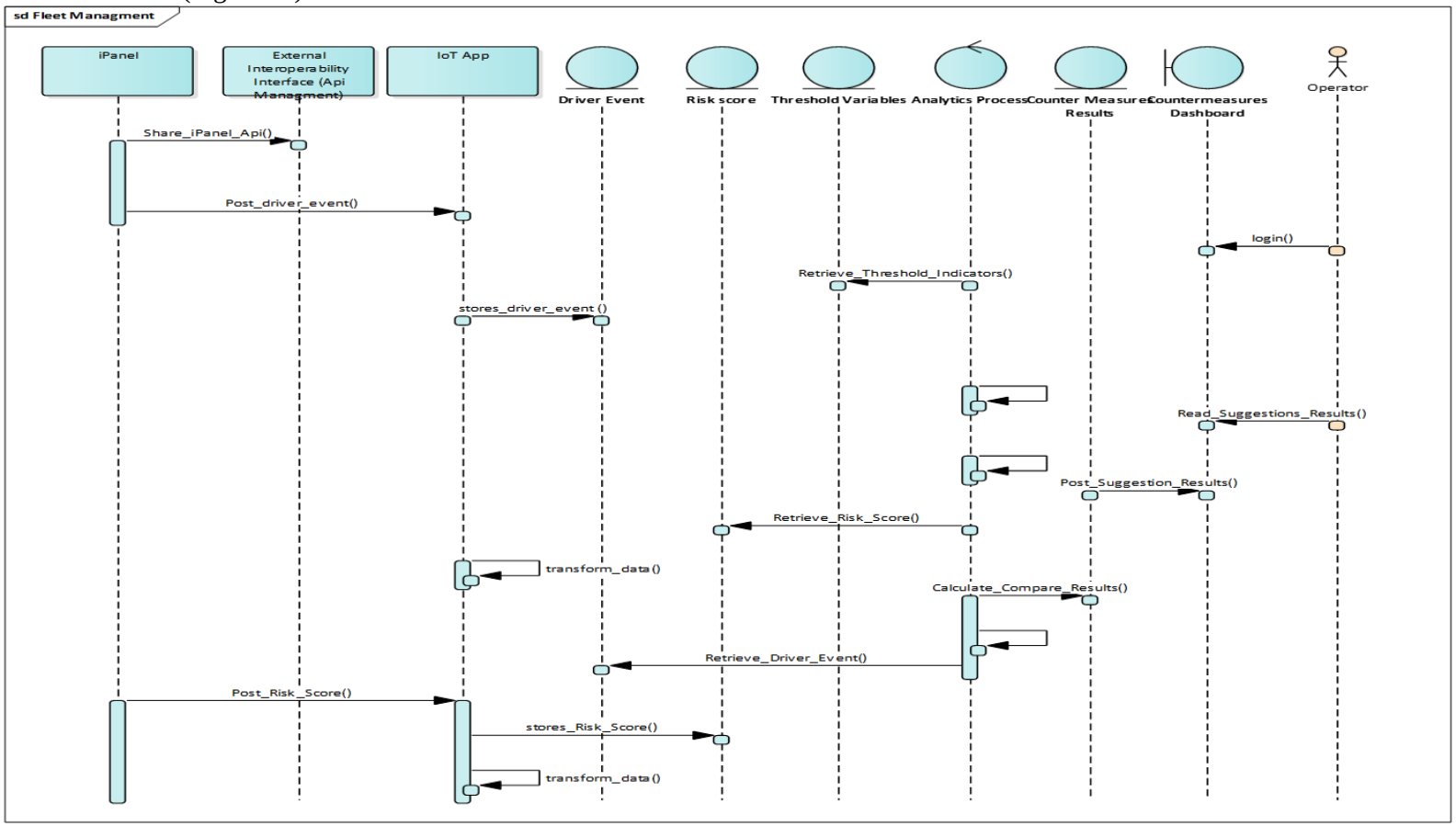

Figure 42. *Data flow for measurements from DATIK face camera while driving during on-duty*

Data flow for measurements from VIF system while driving during on-duty

Drivers will be monitored all the time by DATIK face camera, and their steering behaviour will be processed by VIF Steering wheel algorithm while they are driving on-duty. For the VIF system (here referred to as DMS, i.e., Driver Monitoring System), raw data will be collected on the vehicle where the data are processed. The DMS will receive additional parameters from the DATIK system directly onboard of the vehicle in "close-to" real time and process these data jointly to get a better estimate of driver impairment by comparing these data to drivers' baseline data. Once evidence for driver state impairment exceeds the thresholds for the different fatigue and stress categories, the DMS sends a signal into the PANACEA platform along with diagnostic information (most likely a snapshot of the parameters for summary processing but also overall algorithm tunings and improvements). At the same time, the DMS sends information to the countermeasure system to trigger appropriate direct countermeasures (Figure 43).

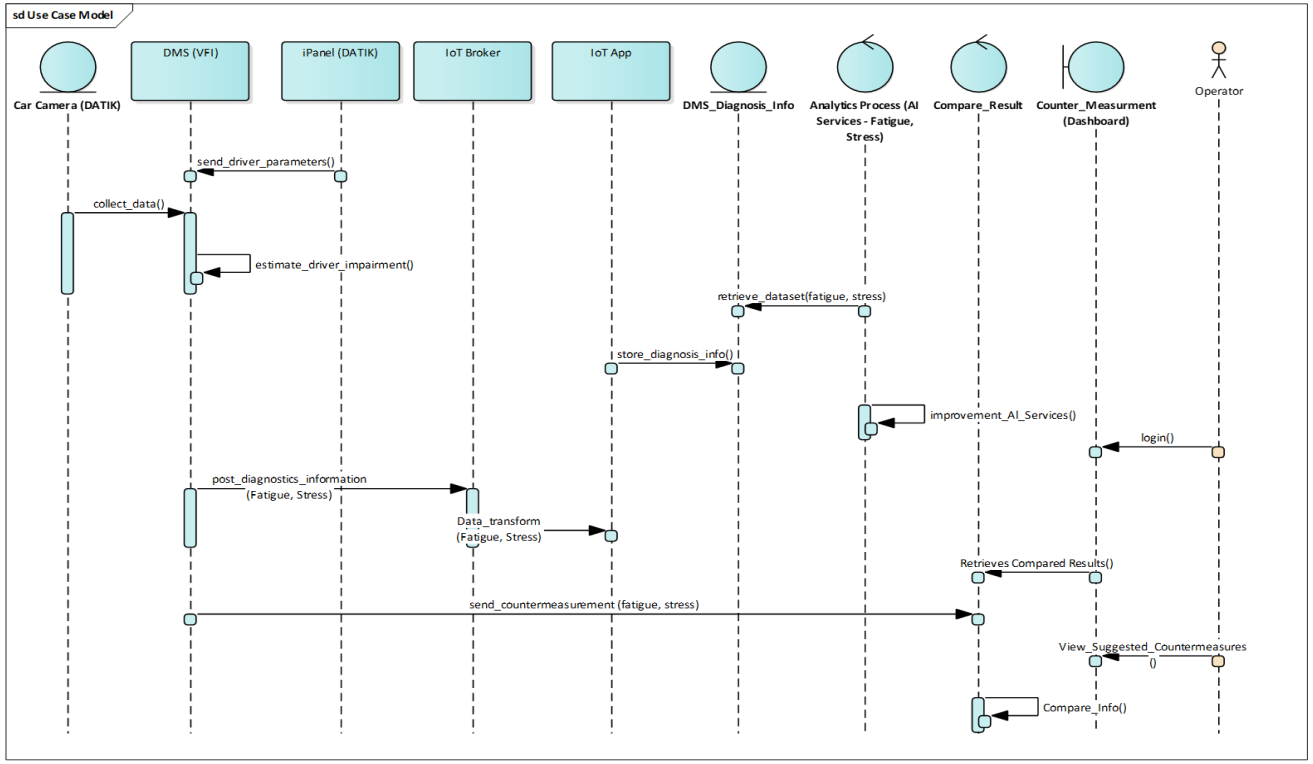

Figure 43. *Data flow for measurements from VIF system while driving during on-duty*