AVENUE

Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE

D2.14 Second Definition of AVENUE services

Co-funded by the Horizon 2020 programme of the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769033

Disclaimer

Document Information

Grant Agreement Number	**769033**
Full Title	Autonomous Vehicles to Evolve to a New Urban Experience
Acronym	AVENUE
Deliverable	D2.14 Second Definition of AVENUE services
Due Date	31.10.2020
Work Package	WP2
Lead Partner	Bestmile
Leading Author	Lisa Labriga
Dissemination Level	Public, restricted

Document History

Version	**Date**	**Author**	**Description of change**
V 1.0 & V 2.0	09-10/2019	Lisa Labriga (Bestmile)	First draft
V 2.0	10/ 2019	Konstantinos Votis, Mary Panou (CERTH)	Chapter 3
V 2.0	06.11.2019	Michel Reisch (SLA)	Review of first draft
V 2.0	05.11.2019	Carlos Ballester (MobileThinking)	Review of first draft
V 2.0	08.11.2019	Christian Zinckernagel (Amobility)	Review of first draft
V 3.0, V 4.0	11/ 2019	Lisa Labriga, Jelena Alonso (Bestmile)	Review of comments & updating deliverable
V 5.0	12/ 2019	Dimitrios Tsiktsiris, Antonios Lalas (CERTH)	Review of final draft
D2.14 Second Definition of AVENUE services	12/ 2019	Lisa Labriga (Bestmile)	Review of comments & updating deliverable, preparation of final version
D2.14 Second Definition of AVENUE services_20200417	17/04/2020	Lisa Labriga (Bestmile)	Adaptation according to comments from European Commission project officer

Table of Contents

Disclaimer II
Document Information II
Document History II
Table of Contents III
List of Figures IV
List of Tables IV
Acronyms VI
Executive Summary VII
1 Introduction 1
1.1 On-demand Mobility 1
1.2 Autonomous Vehicles 1
1.3 Preamble 3
1.4 Methodology: Ideation process 4
2 Outcome ideation process 5
2.1 Feasibility study outcomes 5
2.2 Categorization of in-and-out-of-vehicle services 10
2.3 Services prioritization for phase 2 15
3 Services research 27
3.1 Enhance the sense of security and trust 27
3.2 Passenger presence 29
3.3 Environmental assessment 31
3.4 Fleet management meta-services 32
4 Services defined in D2.13 34
4.1 Expanding the services from phase 1 34
4.2 Matching the original list of services with user stories & service ideas from ideation process .. 35
5 PTO services 36
5.1 Field Agent / Safety Driver App 36
5.2 Services to replace the PTO 36
5.3 Sensors that check if the seat belts are fastened 37
6 Conclusion 38
7 Appendix A: Feasibility study outcomes 39
7.1 As a user, I want to be able to provide feedback about the service 39

7.2 As a user, I want to be entertained while riding the vehicle/service 40
7.3 As a user I want to get assistance/aid when needed during the service 43
7.4 As a user, I want to know where the bus is 46
7.5 As a user, I want to manage my trip 48
7.6 As a user, I want to know if there is room in the vehicle 52
7.7 As a user, I want to be informed about the status of the service 54
7.8 As a user, I want to feel safe using the service 56

List of Figures

Figure 1: Prioritization outcome - user story 1: provide feedback 18
Figure 2: Prioritization outcome - user story 2: Be entertained 19
Figure 3: Prioritization outcome - user story 3: get help 20
Figure 4: Prioritization outcome - user story 4: manage trip 21
Figure 5: Prioritization outcome - user story 6: room in vehicle 22
Figure 6: Prioritization outcome - user story 6: be informed 23
Figure 7: Prioritization outcome - user story 7: feel safe 24
Figure 8: Detection of people fighting 29
Figure 9: Detection of people fighting along with bag snatching 29
Figure 10: Detection of unaccompanied luggage 29
Figure 11: Counting of people in CERTH facilities dataset 31
Figure 12: Counting of people in Navya shuttle 31
Figure 13: Counting of many people in Navya shuttle 31

List of Tables

Table 1: Outcome feasibility study - user story 1: provide feedback 6
Table 2: Outcome feasibility study - user story 2: entertainment 7
Table 3: Outcome feasibility study - user story 3: get help 7
Table 4: Outcome feasibility study - user story 4: shuttle location 8
Table 5: Outcome feasibility study - user story 5: manage trip 9
Table 6: Outcome feasibility study - user story 6: room in vehicle 9
Table 7: Outcome feasibility study - user story 7: be informed 10
Table 8: Outcome feasibility study - user story 8: feel safe 10

Table 9: Outcome categorization - user story 1: provide feedback 11
Table 10: Outcome categorization - user story 2: Be entertained 11
Table 11: Outcome categorization - user story 3: get help 12
Table 12: Outcome categorization - user story 4: vehicle location 12
Table 13: Outcome categorization - user story 5: manage trip 13
Table 14: Outcome categorization - user story 6: room in vehicle 13
Table 15: Outcome categorization - user story 7: be informed 14
Table 16: Outcome categorization - user story 8: feel safe 15
Table 17: Service prioritization for phase 2 - implementation by PTO only 15
Table 18: Service prioritization for phase 2 - implementation by several partners 17
Table 26: Display of the results 25
Table 27: Results of prioritization - ideas with the highest prioritization 25
Table 28: Details on possible implementation in phase 2 26
Table 29: Matching the original list of services with user stories & service ideas from ideation process 36
Table 30: Highest ranked service ideas and possible implementation in phase 2 38

Acronyms

ADS	Automated Driving Systems
AI	Artificial Intelligence
API	Application Protocol Interface
AV	Autonomous Vehicle
BMM	Business Modelling Manager
CB	Consortium Body
CERN	European Organization for Nuclear Research
D7.1	Deliverable 7.1
DC	Demonstration Coordinator
DI	The department of infrastructure
DMP	Data Management Plan
DSES	Department of Security and Economy Traffic Police
DTU test track	Technical University of Denmark test track
EAB	External Advisory Board
EC	European Commission
EC	European Commission
ECSEL	Electronic Components and Systems for European Leadership
EM	Exploitation Manager
EU	European Union
EUCAD	European Conference on Connected and Automated Driving
F2F	Face to face meeting
FEDRO	Federal Roads Office
FEDRO	(Swiss) Federal Roads Office
FOT	(Swiss) Federal Office of Transport
GDPR	General Data Protection Regulation
GIMS	Geneva International Motor Show
GNSS	Global Navigation Satellite System
HARA	Hazard Analysis and Risk Assessment
IPR	Intellectual Property Rights
IT	Information Technology
ITU	International Telecommunications Union
LA	Leading Author
LIDAR	Light Detection And Ranging
MEM	Monitoring and Evaluation Manager
OCT	General Transport Directorate of the Canton of Geneva
ODD	Operational Domain Design
OEDR	Object And Event Detection And Response
OFCOM	Federal Office of Communications
PC	Project Coordinator
PEB	Project Executive Board
PGA	Project General Assembly
PRM	Persons with Reduced Mobility
PSA	Group PSA (PSA Peugeot Citroën)
PTO	Public Transportation Operator
PTO	Public Transport Operator
PTS	Public Transportation Services
QRM	Quality and Risk Manager
QRMB	Quality and Risk Management Board
RN	Risk Number
SA	Scientific Advisor
SAE Level	Society of Automotive Engineers Level (Vehicle Autonomy Level)
SAN	Cantonal Vehicle Service
SDK	Software Development Kit
SMB	Site Management Board
SoA	State of the Art
SOTIF	Safety Of The Intended Functionality
SWOT	Strengths, Weaknesses, Opportunities, and Threats.
TM	Technical Manager
UITP	*Union Internationale des Transports Publics*
V2I	Vehicle to Infrastructure communication
WP	Work Package
WPL	Work Package Leader

Executive Summary

Work package 2 “Requirements and Use Cases” aims to define in detail the use cases of each demonstrator, the scenarios for each implementation phase, and the value-added services required for the success of the demonstrators. Task 2.5 “Demonstrator use case definition” target is on the one hand to develop the use case scenarios and on the other hand to enrich the provisional list of AVENUE services, selecting at least 10 services for demonstration. Part of the work in task 2.5 feeds into deliverables 2.16-2.18, while the work of T2.5 that feeds into this deliverable focuses on the AVENUE services. The task foresees that these services will be further detailed in line with the needs and feedback from the demonstrator and replicator cities.

This list is the second version of AVENUE services that has been reviewed and approved by all project partners, and in particular the PTOs of the demonstration sites, as well as the partners responsible for the technical development and implementation of the services (Bestmile (BM), MobileThinking (MT) and Navya). It is an accurate picture of the status of discussions and ideas of the PTOs and other project partners involved right now – logically it will evolve and change over the course of the project.

The introductory chapter provides a general introduction to the project and its key aspects, as well as complete overview on how the Second Definition of AVENUE services has been determined, the phased approach of the task and a description of the methodology and steps taken.

Chapter 2 describes the outcome of the ideation process, while chapter 3 describes the research that has been conducted by CERTH around some of the services. Chapter 4 focuses on the services defined in the first deliverable on services, D2.13, and outlines the links between the first and second definition of AVENUE services. Chapter 5 focuses on AVENUE services that are for the PTOs benefit rather than for the end-user.

The conclusion finally summarises the work done during phae 2 of task 2.5 as well as the key outcomes of the work which are summarised in this deliverable D2.14.
Comprehensive work has been conducted over the past year by the PTOs, the technical partners as well as some other project partners in order to ideate on potential services that could be developed and implemented in the framework of the AVENUE project. Throughout a multi-step ideation process, initial user stories were detailed and a large number of ideas were developed. Based on the ideation process, the technical partners analyzed all the ideas in terms of their feasibility and grouped into in- and out-of-vehicle services. Finally, all the project partners evaluated and prioritized the services that could be feasible in phase 2, with a special attention given to the evaluation of the PTOs. As a result, nine services have received the highest ranking. Three of them are already confirmed to be implemented in phase 2 (marked “yes”), all others need to be reevaluated by the PTOs. In addition to this, scientific research on several services is ongoing and will be continued in the framework of WP4, conducted by CERTH. When the first results are available, PTOs will evaluate them and will discuss with CERTH in how far they can be tested or implemented in their operations. Lastly, several services have been identified in the project that are rather services for the PTOs themselves. The need for these services is to be further discussed and evaluated in the coming months.

1 Introduction

AVENUE aims to design and carry out full-scale demonstrations of urban transport automation by deploying, for the first time worldwide, fleets of autonomous minibuses in low to medium demand areas of 4 European demonstrator cities (Geneva, Lyon, Copenhagen and Luxembourg) and 2 to 3 replicator cities. The AVENUE vision for future public transport in urban and suburban areas, is that autonomous vehicles will ensure safe, rapid, economic, sustainable and personalised transport of passengers. AVENUE introduces disruptive public transportation paradigms on the basis of on-demand, door-to-door services, aiming to set up a new model of public transportation, by revisiting the offered public transportation services, and aiming to suppress prescheduled fixed bus itineraries.

Vehicle services that substantially enhance the passenger experience as well as the overall quality and value of the service will be introduced, also targeting elderly people, people with disabilities and vulnerable users. Road behaviour, security of the autonomous vehicles and passengers' safety are central points of the AVENUE project.

At the end of the AVENUE project four year period the mission is to have demonstrated that autonomous vehicles will become the future solution for public transport. The AVENUE project will demonstrate the economic, environmental and social potential of autonomous vehicles for both companies and public commuters while assessing the vehicle road behaviour safety.

1.1 On-demand Mobility

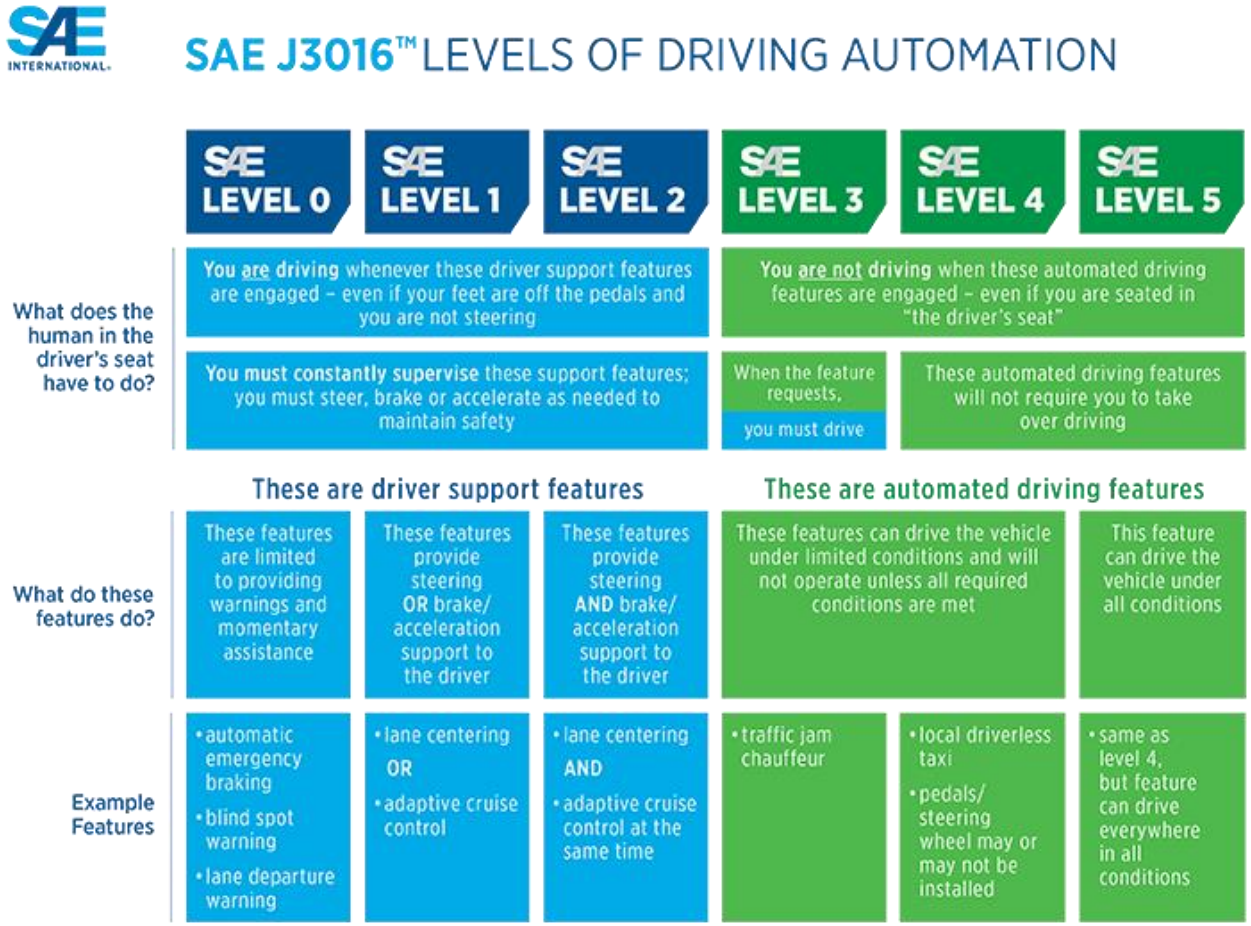
Public transportation is a key element of a region's economic development and the quality of life of its citizens.
Governments around the world are defining strategies for the development of efficient public transport based on different criteria of importance to their regions, such as topography, citizens' needs, social and economic barriers, environmental concerns and historical development. However, new technologies, modes of transport and services are appearing, which seem very promising to the support of regional strategies for the development of public transport.
On-demand transport is a public transport service that only works when a reservation has been recorded and will be a relevant solution where the demand for transport is diffuse and regular transport is inefficient.
On-demand transport differs from other public transport services in that vehicles do not follow a fixed route and do not use a predefined timetable. Unlike taxis, on-demand public transport is usually also not individual. An operator or an automated system takes care of the booking, planning and organization.
It is recognized that the use and integration of on-demand autonomous vehicles has the potential to significantly improve services and provide solutions to many of the problems encountered today in the development of sustainable and efficient public transport.

1.2 Autonomous Vehicles

A self-driving car, referred in the AVENUE project as **an Autonomous Vehicle** (**AV**) is a vehicle that is capable of sensing its environment and moving safely with no human input. The choice of Autonomous

vs Automated was made in AVENUE since, in the current literature, most of the vehicle concepts have a person in the driver's seat, utilize a communication connection to the Cloud or other vehicles, and do not independently select either destinations or routes for reaching them, thus being “automated”. The automated vehicles are considered to provide assistance (at various levels) to the driver. In AVENUE there will be no driver (so no assistance will be needed), while the route and destinations will be defined autonomously (by the fleet management system). The target is to reach a system comprising of vehicles and services that independently select and optimize their destination and routes, based on the passenger demands.

In relation to the SAE levels, the AVENUE project will operate SAE Level 4 vehicles.



1.2.1 Autonomous vehicle operation overview

We distinguish in AVENUE two levels of control of the AV: micro-navigation and macro-navigation. Micro navigation is fully integrated in the vehicle and implements the road behaviour of the vehicle, while macro-navigation is controlled by the operator running the vehicle and defines the destination and path of the vehicle, as defined the higher view of the overall fleet management.

For micro-navigation Autonomous Vehicles combine a variety of sensors to perceive their surroundings, such as 3D video, lidar, sonar, GNSS, odometry and other types sensors. Control software and systems, integrated in the vehicle, fusion and interpret the sensor information to identify the current position of the vehicle, detecting obstacles in the surround environment, and choosing the most appropriate reaction of the vehicle, ranging from stopping to bypassing the obstacle, reducing its speed, making a turn etc.

For the Macro-navigation, that is the destination to reach, the Autonomous Vehicle receives the information from either the in-vehicle operator (in the current configuration with a fixed path route), or from the remote control service via a dedicated 4/5G communication channel, for a fleet-managed operation. The fleet management system takes into account all available vehicles in the services area, the passenger request, the operator policies, the street conditions (closed streets) and send route and stop information to the vehicle (route to follow and destination to reach).

1.2.2 Autonomous vehicle capabilities in AVENUE

The autonomous vehicles employed in AVENUE fully and autonomously manage the above defined, micro-navigation and road behaviour, in an open street environment. The vehicles are autonomously capable to recognise obstacles (and identify some of them), identify moving and stationary objects, and autonomously decide to bypass them or wait behind them, based on the defined policies. For example with small changes in its route the AVENUE shuttle is able to bypass a parked car, while it will slow down and follow behind a slowly moving car. The AVENUE vehicles are able to handle different complex road situations, like entering and exiting round-about in the presence of other fast running cars, stop in zebra crossings, communicate with infrastructure via V2X interfaces (ex. red light control).
The shuttles used in the AVENUE project technically can achieve speeds of more than 60Km/h. However this speed cannot be used in the project demonstrators for several reasons, ranging from regulatory to safety. Under current regulations the maximum authorised speed is 25 or 30 Km/h (depending on the site). In the current demonstrators the speed does not exceed 23 Km/h, with an operational speed of 14 to 18 Km/h. Another, more important reason for limiting the vehicle speed is safety for passengers and pedestrians. Due to the fact that the current LIDAR has a range of 100m and the obstacle identification is done for objects no further than 40 meters, and considering that the vehicle must safely stop in case of an obstacle on the road (which will be “seen” at less than 40 meters distance) we cannot guarantee a safe braking if the speed is more than 25 Km/h. Note that technically the vehicle can make harsh break and stop with 40 meters in high speeds (40 -50 Km/h) but then the break would too harsh putting in risk the vehicle passengers. The project is working in finding an optimal point between passenger and pedestrian safety.

1.3 Preamble

Work package 2 “Requirements and Use Cases” aims to define in detail the use cases of each demonstrator, the scenarios for each implementation phase, and the value-added services required for the success of the demonstrators. A human-centered design approach for the design of the use cases will be followed. The required data to be collected for the impact analysis will also be defined. Existing know-how and best practices will be surveyed, assessed and analyzed. The work in the tasks of WP2 is iterative, and as the provided demonstrators and services become more sophisticated, new iterations of the work of the different tasks will be integrated.

Task 2.5 “Demonstrator use case definition” target is on the one hand to develop the use case scenarios and on the other hand to enrich the provisional list of AVENUE services, selecting at least 10 services for demonstration. Part of the work in task 2.5 feeds into deliverables 2.16-2.18, while the work of T2.5 that feeds into this deliverable focuses on the AVENUE services. The task foresees that these services will be further detailed in line with the needs and feedback from the demonstrator and replicator cities.

This list is the second version of AVENUE services that has been reviewed and approved by all project partners, and in particular the PTOs of the demonstration sites, as well as the partners responsible for the technical development and implementation of the services (Bestmile (BM), MobileThinking (MT) and Navya). It is an accurate picture of the status of discussions and ideas of the PTOs and other project partners involved right now – logically it will evolve and change over the course of the project.

The remainder of the introductory chapter provides a complete overview on how the Second Definition of AVENUE services has been determined and a description of the methodology and steps taken.

1.4 Methodology: Ideation process

After the first list of services had been developed during the first six months of the project, WP4 took up that work and continued by developing the first three services that had been chosen for phase 1. During this development work it became evident that a more user-centered approach to develop the in-and-out-of-vehicle services in AVENUE was needed. With the potential users in mind, and building on the initial experiences in the demonstration sites, the Public Transport Operators (PTOs), technical partners, and key partners involved in WP2 and WP4 decided to groom potential services more in depth and to discuss them in detail.
Therefore, Autonomous Mobility (AM), as work package leader of WP2, organized and moderated a comprehensive ideation process which started in M13.

1.4.1 Phases of services development

The services in the AVENUE project will be developed in three phases. The phases have been defined as follows in WP 2 and WP4:

	WP2 *Step 1: Definition of the services*	WP4 *Step 2: Development of the services*
Phase 1	M1 – M6	M6 – M18
Phase 2	M13 – M18	M19 – M29
Phase 3	M31 – M36	M30 – M40

Table 1: Phases 1-3 of service definition and development

1.4.2 Ideation workshop

An initial ideation workshop was organized in M13 ahead of the General Meeting in Luxembourg, involving PTOs and the technical partners that are part of the development of services.
This ideation was split in three main steps:

1. Definition of target groups: From each PTO and Siemens, the following was collected: target groups, target group traits, user stories based on user needs.
2. Formulation of user stories: All the user stories were then categorized in order to find a common user story.
3. Ideation in brainstorming session: The user stories were “translated” into understandable and actionable development specifications for the coming development phases. This was done through:
    a. Creative brainstorming sessions
    b. Conceptualization of ideas
    c. Setting solution requirements

User stories

1. As a user, I want to be able to provide feedback about the service
2. As a user, I want to be entertained while riding the vehicle/service
3. As a user, I want to get assistance/aid when using the service
4. As a user, I want to know where the bus is
5. As a user, I want to manage my trip
6. As a user, I want to know if there is room in the vehicle
7. As a user, I want to be informed about the status of the service
8. As a user, I want to feel safe using the service

1.4.3 Steps following the ideation workshop

- Categorization of ideas (AM)
- First prioritization of ideas (PTOs)
- Feasibility study (Technical partners)
    - Labels: Phase 1, Phase 2, Phase 3, Not possible, Not in scope
- Service list roadmap (Technical partners)
- Categorization of in-and-out-of-vehicle services (MT & AM)
- Service prioritization for phase 2 (Bestmile & all partners)

2 Outcome ideation process

2.1 Feasibility study outcomes

Each of the technical partners (Navya, MT, CERTH, Bestmile) did a feasibility study of every prioritized service under the 8 user stories. Using the labels “Phase 1”, “Phase 2”, “Phase 3”, “Not possible”, “Not in scope”, the services were ranked into a potential roadmap. This feasibility evaluation considered only the technical feasibility. If and when such service could be implemented in the framework of the AVENUE project, depends on the PTOs’ priorities and will be defined in WP 4.
For the full feasibility analysis including detailed comments, see Annex A.

2.1.1 As a user, I want to be able to provide feedback about the service

Idea	Feasibility	Partners involved & *comments*
Via a questionnaire provided inside the shuttle	Phase 2	MT *Questionnaire could be integrated in the application*
Via PTO website formula	Phase 2	PTOs
Via smiley system (buttons) inside the shuttle	Phase 2	PTOs
Via photo upload to PTO	Phase 2	MT / PTOs *Integration of a photo uploading function in a feedback form of the application*
Via QR code in- and outside shuttle	Phase 2	MT / PTOs *A QR code placed in the shuttles could*

		trigger a questionnaire in a feedback section in the mobile application
Via the mobile application	Phase 2	MT
Emotion-detection built-in camera inside the shuttle	Phase 3 / Not possible	Navya / CERTH *Ongoing scientific research, see chapter 3.*
Via thumbs up / thumbs down to camera inside the shuttle	Not in scope	
Via avatar on screen inside shuttle	Not possible	
Picture feedback (augmented reality -> via bus)	Not possible	

Table 2: Outcome feasibility study - user story 1: provide feedback

2.1.2 As a user, I want to be entertained while riding the vehicle/service

Idea	Feasibility?	Partners involved & *comments*
Via Wi-Fi (access to paid websites with entertainment)	Phase 2	PTOs / Navya *Possible with independent material that does not interfere with the shuttle system*
Via news and updates relevant to the area of the route (sports-news near stadiums etc.)	Phase 2	MT / PTOs *If localized news feeds are available / provided by the PTOs, they can be displayed in the application*
Via quizzes inside the shuttle (Fun fact, area knowledge etc.)	Phase 3	MT / PTOs *Quizzes can be integrated in the application*
Via quiz game between the shuttles (allow passengers to compete against passengers inside another shuttle	Phase 3	MT / PTOs *Could be integrated in the application*
Via augmented reality applications within the shuttle	Phase 3 / Not possible	MT / PTOs / CERTH
Via gamification at bus stops and inside the shuttle (steering wheel for kids, light games in the ceiling, etc.)	Not in scope	
Via smells inside the shuttle	Not in scope	
Via dating and networking (meet others) chats and functions inside the shuttle	Not in scope	
Via fitness exercise games at bus stops (while waiting - stay healthy)	Not in scope	
Via virtual reality guided tours inside the shuttle	Not possible	
Via interactive screens inside the shuttle and at bus stops (news, weather, entertainment, status of operation, etc.)	Not possible	
Via book-renting system at bus stop signs and inside the shuttles	Not possible	
Via guided tours (safety driver or speaker system - designated area)	Not possible	

Table 3: Outcome feasibility study - user story 2: entertainment

2.1.3 As a user I want to get assistance/aid when needed during the service

Idea	Feasibility?	Partners involved & *comments*
Via emergency button inside the shuttle	Phase 1	Navya *Implemented*
Via information in local language / channel	Phase 2	MT / PTOs *Application can be available in several languages, translations to be provided by PTOs*
Via direct call button to police, ambulance, assistance etc.	Phase 2	MT / PTOs *Call button with prefilled emergency button in the application*
Via an automated ramp activated by the users	Phase 2 / Phase 3	Navya
Via chat bot	Phase 3	MT / PTO *Can be implemented via the application but requires human at the receiving end for specific questions*
Via audio detection (ask for help and assistance)	Phase 3	CERTH / Navya / PTOs *Ongoing scientific research, see chapter 3*
Via application (manage booking, communicate etc.) (including services for blind people)	Phase 3	MT / PTOs / Navya
Via other travelers (activation of peer-to-peer help)	Phase 3	MT / PTOs *Only if user login and booking is available*
Via supervision surveillance inside the shuttle (PTO personal over-viewing the shuttle, ready to help)	Phase 3 / Not possible	CERTH *Ongoing scientific research, see chapter 3*
Via automated camera detection of emergencies, needed assistance etc.	Phase 3 / Not possible	CERTH *Ongoing scientific research, see chapter 3*
Virtual agent inside / outside the shuttle	Not in scope	
Via a help robot inside the vehicle (aid people in and outside the shuttle at stops)	Not possible	

Table 4: Outcome feasibility study - user story 3: get help

2.1.4 As a user, I want to know where the bus is

Idea	Feasibility?	Partners involved & *comments*
Via real time map in mobile application	Phase 1	MT *Implemented*

Via Google maps integration (including directions)	Phase 2	MT / PTOs *Can be included in the application but it is a paying service.*
Via Siri, Google assistant, Alexa (ask my phone - chat box - virtual assistant)	Phase 3	MT / PTOs *tbd*
Via mobile vibrations (rising frequency when getting closer to the bus stop)	Phase 3	MT
In-vehicle monitor: - viewable from every seat - sufficient contrast - size of displayed information - content requirements	Phase 3 / Not possible	PTOs / Navya
Via screen at bus stop signs	Phase 3 / Not possible	PTOs / Bestmile
Via screen inside the shuttle (window or designated screens)	Phase 3 / Not possible	PTOs / Navya
Via button at bus stop sign (Expected Arrival Time (ETA) of next shuttle, street-name etc.)	Phase 3 / Not possible	PTOs / BM
Via announcements about a current street, by app, speaker or safety driver inside the shuttle and at the bus stops.	Not in scope	
Via streetlights, indicating where the shuttles are driving	Not possible	
Via sound guidance (beeps getting closer etc.)	Not possible	

Table 5: Outcome feasibility study - user story 4: shuttle location

2.1.5 As a user, I want to manage my trip

Idea	Feasibility?	Partners involved & *comments*
Via call-center (manual booking over the phone)	Phase 2	PTOs
Via personalized function allowing passenger to set standard settings (like wheelchair, dogs, kids etc.)	Phase 2	MT
Via user-based sharing platform allowing users to highlight delays on routes, crowd-based service (delays, vehicle condition etc.)	Phase 2 / Phase 3	MT / PTOs
Via mobile application (booking, pricing, schedule, connections, order other means of transport etc.)	Phase 2 / Phase 3	MT / BM / PTOs
Via screen at bus stops (book, pay, stay updated etc.)	Phase 2 / Phase 3	PTOs / BM
Via 'share your trip' function (allowing passengers to share their position and meet up with friends etc.)	Phase 3	MT
Via booking system that allows parents and friends to book trips for others and see the planned time of arrival and a receipt upon arrival etc.	Phase 3	MT
Via booking system inside the shuttle (via PTO or interactive screen)	Phase 3	PTOs
Via website portal (booking, pricing, updates etc.)	Phase 3	PTOs
Via guided travel function (what to do near the route, what to do between trips etc.)	Phase 3	MT / PTOs
Via integration with Google maps, show routes, book, pay etc.	Phase 3	MT
Via 'Smartbooking', 'remember my trips' function (bring me back to home, back to my car, back to the restaurant, use	Phase 3	MT

calendar information to book trips etc.)		
Via human movements and sounds (whistle to stop shuttle, wave to stop, communicate with human behavior)	Not in scope	
Via automatic booking and payment system based on facial recognition	Not possible	
Via virtual assistant capable of managing booking system etc.	Not possible	

Table 6: Outcome feasibility study - user story 5: manage trip

2.1.6 As a user, I want to know if there is room in the vehicle

Idea	Feasibility?	Partners involved & *comments*
Via an application	Phase 2 / Phase 3	MT / BM / PTOs *Possible if passenger-counting works either via "Driver App" or via cameras or via sensors*
Via online booking system with designated seats	Phase 3	MT / PTOs
Via interaction with the bus stop sign	Phase 3	PTOs / MT
Via camera detection at bus stop signs and inside the shuttles	Phase 3 / Not possible	CERTH *Ongoing research, see chapter 3*
Via light identification of available or taken seats inside the shuttle	Phase 3 / Not possible	Navya / PTOs
Via outside-mounted shuttle screen	Phase 3 / Not possible	Navya / PTOs
Via personal traveler profiles indicating needs (disabilities, language, etc.)	Phase 3 / Not possible	MT / Navya / PTOs
Via audio guidance at bus stop sign and inside the shuttle	Not possible	
Via capacity sensors at bus stop signs and inside the shuttles	Not possible	
Via virtual agent at bus stop signs and inside the shuttles	Not possible	

Table 7: Outcome feasibility study - user story 6: room in vehicle

2.1.7 As a user, I want to be informed about the status of the service

Idea	Feasibility?	Partners involved & *comments*
Via social media accounts (PTOs) (templates)	Phase 2	PTOs
Via user-based portal (allowing passengers to flag shuttles that do not work or are full etc.)	Phase 2	PTOs / MT
Via website with status updates (PTOs)	Phase 2 / Phase 3	PTOs / MT
Via screen inside the shuttle (service updates etc.)	Phase 2 / Phase 3	PTOs / Navya
Via information displayed at bus stop sign	Phase 2 / Phase 3	PTOs
Via mobile application	Phase 2 / Phase 3	MT / BM / Navya / PTO
Via email notifications for subscribed users	Phase 3	PTOs
Via a real-time online tracker of routes	Phase 3	MT
Via Siri, Google assistant, Alexa (ask my phone - chat bot - virtual assistant)	Phase 3 / Not possible	
Via light signal system. (colors representing states of	Phase 3 / Not	

operation - full, out of order etc.)	possible	
Via audio guidance at the bus stop signs and inside the shuttles	Phase 3 / Not possible	
Via screens in crowded areas near the route	Not possible	

Table 8: Outcome feasibility study - user story 7: be informed

2.1.8 As a user, I want to feel safe using the service

Idea	Feasibility?	Partners involved & *comments*
Via a well maintained and clean shuttle	Phase 1	Implemented
Via real time map, so I always know where I am	Phase 1	Implemented
Via clear instructions on how to enter and leave the shuttle	Phase 2	MT / Navya
Via constant repetition of the rules (stickers, notes, safety driver etc.)	Phase 2	PTOs
Via chat function in the mobile application (talk to supervision/ PTO)	Phase 2	MT / PTOs
Via call button inside the shuttle and at bus stops to an PTO (someone to talk to)	Phase 2	Bestmile / Navya
Via sound/audio system that announces that the shuttle is approaching/ leaving/ holding	Phase 2 / Phase 3	Navya / PTOs
Via children safety tracker, be able to ensure you children's safety	Phase 3	Mt / PTOs
Via camera surveillance inside the shuttle (and potentially at the bus stops)	Phase 3	CERTH *Ongoing scientific research, see chapter 3*
Via follow me home function (let someone know where you are)	Phase 3	MT / PTOs
Via specialized camera system that can detect criminal behavior and patterns	Phase 3 / Not possible	CERTH *Ongoing scientific research, see chapter 3*
Via access to the "eyes" of the shuttle. Understand how it drives, does it see the same obstacles and people as you do when looking out the window	Phase 3 / Not possible	
Via emergency button inside the vehicle (directly to authorities)	Phase 3 / Not possible	
Via virtual agent (chat bot) that you can talk to inside the shuttle - call the authorities, I am afraid, etc.	Not possible	
Via smart driving system that slows down after mistakes, breaks lighter after hard breaking etc.	Not possible	

Table 9: Outcome feasibility study - user story 8: feel safe

2.2 Categorization of in-and-out-of-vehicle services

After the feasibility analysis, all services were categorized into in- and out-of-vehicle services.

2.2.1 As a user, I want to be able to provide feedback about the service

Idea	Phase	Type
Via thumbs up/ thumbs down to a camera inside the shuttle	Not in scope	In
Via avatar on the screen inside the shuttle	Not possible	In
Picture feedback (augmented reality -> via bus)	Not possible	In
Via a questionnaire provided inside the shuttle	Phase 2	In
Via PTO website formula	Phase 2	In
Via smiley system (buttons) inside the shuttle	Phase 2	In
Via photo upload to PTO	Phase 2	In
Via QR code in- and outside shuttle	Phase 2	In and Out
Via mobile application	Phase 2	In and Out
Emotion-detection built-in camera inside the shuttle	Phase 3	In

Table 10: Outcome categorization - user story 1: provide feedback

2.2.2 As a user, I want to be entertained while riding the vehicle/service

Idea	Phase	Type
Via gamification at bus stops and inside the shuttle (steering wheel for kids, light games in the ceiling, etc.)	Not in scope	In and Out
Via smells inside the shuttles	Not in scope	In
Via dating and networking (meet others) chats and functions inside the shuttles	Not in scope	In
Via fitness exercise games at bus stops (while waiting - stay healthy)	Not in scope	Out
Via virtual reality guided tours inside the shuttle	Not possible	In
Via interactive screens inside the shuttle and at bus stops (news, weather, entertainment, status of operation, etc.)	Not possible	In
Via book-renting system at bus stop signs and inside the shuttles	Not possible	In and Out
Via guided tours (safety driver or speaker system - area designated)	Not possible	In
Via Wi-Fi (access to paid websites with entertainment)	Phase 2	In
Via news and updates relevant to the area of the route (sports-news near stadiums etc.)	Phase 2	In
Via quizzes inside the shuttle (Fun fact, area knowledge etc.)	Phase 3	In
Via quiz game between the shuttles (allow passengers to compete against other passengers inside another shuttle	Phase 3	In
Via augmented reality applications within the shuttle	Phase 3 / Not possible	In

Table 11: Outcome categorization - user story 2: Be entertained

2.2.3 As a user I want to get assistance/aid when needed during the service

Idea	Phase	Type
Virtual agent inside / outside the shuttle	Not in scope	In and Out
Via help robot inside the vehicle (aid people in and outside the shuttle at stops)	Not possible	In
Via emergency button inside the shuttle	Phase 1	In
Via information in local language / channel	Phase 2	In and Out
Via direct call button to police, ambulance, assistance etc.	Phase 2	In
Via an automated ramp activated by the users	Phase 2 / Phase 3	In
Via chat bot	Phase 3	In
Via audio detection (ask for help and assistance)	Phase 3	In
Via application (manage booking, communicate etc.) (including services for blind people)	Phase 3	In
Via other travelers (activation of peer-to-peer help)	Phase 3	In
Via supervision surveillance inside the shuttle (PTO personal over-viewing the shuttle, ready to help)	Phase 3 / Not possible	In
Via automated camera detection of emergencies, needed assistance etc.	Phase 3 / Not possible	In

Table 12: Outcome categorization - user story 3: get help

2.2.4 As a user, I want to know where the bus is

Idea	Phase	Type
Via announcements about the current street, by app, speaker or safety driver inside the shuttle and at the bus stops.	Not in scope	In and Out
Via streetlights indicating where the shuttles are driving	Not possible	Out
Via sound guidance (beeps getting closer etc.)	Not possible	Out
Via real-time map in the mobile application	Phase 1	Out
Via Google maps integration (including directions)	Phase 2	Out
Via Siri, Google assistant, Alexa (ask my phone - chat box - virtual assistant)	Phase 3	Out
Via mobile vibrations (rising frequency when getting closer to the bus stop)	Phase 3	Out
In-vehicle monitor: - viewable from every seat - sufficient contrast - size of displayed information - content requirements	Phase 3 / Not possible	In
Via screen at bus stop signs	Phase 3 / Not possible	Out
Via screen inside the shuttle (window or designated screens)	Phase 3 / Not possible	In
Via button at bus stop sign (ETA of the next shuttle, street-name etc.)	Phase 3 / Not possible	Out

Table 13: Outcome categorization - user story 4: vehicle location

2.2.5 As a user, I want to manage my trip

Idea	Phase	Type
Via human movements and sounds (whistle to stop the shuttle, wave to stop, communicate with human behavior)	Not in scope	Out
Via automatic booking and payment system based on facial recognition	Not possible	Out
Via virtual assistant capable of managing the booking system etc.	Not possible	Out
Via call-center (manual booking over the phone)	Phase 2	Out
Via personalized function allowing passenger to set standard settings (like wheelchair, dogs, kids etc.)	Phase 2	Out
Via user-based sharing platform allowing users to highlight delays on routes, crowd-based service (delays, vehicle condition etc.)	Phase 2 / Phase 3	Out
Via mobile application (booking, pricing, schedule, connections, order other means of transport etc.)	Phase 2 / Phase 3	Out
Via screen at bus stops (book, pay, stay updated etc.)	Phase 2 / Phase 3	Out
Via share you trip function (allowing passengers to share position and meet up with friends etc.)	Phase 3	Out
Via booking system that allows parents and friends to book trips for others and see the planned time of arrival and the receipt upon arrival etc.	Phase 3	Out
Via booking system inside the shuttle (via PTO or interactive screen)	Phase 3	In
Via website portal (booking, pricing, updates etc.)	Phase 3	Out
Via guided travel function (what to do near the route, what to do between trips etc.)	Phase 3	Out
Via integration with Google maps, show routes, book, pay etc.	Phase 3	Out
Via Smartbooking, 'remember my trips' function (bring me back home, back to my car, back to the restaurant, use calendar information to book trips etc.)	Phase 3	Out

Table 14: Outcome categorization - user story 5: manage trip

2.2.6 As a user, I want to know if there is room in the vehicle

Idea	Phase	Type
Via audio guidance at bus stop sign and inside the shuttle	Not possible	In and Out
Via capacity sensors at bus stop signs and inside the shuttles	Not possible	In and Out
Via virtual agent at bus stop signs and inside the shuttles	Not possible	In and Out
Via an application	Phase 2 / Phase 3	Out
Via online booking system with designated seats	Phase 3	Out
Via interaction with the bus stop sign	Phase 3	In and Out
Via camera detection at bus stop signs and inside the shuttles	Phase 3 / Not possible	In and Out
Via light identification of available or taken seats inside the shuttle	Phase 3 / Not possible	In
Via outside-mounted shuttle screen	Phase 3 / Not possible	Out
Via personal traveler profiles indicating needs (disabilities, language, etc.)	Phase 3 / Not possible	Out

Table 15: Outcome categorization - user story 6: room in vehicle

2.2.7 As a user, I want to be informed about the status of the service

Idea	Phase	Type
Via screens in crowded areas near the route	Not possible	Out
Via social media accounts (PTOs) (templates)	Phase 2	Out
Via user-based portal (allowing passengers to flag shuttles that do not work or are full etc.)	Phase 2	Out
Via website with status updates (PTOs)	Phase 2 / Phase 3	Out
Via screen inside shuttle (service updates etc.)	Phase 2 / Phase 3	In
Via information displayed at bus stop sign	Phase 2 / Phase 3	Out
Via mobile application	Phase 2 / Phase 3	Out
Via email notifications for subscribed users	Phase 3	Out
Via a real-time online tracker of routes	Phase 3	Out
Via Siri, Google assistant, Alexa (ask my phone - chat bot - virtual assistant)	Phase 3 / Not possible	Out
Via light signal system (colors representing states of operation: full, out of order etc.)	Phase 3 / Not possible	Out
Via audio guidance at the bus stop signs and inside the shuttles	Phase 3 / Not possible	Out

Table 16: Outcome categorization - user story 7: be informed

2.2.8 As a user, I want to feel safe using the service

Idea	Phase	Type
Via virtual agent (chat bot) that you can talk to inside the shuttle - call the authorities, I am afraid etc.	Not possible	In
Via smart driving system that slows down after mistakes, breaks lighter after hard breaking etc.	Not possible	In
Via a well maintained and clean shuttle	Phase 1	In
Via real-time map, so I always know where I am	Phase 1	In
Via clear instructions on how to enter and leave the shuttle	Phase 2	In and Out
Via constant repetition of the rules (stickers, notes, safety driver etc.)	Phase 2	In and Out
Via chat function in the mobile application (talk to supervisor/PTO)	Phase 2	In
Via call button inside the shuttle and at bus stops to PTO (someone to talk to)	Phase 2	In and Out
Via sound/ audio system that announces that the shuttle is approaching/leaving/holding	Phase 2 / Phase 3	In and Out
Via children safety tracker, be able to ensure your children's safety	Phase 3	Out
Via camera surveillance inside the shuttle (and potentially at the bus stops)	Phase 3	In
Via follow me home function (let someone now where you are)	Phase 3	Out
Via specialized camera system that can detect criminal behavior and patterns	Phase 3 / Not possible	In and Out
Via access to the "eyes" of the shuttle. Understand how it drives, does it see the same obstacles and people as you do when looking out the window	Phase 3 / Not possible	In and Out
Via emergency button inside vehicle (directly to authorities)	Phase 3 / Not possible	In

Table 17: Outcome categorization - user story 8: feel safe

2.3 Services prioritization for phase 2

In order to advance with the selection of the services for phase 2, a prioritization game was organized during the General Meeting in Geneva, on 9 October 2019.

Out of all the service ideas developed during the ideation process over the past months, 29 service ideas based on the 8 user stories have been deemed feasible in phase 2 or phase 2 / phase 3. These 29 services would be implemented by one of the technical partners (MobileThinking, Navya, Bestmile, CERTH).

Userstory	Idea	Phase	Type	Implementation by				
				PTOs	MT	Navya	CERTH	BM
Implementation by PTO only								
As a user, I want to be able to provide feedback about the service	Via questionnaire provided inside the shuttle	Phase 2	In	X				
	Via PTO website formula	Phase 2	In	X				
	Via smiley system (buttons) inside the shuttle	Phase 2	In	X				
As a user, I want to be informed about the status of the service	Via social media accounts (PTOs) (templates)	Phase 2	Out	X				
	Via website with status updates (PTOs)	Phase 2 / Phase 3	Out	X				
As a user, I want to feel safe using the service	Via constant repetition of the rules (stickers, notes, safety driver etc.)	Phase 2	In and Out	X				

Table 18: Service prioritization for phase 2 - implementation by PTO only

Userstory	Idea	Phase	Type	Implementation by				
				PTOs	MT	Navya	CERTH	BM
Implementation by several partners								
As a user, I want to be able to provide feedback about the service	Via photo upload to PTO	Phase 2	In	X	X			
	Via QR code in- and outside shuttle	Phase 2	In and Out	X	X			
	Via the mobile application	Phase 2	In and Out		X			
As a user, I want to be entertained while riding the vehicle/service	Via Wi-Fi (access to paid websites with entertainment)	Phase 2	In	X		X		
	Via news and updates relevant to the area of the route (sports-news near stadiums etc.)	Phase 2 / Phase 3	In	X	X			

As a user, I want to be informed about the status of the service	Via user-based portal (allowing passengers to flag shuttles that do not work or are full etc.)	Phase 2	Out	X	X			
	Via screen inside the shuttle (service updates etc.)	Phase 2 / Phase 3	In	X		X		
	Via information displayed at bus stop sign	Phase 2 / Phase 3	Out	X		X		
	Via mobile application	Phase 2 / Phase 3	Out	X	X	X		
As a user, I want to feel safe using the service	Via clear instructions on how to enter and leave the shuttle	Phase 2	In and Out		X			
	Via chat function in mobile application (talk to supervisor/PTO)	Phase 2	In	X	X			
	Via call button inside the shuttle and at bus stops to PTO (someone to talk to)	Phase 2	In and Out			X		X
	Via sound/audio system that announces that the shuttle is approaching/leaving/holding	Phase 2 / Phase 3	In and Out	X		X		
As a user, I want to get assistance/aid when needed during the service	Via information in local language / channel	Phase 2	In and Out	X	X			
	Via direct call button to police, ambulance, assistance etc.	Phase 2	In	X	X	X		
	Via an automated ramp activated by the users	Phase 2 / Phase 3	In			X		
As a user, I want to know if there is room in the vehicle	Via an application	Phase 2 / Phase 3	Out	X	X			X
As a user, I want to know where the bus is	Via Google maps integration (including directions)	Phase 2	Out	X	X			
As a user, I want to manage my trip	Via call-center (manual booking over the phone)	Phase 2	Out	X				
	Via personalized function allowing passenger to set standard settings (like	Phase 2	Out		X			

	wheelchair, dogs, kids etc.)							
	Via user-based sharing platform allowing users to highlight delays on routes, crowd-based service (delays, vehicle condition etc.)	Phase 2 / Phase 3	Out	X	X			
	Via mobile application (booking, pricing, schedule, connections, order other means of transport etc.)	Phase 2 / Phase 3	Out	X	X			X
	Via screen at bus stops (book, pay, stay updated etc.)	Phase 2 / Phase 3	Out	X				X

Table 19: Service prioritization for phase 2 - implementation by several partners

2.3.1 Sticker prioritization outcome per user story

All partners were asked to choose their five favorite service ideas to be developed in phase 2. While the "votes" of most partners remained anonymous (red sticker), the PTOs had five votes that clearly indicated their preference: a green sticker with the first letter of their name on it: "H" – Holo = Autonomous Mobility, "K" – Keolis, "S" – Sales-Lentz Autocars, "T" – TPG.

This chapter displays the results of the prioritization by all partners per user story on those services, that are to be implemented by several partners (as in table 18).

2.3.1.1 As a user, I want to be able to provide feedback about the service

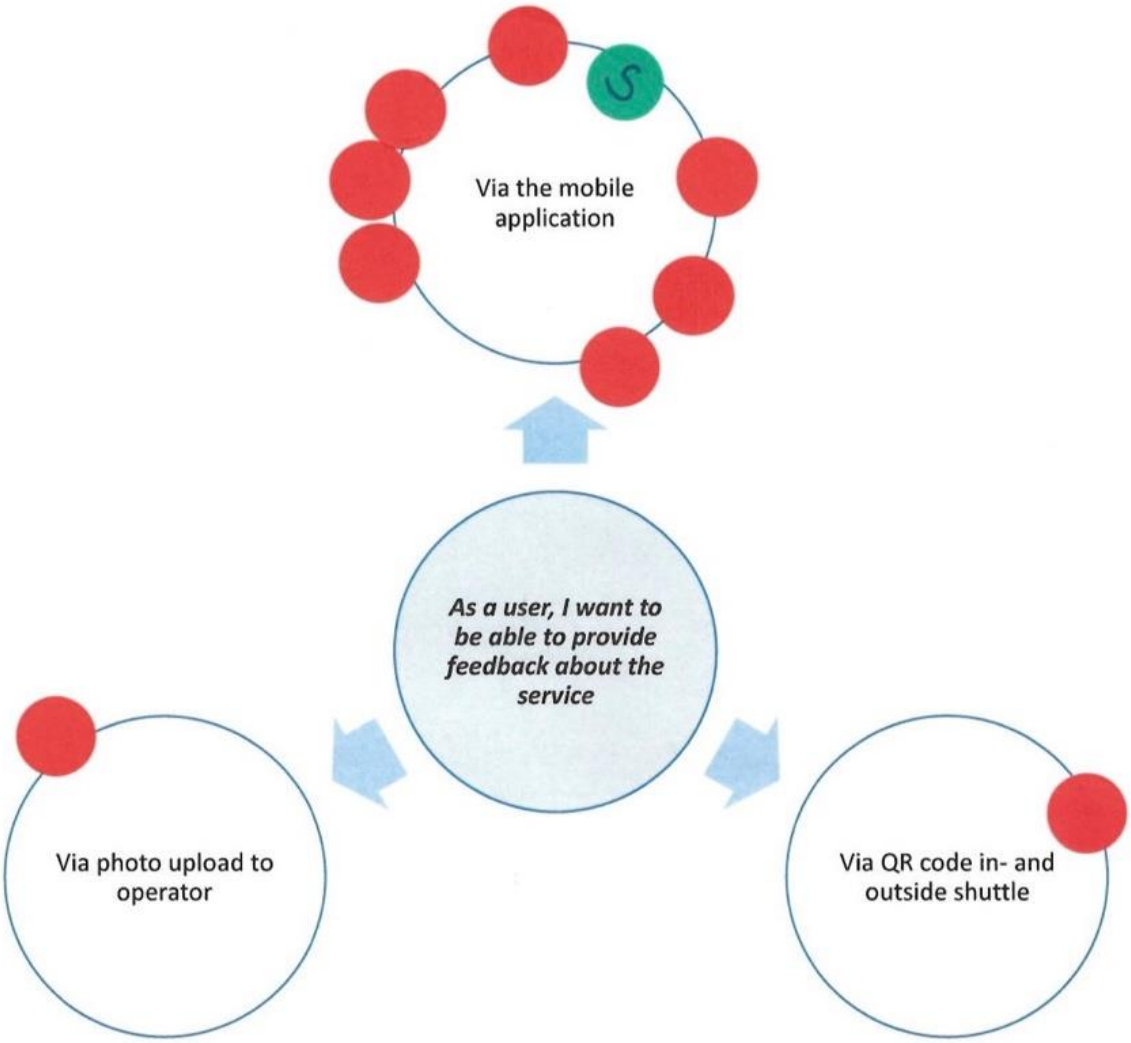


Figure 1: Prioritization outcome - user story 1: provide feedback

2.3.1.2 As a user, I want to be entertained while riding the vehicle/service

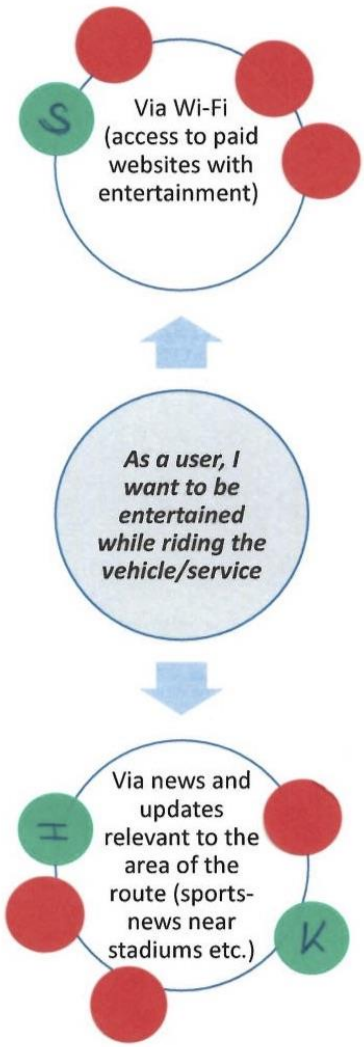


Figure 2: Prioritization outcome - user story 2: Be entertained

2.3.1.3 As a user I want to get assistance/aid when needed during the service

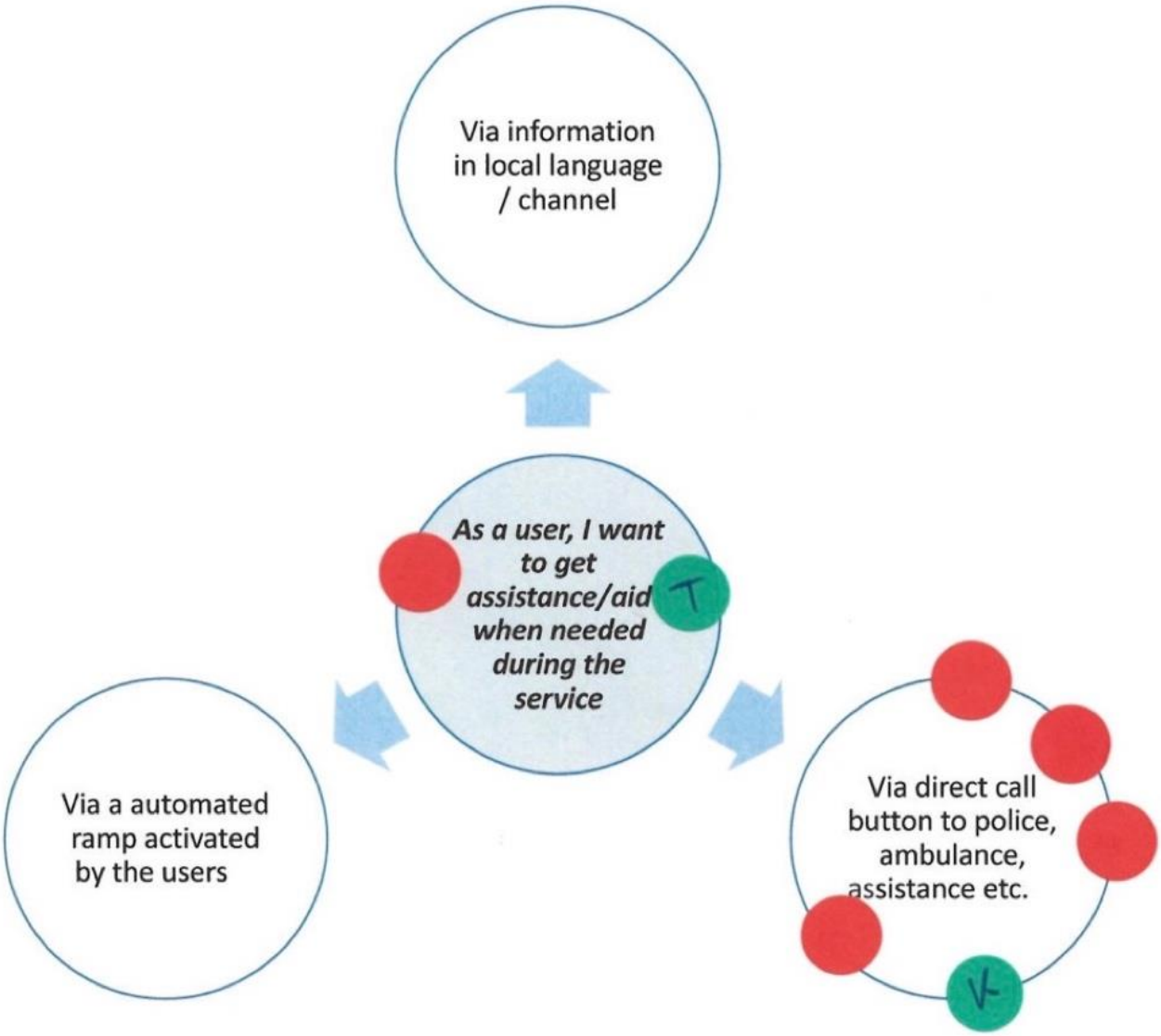


Figure 3: Prioritization outcome - user story 3: get help

2.3.1.4 As a user, I want to manage my trip

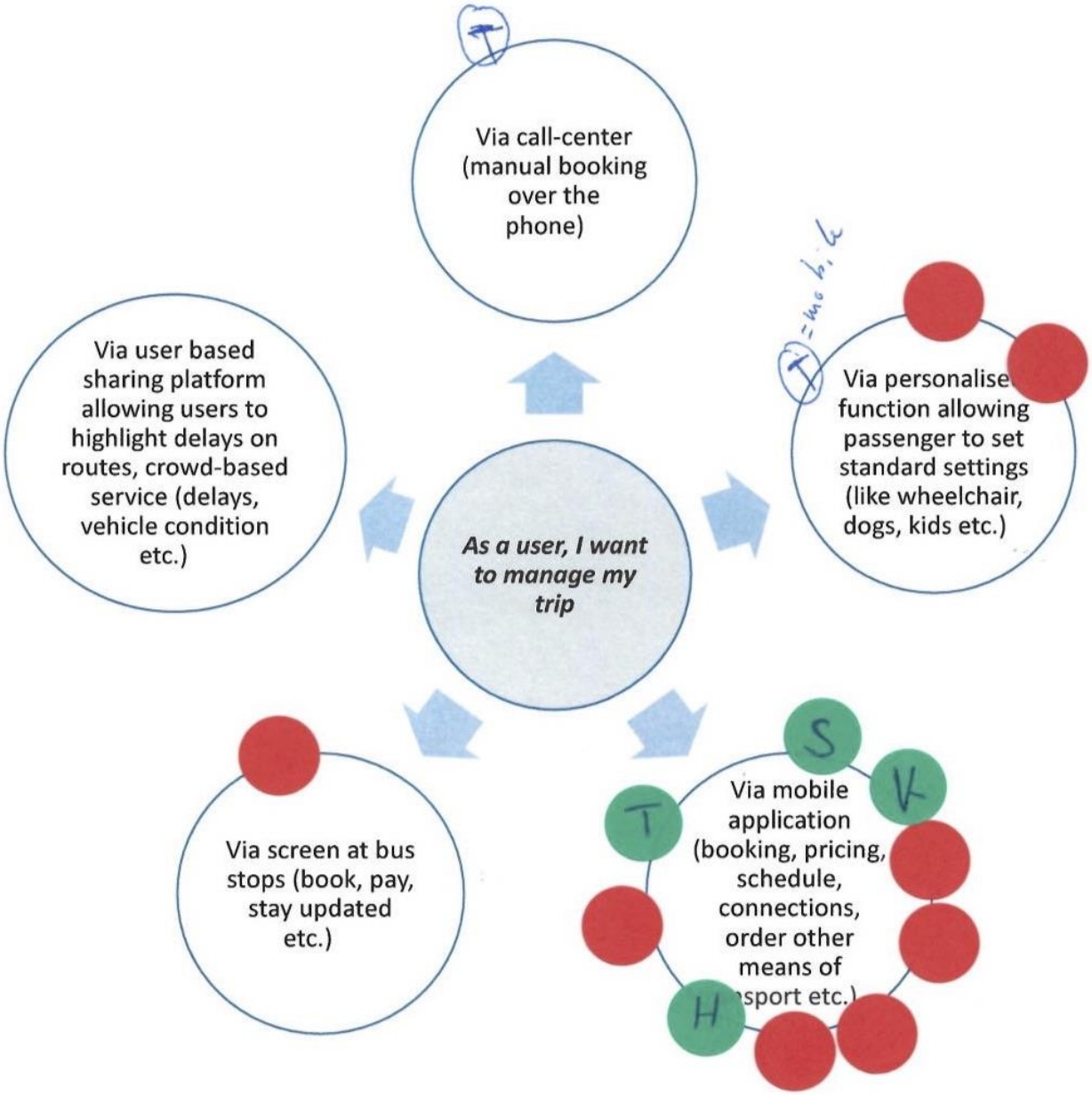


Figure 4: Prioritization outcome - user story 4: manage trip

2.3.1.5 As a user, I want to know if there is room in the vehicle

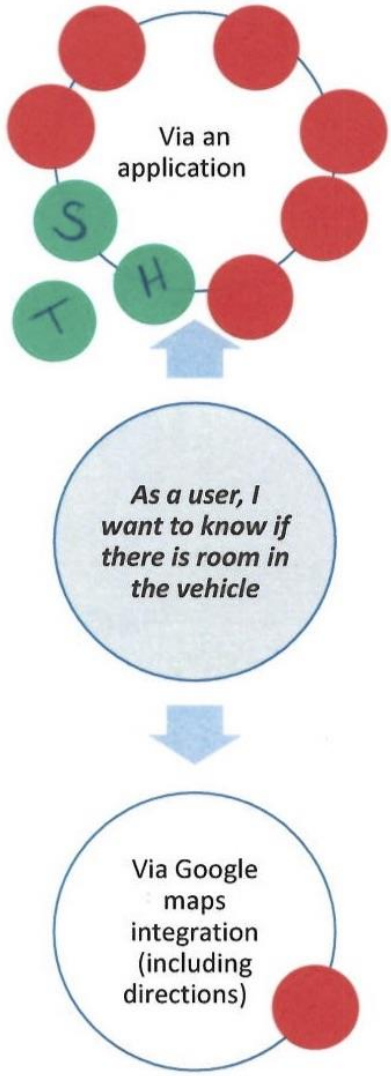


Figure 5: Prioritization outcome - user story 6: room in vehicle

2.3.1.6 As a user, I want to be informed about the status of the service

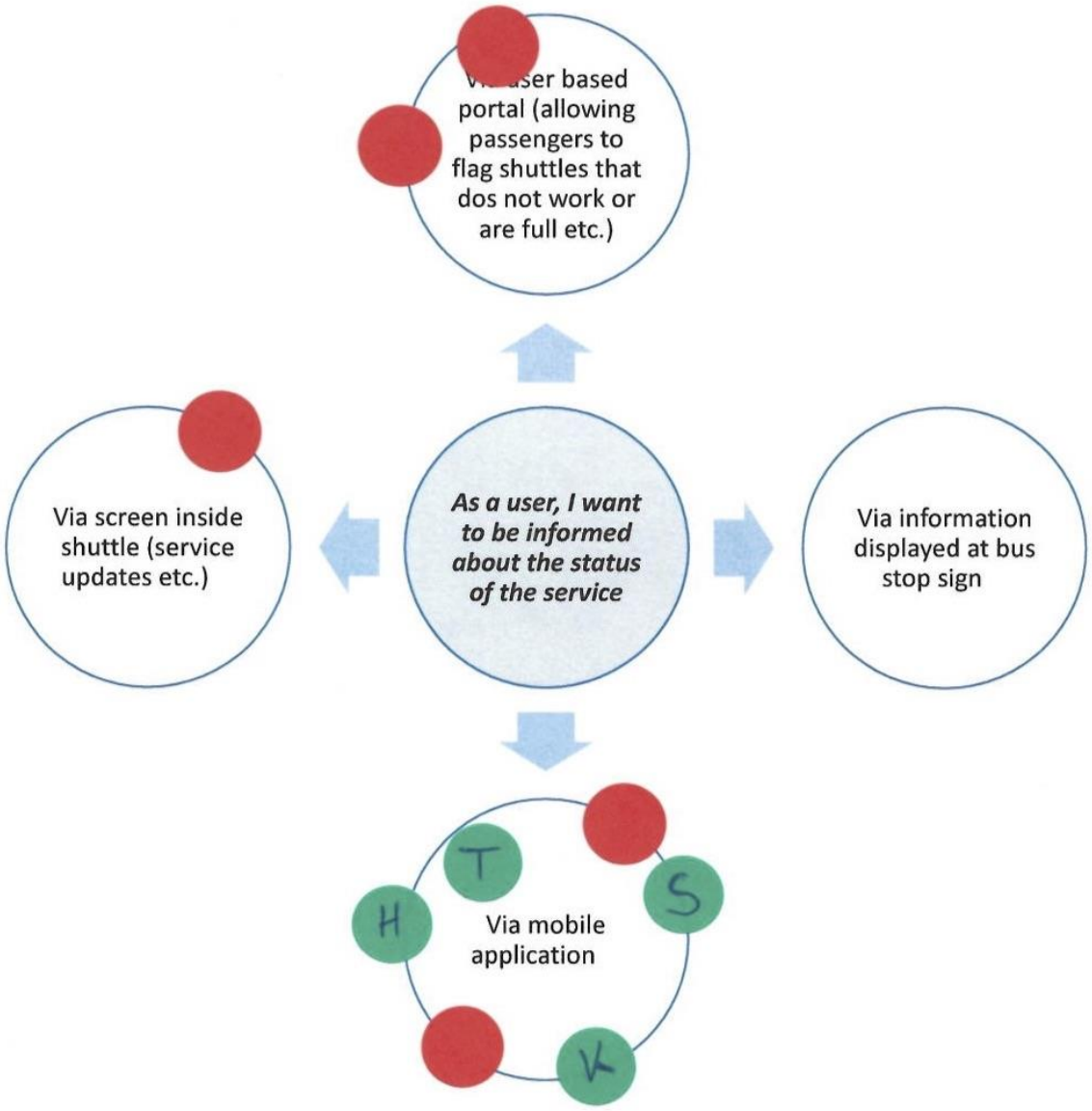


Figure 6: Prioritization outcome - user story 6: be informed

2.3.1.7 As a user, I want to feel safe using the service

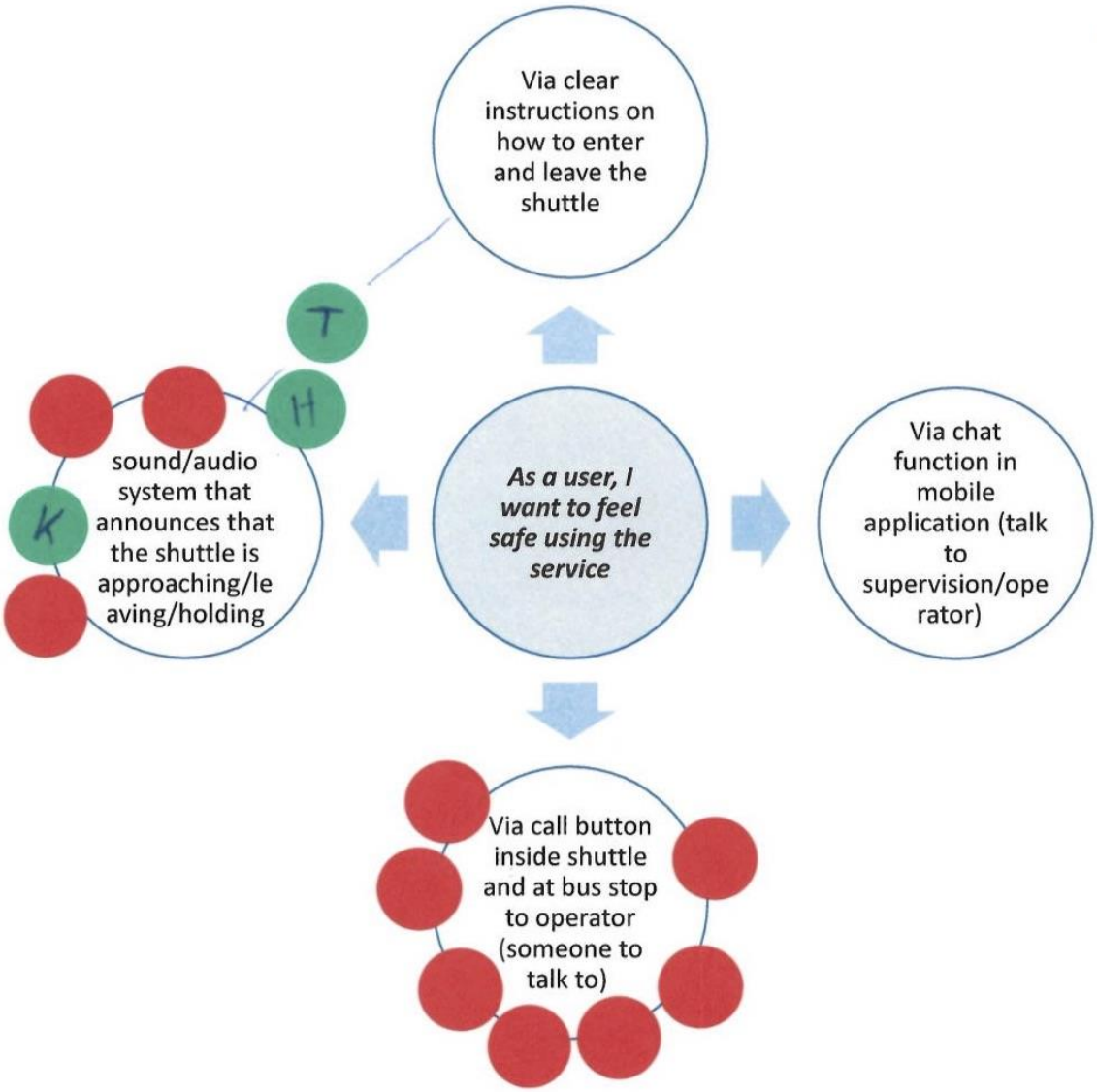


Figure 7: Prioritization outcome - user story 7: feel safe

2.3.2 Ideas that can be implemented by the PTOs alone

This chapter displays the results of the prioritization by all partners per user story on those services, that can be implemented by the PTOs on their own, without the involvement of other partners (as in table 17). Here, the question was thus rather on the PTOs' intention to implement a respective service rather than prioritising.

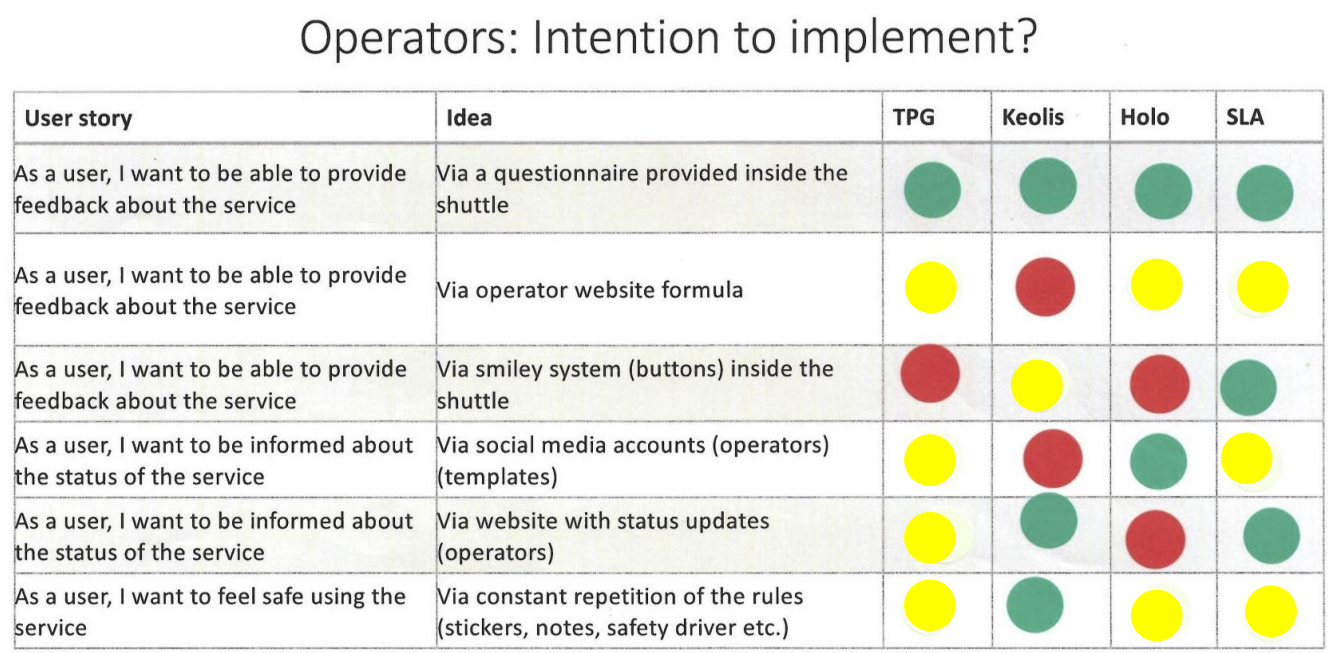


Table 20: Display of the results

= NO = YES = MAYBE

2.3.3 Ideas with the highest prioritization

User story: Service idea	Partners votes	AM	Keolis	SLA	TPG
Provide feedback: Via the mobile application	7	-	-	X	-
Be entertained: Via Wi-Fi	3			X	
Be entertained: Via news and updates relevant to the area	3	X	X		
Get assistance / aid: Via a direct call button to police, ambulance, assistance, etc.	4		X		
Manage my trip: Via the mobile application	5	X	X	X	X
Know if there is room: Via the mobile application	6	X		X	X
Be informed about status: Via the mobile application	2	X	X	X	X
Feel safe: Via a call button inside the shuttle and at bus stop	7				
Feel safe: Via sound / audio system that announces that the shuttle is approaching/leaving	3	X	X		X

Table 21: Results of prioritization - ideas with the highest prioritization

User story: Service idea	Partners votes	Service phase 2?	
Provide feedback: Via the mobile application	7 + 1	**YES**	Providing feedback via the mobile application via a rating system
Be entertained: Via Wi-Fi	3 + 1	TBC	Possible with Navya-independent material, see 2.1.2.2.
Be entertained: Via news and updates relevant to the area	3 + 2	TBC	Depending on PTO priorities; content provided by PTOs; see 2.1.2.4
Get assistance / aid: Via a direct call button	4 + 1	TBC	Via mobile application it can easily

to police, ambulance, assistance, etc.			be implemented
Manage my trip: Via the mobile application	5 + 4	**YES**	Additional services for trip management will be implemented in the mobile app once available
Know if there is room: Via the mobile application	6 + 3	TBC	Available when PTOs start using the AVENUE driver app for passenger counting or when automated counting is available from sensors in the shuttle.
Be informed about the status: Via the mobile application	2 + 4	TBC	See 2.1.7.4
Feel safe: Via a call button inside the shuttle and at bus stop	7	TBC	See 2.1.8.2
Feel safe: Via sound / audio system that announces that the shuttle is approaching/leaving	3 + 3	**YES**	Audio messages to passengers will be available in the shuttle by end of 2019. (Navya – content provided by the PTOs)

Table 22: Details on possible implementation in phase 2

As a next step, the definite services for phase 2 will be selected by the PTOs and in close collaboration with the technical partners (Navya, MT, Bestmile, CERTH).

3 Services research

CERTH is conducting innovative research in the field of services regarding security and safety, passenger presence detection through a camera, a microphone and on environmental assessments. This research lays the ground for potential testing in the demonstration sites. Depending on the progress of the research at CERTH, these services can be tested on some of the demonstration sites directly and then be evaluated by the PTOs.

3.1 Enhance the sense of security and trust

Problem

Several concerns of the end users regarding the safety and robustness of the autonomous vehicles that are directly linked to the final user acceptance of the new technology, can be identified. The prospective passengers fear several possible instances that could arise in case there is no driver in the shuttle, such as:

- No one will be in the shuttle to perform first aid if required
- Feeling of discomfort being all alone in the shuttle at night, especially in certain neighborhoods
- No authority figure present to keep passengers calm (e.g. school kids)
- Vandalism, bag snatching, indoor fighting, unaccompanied luggage

Timely, accurate, robust and automatic detection of various petty crime types or misdemeanors is required, and so is the assistance of authorized end-users in re-identification of any offenders. The petty crimes that are targeted for identification include: petty theft like bag snatching and pickpocketing, vandalism, aggression, illegal consumption of cigarettes, public intoxication, simple assault and disorderly conduct.

User story

As a passenger, I wish to feel secure at any time when using an autonomous shuttle (especially in absence of a driver).

Detection of certain events may raise a notification or an alert to the supervisor and/or the suitable authorities. This may be followed by appropriate notifications and/or instructions to the passengers, while the vehicle may also implement respective actions. Indicative use cases are described next:

Unaccompanied luggage monitoring: There is unaccompanied luggage on the shuttle, and it remains unmoved for a long time. If the detected luggage remains unmoved longer than the predefined time frame, a notification is sent to the security PTO. The security PTO monitors the clips captured and evaluates the criticality of the situation and whether to intervene or not.

Bag Snatch Detection: An assault (petty crime) takes place on a commuter in the shuttle. The commuter is attacked by another person who is attempting to snatch the bag from him/her. The system identifies the event and sends a security alert to the PTO or security supervisor. The course of action of the PTO is a human decision whether to stop the shuttle or notify the passengers via radio system.

Vandalism Detection: A young person takes the shuttle during the night shift. He/ she tries to perform an act of vandalism, painting a graffiti on the windows. The event is detected, and the person is either warned by the radio system of the shuttle or the security personnel intervenes by stopping the shuttle.

Service description

The service aims to address the new reality created as a result of (a) the absence of the driver and (b) the increased threat from terrorism in the European cities. Typically, drivers are trained to handle the

incidents of passengers' misbehavior, incidents of petty crimes, etc. according to the standard procedures adopted by the transport PTO. Surveillance using sensors such as microphones, cameras (cameras of different technologies can be used so that passengers' privacy is protected) and smart software in the shuttles will maximize the feeling of security and the actual level of security. Both PTOs and passengers, and particularly vulnerable passengers such as elderly people, people with disabilities, etc. are expected to benefit from the service. Furthermore, the service provides identification of passenger behavior: vandalism, anxiety, forgotten items, passenger accidents (ex. falling), sitting or standing, apart from the passenger security (petty crimes detection, i.e. aggression, bag-snatching).
The security and trust service exhibit a variety of advantages, which include the on-site intelligence of the platform using low cost devices that can provide identification and notification procedures that will ease the task of the authorities contributing to the timely apprehension of any offender. In this context, various analysis approaches for early petty crime detection are adopted, such as:

- Video analytics
- Depth analytics
- Audio analytics

The service is implemented by adopting a platform for petty crimes and incident detection system developed for the proactive and active detection of abnormal behavior, suspicious objects in conjunction with a variety of sensors. The sensors of the embedded system, which can include various types, have enhanced the interoperability and support integration with legacy cameras. When an event is detected a clip is generated. The streams are sent to the embedded system to analyze and provide notifications. The system uses the standard of-the-shelf cameras and microphones, so no specialized protocols and/or ports are required. In most cases the sensors will be directly connected to the Embedded System through a USB port, whereas IP cameras will also be supported, with the latter being connected through Ethernet or Wi-Fi to the Embedded System.
Experiments and related work
A first analysis about the functional and technical specifications of a software solution has been completed. Visual analytics algorithms of this software were developed for timely, accurate, robust and automatic detection of various petty crime types, as well as the assistance of authorized end-users towards the re-identification of any offenders. Moreover, discussions with NAVYA PTOs continue regarding the contribution that will be provided according to the above-mentioned specifications (video samples, data, legal restrictions, GDPR), along with the identification of the integration to the PTO's services based on their existing technology.
A first data capture with specific cameras has been performed in CERTH facilities as initial approach, taking into account various scenarios to be identified, whereas the video from the indoor environment of Navya shuttle has been used as a second approach. Detailed data captures have been conducted also in TPG's depot in real conditions. The first set of data has been processed and initial results indicate the potential of the security and trust service.
In more details, the experimental evaluation for indoor cases can derive a multi-person skeleton detection of 17 different human body key points, as well as pose tracking, to associate poses that indicate the same person across multiple frames. A skeleton based anomaly detection has been implemented to provide generation of trajectories based on previously detected skeleton features. This approach facilitates the detection of human-related anomalies in the video by learning regular spatio-temporal patterns of skeleton trajectories. The detection type focuses on use cases related to vandalism - graffiti, as well as a person falling/ fainting.
In addition, large variations between the actual and the predicted poses, considered unusual, can be detected. Unusual skeleton poses and motions compared to those of normal activities are considered as

anomalies, and thus the detection type can focus on use cases related to bag snatching and fighting. Furthermore, human-object detection and classification of human-related objects and accessories in a video is also possible. The basic detection of unaccompanied items has been implemented and tested. In this case, the detection type focuses on use cases related to unaccompanied luggage monitoring.

Figure 8: Detection of people fighting

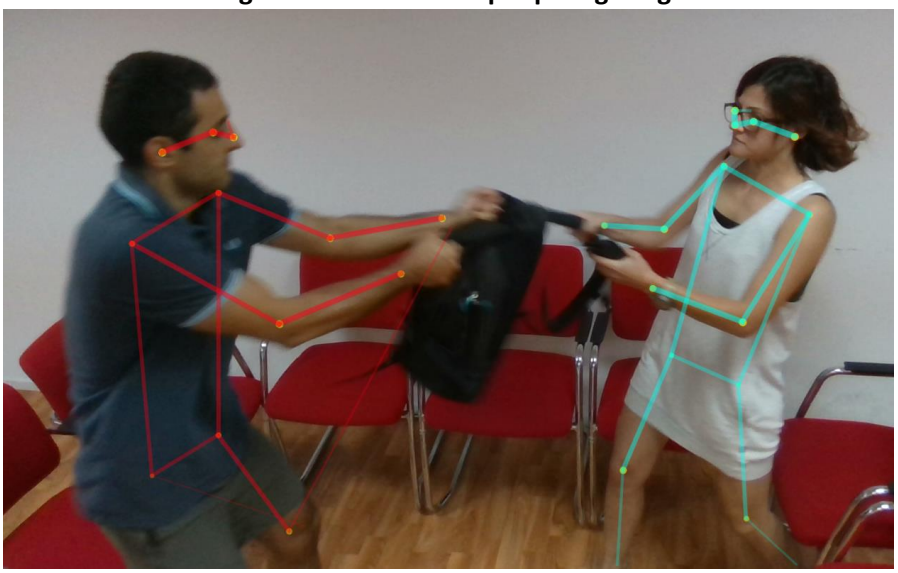


Figure 9: Detection of people fighting along with bag snatching

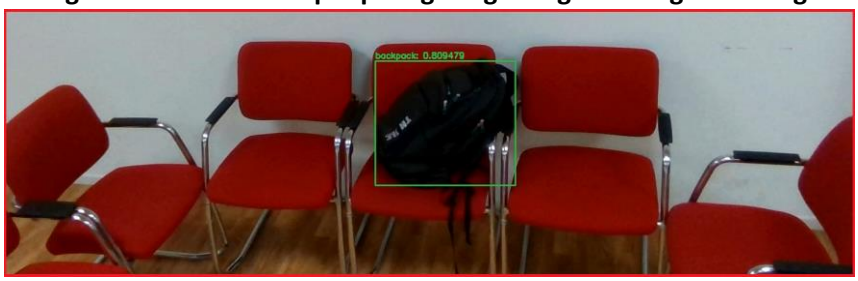


Figure 10: Detection of unaccompanied luggage

3.2 Passenger presence

Problem

A basic problem of PTOs' services is related to the occupation of their vehicles as well as the awareness of the number of people on-board in order to schedule the routes. Furthermore, the passengers would like to know in advance if there is an available seat or enough space on a shuttle to plan their boarding.

User story

As an PTO, I wish to know if there is an available seat or space to assess the option of picking-up a passenger or re-route the shuttle. The operation manager sees the shuttle capacity and the occupancy on the map and the dashboard, as well as in the vehicle telemetry. Capacity is set as an absolute number of people, not as a number of seats (otherwise the counting is not correlated). Occupancy is set as an absolute number of people currently in the shuttle (whether seated or not).

As a passenger, I wish to know if there is an available seat or space before getting on-board on the autonomous shuttle. Occupancy is displayed as real time information, wherever the traveler is, but it doesn't guarantee them a free spot when the shuttle arrives at the station of their choice.

Service description

The service provides a video analysis of the vehicle internals, using the on-board camera, in order to identify the vehicle occupation, vehicle free space, as well as counting people on-board. Automatic assessment of space occupation using the on-board cameras is enabled. Capacity is set as an absolute number of space units. For example, each space unit is associated with one standing passenger. Occupancy is set as an absolute number of space units currently in the shuttle. For the operation manager, occupancy is visible on the dashboard of the Avenue platform, whereas occupancy is displayed as real time information via the Avenue mobile app, wherever the traveler is. Each passenger (normal, big size, wheelchair user, seated) can determine whether he/ she can fit in or not. Assessment for different cases can be provided to assist the passengers on determining whether to request onboarding or not. Automatic counting of people using the on-board cameras is also provided. Additional information can be derived from automated people-counting, while fusion of data related to space occupation and counted number of people can provide more accurate information about the capacity and occupancy of the vehicle. Moreover, occupancy marked with information for the different user cases is displayed as real time information, wherever the traveler is, however it does not guarantee them a free spot by the time the shuttle reaches the station of their choice.

Experiments and related work

A first analysis about the functional and technical specifications of a software solution has been completed. The visual analytics algorithms for this software were developed for the timely, accurate, robust and automatic detection of people entering or leaving the shuttle. Moreover, discussions with the shuttle PTOs are still ongoing. These discussions concern the contribution to be provided according to the above-mentioned specifications (video samples, data, legal restrictions, GDPR), along with the identification of the integration to the PTO's services based on their existing technology.

A first data capture with specific cameras has been performed in CERTH facilities as initial approach, taking into account various scenarios to be identified, whereas a video from the indoor environment of Navya shuttle has been used as a second approach. Detailed data captures have been conducted also in TPG's depot in real conditions. The first set of data has been processed and the initial results indicate the potential of the security and trust service.

In more details, the experimental evaluation for indoor cases can derive passenger detection and counting, as well as the real-time calculation of occupied passenger seats. Moreover, the video from Navya shuttles' camera in real conditions has been processed to provide detection and counting of people getting on or off the vehicle. Real-time calculation of occupied passenger seats can be provided. Computational vision and artificial Intelligence algorithms have been employed to achieve this objective. Indicative results are illustrated in the figures below.

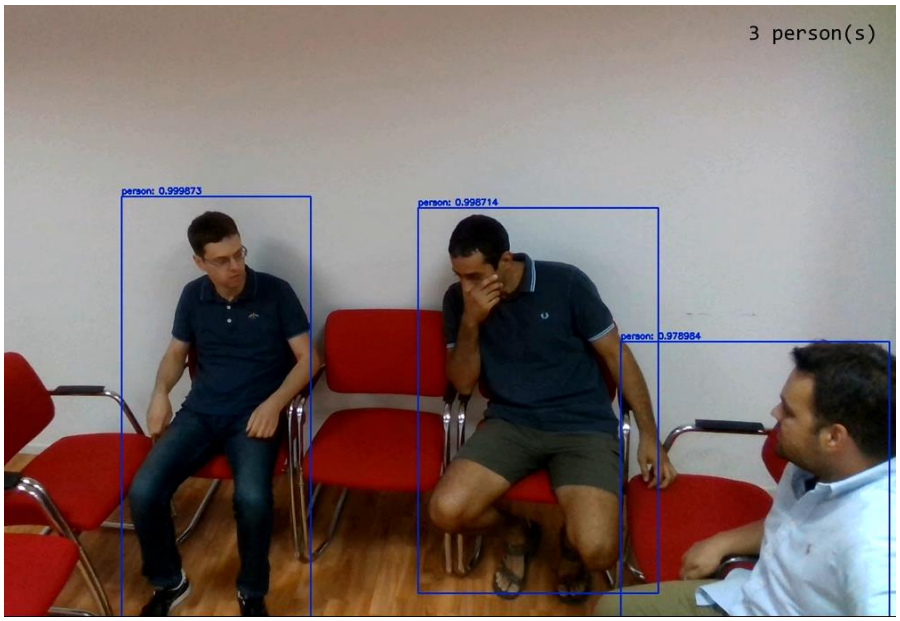


Figure 11: Counting of people in CERTH facilities dataset

Figure 12: Counting of people in Navya shuttle

Figure 13: Counting of many people in Navya shuttle

3.3 Environmental assessment

Problem

The environmental conditions in the autonomous vehicle may not be adequately controlled due to the absence of a driver. Minimum acceptable conditions and comfort, such as good air quality, acceptable odours and absence of smoke are necessary for the safe transport of the passengers as well as the

viability of the whole autonomous service, since lack of these conditions within the vehicle could significantly discourage potential passengers.

User story

As a user, I wish to travel in a clean and comfortable environment and be notified if the conditions have deteriorated.

Detection of certain pollutants, such as CO2, NO2, or dust particles in the indoor environment, along with critical temperature variations, is important for the condition of certain passengers, especially ill people, such as asthma patients. Smoke in the vehicle, i.e. from a person that lights a cigarette, will deteriorate the passenger experience but may also put in danger the whole vehicle (danger of fire). Detection of certain events (air quality deterioration, smoke) may raise a notification or an alert to the passengers along with instructions on how to handle this situation, while the vehicle may also implement respective actions.

As an PTO, I wish to be notified when environmental conditions are considered harmful for the passengers.

Detection of certain air quality indexes and pollutants in the indoor environment, along with critical temperature variations are necessary for providing a secure service to the passengers. Smoke in the vehicle will deteriorate the passenger experience, put in danger the whole vehicle (danger of fire) and may also result in cancelling the autonomous transport service. Detection of certain events (air quality deterioration, smoke) may raise a notification or an alert to the supervisor and/or the suitable authorities (i.e. police, fire department). This may be followed by appropriate notifications and/or instructions to the passengers, while the vehicle may also implement respective actions.

Service description

The service is based on the collection of several vehicle telemetry information from sensors and related services, such as:

i. Tire pressure (indicatively using Bluetooth tire valves or other approaches)

ii. Environmental sensors (for assessing pollution, air quality in the vehicle, such as CO2, NO2, dust particles concentrations, temperature in the vehicle etc.)

iii. Smoke sensors and smoking detection (for fire and also people that smoke in the vehicle)

Several sensors should be embedded into the vehicle for this purpose along with proper connectivity with a central assessment system, that can provide notifications to the passengers, the supervisors and suitable authorities if required.

Experiments and related work

Initial investigations have been performed regarding the available environmental sensors that could be used in Navya shuttles.

3.4 Fleet management meta-services

Problem

The prediction of vehicle behavior as well as the identification of complex situations is very important for the efficient fleet management, but also for the re-design of routes and maintenance procedures to achieve optimal performance of the complete autonomous solution.

User story

As an PTO, I wish to predict vehicle needs for maintenance. Prediction of vehicle needs for maintenance facilitates operation and diminishes costs.
As an PTO, I wish to identify complex situations that have occurred on the road during operation in order to re-design routes and services.
As an PTO, I wish to predict traffic in order to re-design routes and services.

Service description

The service involves offline and online processing of the data streams to identify critical parameters and provide guidelines. In more details, these services involve:

- Prediction of the vehicle maintenance needs based on vehicle information (data are required related to vehicle telemetry, such as history for energy consumption, routes, traffic, etc.).
- Post-analysis of vehicle behavior based on vehicle information (data are required related to vehicle telemetry, such as history for energy consumption, routes, traffic, etc.).
- Post-analysis of fleet management decisions to identify if optimality was reached. Indicative assessment includes comparison for different routes etc.
- Post-analysis of vehicle road collected information for identifying "interesting"/"complex" situations

4 Services defined in D2.13

4.1 Expanding the services from phase 1

In deliverable D2.13, “First Definition of AVENUE services”, the three services for phase 1 have been described in detail – all of them have been developed during phase 1 in the project and are available via the mobile applications.

For these three services, enhanced versions are being evaluated for phase 2 and 3 of the project:

Visualization in real time of the path / position of shuttle

Version 2 of this service will provide additional information regarding the trip, such as the estimated time of arrival of the vehicle, the time to destination, etc. to the end-user. This will be available in all the on-demand services through the booking information.

On-demand stop

The enhanced version of this service provides a real on-demand service, according to the final objective for all AVENUE demonstration sites.

Provide passenger presence information

Versions 2 and 3 of this service are based on an automatic counting of passengers and luggage in the vehicle, via sensors or cameras. CERTH is carrying out an innovative research on both subjects. See chapter 3 for more information.

4.2 Matching the original list of services with user stories & service ideas from ideation process

Service name D2.13	Chapter in D2.13	Matching user story from ideation process	Matching service idea from ideation process
Intelligent / Integrated trip planner	3.1.1.	I want to manage my trip	Via mobile application
On demand zone awareness / notification	3.1.2.	I want to manage my trip	tbd
Automatic trip planning suggestions	3.1.3.	I want to manage my trip	Via Smartbooking, remember my trips function
Field Agent App	3.1.4.	*N/A -> "PTO service"*	
Wi-Fi in the bus	3.1.5.	I want to be entertained	Via Wi-Fi
Detection of vandalism	3.1.5.	I want to feel safe	Via camera surveillance inside the shuttle (see chapter 3)
Inclusive transport service	3.1.5.	I want to get assistance/aid	Several ideas
Using the intercom/loudspeaker system for information messages	3.1.5.	I want to be informed about the status of the service	Via audio guidance at the bus stop signs and inside the shuttles
Using the intercom system to get in touch with an PTO	3.1.5.	I want to feel safe	Via call button inside shuttle and at bus stop to PTO (someone to talk to)
Using the road-facing screens for information display	3.1.5.	I want to be informed	Via screen inside shuttle (service updates etc.)
Services to replace the PTO	3.1.5.	*N/A -> "PTO service"*	
Sensors that check if the seatbelts are fastened	3.1.5.	*N/A -> "PTO service"*	
Problem to be addressed: Emergency situations	3.1.6.	I want to get assistance/aid	*All ideas*
Problem to be addressed: Health problems	3.1.6.	I want to get assistance/aid	*All ideas*
Problem to be addressed: Unsafe feeling	3.1.6.	I want to feel safe	*All ideas*
In-vehicle entertainment	3.3.1.	I want to be entertained	*All ideas*
Virtual personality interaction	3.3.2.	I want to be entertained	Via augmented reality applications within the shuttle
Trip planned via call centers	3.3.3.	I want to manage my trip	Via call center (manual booking over the phone)
Mutual help assistance	3.3.4.	I want to get assistance/aid	
Single button vehicle calls and	3.3.5.	I want to get assistance/aid	Via direct call button to

help request			police, ambulance, assistance etc.

Table 23: Matching the original list of services with user stories & service ideas from ideation process

5 PTO services

Besides the services directed to the end-users of AVENUE services, several others meant for PTOs were identified in the first 18 months of the project. The need for these additional services are to be further discussed and evaluated in the next few months.

5.1 Field Agent / Safety Driver App

User Story

As an PTO, I want my safety driver to be able to enter and track operational details in an automated way and move away from tracking and monitoring in a paper format. As an PTO, I also want to be able to monitor the inputs from the safety drivers in the PTO Dashboard, which I already use to monitor the vehicles.

How

Bestmile's Field Agent App already provides the possibility to track operational incidents as "field logs" and to display and edit them in the PTO Dashboard. Here are some additional functionalities of the Field Agent App that could be interesting for the PTOs:

- Morning checklist
- Evening checklist
- Signing of checklists
- Attaching a picture to an incident report
- Passenger counting

Feedback from the PTOs

This service was added to the list of existing services as a result of the discussion during different workshops, and as per strong requests from all PTOs. It would be an important operational tool for the PTOs allowing for significant time savings both for the safety drivers and the supervisors.

5.2 Services to replace the PTO

At the moment, the PTO takes over several functions that would need to be replaced by an automated service once the PTO is removed from the shuttle. Most initial points concern the communication with the passengers:

- Communication with the (potential) passengers outside the shuttle on various topics: E.g. signal the passengers that they have to walk to the the next stop, before the shuttle arrives there.
- Communication with other people in traffic outside the shuttle: E.g. sign to pedestrians that they can pass the pedestrian crossing, so that the shuttle can move past a priority zone.
- Request that the passengers onboard comply with the safety recommendations: Stay seated until the shuttle stops completely. Inform that the shuttle breaks hard and the passengers should be seated at all times, etc.

- Answer questions on the actual operation: Shuttle's destination, next stop, costs.
- Answer questions on the specific pilot project: E.g. Who is doing the project? How long will it run? Who is paying for the bus?
- Answer questions regarding the shuttle and AV's in general: E.g. Will it ever go faster? How much does it cost? What are your thoughts on the Uber accident? And other technical questions.
- Answer social questions: E.g. Will shuttle drivers be unemployed? When will we see this in everyday life and not just as a pilot project? Etc.

Furthermore, the PTOs help disabled passengers to enter or leave the bus and sometimes hold the doors of the bus open for people getting on or off the bus.

5.3 Sensors that check if the seat belts are fastened

In some countries, such as Switzerland, it is currently obligatory to have the seat belts fastened in an autonomous shuttle. Currently, the safety driver informs users of this obligation and asks each new passenger to put on their seat belt. The idea of this service would be to replace this human alert by a sensor that detects if the seat belts are fastened and, if not, triggers a message to be played through the loudspeakers asking the passengers to fasten their seat belts.

6 Conclusion

Comprehensive work has been conducted over the past year by the PTOs, the technical partners as well as some other project partners in order to ideate on potential services that could be developed and implemented in the framework of the AVENUE project. Throughout a multi-step ideation process, initial user stories were detailed and a large number of ideas were developed. Based on the ideation process, the technical partners analyzed all the ideas in terms of their feasibility and grouped into in- and out-of-vehicle services. Finally, all the project partners evaluated and prioritized the services that could be feasible in phase 2, with a special attention given to the evaluation of the PTOs.

As a result, nine services have received the highest ranking (see table below). Three of them are already confirmed to be implemented in phase 2 (marked "yes"), all others need to be reevaluated by the PTOs.

User story: Service idea	Partners votes	Service in phase 2?
Provide feedback: Via the mobile application	7 + 1	**YES**
Be entertained: Via Wi-Fi	3 + 1	TBC
Be entertained: Via news and updates relevant to the area	3 + 2	TBC *Depending on PTO priorities; content provided by PTOs*
Get assistance / aid: Via a direct call button to police, ambulance, assistance, etc.	4 + 1	TBC *Feasible via the mobile application*
Manage my trip: Via the mobile application	5 + 4	**YES** *Additional services for trip management will be implemented in the mobile app once available*
Know if there is room: Via the mobile application	6 + 3	TBC *Available when PTOs start using the AVENUE driver app for passenger counting or when automated counting is available from sensors in the shuttle.*
Be informed about status: Via the mobile application	2 + 4	TBC
Feel safe: Via a call button inside the shuttle and at bus stop	7	TBC
Feel safe: Via sound / audio system that announces that the shuttle is approaching/leaving	3 + 3	**YES** *Audio messages to passengers will be available in the shuttle by end of 2019. (Navya – content provided by the PTOs)*

Table 24: Highest ranked service ideas and possible implementation in phase 2

In addition to this, scientific research on several services is ongoing and will be continued in the framework of WP4, conducted by CERTH. When the first results are available, PTOs will evaluate them and will discuss with CERTH in how far they can be tested or implemented in their operations.

Lastly, several services have been identified in the project that are rather services for the PTOs themselves. The need for these services is to be further discussed and evaluated in the coming months.

7 Appendix A: Feasibility study outcomes

7.1 As a user, I want to be able to provide feedback about the service

Bestmile (for all ideas under this user story): For Bestmile, whatever the way to collect the data, the question is whether or not we want the information to be displayed in the PTO Dashboard. We do not really see it as relevant as it is not real-time data needed for the fleet orchestration. However, it could be a way to display the final information. This would mean an automated process to gather the data.

7.1.1 Emotion-detection built-in camera inside the shuttle

- Navya: TBC - Videos are a very sensible topic regarding GPDR.
  Usage should be only local (in the vehicle).
  Shuttles are commercially used by the PTO. Therefore, this feature can only be tested with the PTO's authorization, using separate material, for a very short period of time, only if it does not compromise safety and user comfort nor if it impacts the passengers and legal agreements.
- CERTH: YES - Video analysis software is part of the security and trust service. Emotion detection is an additional feature, but it is technically feasible, as commented by Navya. / Roadmap = Phase 3, *if* required and *if* the issues with GDPR are resolved along with data collection and access to vehicles.

→ Phase 3 / Not possible (CERTH + NAVYA)

7.1.2 Via the mobile application

- MT: YES - We could integrate a form or a rating system in the application / Roadmap = Phase 2

→ Phase 2 (MT)

7.1.3 Via QR code inside shuttle

- Navya: YES - With PTO's authorization.
- MT: YES - The QR code will trigger the questionnaire of feedback section / Roadmap = Phase 2 (assuming QR code are set and placed in buses)

→ Phase 2 (MT + PTOs)

7.1.4 Via photo upload to PTO

- MT: YES – We could integrate a photo upload functionality in the feedback form / Roadmap = Phase 2

→ Phase 2 (MT + PTOs)

7.1.5 Via avatar on screen inside shuttle

- Navya: NO – Not possible

→ Not possible

7.1.6 Via smiley system (buttons) inside the shuttle

- Navya: TBC - With a separate material? How to install and provide electricity? How to synchronize the data and who will do this?

→ Phase 2 (PTOs)

7.1.7 Via thumbs up / thumbs down to camera inside the shuttle

- Navya: NO

→ Not in scope

7.1.8 Via PTO website formula

→ Phase 2 (PTOs)

7.1.9 Via a questionnaire provided inside the shuttle

- MT: YES – We could integrate a questionnaire in the application and activate it automatically / Roadmap = Phase 2

→ Phase 2 (PTOs)

7.1.10 Picture feedback (augmented reality -> via bus)

- Navya: TBC – Concept not clear
- MT: We do not understand this Idea.
- CERTH: YES - We could provide some kind of AR solution, but maybe it is out of scope within the Avenue project. / Roadmap = Phase 3 if required

→ Not possible

7.2 As a user, I want to be entertained while riding the vehicle/service

Bestmile (for all ideas under this user story): N/A

7.2.1 Via virtual reality guided tours inside the shuttle

- Navya: TBC - Possible with independent material. With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: No - We are not experts in VR. However, if someone else is capable of developing VR tours, we can link them from the mobile application.

- CERTH: Yes - we could provide some kind of a VR solution, but maybe it is out of scope within the Avenue project. / Roadmap = Phase 3 if required

→ Not possible

7.2.2 Via Wi-Fi (access to paid websites with entertainment)

- Navya: Yes - Possible with independent material not interfering with the shuttle system (ex: independent WIFI module with independent SIM).
- MT: N/A
- CERTH: N/A

→ Phase 2 (Nayva + PTOs)

7.2.3 Via quizzes inside shuttle (Fun fact, area knowledge etc.)

- Navya: TBC - With mobile app or independent material.
- MT: Yes - It is possible to integrate it in the mobile application / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT + PTOs)

7.2.4 Via news and updates relevant to the area of the route (sports-news near stadiums etc.)

- Navya: TBC We will soon release the audio announcement system. Solutions can be studied and generated before or after the bus stop.
- MT: Yes, assuming that we have localized news feeds, we can display it in the mobile application / Roadmap = When feeds are available
- CERTH: N/A

→ Phase 2 (MT + PTOs)

7.2.5 Via interactive screens inside the shuttle and at bus stops (news, weather, entertainment, status of operation, etc.)

- Navya: TBC Possible with independent material. With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: N/A

→ Not possible

7.2.6 Via guided tours (safety driver or speaker system - area designated)

- Navya: Ye - We will release soon the audio announcement system. Solutions can be studied and triggered before or after the bus stop.
- MT: N/A
- CERTH: N/A

→ Not possible

7.2.7 Via gamification at bus stops and inside the shuttle (steering wheel for kids, light games in the ceiling, etc.)

- Navya: TBC Possible with independent material. With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: Yes, we could provide some kind of gamification solution, but maybe it is out of scope within the Avenue project. / Roadmap = Phase 3 if required

→ Not in scope

7.2.8 Via book-renting system at bus stop signs and inside shuttles

- Navya: Yes, possible with independent material. With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: N/A

→ Not possible

7.2.9 Via smells inside the shuttles

- Navya: Yes, possible with independent material. With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: N/A

→ Not in scope

7.2.10 Via dating and networking (meet others) chats and functions inside the shuttles

- Navya: N/A
- MT: No - We do not think this is inside the scope of AVENUE. There are many applications for dating and networking and the buses are so small that it does not make sense in our opinion.
- CERTH: N/A

→ Not in scope

7.2.11 Via fitness exercise games at bus stops (while waiting - stay healthy)

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Not in scope

7.2.12 Via quiz game between shuttles (allow passengers to compete against passengers inside another shuttle)

- Navya: N/A Possible via a connected centralized system and the mobile application. Not from the shuttle directly.
- MT: Yes, it is possible to integrate it in the mobile application / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT + PTOs)

7.2.13 Via augmented reality applications into the shuttle

- Navya: TBC Possible with independent material. Same comment as D7
- MT: ? It depends a lot on what is asked in terms of AR. We can integrate simple things, but we do not have the technical skills to create 3D models.
- CERTH: Yes, we could provide some kind of AR solution, but maybe it is out of scope within the Avenue project. / Roadmap = Phase 3 if required

→ Phase 3 (MT + PTOs + External partner)

7.3 As a user I want to get assistance/aid when needed during the service

Bestmile (for all ideas under this user story): For Bestmile, whatever the means to request assistance, it is important for the orchestration to know if the situation will result in an immobilization or rerouting of the shuttle as it will most probably impact its availability for the next missions. An integration with the selected system is thus necessary and the feasibility will depend on the technical difficulty.
In the specific case of a chatbot, a dedicated interface needs to be implemented in the Dashboard for the PTO to answer questions. Same for a VoIP system, whether triggered by a button or by a more complex audio detection system.

7.3.1 Via other travelers (activation of peer-to-peer help)

- Navya: N/A
- MT: Yes - The implementation will depend on the stage of other services like booking for example. Feasible using glocalization of passengers. (Helper pool of users) / Roadmap = When/if user login is available
- CERTH: N/A

→ Phase 3 (MT + PTOs)

7.3.2 Via supervision surveillance inside the shuttle (PTO personal over-viewing the shuttle, ready to help)

- Navya: Yes, via Intercom system with a supervision center.
- MT: N/A
- CERTH: Yes, video analysis software is part of the security and trust service. Videos are a very sensible topic regarding GPDR. Usage should be only local (in the vehicle). Shuttles are

commercially used by the PTO. Therefore, it can only be tested under the PTO authorisation with separate material, for a very short period, only if it does not infringe safety, and user comfort nor impact on passengers and legal agreements. Technically feasible remotely with third video based solution or embedded through additional equipment. / Roadmap = Phase 2 provided issues with GDPR will be resolved along with data collection and access to vehicles, otherwise Roadmap = Phase 3

→ Phase 3 / Not possible (CERTH + NAVYA + Bestmile + PTOs)

7.3.3 Via chat bot

- Navya: N/A
- MT: Yes, we can implement the chatbot in the application, but such a tool requires an PTO behind for specific questions / Roadmap = Phase 2
- CERTH: N/A

→ Phase 3 (MT)

7.3.4 Via automated camera detection of emergencies, needed assistance etc.

- Navya: TBC - Same as D2 with independent material - With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: Yes, video analysis software is part of the security and trust service. Videos are a very sensible topic regarding GPDR. Usage should be only local (in the vehicle). Shuttles are commercially used by the PTO. Therefore, it can only be tested under the PTO authorisation with separate material, for a very short period, only if it does not infringe safety, and user comfort nor impact on passengers and legal agreements. Technically feasible remotely with third video based solution or embedded through additional equipment. / Roadmap = Phase 2 provided issues with GDPR will be resolved along with data collection and access to vehicles, otherwise Roadmap = Phase 3

→ Phase 3 / Not possible (CERTH + Navya)

7.3.5 Via emergency button inside the shuttle

- Navya: Yes, already in place but should be careful with the usage. Via Intercom system with supervision center.
- MT: N/A
- CERTH: N/A

→ Phase 1 (Implemented)

7.3.6 Via direct call button to police, ambulance, assistance etc.

- Navya: No - Not available. Via Intercom system with supervision center.
- MT: Yes, easily done. Click and open the Call application with prefilled phone number / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (Nayva + MT + PTOs)

7.3.7 Via application (manage booking, communicate etc.) (including services for blind people)

- Navya: N/A
- MT: Yes, depends on the availability of other services such as booking. / Roadmap = When services are available
- CERTH: N/A

→ Phase 3 (MT + Nayva + PTOs)

7.3.8 Via an automated ramp activated by the users

- Navya: Yes, available on some shuttles that chose the PMR Ramp option
- MT: N/A
- CERTH: N/A

→ Phase 2/3 (Navya)

7.3.9 Via audio detection (ask for help and assistance)

- Navya: No - With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: Yes, video analysis software is part of the security and trust service. Videos are a very sensible topic regarding GPDR. Usage should be only local (in the vehicle). Shuttles are commercially used by the PTO. Therefore, it can only be tested under the PTO authorisation with separate material, for a very short period, only if it does not infringe safety, and user comfort nor impact on passengers and legal agreements. Technically feasible remotely with third video based solution or embedded through additional equipment. / Roadmap = Phase 2 provided issues with GDPR will be resolved along with data collection and access to vehicles, otherwise Roadmap = Phase 3

→ Phase 3 (CERTH + Navya + PTOs)

7.3.10 Virtual agent inside / outside the shuttle

- Navya: No - With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: Yes, virtual assistant solutions are available and can be tailored to specific applications related to the shuttles, if required. Technically feasible. / Roadmap = Phase 3 if required

→ Not in scope

7.3.11 Via a help robot inside the vehicle (aid people in and outside the shuttle at stops)

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Not possible

7.3.12 Via information in local language / channel

- Navya: TBC - Possible with independent material
- MT: Yes - Internationalization of mobile applications. Translations must be provided by PTOs / Roadmap = Phase 2 if translations are available
- CERTH: N/A

→ Phase 2 (MT + PTOs)

7.4 As a user, I want to know where the bus is

Bestmile (for all ideas under this user story): The position of the vehicle can be sent to external systems from the PTO Dashboard or directly from the vehicle. In case of the Dashboard, an integration with Bestmile vehicle protocol is necessary to get the information.
The PTO Dashboard is not conceived to process location information and create messages or announcements.

7.4.1 Via real time map in mobile application

- Navya: N/A
- MT: Yes, done on our side. We are still waiting for BM API to work / Roadmap = Phase 1 if Bestmile API is available
- CERTH: N/A

→ Phase 1 (Implemented)

7.4.2 Via mobile vibrations (rising frequency when getting closer to the bus stop)

- Navya: N/A
- MT: ? - It is doable; however, we don't think it is a good idea as it will consume a lot of battery and we will need to constantly geo-localize the users. / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT)

7.4.3 Via Siri, Google assistant, Alexa (ask my phone - chat box - virtual assistant)

- Navya: No, these features were tested inside the shuttle and are not viable inside the Public transport systems (noise, insufficiency, limited connectivity and long inactivity).
- MT: ? – Theoretically, it is doable. However, it highly depends on the command we want to be able to trigger with Siri & Co / Roadmap = Phase 3
- CERTH: Yes, virtual assistant solutions are available and can be tailored to specific applications related to the shuttles, if required. Technically feasible. / Roadmap = Phase 3 if required

→ Phase 3 (MT + PTOs)

7.4.4 Via screen at bus stop signs

- Navya: N/A

- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Bestmile + MT + PTOs)

7.4.5 Via screen inside the shuttle (window or designated screens)

- Navya: Yes, already available on the touch screen
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Bestmile + MT + PTOs)

7.4.6 Via streetlights indicating where the shuttles are driving

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Not possible

7.4.7 Via button at bus stop sign (ETA of next shuttle, street-name etc.)

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Bestmile + MT + PTOs)

7.4.8 Via sound guidance (beeps getting closer etc.)

- Navya: No - We will release soon the audio announcement system. Solutions can be studied and triggered before or after the bus stop.
- MT: N/A
- CERTH: N/A

→ Not possible

7.4.9 Via Google maps integration (including directions)

- Navya: No, too complicated in the shuttle
- MT: Yes - GoogleMap Direction API is not free of charges. PTO's will have to pay to use such service. / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (MT + PTOs)

7.4.10 Via announcements about the current street, by app, speaker or safety driver inside the shuttle and at the bus stops.

- Navya: Yes - We will release soon the audio announcement system. Solutions can be studied and triggered before or after the bus stop.
- MT: N/A
- CERTH: N/A

→ Not in scope

7.4.11 In vehicle monitor

- viewable from every seat
- sufficient contrast
- size of displayed information
- content requirements

- Navya: No, not possible today.
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Navya)

7.5 As a user, I want to manage my trip

7.5.1 Via mobile application (booking, pricing, schedule, connections, order other means of transport etc.)

- Navya: N/A
- Bestmile: Yes, Bestmile platform processes the data about the mobility service and sends to MT some important information like vehicle position or ETA to next station. Simple pricing algorithms can also be considered.
- MT: Yes, we will integrate the services as they become available / Roadmap = Depending on availability.
- CERTH: N/A

→ Phase 2 / Phase 3 (MT + Bestmile + PTOs)

7.5.2 Via call-center (manual booking over the phone)

- Navya: N/A
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Phase 2 (PTOs)

7.5.3 Via screen at bus stops (book, pay, stay updated etc.)

- Navya: N/A
- Bestmile: Yes, Bestmile developed an interface for tactile Kiosk at stations. For now, it only displays real-time information about the mobility service and project, without any user login system. This is doable in Phase 3 but raises certain security questions (if people forget to disconnect for example).
- MT: N/A
- CERTH: N/A

→ Phase 2 / Phase 3 (MT + Bestmile + PTOs)

7.5.4 Via user-based sharing platform allowing users to highlight delays on routes, crowd-based service (delays, vehicle condition etc.)

- Navya: N/A
- Bestmile: N/A
- MT: Yes - Doable via feedback section / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (MT + PTOs)

7.5.5 Via share your trip function (allowing passengers to share their position and meet up with friends, etc.)

- Navya: N/A
- Bestmile: N/A
- MT: Yes, doable. Will be developed with the 'Follow my kid' feature. We can start by sharing a given position at a given time and later on augment it with real-time updates / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT)

7.5.6 Via booking system that allows parents and friends to book trips for others and see the planned time of arrival and the receipt upon arrival etc.

- Navya: N/A
- Bestmile: N/A
- MT: Yes, if the "User account" notion is in the mobile application, then it's possible. / Roadmap = When/if "User account" are available.
- CERTH: N/A

→ Phase 3 (MT)

7.5.7 Via personalized function allowing passengers to set standard settings (like wheelchair, dogs, kids etc.)

- Navya: N/A
- Bestmile: Yes, this would trigger some dedicated actions in the optimization. For example, if someone is in a wheelchair, we should consider a longer onboarding and offboarding time.
- MT: Yes, doable by augmenting the user profile (local storage at first and in main User account later when available) / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (MT)

7.5.8 Via booking system inside the shuttle (via PTO or interactive screen)

- Navya: No - With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Phase 3 (PTOs)

7.5.9 Via website portal (booking, pricing, updates etc.)

- Navya: N/A
- Bestmile: Yes, Bestmile developed a web portal. For now, it only displays real-time information about the mobility service and project, without any user login system. Doable in Phase 3 but should not be a priority.
- MT: N/A
- CERTH: N/A

→ Phase 3 (PTOs)

7.5.10 Via automatic booking and payment system based on facial recognition

- Navya: No - With a separated material ? How to install and provide electricity ? how to synchronize the data and who will do this ?
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Not possible

7.5.11 Via guided travel function (what to do near the route, what to do between trips, etc.)

- Navya: No - With a separated material ? How to install and provide electricity ? how to synchronize the data and who will do this ?
- Bestmile: N/A

- MT: yes- Content/feed must be provided / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT + PTOs)

7.5.12 Via integration with Google maps, show routes, book, pay, etc.

- Navya: N/A
- Bestmile: N/A
- MT: Yes, we will integrate the services as they become available / Roadmap = Depending on availability
- CERTH: N/A

→ Phase 3 (MT)

7.5.13 Via human movements and sounds (whistle to stop shuttle, wave to stop, communicate with human behavior)

- Navya: N/A
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Not in scope

7.5.14 Via Smartbooking, remember my trips function (bring me back to home, back to my car, back to the restaurant, use calendar information to book trips etc.)

- Navya: N/A
- Bestmile: N/A
- MT: Yes, whenever the features like booking or trip planner are available, we will add shortcuts like 'Bring me home' in the application / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (Bestmile + MT)

7.5.15 Via virtual assistant capable of managing booking system etc.

- Navya: N/A
- Bestmile: N/A
- MT: N/A
- CERTH: Yes, virtual assistant solutions are available and can be tailored to the specific applications related to the shuttles, if required. Technically feasible but probably out of scope within the Avenue project. / Roadmap = Phase 3 if required

→ Not possible

7.6 As a user, I want to know if there is room in the vehicle

Bestmile (for all ideas under this user story): In an open-access system, some capacity sensors should detect the available space and could send this information to the PTO Dashboard. In a reservation-based system, with bookings for on-demand trips, the PTO Dashboard knows the theoretically available capacity of each vehicle and can send this information, through the vehicle protocol, to a 3rd-party system. The way the information is further translated to passengers is not managed by Bestmile.

7.6.1 Via an application

- Navya: No - Requires the available space in the shuttle which is actually not provided or planned by NAVYA.
- MT: Yes - Available when PTOs will start using our driver app. Automatically after when there will be sensors in AVs. / Roadmap = Phase 1&2
- CERTH: The output of the video analysis algorithms regarding space occupation can be provided to the mobile app for informing the passengers. / Roadmap = Phase 3 if required

→ Phase 2 / Phase 3 (MT + Bestmile + PTOs)

7.6.2 Via online booking system with designated seats

- Navya: Seats can be associated to numbers (stickers).
- MT: Yes, when/if booking is available / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT + PTOs)

7.6.3 Via interaction with the bus stop sign

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Phase 3 (PTOs + MT)

7.6.4 Via outside-mounted shuttle screen

- Navya: No - With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- MT: N/A
- CERTH: N/A

→ Phase 3 /Not possible (Navya + PTOs)

7.6.5 Via personal traveler profiles indicating needs (disabilities, language, etc.)

- Navya: N/A
- MT: Yes,depends on the capacity to analyze free space automatically / Roadmap = When the appropriate data is available

- CERTH: N/A

→ Phase 3 /Not possible (MT + Navya + PTOs)

7.6.6 Via audio guidance at bus stop sign and inside the shuttle

- Navya: No, no available space calculation. No dynamic audio messages in the shuttle.
- MT: N/A
- CERTH: N/A

→ Not possible

7.6.7 Via capacity sensors at the bus stop signs and inside the shuttles

- Navya: No, no available space calculation through capacity sensors. No dynamic audio messages in the shuttle.
- MT: N/A
- CERTH: N/A

→ Not possible

7.6.8 Via camera detection at bus stop signs and inside the shuttles

- Navya: TBC - No available space calculation through video at NAVYA. Third solutions based on remote video stream could be explored.
- MT: N/A
- CERTH: Yes, video analysis software is part of the security and trust service. Vehicle occupation, vehicle free space, and people on-board counting are technically feasible. Videos are a very sensible topic regarding GPDR. Usage should be only local (in the vehicle). Shuttles are commercially used by the PTO. Therefore, it can only be tested under the PTO authorisation with separated material, for a very short period, only if it does not infringe safety, and user comfort nor impact on passengers and legal agreements. Technically feasible remotely with third video based solution or embedded through additional equipment. / Roadmap = Phase 2 provided issues with GDPR will be resolved along with data collection and access to vehicles, otherwise Roadmap = Phase 3

→ Phase 3 / Not possible (CERTH + Navya)

7.6.9 Via virtual agent at bus stop signs and inside the shuttles

- Navya: TBC - Through additional equipment.
- MT: N/A
- CERTH: Yes, virtual assistant solutions are available and can be tailored to specific applications related to the shuttles, if required. Technically feasible but probably out of scope within the Avenue project. / Roadmap = Phase 3 if required

→ Not possible

7.6.10 Via light identification of available or taken seats inside the shuttle

- Navya: TBC - Through additional equipment.
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Navya)

7.7 As a user, I want to be informed about the status of the service

Bestmile (for all ideas under this user story): In the PTO Dashboard, the PTO can define important messages, in different languages, for a defined timespan, that can then be displayed in the traveler application, on the interactive Kiosk or on the web portal. The interface to input the messages already exist. The information could then potentially be sent further to 3rd-party systems via an API. The way this information is then displayed to final users is not managed by Bestmile.

7.7.1 Via website with status updates (PTOs)

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Phase 2 / Phase 3 (MT + Navya + PTOs)

7.7.2 Via screen inside shuttle (service updates etc.)

- Navya: TBC - details needed
- MT: N/A
- CERTH: N/A

→ Phase 2 / Phase 3 (Navya + PTOs)

7.7.3 Via information displayed at bus stop sign

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Phase 2 / Phase 3 (MT + Navya + PTOs)

7.7.4 Via mobile application

- Navya: N/A
- MT: YES - We will show disruptions, etc. if the data is provided by Bestmile, NAVYA, PTO / Roadmap = When the appropriate date is available.
- CERTH: N/A

→ Phase 2 / Phase 3 (MT + Navya + PTOs)

7.7.5 Via social media accounts (PTOs) (templates)

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Phase 2 (PTOs)

7.7.6 Via screens in crowded areas near the route

- Navya: N/A
- MT: N/A
- CERTH: N/A

→ Not possible

7.7.7 Via Siri, Google assistant, Alexa (ask my phone - chat bot - virtual assistant)

- Navya: N/A
- MT: ? - Theoretically it is doable. However, it highly depends on the command we want to be able to trigger with Siri & Co / Roadmap = Phase 3
- CERTH: Yes, virtual assistant solutions are available and can provide information upon request, if required. Technically feasible. / Roadmap = Phase 3 if required

→ Phase 3 / Not possible (MT)

7.7.8 Via light signal system. (colors representing states of operation - full, out of order, etc.)

- Navya: TBC - details needed
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Navya + PTOs)

7.7.9 Via email notifications for subscribed users

- Navya: N/A
- MT: N/A - We do not have access to contact information of subscribed users. Therefore, PTOs should do this.
- CERTH: N/A

→ Phase 3 (PTOs)

7.7.10 Via audio guidance at the bus stop signs and inside the shuttles

- Navya: TBC - Can be possible via voice announcement at bus stop. We will release soon the audio annoucement system. Solutions can be studied and triggered before or after the bus stop.
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Navya + PTOs)

7.7.11 Via a real-time online tracker of routes

- Navya: N/A
- MT: Yes - We will show disruptions, etc. if the data is provided by Bestmile, NAVYA, PTO / Roadmap = When the appropriate date is available
- CERTH: N/A

→ Phase 3 (MT)

7.7.12 Via user-based portal (allowing passengers to flag shuttles that do not work or are full, etc.)

- Navya: N/A
- MT: Yes - Doable via feedback section / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (MT + PTOs)

7.8 As a user, I want to feel safe using the service

7.8.1 Via access to the "eyes" of the shuttle. Understand how it drives, does it see the same obstacles and people as you do when looking out the window

- Navya: No - Rejected in NAVYA's UI strategy. Stress and anxiety were detected
- Bestmile: N/A
- MT: ? - Provided that NAVYA gives access to a processed render of the sensors data, we could display it in the mobile application / Roadmap = When/if the appropriate date is available
- CERTH: N/A

→ Phase 3 / Not possible (Navya + MT)

7.8.2 Via call button inside the shuttle and at bus stop to PTO (someone to talk to)

- Navya: Yes, via Intercom system with supervision center
- Bestmile: Yes, same system as for emergency situation. VoIP system could be implemented in Phase 2.
- MT: N/A
- CERTH: N/A

→ Phase 2 (Bestmile + Navya)

7.8.3 Via chat function in the mobile application (talk to supervision/PTO)

- Navya: N/A

- Bestmile: N/A
- MT: Yes, we can implement a means to enter in communication with PTOs within the application, but such a tool requires an PTO behind for specific questions / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (MT + PTOs)

7.8.4 Via a well maintained and clean shuttle

- Navya: Yes - Under PTO authorization
- Bestmile: N/A
- MT: N/A
- CERTH: yes - Cleanliness information solutions can be based on environmental sensors (for pollution, air quality in the vehicle, temperature in the vehicle etc.), as well as smoke sensors and smoking detection (for fire and also persons that smoke in the vehicle). Technically feasible. / Roadmap->Phase 3

→ Phase 1 (Implemented)

7.8.5 Via emergency button inside vehicle (directly to authorities)

- Navya: Yes, the emergency button triggers immobilization; its status is sent via NAVYA API (depending on 3G) and can be sent (indirectly) to the authorities.
- Bestmile: Same comment as for the emergency situation: the fleet orchestration system needs to know if this will trigger a vehicle immobilization or rerouting.
- MT: N/A
- CERTH: N/A

→ Phase 3 / Not possible (Navya + PTOs)

7.8.6 Via camera surveillance inside the shuttle (and potentially at the bus stops)

- Navya: Yes, the cabin video stream will be available through NAVYA API. GDPR and privacy issues need to be carefully considered.
- Bestmile: N/A
- MT: The video stream could be integrated into the PTO Dashboard. GDPR and privacy issues need to be carefully considered.
- CERTH: Yes, camera surveillance and video analysis software are part of the security and trust service. Identification of the passenger behavior: vandalism, anxiety, forgotten items, passenger accidents (e.g. falling), sitting or standing, passenger security (petty crimes detection. i.e. aggression, bag-snatching) are technically feasible. Videos are a very sensible topic regarding GPDR. Usage should be only local (in the vehicle). Shuttles are commercially used by the PTO. Therefore, it can only be tested under the PTO authorisation with separated material, for a very short period, only if it does not infringe safety, and user comfort nor impact on passengers and legal agreements. Technically feasible remotely with third video based solution or embedded through additional equipment. / Roadmap = Phase 2, provided that the issues with GDPR are resolved along with data collection and access to vehicles, otherwise Roadmap = Phase 3

→ Phase 3 (CERTH + Navya + PTOs)

7.8.7 Via children safety tracker, be able to ensure your children's safety

- Navya: N/A
- Bestmile: N/A
- MT: Yes, doable. We can start by sharing a given position at a given time and later on augment it with real-time updates / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT + PTOs)

7.8.8 Via virtual agent (chat bot) that you can talk to inside the shuttle - call the authorities, I am afraid, etc.

- Navya: N/A
- Bestmile: N/A
- MT: N/A
- CERTH: Yes, virtual assistant solutions are available and can provide information upon request, if required. Technically feasible. / Roadmap = Phase 3 if required

→ Not possible

7.8.9 Via specialized camera system that can detect criminal behavior and patterns

- Navya: TBC - With a separated material ? How to install and provide electricity ? How to synchronize the data and who will do this ?
- Bestmile: Same comment as for emergency situation: the fleet orchestration system needs to know if this will trigger a vehicle immobilization or rerouting.
- MT: N/A
- CERTH: Yes, identification of passengers' behavior: vandalism, anxiety, forgotten items, passenger accidents (e.g. falling), sitting or standing, passenger security (petty crimes detection. i.e. aggression, bag-snatching) are technically feasible. Videos are a very sensible topic regarding GPDR. Usage should be only local (in the vehicle). Shuttles are commercially used by the PTO. Therefore, it can only be tested under the PTO authorisation with separated material, for a very short period, only if it does not infringe safety, and user comfort nor impact on passengers and legal agreements. Technically feasible remotely with third video based solution or embedded through additional equipment. / Roadmap = Phase 2, provided that the issues with GDPR are resolved along with data collection and access to vehicles, otherwise Roadmap = Phase 3

→ Phase 3 / Not possible (CERTH + NAVYA + PTOs)

7.8.10 Via real time map, so I always know where I am

- Navya: N/A
- Bestmile: Yes, same as above
- MT: Yes, done, we already display the position of the user in a map / Roadmap = Phase
- CERTH: N/A

→ Phase 1 (Implemented)

7.8.11 Via clear instructions on how to enter and leave the shuttle

- Navya: Yes, Audio messages for the passengers will be available in the shuttles by the end of 2019. Audio messages to display should be agreed upon. Complementary systems could be considered.
- Bestmile: N/A
- MT: Yes - We can display this assuming we are provided with the correct information. / Roadmap = Phase 2
- CERTH: N/A

→ Phase 2 (MT)

7.8.12 Via sound/audio system announcing that the shuttle is approaching/ leaving/ holding

- Navya: Yes, audio messages for the passengers will be available in the shuttle by the end of 2019. Audio messages should be agreed upon. Complementary systems could be considered.
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Phase 2 / Phase 3 (Navya + PTOs)

7.8.13 Via constant repetition of the rules (stickers, notes, safety driver, etc.)

- Navya: Yes, with PTOs' authorization
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Phase 2 (PTOs)

7.8.14 Via smart driving system that slows down after mistakes, breaks lighter after hard breaking, etc.

- Navya: TBC (To be double-checked). Need more details.
- Bestmile: N/A
- MT: N/A
- CERTH: N/A

→ Not possible

7.8.15 Via 'follow me home' function (let someone know where you are)

- Navya: N/A
- Bestmile: N/A

- MT: Yes, doable. We can start by sharing a given position at a given time and later on augment it with real-time updates / Roadmap = Phase 3
- CERTH: N/A

→ Phase 3 (MT + PTOs)