The PANACEA SYSTEM: A Technical Perspective

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PANACEA
FITNESS TO DRIVE

PANACEA Final Event
10 September, 2024

Objectives

- Present the technical perspective of
  - Sensor integration
    - Why did we select this approach
    - What was our process
    - Lessons Learned
  - *Development of the decision making progress*
    - *Lessons Learned*

The PANACEA project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 953426

PANACEA Commercial Health Toolkits

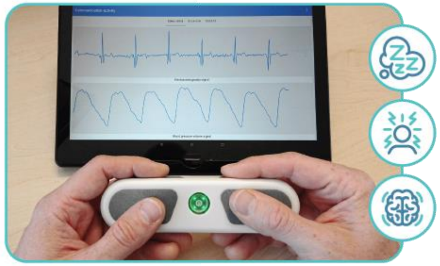
Fatigue Sensor (Optalert)

Fatigue Sensor (BMM fatigue model)

Stress Sensor (GSR)

Stress and Cognitive Load Sensor (Deepblue)

Fatigue, Stress and Cognitive Load Sensor (AIT)



Cognitive Distraction Sensor (ViF)

Driver State Monitor (Datik)

Alcohol Sensor (BACtrack)

Alcohol Sensor (Senseair)

Alcohol Sensor (Senseair)

Drug Sensor (LEITAT)

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Sensor Integration Challenges

- Variety of sensor systems with different functionalities …
  - Mostly developed for singular, not joined use
  - Some commercially available, some research systems
  - Varying ability to modify, especially systems that are on the market
  - Proprietary cloud solutions
  - Different log-in and user identification
  - Different output data formats and protocols

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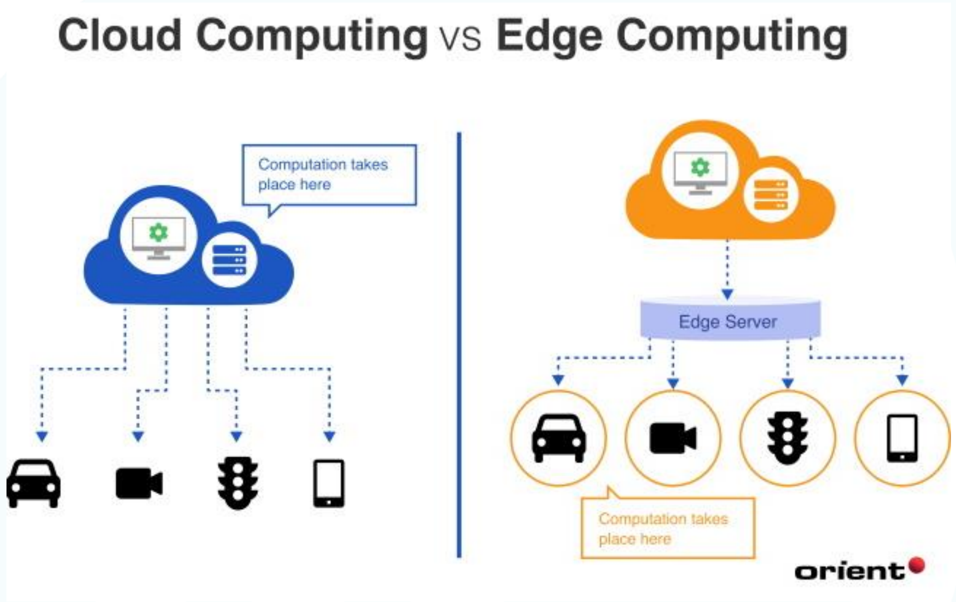
PANACEA Integration Approach

- PANACEA had two fundamental options for sensor integration solution
  1. A cloud-based system where data are processed, stored, fused, interpreted, and distributed
  2. An edge-based approach where processing happens closer to the source, most on the vehicle
- Main advantage 1: processing power for fused signals and generalizability!
- Main disadvantage 1: extensive data exchange, potentially privacy



Allowing a multi-purpose solution for all 3 required pilots (and many more!)

Requiring a different integration solution for each pilot

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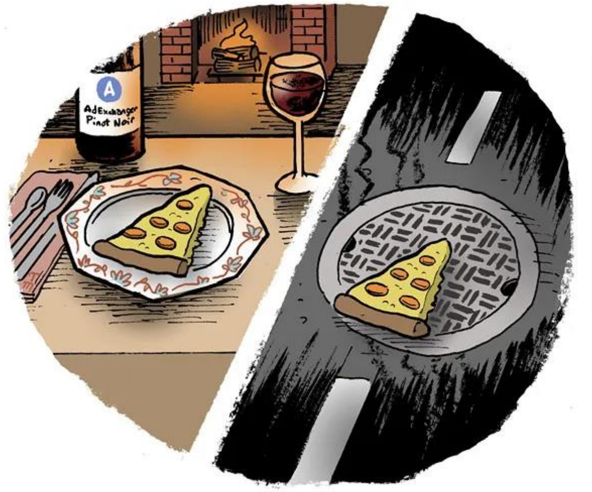
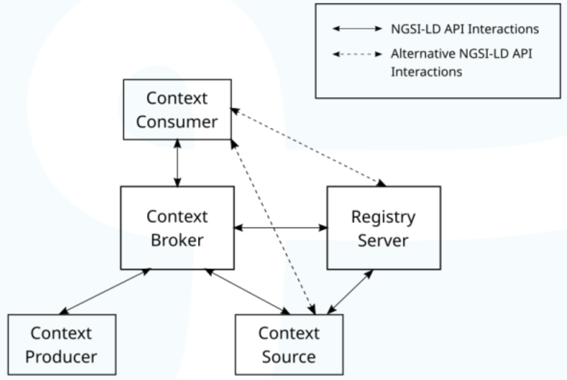
Sensor Integration Framework

- The PANACEA project based its sensor integration on FIWARE
  - FIWARE is an open source IOT platform for building Smart Solutions
  - Set of standards to connect “smart applications”
  - Supported by the European commission
    - Therefore selected over many competitors such as Verizon Real Time Response System, FLIR City, Iotsnap, …
  - The FIWARE information model and API is NGSI-LD and was initiated by the FIWARE programme



Context Matters

https://rainbowraw.wordpress.com/2013/09/21/understanding-context-influence-interpretation-of-belonging/



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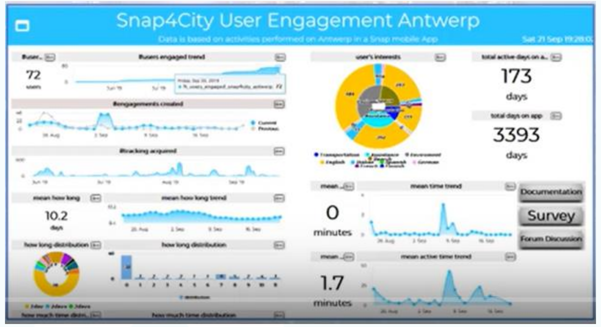
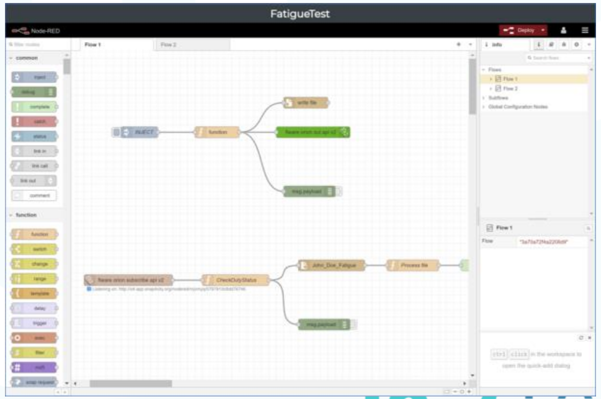
Integration Toolset: Snap4City

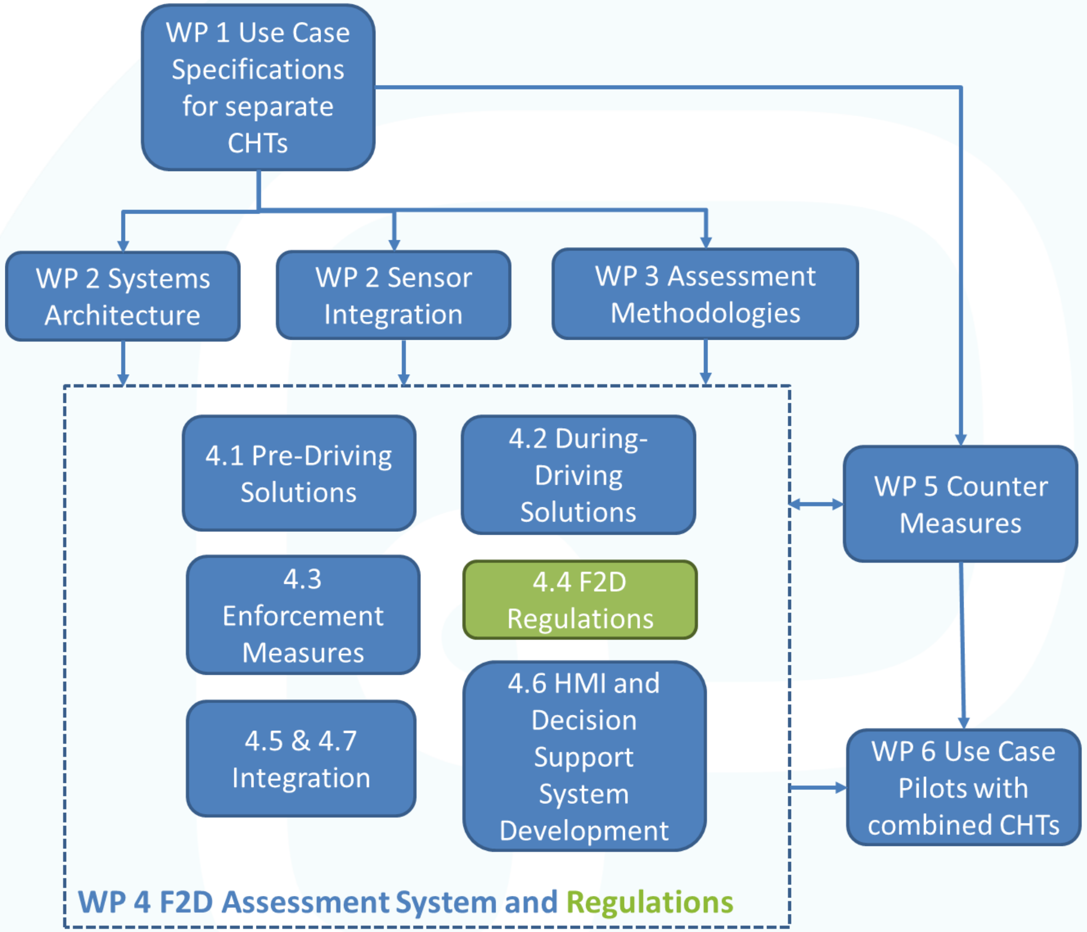
- Snap4City was developed as part of the EU project Select4Cities
  - a data management platform that helps communities and organizations to manage data on-cloud and/or on-premise.
  - open, standardized data-driven
  - service-oriented
  - for large-scale co-creation, testing and validation of urban Internet of Everything (IoE) applications and services
- Snap4City is a 100% open-source FIWARE Platform and Solution by DISIT Lab of the University of Florence, Italy.





Sensor Integration Design and Implementation

- The sensor integration formed the technical center part of the PANACEA project and was prepared by the use case specifications
  - Technical prerequisites in WP 1 – 3
- Use of CHT imposes specific requirements on integration



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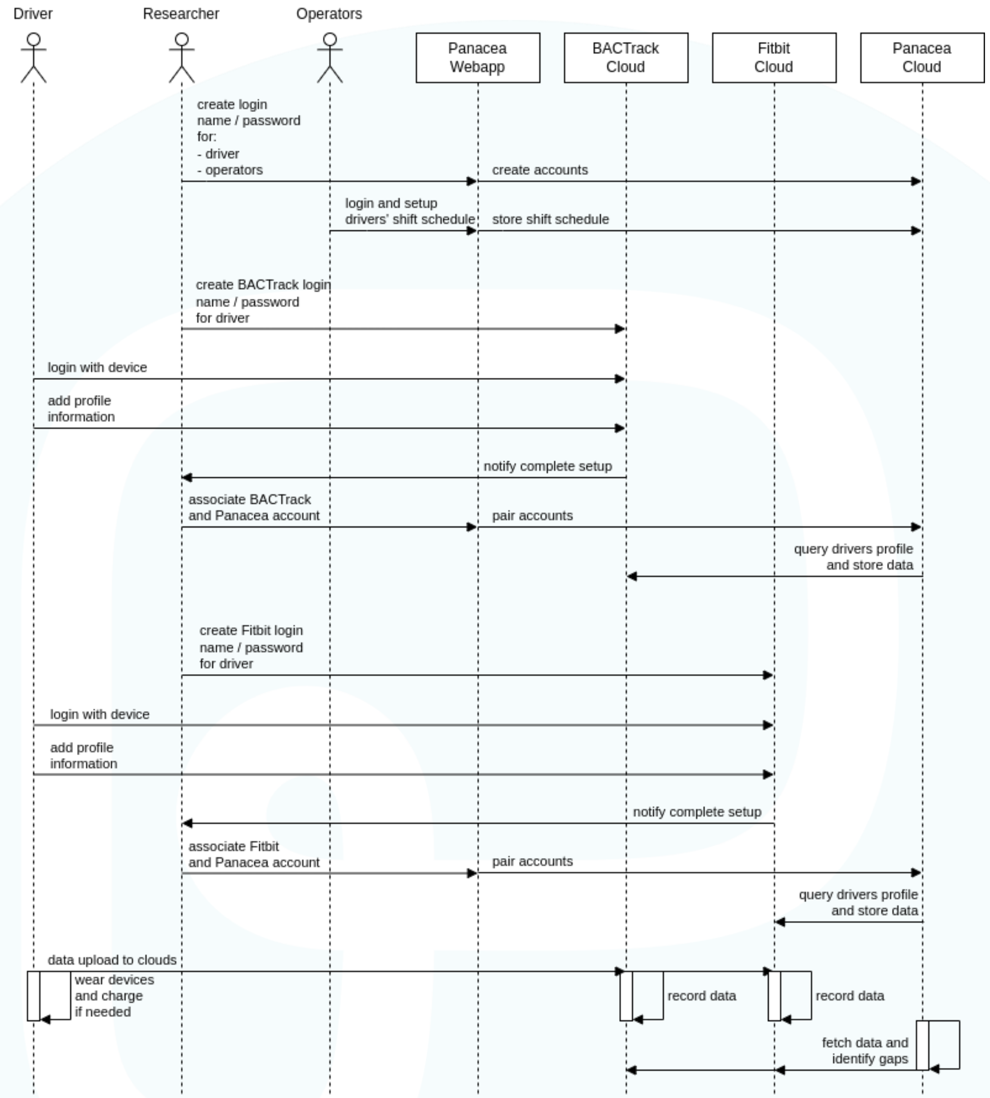
Sequence Diagrams

- A critical step in the development of the PANACEA technical system consisted in the definition of the interactions between the different actors, sensors and Panacea components
- The use of sequence diagrams for the definition of the necessary operational detail and elicitation of requirements was extremely helpful



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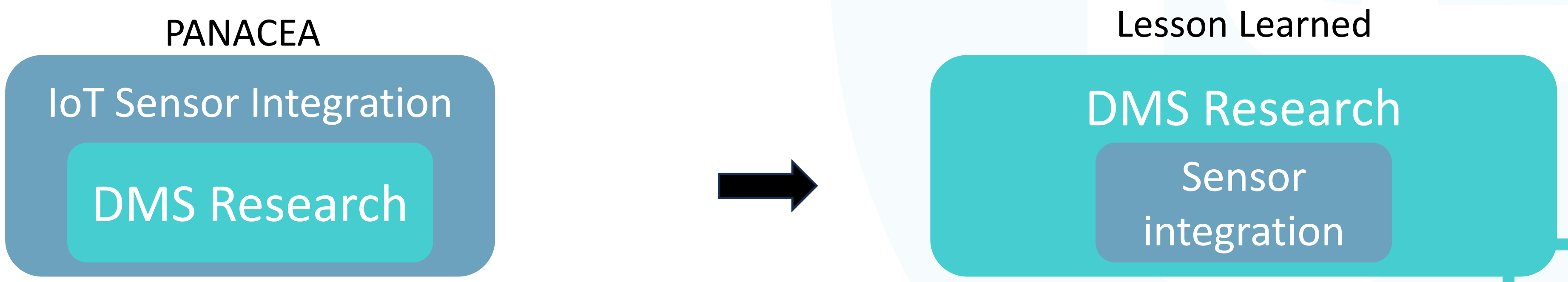
Integration Lessons Learned

- Panacea investigated an IoT approach for DMS sensor integration:
  - Sensor providers and researchers need to learn the integration language
  - IOT tools such as Snap4city are powerful but require significant ramp-up from the partners
  - IOT complexity may only be appropriate for mature applications and large sensor integration (> 100 sensors?): not primarily for driver assessment research
  - Recommend locating driver assessment research as container that holds which IoT R&D occur
  - Selecting the sensors to integrate dependent on the concrete project objectives
    - Enable, if possible, modifications to sensors themselves as part of the project



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Objectives

- Present the technical perspective of
  - *Sensor integration*
    - *Why did we select this approach*
    - *What was our process*
    - *Lessons Learned*
  - Development of the decision-making process
    - How we develop a fitness-to-drive assessment methodology
    - Lessons Learned

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Which systems assess which impairment types

Systems	Impairment types					
	Alcohol	Drugs	Fatigue	Stress	Cognitive load	Cognitive distraction
BMM			x			
BACtrack Skyn	x					
AIT smartPWA			x	x	x	
Datik FitDrive			x			
Datik Pre-questionnaire			x			
DBL Neurometrics Toolbox				x	x	
Optalert Eagle LIGHT			x			
Grove GSR				x		
LEITAT Drug Detector		x				
Senseair Go	x					
Senseair Wall	x					
ViF Driver Monitoring System						x

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Harmonised categories of impairment

Alcohol	Drugs
Normal to low risk	Not presence
Slightly to extremely increased risk	Presence

Scores	Fatigue	Stress	Cognitive load	Cognitive distraction
1	Alert	No stress	Very low cognitive load	No cognitive distraction
2	Neither alert nor fatigue	Low stress	Low cognitive load	Low cognitive distraction
3	Fatigued, but no effort to stay awake	Moderate stress	Moderate cognitive load	Moderate cognitive distraction
4	Fatigued, some effort to stay awake	High stress	High cognitive load	High cognitive distraction
5	Very fatigued, fighting sleep	Severe stress	Severe cognitive load	Severe cognitive distraction

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Criteria & thresholds: alcohol

BrAC (mg/L) limits in the countries of PANACEA pilot sites for **professional drivers**

	Greece	Spain	Sweden	Norway
Sober	0	0	0	0
Driver may drive	0 < BrAC < 0.1	0 < BrAC <0.15	0 < BrAC < 0.1	BrAC ≤ 0.1
Driver must stop	BrAC ≥ 0.1	BrAC ≥ 0.15	BrAC ≥ 0.1	BrAC >0.1

In PANACEA, the same alcohol limits will be used in all three UC sites (following Greece and Sweden).

Fit to drive?	Risk Level	BrAC (mg/L)
Fit to drive	Normal to low	BrAC < 0.1
Not fit to drive	Slightly to extremely increased	BrAC ≥ 0.1

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Criteria & thresholds: drugs

Drugs tested: **Benzodiazepines and Methadone**

Non-alcoholic drug limits for **professional drivers** in the countries of PANACEA pilot sites

	Greece	Spain	Sweden	Norway
Licit drugs	No tolerance	No tolerance*	No tolerance*	Drug limits established
Illicit drugs	No tolerance	No tolerance*	No tolerance*	Drug limits established

*except if prescribed by doctor

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Criteria & thresholds: fatigue and stress

Fit to drive?	Scores	Fatigue	KSS
Fit to drive	1	Alert	1-4
Fit to drive	2	Neither alert nor fatigue	5
Fit to drive	3	Fatigued, but no effort to stay awake	6-7
Not recommended to drive	4	Fatigued, some effort to stay awake	8
Not fit to drive	5	Very fatigued, fighting sleep	9

KSS: Karolinska Sleepiness Scale

Fit to drive?	Scores	Stress	SUS
Fit to drive	1	No stress	1-4
Fit to drive	2	Low stress	5
Fit to drive	3	Moderate stress	6
Fit to drive	4	High stress	7-8
Not recommended to drive	5	Severe stress	9

SUS: Stockholm University Stress Scale

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Criteria & thresholds: cognitive load, distraction

Fit to drive?	Scores	Cognitive load
Fit to drive	1	Very low cognitive load
Fit to drive	2	Low cognitive load
Fit to drive	3	Moderate cognitive load
Fit to drive	4	High cognitive load
Not recommended to drive	5	Severe cognitive load

Fit to drive?	Scores	Cognitive distraction
Fit to drive	1	No cognitive distraction
Fit to drive	2	Low cognitive distraction
Suspicion not fit to drive - advisory	3	Moderate cognitive distraction
Strong suspicion not fit to drive - warning	4	High cognitive distraction
Not recommended to drive	5	Severe cognitive distraction

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From Impairment per Sensor to per Type

- Impairment per Sensor (IpS):
  - Participant_ID
  - Sensor_ID
  - Impairment Type
  - Timestamp
  - Value
- Impairment per Type (IpT):
  - Participant_ID
  - Impairment_Type
  - Timestamp
  - Value

- Drugs
  - LEITAT Drug Detector, Drugs
- Alcohol
  - Senseair Go, Alcohol
  - Senseair Wall, Alcohol
  - BACtrack Skyn, Alcohol
- Fatigue
  - smartPWA, Fatigue
  - FitDrive, Fatigue
  - EagleLIGHT, Fatigue
  - PreQ, Fatigue

- Stress
  - SmartPWA, Stress
  - GSR, Stress
  - Neurometrics, Stress
- Cognitive Load (CL)
  - smartPWA, CL
  - Neurometrics, CL
- Cognitive Distraction (CD)
  - ViF, CD

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Decision-making process (1/2)

STAGE 1 Collect data from each sensor and assess impairment for each sensor (i.e. allocate a PANACEA score)

	1	2	3	4	5
Drugs	Not present	Present			
Alcohol	Normal to low risk	Slightly to extremely increased risk			
Fatigue	Alert	Neither alert nor fatigued	Fatigued, but no effort to stay awake	Fatigued, with some effort to stay awake	Very fatigued, fighting sleep
Stress	No stress	Low stress	Moderate stress	High stress	Severe stress
Cognitive Load	Very low cognitive load	Low cognitive load	Moderate cognitive load	High cognitive load	Severe cognitive load
Cognitive Distraction	No cognitive distraction	Low cognitive distraction	Moderate cognitive distraction	High cognitive distraction	Severe cognitive distraction

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Decision-making process (2/2)

Default:
FIT TO DRIVE

STAGE 2 Based on the data collected in Stage 1, assess the overall fitness to drive

Drugs	Alcohol	Fatigue	Stress	Cognitive Load	Cognitive Distraction	Decision
2						NOT FIT TO DRIVE
1	2					NOT FIT TO DRIVE
1	1	5				NOT FIT TO DRIVE
1	1	4				NOT RECOMMENDED TO DRIVE
1	1		5			NOT RECOMMENDED TO DRIVE
1	1			5		NOT RECOMMENDED TO DRIVE
1	1				5	NOT RECOMMENDED TO DRIVE
1	1	< 4	< 5	< 5	4	STRONG SUSPICION NOT FIT TO DRIVE – WARNING
1	1	< 4	< 5	< 5	3	SUSPICION NOT FIT TO DRIVE – ADVISORY

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Web app for drivers / riders
Mobile app for drivers / riders
Web app for operators
USER FACING
Snap4city platform
DSS
CCS
BACK FACING
STRESS
FATIGUE
ALCOHOL & DRUGS
Stress Sensor (GSR)
Stress and Cognitive Load Sensor (ViF/DeepBlue)
Fatigue, Stress and Cognitive Load Sensor (AIT)
Fatigue Sensor (BMM fatigue model)
Drive State Monitor (Datik)
Fatigue Sensor (Optalert)
Alcohol sensor (Wall)
Alcohol Sensor (Go)
Drug Sensor (LEITAT)
BACtrack Skyn (Wristband)
CHTA
CHTB
CHTC
CHTs

Lessons Learned

- Technical requirements for the sensors for roadside assessments are very different than those for the in-vehicles or on-site assessments at UC sites.
- Adapting FitDrive for fatigue detection in shuttles was a very demanding task.
- Appropriate data is needed to improve the assessment per sensor.
- Unfamiliarity with Snap4City makes integrating sensors, Decision Support System (DSS), and Cloud-based Countermeasure System (CCS) into the PANACEA platform became a very challenging task.
- The choice of integration and data management platform is key.
- The participant group for pilot test affects our ability to test the fitness-to-drive assessment system.

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Thank you!

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