AVENUE

Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE

D4.7 First-iteration Out-of-vehicle services

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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
QRMB	Quality and Risk Management Board
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

This is the first version of the T 4.3 Out-of-vehicle services deliverable which is due at month 11, only 5 months after the start of beginning of the task itself. It's main focus is to describe in details the conception and development of all the services that will be used by travellers outside of the AVs. In some limited cases, some of the Out-of-vehicle services can be also used inside the AVs.

From WP2 D2.13, a list of services was established in collaboration with the four operators, ranging from real time visualization of the route to on-demand booking services. This list of services was defined in three development phases indicating when each in- and out-of-vehicle service shall be developed, adapted, tested and integrated within the four operators and their local travellers. The following out-of-vehicle services were chosen for phase 1 - running from M6 to M18:

- Visualization in real time of the path/position of shuttle
- On-demand stop
- Passenger presence information

The main focus of this deliverable is the prototyping, testing, integration and implementation of the previous out-of-vehicle services. This process is iterative and user insights and feedback will be gathered in several rounds, contributing to the specifications of these services during the AVENUE project. This iterative process is important with the purpose of ensuring that the services actually meet real user needs and provide real value for the passenger when travelling with the autonomous vehicles.

This deliverable is structured in three main sections:

- A detailed description of the out-of-vehicle services that have been selected to be developed and tested during the first phase of the project (section 2).
- The prototyping and testing process and results, including interactive wireframes and paper prototype testing results (section 3)
- An overview of the services development process, including technical choices and implementation status (section 4)

A conclusion and wrap-up section together with a set of next steps concludes the deliverable.

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.

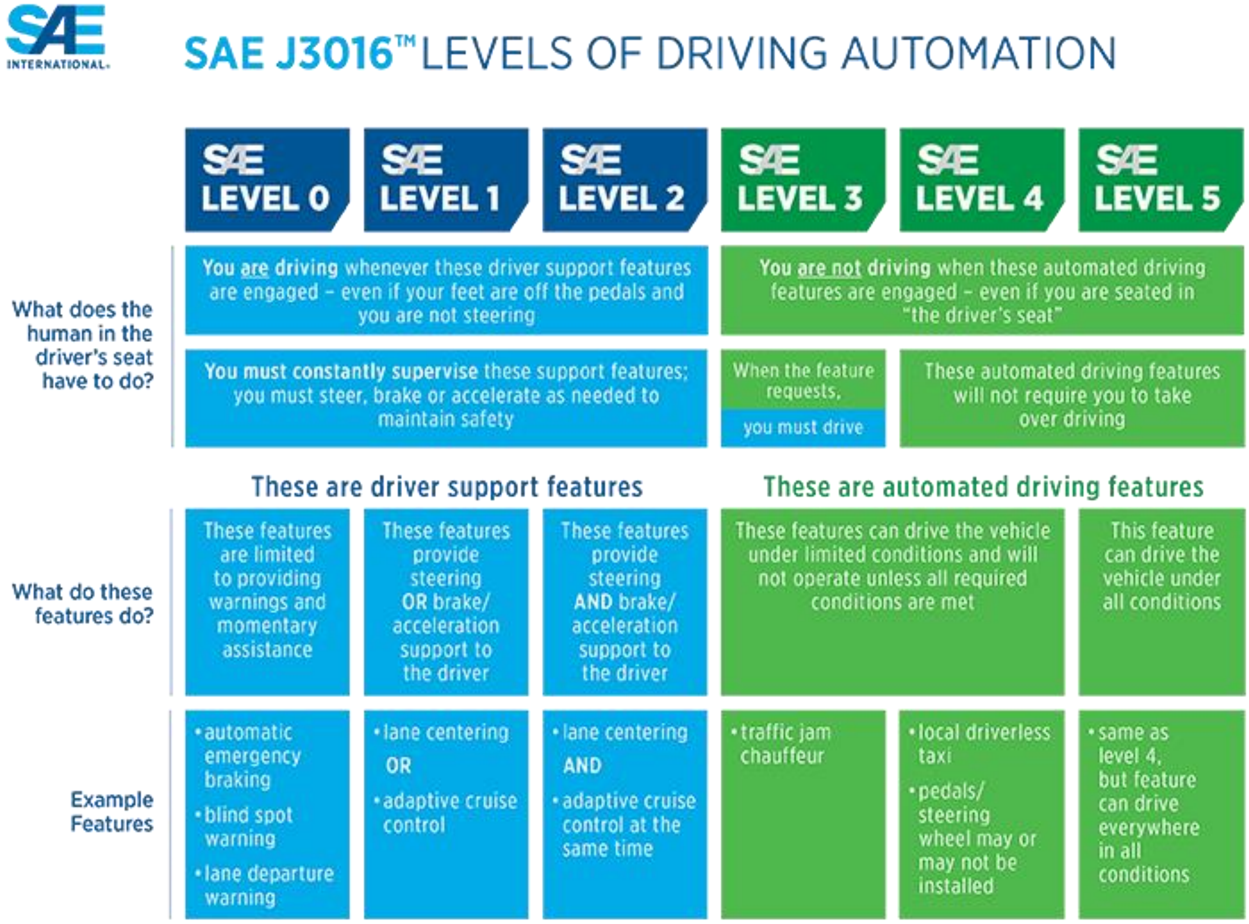
On-demand transport differs from other public transport services in that vehicles do not follow a fixed route and do not use a predefined timetable. Unlike taxis, on-demand public transport is usually also not individual. An operator or an automated system takes care of the booking, planning and organization.

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.



SAE J3016™ LEVELS OF DRIVING AUTOMATION

	SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
What does the human in the driver's seat have to do?	**You are driving** whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			**You are not driving** when these automated driving features are engaged – even if you are seated in "the driver's seat"		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			These are automated driving features		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/ acceleration support to the driver	These features provide steering AND brake/ acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example Features	• automatic emergency braking • blind spot warning • lane departure warning	• lane centering OR • adaptive cruise control	• lane centering AND • adaptive cruise control at the same time	• traffic jam chauffeur	• local driverless taxi • pedals/ steering wheel may or may not be installed	• same as level 4, but feature can drive everywhere in all conditions

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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 V2I 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 **WP4** aims to design, develop, adapt and integrate services to support users of autonomous vehicles before the trip, during the trip, and at the end of the trip. The main objective of WP4 is to provide services in order to demonstrate that the user experience can be seamless and secure, and that people embrace this new technology. Hence, we have to include the following services:

- Adapt and integrate existing transport services

- Develop autonomous vehicle specific services
- Provide services that foster the acceptance of driverless vehicles by both passengers and people interacting with the shuttles
- Introduce safety related services

The target of **task T4.3** is to develop, test and integrate innovative out-of-vehicles services, in collaboration with the four operators in Lyon, Luxembourg, Geneva and Copenhagen, respectively. The out-of-vehicle services should in combination with the in-vehicle services support a holistic service for travellers commuting with the autonomous vehicles.

Out-of-vehicle services are services developed to improve the user experience when travelling with autonomous vehicles. The services are user-centric and focus on supporting travellers with smart solutions both *before* and *after* they use the autonomous vehicle.

During the development of the out-of-vehicle services, different target groups - including their characteristics and traits - will be considered, ensuring a broad acceptance of the aforementioned services. Furthermore, this deliverable will introduce and describe the testing framework, that will be used to test and implement the application-based services chosen for each phase.

2 Out-of-vehicle services

In this section, we present the out-of-vehicle services selected for phase 1 (M6-M18) in detail, including their overview, current version for this phase, their main user story, their technical requirements and, finally, the future versions and improvements envisioned for each of them.

2.2 Real-time visualization

The main goal of this service is to display the real-time position of an autonomous shuttle at all times on a map. Knowing both before and during the ride the real-time position of the shuttle increases the usefulness of the system as a whole, and as a consequence, user adoption.

This service serves as the base for many other services to come, both in- and out-of-vehicle. It also allows to display other useful information to the travellers such as pick-up time, where they are during the ride and distance to destination, which improves the sense of reliability and trustworthiness of the system.

2.2.1 Current version

In order to start the development as early as possible, and due to the restrictions inherent to other services and/or components not being yet developed or fully functional, the first version of the real-time visualization service has been reduced to its main core feature: displaying the position of the shuttle on a map.

Even though being a very basic service, being able to locate and follow a shuttle on the map is one of the most important and demanded features both by end-users and PTOs, and it serves also as the foundation for many other services and features to come such as on-demand requests or passenger counting.

2.2.2 User story

The passenger wants to know where the shuttle is, locate it on a map, and see relevant information about the shuttle

- BM provides several API endpoints, secured by API key, that give back all the information needed regarding a PTO site and its vehicles
- With the information received, MT can place on a map the positions in real-time of the shuttles deserving a particular site, and also display other information, related to this service (i.e. ETA to user's location in future versions) or to other services (i.e. shuttle occupancy or remaining space)

2.2.3 Technical requirements

Following we outline the main technical requirements for the current version of the service to work. We are as well in the process of defining a communication standard in the form of request/response specifications, in order to exchange information between the traveller application and the command and control platform, initially provided by Bestmile.

The goal of this communication standard is that once defined, any other building block of the architecture that will provide the same functionality, will be able to plug-in and communicate by using the same specifications for the same type of service.

As currently the provider for most of the services' data (vehicle position, passenger count information, etc.) is Bestmile, the request/response specifications will be defined and adopted from those of their exposed APIs.

Technical requirements			
Vehicle / Vehicle API	**Traveller API**	**User app**	**Operator app/PT**
Send position to AVENUE platform	Provide position of AVs via endpoint	Get real-time position from API and display to end-user	N/A

Table 1: Real-time visualization - Technical requirements

2.2.4 Future versions

The following table describes the possible features and improvements of the future versions of the service.

Upcoming versions of the service will improve and augment the functionality of the first version by providing useful information to the traveller such as ETA to pick-up point or destination, connections on the relay stop, intermediate stops or detours for pooled rides, and other relevant data to make the travel experience as good and trustworthy as possible.

Idea for future versions of the service	Description	Technical requirements			
		Vehicle	API	User app	Operator app/PT
V2	Extra information regarding the trip, such as estimated arrival time of the vehicle at pick-up, time to destination, etc. will be provided to the end-user	No change	Provide time remaining for arrival to a particular location via API endpoint	List the extra information obtained from the API along with the previous version information	N/A
V3	Information about intermediate/unexpected stops for pooled rides	Active mission control	Provide intermediate stops and pooled ride information via API	List information regarding the pooled ride along with the previous info	N/A

Table 2: Real-time visualization - Future versions

2.3 On-demand stop

Before AVENUE is ready for fully on-demand operations without the notion of fixed routes and stops, autonomous shuttles in each of the partner sites follow predefined routes with predefined stops.

From an operational point of view **as described in D4.1**, stopping only when there is a request is already a step forward towards a real on-demand service, and moreover it reduces unnecessary travel time by optimizing the shuttle's operation.

From an ***end-user point of view***, which is what concerns the in- and out-of-vehicle services, this service enables them to easily interact with the autonomous vehicle from the outside (*but also from the inside*) and to instruct it to stop when the situation requires it (i.e. when waiting at a stop that is deserved by the AV only on-demand)

2.3.1 Current version

The first version of the on-demand stop service allows a user to request a stop, both outside the shuttle by pressing a button on the traveller application, or inside the shuttle by either requesting it from the application (*or pushing the stop button present inside the shuttle, in a more traditional way*).

In any of those cases, and due to the lack of active mission control functionality for the time being, a workaround has been devised in order to be able to offer the service **to the end-user**. A temporary companion app, which is able to get stop requests coming from the traveller app and relay them to the appropriate vehicle operator, will be put in place allowing them to stop the shuttle when needed.

2.3.2 User story

This service's user story is divided into two parts, as there are two actors involved, namely the passenger who requests a stop at a certain place or position, and the shuttle operator, who receives a notification and manually stops the shuttle where it was requested (normally at a defined stop).

As this way of operating for this service is temporary, only until real on-demand and missions are available, the API used to manage this service is also temporary and developed by MT. The sole purpose of the API is to interconnect the passenger's application with the – *also temporary* – shuttle operator's application in order to communicate the stop requests to the right operator.

Passenger requests a stop ***outside*** *the vehicle*
Passenger requests a stop ***inside*** *the vehicle*

- MT provides an API endpoint, secured by API key, to be able to request a stop.
- Mandatory parameters:
  - vehicle (inferred from GPS position of the user, or by the user selecting the desired vehicle on the map)
  - station/stop id
  - coordinates
  - timestamp
- The stop request data is stored temporarily in the system, until it is dispatched to the operator

Operator receives a stop request in his application, and stops the shuttle when appropriate

- When the system receives a stop request, it dispatches it to the appropriate operator by matching the vehicle of the request to the operator app of this vehicle
- Discuss if vehicle occupancy needs to be taken into account:
  - if full, do we give feedback to the user and we dispatch to another vehicle (if more than one doing the same route)
  - if full, we check if there are stop requests coming from inside that vehicle, as this would mean someone is getting down at the same stop where the user requested to get in
  - if full, we do not take specific actions

2.3.3 Technical requirements

Following we outline the main technical requirements for the current version of the service to work. We are as well in the process of defining a communication standard in the form of request/response specifications, in order to exchange information between the traveller application and the command and control platform, initially provided by Bestmile.

The goal of this communication standard is that once defined, any other building block of the architecture that will provide the same functionality, will be able to plug-in and communicate by using the same specifications for the same type of service.

As currently the provider for most of the services' data (vehicle position, passenger count information, etc.) is Bestmile, the request/response specifications will be defined and adopted from those of their exposed APIs.

Technical requirements			
Vehicle	**API**	**User app**	**Operator app/PT**
Button functional	API needs to be capable of sending the information from the user app to the operator's app, via API endpoints.	Provide a user with an interface to request the bus to stop via pressing a button	Operator to stop the vehicle manually on the requested stop

Table 3: On-demand stop - Technical requirements

2.3.4 Future versions

The following table describes the possible features and improvements of the future versions of the service.

The main difference with the first version of the service is that a companion app for the operator is not anymore needed as the request is directly transmitted by means of active mission control directly to the vehicle.

Idea for future versions of the service	Description	Technical requirements			
		Vehicle	**API**	**User app**	**Operator app/PT**
V2	User can request a stop on demand: - At the stop by pressing a button on the user application - Inside the vehicle by pushing the stop button or requesting it from the user application	Active mission control	API needs to enable communication from the user app to the vehicle in order to send active missions with the requested stop as destination	No change	N/A

Table 4: On-demand stop - Future versions

It is important to note that any version of this service will be rendered obsolete once vehicles enter on a full demand mode, which will have no fixed route nor fixed stops. Nevertheless, the service can be kept operational for those sites and vehicles that still operate in a fixed route mode with predefined stops as well as station-to-station mode without a fixed route.

2.4 Passenger presence

In order to allow for fully on-demand autonomous operations, the means for knowing at any moment how many people are inside the shuttle and, more importantly, the remaining capacity inside the vehicle, need to be put in place.

From and **end-user perspective**, knowing the remaining available space inside the vehicle is a key piece of data to decide whether to wait for the next vehicle, book another vehicle or whether there is enough space for him and his party/personal belongings.

Besides this, **and from an operational point of view as described in D4.1**, simple actions basic to an on-demand service such as requesting a ride or booking a vehicle are not possible **for a PTO** without being able to estimate beforehand whether there is enough space in the vehicle to fulfil the requested service or not. Also, information and statistics about vehicle occupancy are key for PTOs in order to better understand, plan, and optimize their operations.

2.4.1 Current version

For the first version of this service, and given the lack of means for counting passengers in an automatic fashion, a partially non-automated version of the service will be put in place temporarily.

The operators inside the vehicles, via the companion app already introduced in the previous section, will manually input at each stop the number of passengers coming in, going out, or both. This information will be received by AVENUE platform, which in turn will make it available for consumption by the client apps, letting end-users know how many taken places inside the vehicle and how much free space (capacity) remaining.

2.4.2 User story

The user story for this service is divided into two parts as well, given that there are 2 different actors with different timelines: the shuttle operator, who counts and inputs data into the system, and the final consumers of data, namely the (future) passengers.

When automatic means for counting people will be put in place, part of the user story will change as the driver will not have to interact with any application nor provide the data for the shuttle occupancy.

Vehicle Operator reports how many person(s) jumped in the shuttle, at each stop
Vehicle Operator reports how many person(s) jumped out of the shuttle, at each stop

- BM provides an API endpoint, secured by API key, to be able to report these 2 pieces of information
- The same endpoint can be used to report both at the same time
- Mandatory parameters:
  - vehicle
  - coordinates
  - number of people in
  - number of people out
  - (both)

- Optional parameters:
  - station
  - driver
- Each report from the driver is propagated to the system as an event and stored for reporting
- The last report is used to compute the occupancy of the shuttle for the travellers to see on their respective devices

Traveller sees shuttle capacity and occupancy

- Capacity is set as an absolute number of people, and 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)
- For the traveller application, this information is available through the traveller application user interface
- There is no distinction between seats and standing spots
- Occupancy is displayed as a real time information, wherever the traveller is, it doesn't guarantee them a free spot when the shuttle will be at the station of their choice

2.4.3 Technical requirements

Following we outline the main technical requirements for the current version of the service to work. We are as well in the process of defining a communication standard in the form of request/response specifications, in order to exchange information between the traveller application and the command and control platform, initially provided by Bestmile.

The goal of this communication standard is that once defined, any other building block of the architecture that will provide the same functionality, will be able to plug-in and communicate by using the same specifications for the same type of service.

As currently the provider for most of the services' data (vehicle position, passenger count information, etc.) is Bestmile, the request/response specifications will be defined and adopted from those of their exposed APIs.

Technical requirements			
Vehicle	**API**	**User app**	**Operator app/PT**

N/A	Bestmile platform is already capable of receiving this information via the HERMES protocol. In addition, Bestmile platform must be capable of receiving the passenger presence information from the operator companion app and make it accessible via an API endpoint.	The app will display to the user how many people are inside the shuttle and how many free places are remaining	The operator needs to have a companion app that enables the input of the number of persons inside the bus

Table 5: Passenger presence - Technical requirements

2.4.4 Future versions

The following table describes the possible features and improvements of the future versions of the service.

The main differences between the future versions and the current version of the service for phase 1 is the way of counting people. In future versions, image detection algorithms will be put in place and will allow, via the cameras inside the vehicles, to compute the amount of people in the shuttle at any given time. At this point, the companion app for the shuttle operator will be deprecated and there will not be a need for it.

Additionally, and with the improvement of these algorithms, other objects will be able to be factored in, such as luggages, prams or wheelchairs, allowing for a much more precise estimation of the remaining capacity of the shuttle which will provide very useful information for the passenger.

Finally, when booking a ride through the app, the user will be able to specify for how many people is the booking and if there are additional items to be taken into account (such as prams or luggages), in order to better match the available space with the user requests.

Ideas for future versions of the service	Description	Technical requirements			
		Vehicle	API	User app	Operator app/PT
V2	The vehicle will count the number of people inside itself by automatic means such as image recognition or presence sensors:	Needs to integrate automatic means of counting people	No change	No change	N/A

	• Additional information can be derived from automated counting of people. • 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. • Occupancy annotated with info for the different user cases is displayed as a real-time information, wherever the traveller is, it doesn't guarantee them a free spot when the shuttle will be at the station of their choice.	such as cameras for image detection and/or presence sensors (on doors, on seats…)			
V3	The vehicle will, additionally to counting people, count and factor into the remaining free space items such as prams, wheelchairs and or luggage: • 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, it's visible on the dashboard • Occupancy is displayed as a real time information, wherever the traveller is. • Each passenger (normal, high volume, wheel chair user, seated case) can	Image detection algorithms should be able to detect certain type of items	No change	No change	N/A

	determine whether he can fit or not. • Estimation for different cases can be provided to facilitate the passengers.				

Table 6: Passenger presence - Future versions

3 Prototyping and user-testing

The goal of prototyping is to have a rapid testable version of a product or a user interface, in order to get an initial user feedback to better understand their needs and develop the final software version according to those. Prototyping can be carried out in different ways:

- Paper prototyping, on which a mock of the final service is sketched on paper and given to test to end users
- Interactive wireframing, on which application wireframes of the final service are produced and given to the user in the form (usually) of interactive application

In AVENUE, we include prototyping for each service from the very beginning, in order to identify the real user needs before starting the actual process of service development and implementation. By taking the “prototyping-first” approach, we are able to match user needs more precisely and to deliver services that are overall much more usable and accessible for all types of user.

Prototyping is carried out in the form of interactive wireframes that are subsequently tested with real users and improved and refined according to their feedback. Prototyping is used as well to identify obstacles and pitfalls in terms of usability and accessibility for both regular users and users with special needs, whom might need interfaces adapted to their specific requirements.

3.2 Interactive prototype

A prototype has been created in order to quickly test the potential mobile application interfaces of the three defined services. It also served to all partners to **align on expectations and desires** in a more concrete way. For now, the developed prototype only concerns the three first imagined services, but will be completed through time and throughout the project.

It is important to note that the sole objective of the created prototype is to test potential features and navigation. It is not intended to test any design or accessibility. The accessibility will be addressed on a later stage following the mobile application development common guidelines as well as recommendations provided by Siemens. The design will follow the Material Design guidelines[1] for the generic elements. For branding, each version of the application will be adapted to the branding of each PTO (colors, logo).

[1] https://material.io/design/

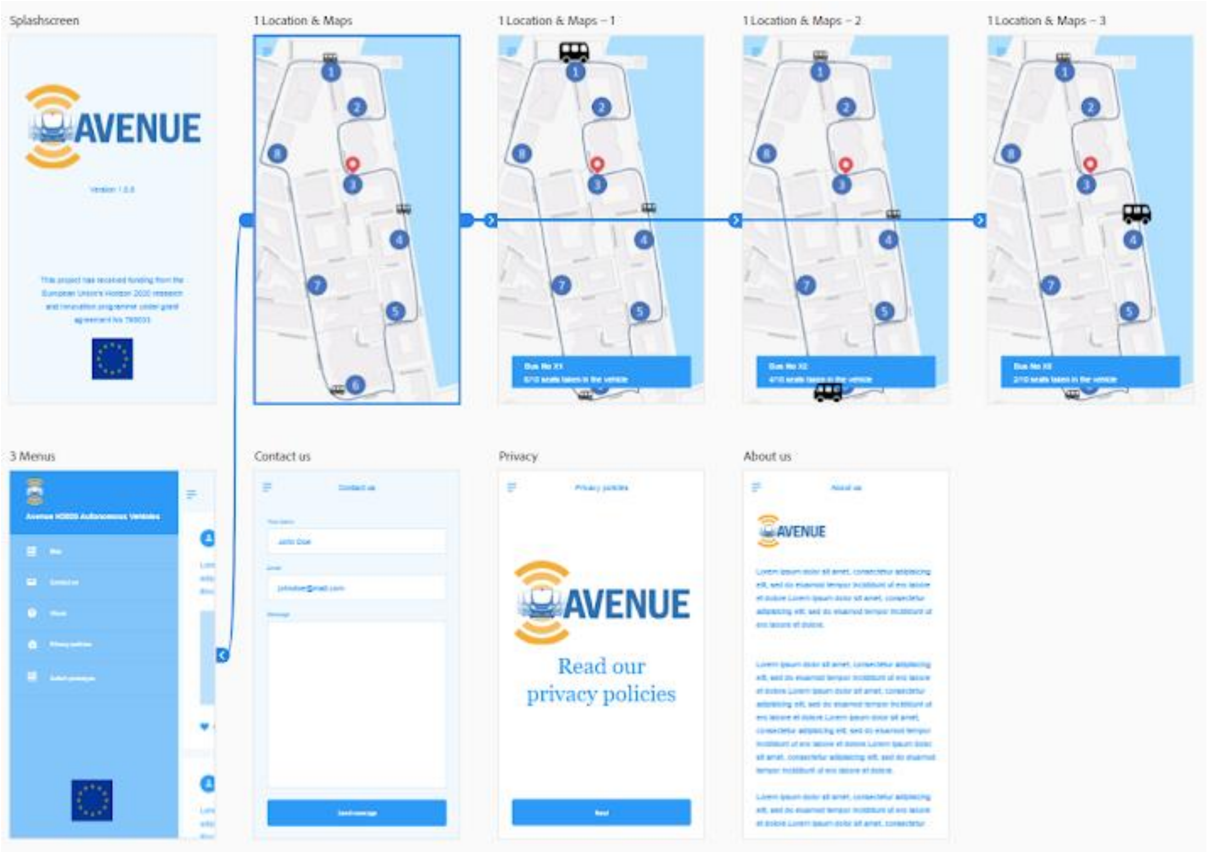


Figure 1 Interactive mobile application prototype

All the prototype screenshots are available in the **Appendix C: Prototype screenshots - session 1.**

The interactive version of the prototype is available at the following link:

https://xd.adobe.com/view/43590f94-8609-46e5-46b2-6ed1ae841f6f-3568/

Password: H2020-avenue

3.3 Testing framework

This section presents the testing framework, including a guide and a playbook, used to test every service prototype. The framework has been developed by Autonomous Mobility as part of their work in T4.2, and has been provided to every PTO to enable them to test the prototype with their own user groups.

Before proceeding to the development phase, each service that has been defined needs to be user-tested against the prototype, in order to check user interface usability and user experience, detect roadblocks and problems early on, and to validate the functionality and pertinence of the service offered.

For each service a test framework has been developed ensuring a holistic and iterative development of the services. The process includes 4 main stages as follows:

1. Demonstration (prototype)
2. Feedback collection (user test or prototype)
3. Analysis (consolidation of insights and feedback)
4. A restart of the exact same procedure (iterative development)

This process is further defined regarding the setup in WP4 in figure 2, highlighting which partners are responsible for what steps of this holistic process.

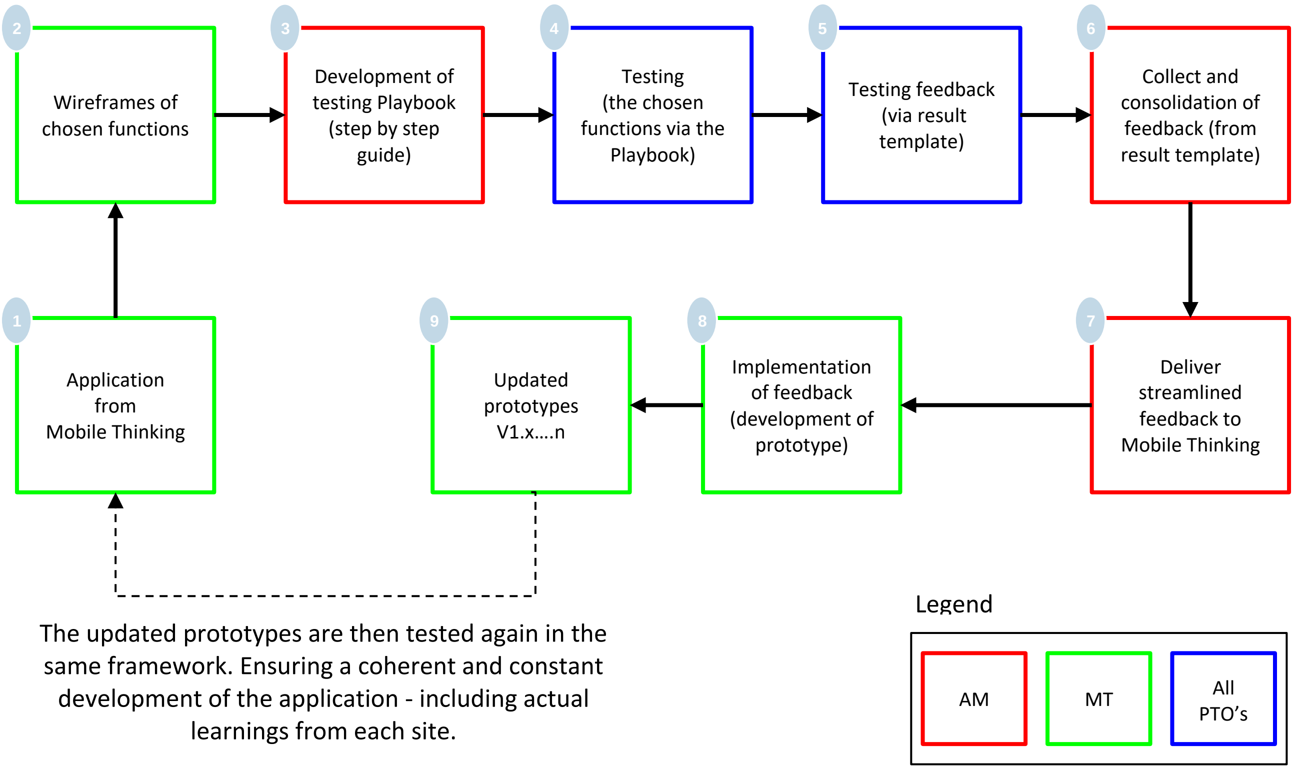

2
Wireframes of chosen functions
3
Development of testing Playbook (step by step guide)
4
Testing (the chosen functions via the Playbook)
5
Testing feedback (via result template)
6
Collect and consolidation of feedback (from result template)
1
Application from Mobile Thinking
9
Updated prototypes V1.x….n
8
Implementation of feedback (development of prototype)
7
Deliver streamlined feedback to Mobile Thinking
The updated prototypes are then tested again in the same framework. Ensuring a coherent and constant development of the application - including actual learnings from each site.
Legend
AM
MT
All PTO's

Figure 2 Iterative prototyping (holistic view)

To support the iterative testing framework for in- and out-of-vehicle services, a testing guide was developed and distributed to the four operators. The testing guide includes a playbook and a result template, allowing the testing session to be streamlined at all four operation sites. The testing guide will be introduced in the following section.

3.3.1 Testing guide

As a supporting element for the testing framework a testing guide was developed. The testing guide was developed by Autonomous Mobility, then distributed to Mobile Thinking for feedback, and then adjusted before distributed to the operators.

The purpose of this testing guide, is to introduce, explain and prepare the operators on how to test the prototypes for the chosen in- and out-of-vehicle services from phase 1 in WP2.

The overall goal of the testing sessions is to gather true user-oriented insights with the purpose of implementing and integrating the insights in the next versions of the prototypes. It is an iterative process and the testing sessions will be conducted multiple times, ensuring a true user-centric development of the applications for the in- and out-of-vehicle services, over time. During the testing sessions different users from the local operation sites, will be introduced to wireframes and prototypes of the application, with the purpose of providing feedback.

To support the testing session the following sections will introduce some do’s and don’ts, the playbook - a step by step guide for the testing session - and the result template - documentation of the insights from the testing session.

3.3.2 Do’s & don’ts

When testing with users, try to keep the following information in mind.

1. Try to capture the pure essence of the users opinion
    a. Listen and write down exactly what they are saying
    b. Don’t conclude until the interview/testing session is over
    c. Meet answers with all right, yeah, sounds nice etc. to encourage participant to continue adding feedback

2. Try to avoid being biassed when interacting with the users
    a. Steer the conversation/testing session, but don’t include you opinion, hence affect or shape the users opinions

3. When co-creating with users
    a. Let the users do the talking
    b. Let the users write/draw/explain the answers (on post its or plain paper if needed)
    c. Take their answers seriously! No ideas are bad ideas!

3.3.3 Playbook

As a support to the testing session, a playbook has been developed for the first prototype iteration, providing a step by step guide to the interviewers. The purpose of the playbook is to steer the testing session.

The overall structure of a Playbook is as follows:

- An introduction (introduce the context and the purpose of the user insights - and get demographic information)
- A comforting exercise (get the interviewee/participants talking and feeling comfortable)
- Stage discussion (get started talking about the subject - first user opinions)
- Development exercises (get the user involved in the prototype - insights/feedback/ideas)

- A closing (thank the interviewee/participant and conclude on their attribution)

The playbook includes a script and a time estimate for each step. The main objective of the playbook is to ensure a short, effective and similar testing session at all four operation sites, as well as function as a structure for usable insights for the further development by MobileThinking.

The first playbook can be seen in **Appendix A: Playbook - testing session 1.**

3.3.4 Result template

As a support to the playbook a simple result template has been developed with the purpose of ensuring similar and structured results from the four operations sites. The result template has the same design-setup as the playbook, indicating the same step by step numbers.

Is it recommended that the interviewers/conductors prints out the playbook and the needed wireframes (if not interactive), but use the result template via a computer. For each step in the playbook, there is an empty field in the result template, enabling the interviewers/conductors to document the insights and feedback from the users instantly during the sessions - hopefully easing the process of documenting the feedback.

It is recommended to conduct the testing sessions with a colleague, so that one can focus on the actual interview with the user (via the playbook) and one can write the answers down directly in the result template.

The results from the first testing session - by the four operators - can be found as an annex.

3.3.5 Consolidation and implementation of results

The results from the testing framework (the result template), will be consolidated ensuring constructive and streamlined feedback, allowing MobileThinking to further develop and update the prototypes in an iterative manner.

The test results are interpreted and categorised in smaller chunks and delivered as pointers for MobileThinking, highlighting the main issues, aspects, opinions, behaviour and so forth, for MobileThinking to take into account when further developing the prototypes and services.

The consolidated feedback can be seen in D4.7 as well as the actions planned.

3.4 Testing results

This section presents a summary of results gathered during the first prototyping and testing session. It describes the tested user groups as well as the most relevant results gathered. The entire results are available in **Appendix B: Consolidated results - session 1.**

3.4.1 Demographics

In this first session of testing, fifteen people from three different countries have been interviewed. In Switzerland, Denmark and Luxembourg, the PTO's of the AVENUE project went on the field and asked some of their users to participate to the survey.

Fifteen people of various age range provided us with very insightful feedback.

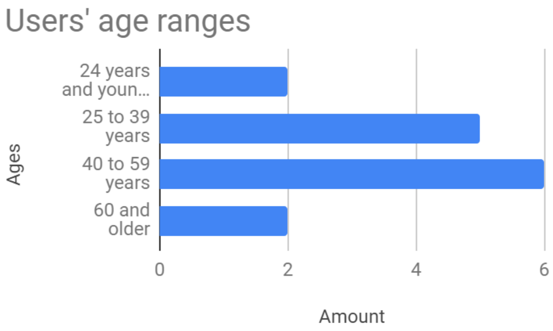


Figure 3: Testing results - Age ranges

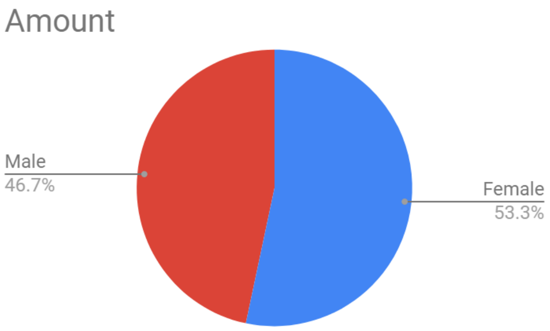


Figure 4: Testing results - Gender

It is interesting to note that **80% of testers are keen to participate to the next sessions** of tests. This indicates that there is a very big interest in the AV services on the passenger level.

3.4.2 Autonomous vehicle as a concept

Out of the full questionnaire, we have extracted here the most relevant insights.

To the question "Could you imagine a society with self driving vehicles" it appears that most of the population is already ready (60%). It is interesting to note that 20% of users are not ready yet but can definitely imagine it becoming mainstream in our society. It is safe to say that at least **80% of the interviewed people can envision using AVs in the future**.

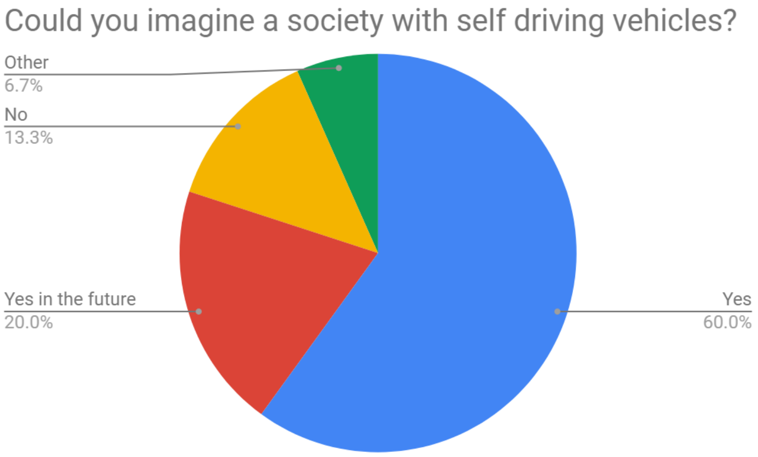


Figure 5: Testing results - AV as a concept

Most users see autonomous vehicles as a positive concept for the society as well as for individuals. The testers' biggest imagined benefits are **"gain of time"** and **"traffic reduction".** It also seems that autonomous vehicles are seen as **"safe"** for most of the users. Another worth-mentioning answer was the ability to have 24/7 services due to the fact that no human being is needed anymore.

The only negative answer that got collected was the fact that "**people might lose jobs"** as there will not be any need for drivers anymore. This doesn't concern the AVENUE project, but rather a society where all vehicles would be driverless.

3.4.3 AVENUE mobile application prototype

For the first test session, it was decided to use only screenshots rather than the full interactive prototype for the sake of simplicity. The interactions have been tested by asking questions like *"when looking at the prototype, what would you like to press"* as well as asking the users what they would expect of such actions. The goal was to collect more than reactions to what has already been done. Doing it this way allowed us to collect insights that we might not have thought of.

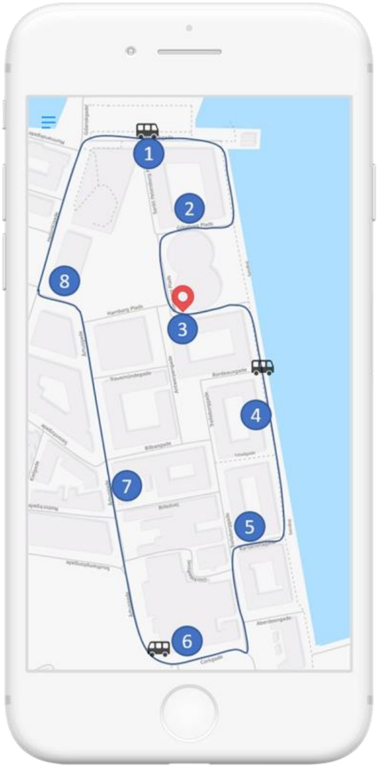


Figure 6: Testing results - Application prototype

For instance, we expected the testers to intuitively press an AV on the map in order to get information. The interesting part is that most of the users (**81.3%**) decided to click on the bus stop rather than on the AV itself.

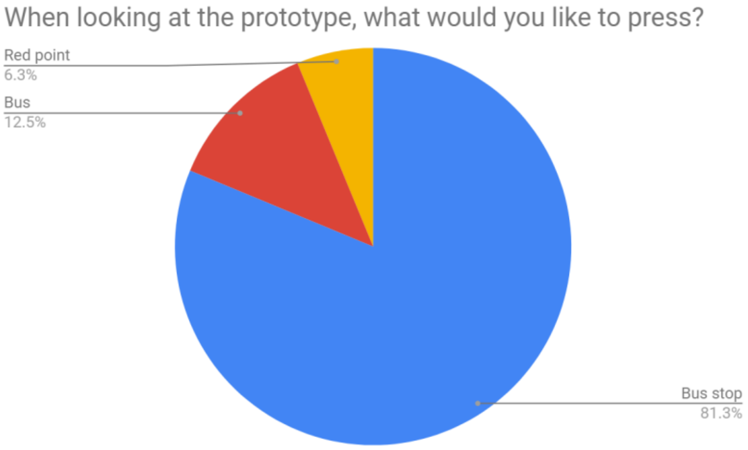


Figure 7: Testing results - Application testing

This fact showed us two things. One, users are more familiar with getting public transport information from a bus stop directly. When the next bus will arrive, etc. In the AVENUE project the goal is to suppress bus stops. This initial results show us that mobile application design must be clear enough so that users perform the correct actions.

Two, the AVENUE mobile application must, at first, provide information when a user clicks on a bus stop. Even if they will tend to disappear, we will add to the first services the possibility to click on a bus stop. This action will display typical information such as the name of the bus stop, when the next AV will arrive, etc. Later on, when the bus stops will be removed from the AVENUE mobile application, we will perform another specific design testing round in order to ensure that the user knows what action to take to request an AV.

As the following chart shows, the majority of users are keen to use a smartphone application to interact with the AV service. For ~15% of them it will depend on the application itself, which emphasizes the need of a user-centric development process.

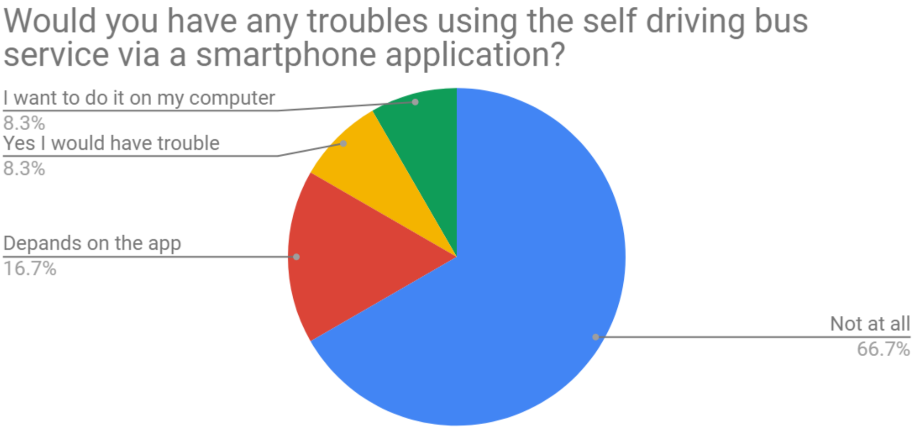


Figure 8: Testing results - Ease of use

A minority of users already express the need of an “offline” way of using the AV services. In the AVENUE project, we will implement ways for the users not familiar with technology to be able to use the AV services as they normally do with public transport.

3.4.4 Main user-suggested features

In order to collect insights and requirements directly from potential users, it has been decide to ask them to think of additional features they would like to have in the mobile application. It is important to note that no suggestions have been made by the interviewers.

The entire set of answers is available in the **Appendix B: Consolidated results - session 1.** Here are the most common collected answers.

- 6 times - Get notified when the bus arrives, time to pick-up and departure time
- 4 times - Notifications on delays and service interruptions
- 2 times - Time to destination
- 2 times - Number of free seats
- 2 times - See vehicle’s route
- 2 times - Room for stroller/bike

More features are listed in Appendix B.

4 Development

In this section, we present the general overview of the service development lifecycle used in AVENUE, and we give insights on the technologies and frameworks used for the implementation of the AVENUE in- and out-of-vehicle services and end-user applications. Finally, we provide an initial overview of the implementation process and technical decisions taken for the traveller application.

4.2 Development lifecycle

Following, the main phases of the development lifecycle are presented. These phases are applied to each and every service developed in AVENUE in a continuous iteration fashion, except for the prototyping one that is done once for each service, before starting the development phase.

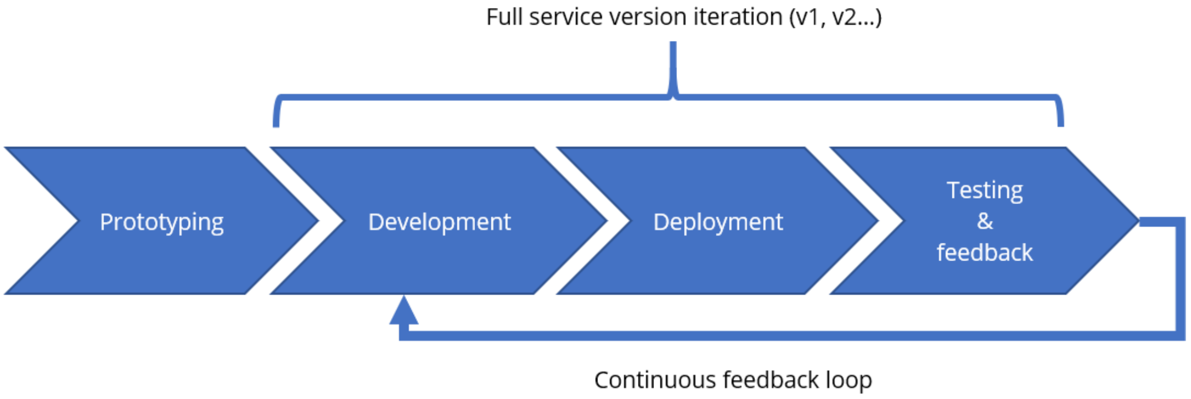


Figure 9: Development lifecycle

4.3 Development tools and technologies

In order to give a clearer overview of the development process, following we list and describe the principal tools, frameworks, and technologies used in the implementation of AVENUE in- and out-of-vehicle services.

4.3.1 Code versioning

To allow for a collaborative development effort, centralize the code produced under AVENUE project, and implement the best practices of coding, a Gitlab code repository provided by University of Geneva is used.

Gitlab CE (community edition) is an open source free-to-use code versioning tool, that enables teams to work on the same code at the same time, keeps track of different versions of the code, provides means for continuous deployment and integration (CI/CD), and offers capabilities for issue creation and tracking as well as project organization into features and milestones.

By using GItlab, we ensure that code is accessible to every partner in the project, that everyone has a clear vision on where the development process is, and where it is heading, and we make it possible for no matter which entity to collaborate in the implementation of AVENUE services and applications.

4.3.2 Traveller app

The traveller app is the main application that will enable the end-users to access the in- and out-of-vehicle AVENUE services. The traveller app will be developed natively for Android and iOS, as native development offers more flexibility, a better user experience, access to more features on the user’s device , and moreover is the preferred implementation choice of the PTOs.

In a first implementation round, and in order to have a basic yet functional application as soon as possible, an Android version of the application will be developed. By targeting only one of the two main operative systems (Android, iOS) at the beginning, we can have an application that can be rapidly deployed and tested. This will let us collect feedback in order to subsequently improve it while at the same time developing the iOS version with all the corrected issues from the very beginning, optimizing both development and ready-to-market times.

From a technical point of view, we will target Android v21 and higher (commercial name: 5.0 Lollipop) covering 85% of the Android devices on the market, and iOS 11 and higher, which covers more than 90% of the market devices. Each of the app versions will come into differently branded flavours, one for each PTO. Branding will include elements such as different logos, primary colours and other individual brand elements, while keeping the layout and user interface constant across all variants.

Finally, some third-party services and libraries, such as Google Maps API will be used, particularly to provide for functionality that is already well established and mature and does not need to be reinvented or coded from scratch.

4.3.3 Companion app

The companion app is a temporary application for the shuttle operators, in order to circumvent some technical limitations regarding existing features, to enable certain services to work in a seamless way for the user, until the required technology has been put in place.

In a first moment, the companion app will be used to enable the on-demand stop and passenger presence services, letting the operator interact with the AVENUE platform to provide and receive information that will let him perform some of the tasks that will be automated in the nearby future.

Technically speaking, and given that the companion app is a temporary solution deemed to disappear, a hybrid approach will be used. Hybrid applications can be deployed in different OSes and devices, but they share a unique code-base, speeding up the implementation time while still offering a good user experience. However, they can feel less fluid, and some native device functionality can be cumbersome or plainly impossible to integrate and use, hence why this approach is not used for the end-user application.

4.4 Implementation status

The implementation of the mobile applications must meet some fundamental requirements. The apps must feature the mobile services we envisioned to deliver in the context of AVENUE and be easily customizable for the different PTO partners of the project. Each PTO wants their own Android and iOS apps in the app stores and not a generic AVENUE application. The apps must comply with their corporate colours and present their logo. More importantly, they must be able to host their own back-end solution to provide the standardized AVENUE services to their travellers and employees. In addition, in future, some of them could demand the removal or addition of services from the application to customize its functionalities.

We expect to deliver mobile applications for travellers for the Android and iOS platforms and a specific application for the employees of each PTO present in the vehicle during the test phases (possibly web based). The total number of applications to maintain and deploy in the app stores will be 8 (4 PTOs with iOS and Android versions) and 4 apps private to the PTO for their employees. In the future, with the addition of at least two PTOs we are expecting the total number of applications to grow. We will have 12 apps for traveller and 6 for PTO employees. Meeting all of the requirements and ensure maintainability is a technical challenge that we tackled from the very beginning of the apps design and development phases.

At the moment of this writing we are focusing on the Android application for travellers. The Android development environment offers the possibility to create the infrastructure to promptly answer to all of the problematic above. We have a single code repository for all the different PTOs apps and the customization happens when we generate the application for testing and deployment to the public. Additionally, in the last months Google introduced new architecture components to make Android applications very modular.

To allow for the application branding (PTO colours and logo customization) and services configuration we made extensive use of build and flavour configuration scripts[2].

These scripts allow us to generate the different applications for each PTO in a scalable way. We can easily add new configuration features and new PTOs. The current branding flavour configuration allows to customize: the application name, the PTO logo, the 3 main application colours (using the range of PTO corporate colours). We have also a flavour configuration for APIs and back-end services. Each PTO can have a test and a production environment (for example different API endpoints for testing and production purposes).

From the point of view of the code repository, common to all the PTOs, the new Android architecture components based on Android Jetpack[3] allows the creation of a very modular application architecture[4] as can be seen on the following diagram.

[2] https://developer.android.com/studio/build/build-variants

[3] https://developer.android.com/jetpack/?gclid=EAIaIQobChMIx5rNuZvt3gIVrrftCh1mEwhOEAAYASAAEgK7G_D_BwE

[4] https://developer.android.com/jetpack/docs/guide#recommended-app-arch

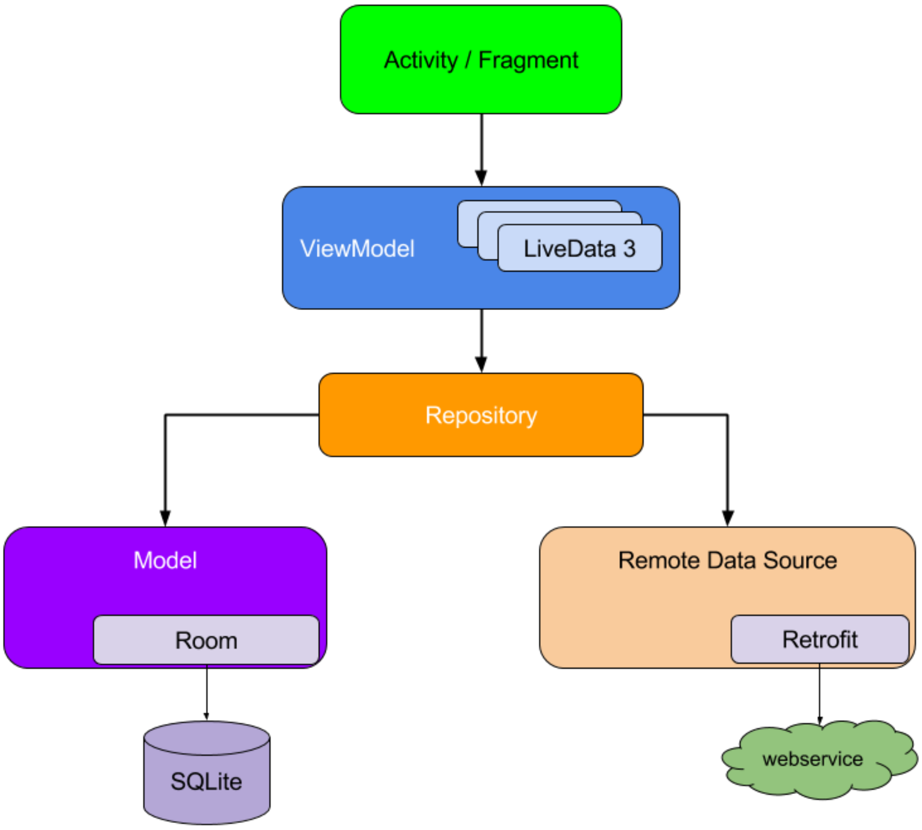


Figure 10: Mobile applications architecture

This architecture provides us with the necessary building blocks to ensure that the code base remains highly maintainable, flexible and most importantly testable (we apply the concept of test-driven development[5]). The architecture we chosen covers us also in the eventuality that in the future the requirements of PTOs might diverge considerably and therefore require that we maintain a code base per PTO. If we have to create personal repositories for some PTOs, the whole current central code base or part of it can be easily ported to become a library that we can share among all the PTO personal code. At the moment, we successfully implemented the main structure of the app architecture and started to develop the first AVENUE service in top of it.

All of the above is applicable also for the iOS applications that will follow the first Android version. Although much stricter the development environment of Apple offers the possibility to have the same configurations as per Android. To facilitate the development of the iOS applications we will investigate if we can effectively use the same architectural concepts as done for the Android counterpart (or at least find a very similar approach). This procedure will enable an easier implementation and better communication between Android and iOS developers. Most of the features could be architected in a very similar way for both iOS and Android. If in the future the code base of a PTO will diverge we will be able to apply the same procedure we envisioned for Android also in iOS.

[5] https://en.wikipedia.org/wiki/Test-driven_development

4.4.1 Accessibility and Usability

In order to render the traveller application accessible by all the target user groups of AVENUE, we will follow the main accessibility guidelines and best practices for iOS and Android applications[6,7,8]. We will also provide either settings or modes to enable high contrast text-background pairs and bigger font sizes in order to improve readability by people that require it.

In terms of usability, we will implement intuitive and easy to use interfaces with well defined elements and interaction and display areas and elements to render the usage of the app as simple as possible.

5 Conclusions

This deliverable has presented the first services selected for the first phase of T4.3, and their different versions including future ones. It has also introduced the testing framework developed for the AVENUE services as well as presented the first round of results obtained from the first round of user-tests over a paper prototype.

Finally, it has given an overview of the development lifecycle of the services, different technological choices done, and the current status of the implementation process. Following, we briefly list the next steps and action points for the months coming.

5.2 Next steps

- Android implementation of the traveller application, initially with the real-time positioning service. The other services will be subsequently and incrementally incorporated to the application.
- Testing of the Android application in order to detect early-on any problem, be it technical or user interface related.
- Improvement of Android application based on the feedback.
- iOS implementation of the traveller application, already including all the feedback collected form the Android application testing.
- Deployment of the traveller application in its different flavours for each operator, and testing phase in each of the PTOs sites once the sites are up and running (*expected early July 2019*)
- Implementation of the v2 of the services already deployed, in parallel with the testing phase.
- Planning and provisioning for phase two of in- and out-of-vehicle services before it starts on M18.

[6] https://developer.apple.com/accessibility/ios/

[7] https://developer.apple.com/design/human-interface-guidelines/ios/app-architecture/accessibility/

[8] https://developer.android.com/guide/topics/ui/accessibility/apps

Appendix A

Playbook - testing session 1

Appendix A: Testing session 1

AVENUE WP4

PTO's

Date:

Facilitator:

Operation site:

#	Phase	What	How	Outcome	Time
1	Opening	Opening	Hello and thank you for coming and contributing to our development of In and out of vehicle services for self driving busses. I would like to start by saying that this testing session will take around 25-30 minutes. We are a part of a European Union funded project called AVENUE (Autonomous Vehicle to Evolve to a New Urban Experience). The main objective of this project is to demonstrate and implement autonomous vehicles in urban transport. The project consist of 16 partners across 7 European countries. Today we are going to test some aspects of the first version of an app, which is being developed in this project. The purpose of this testing session is to get your perspectives, opinions and insights on this first version of the app - so that we can figure out what works and what doesn't work - and then adjust the app afterwards. Please feel free to be completely honest about what you think, when you see the app - and we encourage you to say whatever comes to mind when you see the pages in the app. Before we begin showing you the app, we would like to ask you some demographic questions (insert answers in Result template): - Name (only for internal use, will never be published or linked to you answers) - Occupation: (what do you do?) - Age: (how old are you?) - Gender: (male or female?) - Any disabilities: (do you have any disabilities?) - Other relevant information: (is there anything else we should know that could be relevant for this session)	Let the participant understand why this testing session is necessary and why their insights are valuable.	4 min

2	Create comfort	Let the user speak freely and warm up	All right thank you. Let’s begin. Just to warm up, we would like to ask you a question about public transport. **Q1: Please tell us about a positive experience that you have had with public transport recently. It can be anything.** R1: [Write down answer in Result template] **Q2: Please elaborate on why this experience was positive? What kind of positive experience was it?** R2: [write down answer in Result template] Thank you. Now let’s move on.	The participant has to get comfortable about being in this interview. The vibe has to be relaxed for the participants to fully open up and provide feddback.	4 min
3	Stage discussion	Build the context. Get the user to talk and think within the field of interest.	Before looking into the app page that we have brought today, we would like to begin with asking you some questions regarding self driving vehicles. **Q3: Could you imagine a society with self driving vehicles?** R3: [write down answer in Result template] **Q4: What benefits do you think you would experience?** R4: [write down answer in Result template] Now that we are warmed up, we would like to begin the app testing. Here is a picture of the main page in the app. **[Show picture 1 to the participant]** **Q5: Now, what are the 5 first things that come to your mind when seeing this picture.** R5: [write down answer in Result template] **Q6: Please shortly explain why each thing come to mind.** R6: [write down answer in Result template] Thank you. Now let's move on.	Lead the participant into the context, Enable them to be precise, by understanding the purpose of the testing and the subject of interest.	7 min

4	Development exercise	Test prototype / wireframes with participant	Now that you have seen the app page (as a picture) we would like you to imagine that the picture was interactive - that it was an app screen where you could press anything. **Q7: When looking at the page, what would you like to press?** NB: Help them out if they do not understand. Examples: Like what would you like to be able to do on this page when pressing objects? R7: [write down answer in Result template] **Q8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects?** R8: [write down answer in Result template] Now imagine that a self driving bus was operating in your neighborhood. **Q9: Would you have any troubles using the self driving bus service via a smartphone application?** R9: [write down answer in Result template] **Q10: If yes/no could you elaborate?** R10: [write down answer in Result template] Thank you. Before we round up we would like to ask you one last question. **Q11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do?** R11: [write down answer in Result template]	User feedback, ideas and opinions on the subject and wireframe	10 min
5	Closing	Round up the testing session	Thank you for participating in this testing session, the feedback that we have received from you will be very valuable in our further development of the application/service. Do you have any questions? That you would like to answer? Or anything to add? Please feel free. **Q12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact.** R12: [write down email and/or phone number in Result template] At last we want to ensure you, that your personal information will not be used or linked to you answers. It is only in order for us to get in contact with you again. We are completely GDPR compliant.	A good ending to the testing session and contact information of the participant	4 min

Appendix B

Consolidated results - session 1

Consolidated results from first user test iteration

WP4: In-and-out-of-vehicle services

Gender	Female	Female	Male	Feamle	Male	Female	Male	Female	Male	Male	Female	Female	M	Feamle	Male
24 years and younger		x								x					
25 to 39 years	x						x	x			x			x	
40 to 59 years			x	x					x			x	x		x
60 and older					x	x									

#	Phase	What	TPG 1	TPG 2	TPG 3	TPG 4	TPG 5
1	Opening	Opening	Contact information (write in here) - Occupation: administration - Age: between 30-40 (doesn't want to tell me) - Gender: F - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: Student - Age: 11 - Gender: F - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: Coordinateur - Age: 46 - Gender: M - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: School teacher - Age: 54 - Gender: F - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: Retired - Age: 67 - Gender: M - Any disabilities: Walking stick - Other relevant information:
2	Create comfort	Let the user speak freely and warm up	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. No specific	R1: I was late for the tram, but he opened his doors again and I could go in.	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. Due to an early message regarding a delay of a train and the proposed solution to take a specific tram, I arrived perfectly on time	R1: I lost (forgot) my bag in the tram	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. Tram arrived on time
			R2: Please elaborate on why this experience was positive? What kind of positive experience was it?	R2:	R2: Please elaborate on why this experience was positive? What kind of positive experience was it? I arrived perfectly on time	R2: I called the TPG and the driver found my bag	R2: Please elaborate on why this experience was positive? What kind of positive experience was it? People assume that it is normal to arrive on time but still a lot to be done to improve
3	Stage discussion	Build the context. Get the user to talk and think within the field of interest.	R3: Could you imagine a society with self driving vehicles? Would I notice the diffeence?	R3: Oui	R3: Could you imagine a society with self driving vehicles? Yes	R3: Yes	R3: Could you imagine a society with self driving vehicles? Not sure, maybe in 20-30 years
			R4: What benefits do you think you would experience? Depends on the services. Are they the same,more...?	R4:	R4: What benefits do you think you would experience? Less time lost Services needs to be the same and plus	R4: What is the difference for me (passenger) between a driverless vehicle and a "normal" vehicle? Here I had to explain that the difference is not in the driverless or not configuration but in the fact that it concerns on demand personalised transport which is interesting	R4: What benefits do you think you would experience? Negative, people loose their jobs
			R5: Now, what are the 5 first things that come to your mind when seeing this picture. Busline Bus stops Busses Small area Where is this?	R5: Mobile phone - destinations - crossing - city - routing - application	R5: Now, what are the 5 first things that come to your mind when seeing this picture. Bus line Bus stops in a regular sequence Circulate in one direction Serves area I want to order a bus	R5: Route - destination - address - street - vehicles	R5: Now, what are the 5 first things that come to your mind when seeing this picture. Busline Bus stops Busses Numbered dots Pointer where I am

#	Phase	What	SLA 1	SLA 2	SLA 3	SLA 4	SLA 5
1	Opening	Opening	Contact information (write in here) Malou Wagner - Occupation: retiree - Age: 61 - Gender: f - Any disabilities: / - Other relevant information: /	Contact information (write in here) Ken Theobald - Occupation: Manager fleet Sales-Lentz - Age: 30 - Gender: m - Any disabilities: / - Other relevant information: /	Contact information (write in here) Evelyne Thomas - Occupation: Physiotherapist - Age: 28 - Gender: f - Any disabilities: / - Other relevant information: uses PT on a regular basis	Contact information (write in here) Jens Schönherr - Occupation: Responsible warehouse Sales-Lentz - Age: 51 - Gender: m - Any disabilities: / - Other relevant information: /	Contact information (write in here) Dylan Freitas - Occupation: apprentice mechanical workshop - Age: 22 - Gender: m - Any disabilities: / - Other relevant information: takes public transport on a daily basis
2	Create comfort	Let the user speak freely and warm up	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything.: personal contact to the driver, chatting with the driver	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything.: good information on luxembourgish public transport app (mobilitéit.lu) and high frequency of buses in Luxembourg during peak hours	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. PT was on-time , no stress to get from A to B	R1: Please tell us about a positive experience that you have had with public transport recently. Driver was nice	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything.: easy to see on a screen in the bus when the bus is arriving at destination, instant indication in the bus when the bus has a delay
			R2: Please elaborate on why this experience was positive? What kind of positive experience was it? getting into the bus and asking the driver if the bus is still stopping at a certain bus stop and if the terminal station has changed yet or not (because in Luxembourg a lot of terminal stations in Lux.City are changing now and in the coming weeks). Driver could give these informations immediately without having to check a timetable online or offline	R2: Please elaborate on why this experience was positive? What kind of positive experience was it? easy to find connections, timetables, easy to schedule my day, to get to a certain place in time without using my own car, to get notified about delays	R2: Please elaborate on why this experience was positive? What kind of positive experience was it? PT had no traffic jams in contrast to cars because of dedicated bus lanes, less stress than driving on my own because of being stuck in traffic jams, during trips in PT I can do other things like reading a book, newspapers, working on laptop	R2: Please elaborate on why this experience was positive? What kind of positive experience was it? I had a small chat with the driver while the bus was standing at the bus stop.	R2: Please elaborate on why this experience was positive? What kind of positive experience was it? easy to plan my day
3	Stage discussion	Build the context. Get the user to talk and think within the field of interest.	R3: Could you imagine a society with self driving vehicles? Yes	R3: Could you imagine a society with self driving vehicles? Yes but only in a few years, especially for taxi services (or uber), but no real public transport	R3: Could you imagine a society with self driving vehicles? Yes in future but not yet	R3: Could you imagine a society with self driving vehicles? No	R3: Could you imagine a society with self driving vehicles? No , I feel safer when there is a driver in the car
			R4: What benefits do you think you would experience? More safety, less accidents	R4: What benefits do you think you would experience? Less accidents, more flexibility for passengers	R4: What benefits do you think you would experience? Less traffic jams, less accidents	R4: What benefits do you think you would experience? Nothing	R4: What benefits do you think you would experience? You could have a bus service 24/24hrs 7 days a week
			R5: Now, what are the 5 first things that come to your mind when seeing this picture. 1. 8 bus stops, 2. 3 buses are driving , 3. why is the red point not next to station 1, 5. the bus stops are too close to each other (she did not now what the red dot was)	R5: Now, what are the 5 first things that come to your mind when seeing this picture. 1. I can see where I am right now 2. bus stops 3. to know in which direction the bus is driving 4. in what streets the bus is driving, 5. I don't see the time when the bus is arriving at a certain stop	R5: Now, what are the 5 first things that come to your mind when seeing this picture. 1.easy route 2.bus stops evenly distributed 3.well-arranged 4.what should I push to get information 5.I don't know when the next shuttle is arriving at a certain bus stop, no times indicated	R5: Now, what are the 5 first things that come to your mind when seeing this picture. 1.The points are the bus stops, 2.bus stops are too near to each other, 3. looks like a sightseeing tour, 4. 3 buses are driving, 5. 8 bus stops	R5: Now, what are the 5 first things that come to your mind when seeing this picture. 1.The line is the route that the bus takes 2. easy to see where the bus is currently, 3.good overview over the whole bus route,4. I can see the current position of the bus, 5.I can see my current position

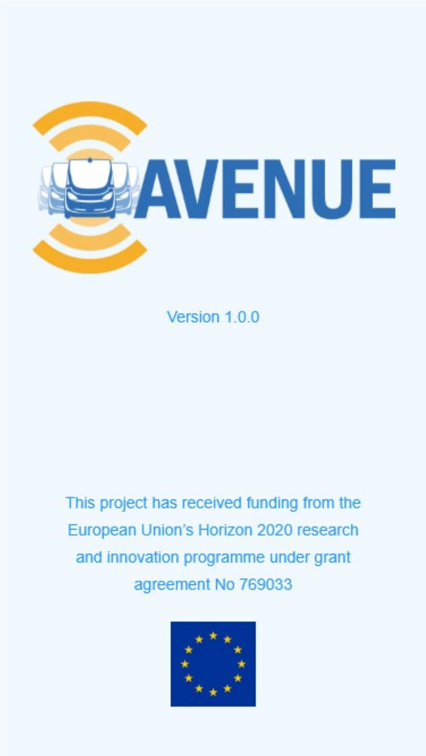
#	Phase	What	AM 1	AM 2	AM 3	AM 4	AM 5
1	Opening	Opening	Contact information (write in here) - Occupation: external profesor at DTU and CEO - Age: 34 - Gender: Man - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: Projektleder - Age: 57 - Gender: Woman - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: CEO - Age: 54 - Gender: Man - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: design engineer - Age: 28 - Gender: women - Any disabilities: No - Other relevant information:	Contact information (write in here) - Occupation: CEO & co-founder - Age: 49 - Gender: mand - Any disabilities: No - Other relevant information:
2	Create comfort	Let the user speak freely and warm up	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. It depends on how tyou define public transport. Lately I have been saved by Drive now and Din bybil/GreenMobility (shared cars). I alway get out of the door late, and then I just jump into one of the shared cars, which reduce the transit time a lot. It takes 15 minutes into the city by car and 30 minutes with public transport if I am lucky.	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. Well when you arrive in the airport, have picked up your suitcase and run down the ramp (to the platform) and the train is there and you get home fast. You know when you reach something coinsidental. That you don't have to stand there and wait for 30 minutes or the trains are cancelled.	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. Yes well I always take the Kystbanen (the coastal train line) when I go to the city. I drive to the station and park the car at Skodsborg (station), it is the only place there are room for parking, everywhere else on the way in is occupied. The positive experience - Skodsborg is a nice area to visit - a nice scenaira before going with the train. There is the need to be able to predict, typically you have a plan so you don't have time to drive around to find a parking spot. I would never drive into the city of Copenhagen and park there.	R1: Please tell us about a positive experience that you have had with public transport recently. It can be anything. Yes I think generally that bus 180 from Lyngby to DTU, there is a busdriver that tells some funy stories, that is very cosy. It makes the right more personal kind of.	R1: I need to think realy long time back. Yes I can remember that I lived in Germany and was back in DK for at christmas lunch, And going back to the airport from Virum, I could jump on the metro - it was when it had just opened - and that drove directly to the airport. It was easy. In Japan they appologies if they are just 1 minute late, and you always arive on time, everything is connected, it is effecient. That is not my impression from my kids here in DK.
			R2: Please elaborate on why this experience was positive? What kind of positive experience was it?	R2: Please elaborate on why this experience was positive? What kind of positive experience was it?	R2: Please elaborate on why this experience was positive? What kind of positive experience was it?	R2: Please elaborate on why this experience was positive? What kind of positive experience was it?	R2:
3	Stage discussion	Build the context. Get the user to talk and think within the field of interest.	R3: Could you imagine a society with self driving vehicles? Yes yes	R3: Could you imagine a society with self driving vehicles? yes I can	R3: Could you imagine a society with self driving vehicles? Yes i can imagine that.	R3: Could you imagine a society with self driving vehicles? Yes I hope it will come soon. Am very open for it.	R3: Yes I am just waiting for it to happen. I can only go too slow.
			R4: What benefits do you think you would experience? Autonomous transport is already here like the Metro. That the cars are autonomous the exploitation of the available assets will be much better. Righ now there are 700 cars in the parking lot outsite the office, but they are not available for me. And those that are have a driver eg taxi, so I believe the exploitation will be much higher.	R4: What benefits do you think you would experience? - It might be deleverance to my home, so I don't have to drive and pick it up. - or pick-up of gardening desposals. - When my kids go party in the night, that I know not to worry, that they can get home safely. And I don't have to get up at in the nigth to pick them up. - fewer cars on the roads, because more will drive together. So less wasted time due to less trafic. - if a supermarket could bundle theire orders for the same area, and deliver their products to all neighbours at the same time. - when you drive down in Europe, then you would arrive rested to the destination. And there wouldn't be so much trafic or congestions, or maybe it could just go around the congestions on it own.	R4: What benefits do you think you would experience? Well where I live there there aren't that much public transport nor frequent especially out site rush hours, there might be 1 or 2 busses every hour. AVs migh be able to solve that in connection with the costs of having more busses with drivers - maybe it can be more like on-demand solutions, so it can be more cost effecient. There are also trends with people moving out of the cities, but often what retains them for doing so is the lack of suffiecient public transport.	R4: What benefits do you think you would experience? I believe that the congestions people create with cues on the highways and the like, I belive that AVs will solve that a lot. In regards to the environment there will be used less energy, fuel. I believe there will happen less accidents. Now I am relatively used to automatic transmission, and then parking it will be a lot easier if you don't have to do anything. It is cool to be passengar in a Tesla, that you can say just follow the car in front of you, or that it can drive on its own including overtaking in the trafic.	R4: Talking on phones - work during transport that is important. If I can get somebody to drive me, so I can work during the transport, then that is what I do - always. I think that AVs can exploit the entire space (full capacity usage) in the vehicle - when the whell and the like are taken out.
			R5: Now, what are the 5 first things that come to your mind when seeing this picture. - where are we in the world? - what are the numbers - it is a circle - the bus will move, it is something that is gps tracked, so you can see where the bus is - it is relative small distances, it looks like you can walk around when you look at the building sites - I stand there at the red dot - the numbers are probaly a bus stop, but why this naming (the numbers)	R5: Now, what are the 5 first things that come to your mind when seeing this picture. - it is a bus route with 8 stops and the route is close to the water - is the red dot indication where I am going, my destination, here at number 3 - is there driven 3 busses all the time (due to the 3 busses on the picture) - I am missing the distance dimensions, so I know how long time it takes to walk or drive - what might this be on the picture (pointing to a certain building on the map)	R5: Now, what are the 5 first things that come to your mind when seeing this picture. - there are busses there drive aound in a circle - they drive with a certain frequency so that you can get around - who might use these busses, it is probably not that many that need to get aourend here (in the circle), so it must be something that connects with other trafic eg station or bus - are you allowed to bring your bike on board? it is difficult to get aroun in Nordhavn, so in this case this (the AVs) might be a good solution to solve the logistics - there are some great distances and no real public transport there.	R5: Now, what are the 5 first things that come to your mind when seeing this picture. - the route the car or transport means is driving, a determinded route - you can be picked at the 8 places marked - I am at the red dot - that you can get of at the marked places - that it drives in one direction, round in a circle	R5: - busses that drives around the route - indicated by the line - can press the settings - I am at number 3 - there are some busses at the places indicated on the map - the blue numbers are stops

#	Phase	What	KEOLIS 1	KEOLIS 2	KEOLIS 3	KEOLIS 4	KEOLIS 5
1	Opening	Opening	-	-	-	-	-
2	Create comfort	Let the user speak freely and warm up	-	-	-	-	-
			-	-	-	-	-
3	Stage discussion	Build the context. Get the user to talk and think within the field of interest.	-	-	-	-	-
			-	-	-	-	-
			-	-	-	-	-

			R6: Please shortly explain why each thing come to mind.	R6: Where are we?		R6: are the vehicles all going the same direction?	R6: Please shortly explain why each thing come to mind.	R6: Please shortly explain why each thing come to mind.	R6: Please shortly explain why each thing come to mind. 1. red arrow indicates were I am right now 2.the 8 numbered points are next to the bus line so I suppose these are bus stops 3. the 3 buses are facing in the same direction so I know what way they are driving, 4. street names are indicated on the map 5. No times are visible next to the stops	R6: Please shortly explain why each thing come to mind. 1. It's an easy route because not that many turns, lot of straight lines 2.same distance between bus stops 3.easy to get an overview, no unnecessary things/informations on the map, 4. more important information should be immediately visible without having to push a certain button (like time when the next shuttle is arriving at a certain bus stop), 5. same as 4.	R6: Please shortly explain why each thing come to mind. 1. what else could be the 8 circles next to the route, 2.no explanation, 3.no explanation 4.there are three buses on the map, so I suppose this is the total number of buses driving right now 5.8 circles = 8 stops	R6: Please shortly explain why each thing come to mind. 1. there are 3 buses on a line on this map, so I think the line is the route 2+3+4. The total route is shown on the map, so it is easy to see the current location of the bus, 5. Red arrow is indicating my current position	R6: Please shortly explain why each thing come to mind. - the icon looks like a bus - the numbers are probably busstops - it looks like some kind of route due to the blue line, and when you see a bus on the picture, and a bus usually demands a busstop - is the red dot usually indicate my destination and not where I am - when you use other apps.	R6: Please shortly explain why each thing come to mind. - I use my phone on daily basis to get around, and in that the red mark indicated the destination, the adress I entered into the app. Eg using google map. - The numbers indicate that there are 8 stops - the icon looks like a bus - bus does it mean that there are 3 busses driving around at all times, or that there is only one bus.	R6: Please shortly explain why each thing come to mind. - If you get out there (Nordhavn) and you don't have a car, then you will have to walk otherwise wait a long time for the bus. So here it will realy solve somthing, create some easy connectivity - there is also the international school, where the parants drive there kids to everyday - but kids are ready these days to go on their own, there just needs to be the means to do so.	R6: Please shortly explain why each thing come to mind. - stops because there is a number - it starts at number 1 and goes in a ring due to the numbering and the busses turning in the same direction. - location icon, it is like the google icon	R6: - You use simple icons - I can press settings, and write my profil or something - I am at number 3, the red 'here am I' symbol indicates that - There are some busses right here - shows where is the bus now and that it is just around the corner - The blue numbers for the stops - the numbers might indicate the direction the bus is driving	-	-	-	-	-
4	Development exercise	Test prototype / wireframes with participant	R7: When looking at the page, what would you like to press? Bus stops	R7: Numbers - map	R7: When looking at the page, what would you like to press? The blue numbered dots	R7: At the numbers	R7: When looking at the page, what would you like to press? The bus next to me	R7: When looking at the page, what would you like to press? At one of the bus stops	R7: When looking at the page, what would you like to press? At one of the 8 bus stops	R7: When looking at the page, what would you like to press? At a bus stop	R7: When looking at the page, what would you like to press? On the red point	R7: When looking at the page, what would you like to press? At one of the bus stops	R7: When looking at the page, what would you like to press? - just found the website with the new DOT (Danish public transport realtime map). I don't use Rejseplanen, but the DOT map, so that I can press on the busstop and get to know when the next 2-3 busses come in realtime - like google maps, they use real time trafic, which our normal public bus information system don't do when they provide the arrival time at the next stop. So a realtime indication of when I arrive according to other trafic - Maybe also be able to tell the user that the chosen route due to the lenth (distance) and realtime trafic it will be faster to walk	R7: When looking at the page, what would you like to press? - if I push on eg number 5, I stand there right now, then I like to know when will the next bus arrive and how long time does it take to reach my destination from where I board. - If I were a turist, I like to know what is nearby that could be interesting to se - like a hop-on hop-off bus - if it were in the airport, I like to know where the different terminals were - eg terminal 1 and what aircraft companies at each terminal	R7: When looking at the page, what would you like to press? - like to indicate that there is a need for pick-up, maybe by pressing one of the numbers - know when the next one arrives, so maybe it is written somewhere at the stop or in the app - that you can book space for a bike or the like or indicate the need for assistance	R7: When looking at the page, what would you like to press? - would like to se where the bus is - would like to see where I stand - press number 3 and see how many passengers there are onboard - how long time it will take to get to the different numbers/stops based on the trafic - the travel time - see if there is room for me - that there would be something in the buttom (of the screen) where you can press and see if it is your normal route, or that you can connect to Rejseplanen (normal PTO travelsystem) or to other public transport or shared like citybikes - settings, being able to do something where you can see cafées and restaurents	R7+8: - press the bus and expect to see when it will reach me. - or if I press on the stop I will be told when the bus arrive at the stop - how many minutes untill it comes. - press the stop I like to know what is in the nearby location (restaurent, buildings etc.) - press the red one, telling me you are here - press the bus so I can se what number it has, so I know I am taking the right one (busline like the taxi number when driving with uber) - the settings buttom just the usual. - I expect that the map can be zoomed in on, so visually disabled can read it too and that you can move around in the map - like the uber function	-	-	-	-	-
			R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? When does the bus arrive?	R8: What does the number represent? - Search - find the best route to destination	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? I want to order a bus	R8: I want to be able to see: search bar - Find a route - Book a shuttle - show me way to my destination - How much does my travel cost? - Time it takes for arrival	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? I want to take this bus	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? I would press on one of the bus stops to get the information on when the next bus is coming	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? I would press at one of the bus stops to see when the bus is arrving at this stop and when it is departing at this stop, in general to get more information about this particular bus stop	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? The bus stops are the most visible/dominat features on the page	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? To know what information you could get from this point, what is this point	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects? Get the information on when the bus arriving at this stop	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects?	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects?	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects?	R8: Can you please elaborate on why you would like to press these objects? What kind of information would you want to get from pressing the objects?	R8:	-	-	-	-	-
			R9: Would you have any troubles using the self driving bus service via a smartphone application? Can you make it the same as the CFF (swiss train) or TL (Transport company Lausanne)	R9: No	R9: Would you have any troubles using the self driving bus service via a smartphone application? No	R9: depends on app	R9: Would you have any troubles using the self driving bus service via a smartphone application? I need big letters anmd numbers to be able to read on my smartphone	R9: Would you have any troubles using the self driving bus service via a smartphone application? no	R9: Would you have any troubles using the self driving bus service via a smartphone application? No	R9: Would you have any troubles using the self driving bus service via a smartphone application? No	R9: Would you have any troubles using the self driving bus service via a smartphone application? Yes, human contact is missing	R9: Would you have any troubles using the self driving bus service via a smartphone application? No	R9: Would you have any troubles using the self driving bus service via a smartphone application?	R9: Would you have any troubles using the self driving bus service via a smartphone application? No, no problem at all	R9: Would you have any troubles using the self driving bus service via a smartphone application? Yes that would be fine	R9: Would you have any troubles using the self driving bus service via a smartphone application? I would like to be able to use the app on the computer. Like my google account, so that it is connected to google like google maps. So I can se where the routes are.	R9: No	-	-	-	-	-
			R10: If yes/no could you elaborate? See R9	R10:	R10: If yes/no could you elaborate?	R10: Is the app age centered?	R10: If yes/no could you elaborate? See R9	R10: If yes/no could you elaborate? No because most of the apps are similar to use, most of the apps are self explanatory	R10: If yes/no could you elaborate? Most apps are the same, I know the basics of an app, most apps are easy to use	R10: If yes/no could you elaborate? I am used to use different apps, most apps are self-explanatory	R10: If yes/no could you elaborate? For me it is easier to talk directly to a person when I want to get information then to try to get information from an app where I don't know how it's working	R10: If yes/no could you elaborate? Most apps are easy to use and understandable without a big explanation	R10: If yes/no could you elaborate?	R10: If yes/no could you elaborate?	R10: If yes/no could you elaborate?	R10: If yes/no could you elaborate?	R10:	-	-	-	-	-
			R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? See R9	R11: GPS - Search bar - confirmation message - Can I look for my order at McDonalds while the shuttle waits for me?	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? Book a ride	R11: I want to be able to call helpline to order a shuttle	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? Notify that I arrived at the busstop and that he can pick me up	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? Get informations on delays of the vehicle, days when the vehicle is not driving, operating hours and operating days	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? When the bus is ariving, the time the bus takes to reach the deastination	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? Indicate times when the next shuttle is arriving, indicating the place where the shuttle can pick me up, indicate the number of free seats, get notifications about service interuptions or problems with the shuttle	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? To see where the route of the vehicle, to get the time when the vehicle is departing at a certain point, when it is arring at a certain point and the time to get from A to B.	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? Operational times of the vehicle, days when it is not driving	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? - It would be good to show the departuretimes on the actual bus stops as well as in the app - it is obvious that there is a need to know availablity, it would be good to know if there is room for the stroller - notification function - e.g. the train is delayed today, by connectingh the function like google assistance - knowledge about when the next bus arrives, or suggesting take the next bus - do you busses overtake eachother? So that it at sometimes would be better to take the second bus - because it will overtake the first one, because the first one will stop at all stops and the second on will overtake it.	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? - If I need a ticket, I like to be able to buy it in the app both for me and if we are a group that travels together - In England they have these huge parkinglots, that functions as hubs, where people park and jump on a bus. Maybe the AVs could solve this too. - at number 1 there is a turist attraction and at xx o'clock change of guards happen, or here there is a connection to the metro, here there is a restuarent, and here there is a connection to the airport or the ferry. - I would also like to be able not to get all this information, so it should be an add-on option	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? - book room for a bike, indicate need for assistance - It would be realy nice if it was integrated with the citybikes or train - a connection so you knew when will the next train leave or is there a connection from here. - or is there a bike in the bike stand, maybe I could pre-book the bike. - an integration with Rejseplanen. A part of the overall public transport solutions in Copenhagen. - able to see the AV in google map, when you look up how to get there - as a last and first mile solution.	R11: If you had to use a smartphone app to drive with self driving vehicles, could you think of any features/functions that you would like the app to be able to do? It is really important being able to see in what direction the map turns, what direction am I moving in. And see where are the busses on the route.	R11: Going back to uber - then I am realy happy about reseiving a pdf receipt when the ride is over, which I then can mail directly to my acountant. Og if I forget to mail it, then I receive a monthly overview of all my rides, and can from that click on the pdf and mail to the accountant. If I shall think more out of the box - if I get foreign visitors that don't have the app, then I would like to pay for their ride and just sent them a link, or to my kids. Or just a giftcard function or the like, using som sort of code that they can use, scan when they enter the buss.	-	-	-	-	-
5	Closing	Round up the testing session	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Via Jeroen	R12: Yes via Jeroen	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later Via Jeroen	R12: Yes evaochar@yahoo.es	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Not interested	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Yes, mawagner@tango.lu	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. NO	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Yes, evelyne0105@gmail.com	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. NO	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Yes freitasdylang6@hotmail.com	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Yes just ask again	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. If I am in the area, then yes	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. yes of course	R12: If you are up for it, we would like to get in touch with you again later in the development phase, to test a more refined application? If so, we just need to get your email and/or phone number for later contact. Yes that would be cool.	R12: May we ask you to test the next version in a months time? Yes, I also have some students you can ask if you like.	-	-	-	-	-

Appendix C

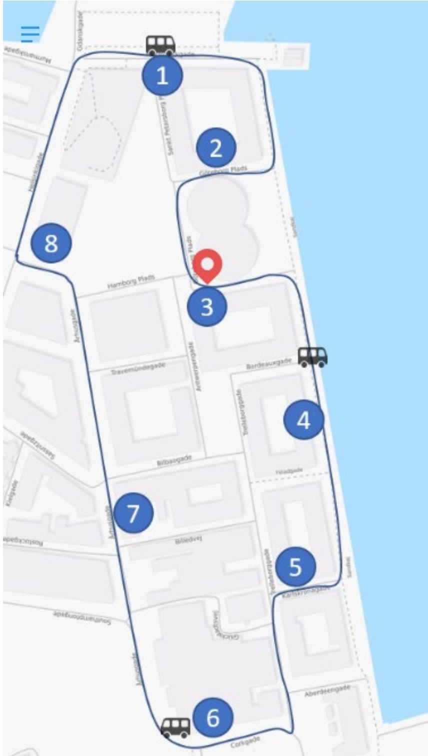
Prototype screenshots - session 1

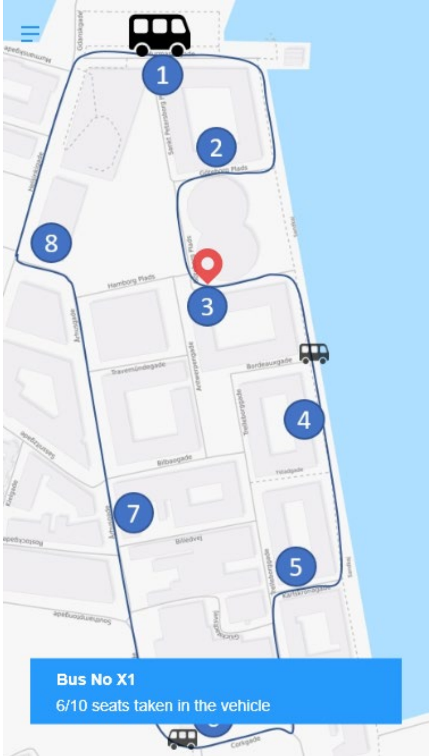


AVENUE

Version 1.0.0

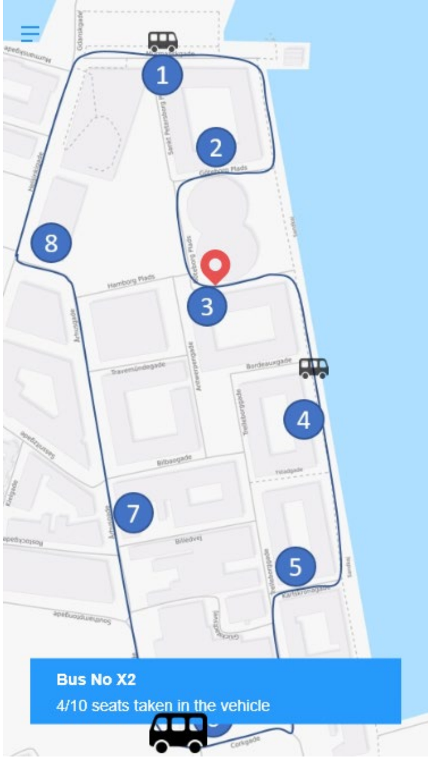
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769033





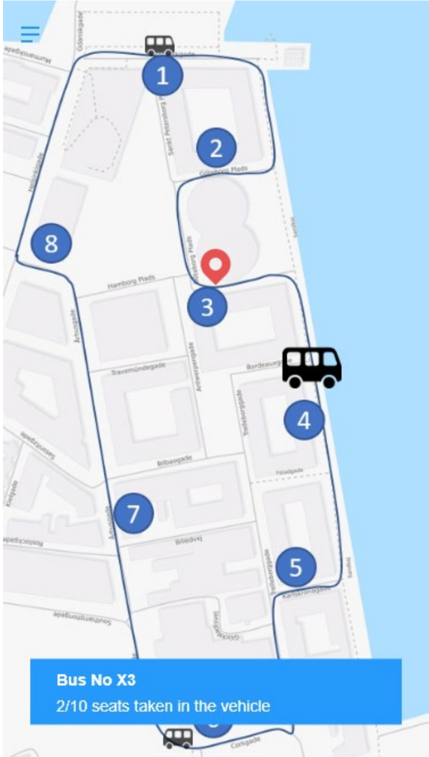
Bus No X1

6/10 seats taken in the vehicle

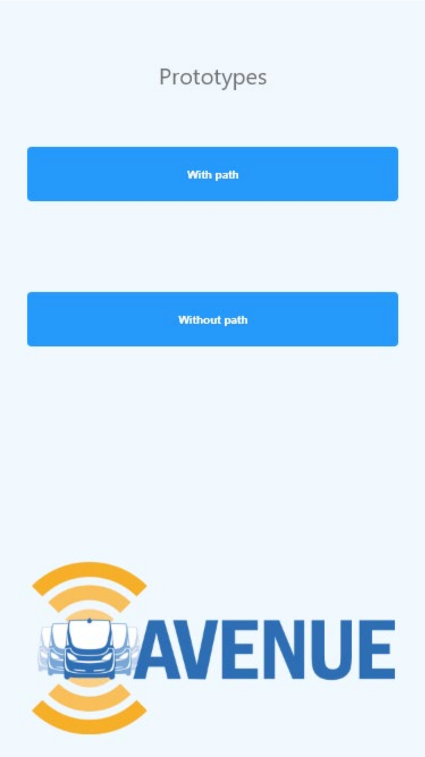


Bus No X2

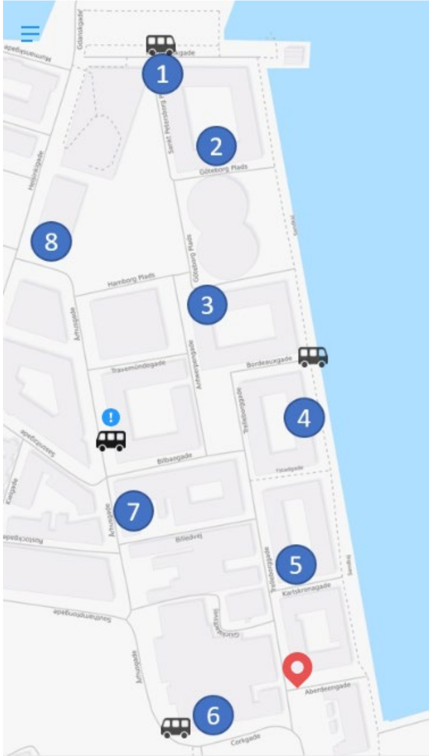
4/10 seats taken in the vehicle

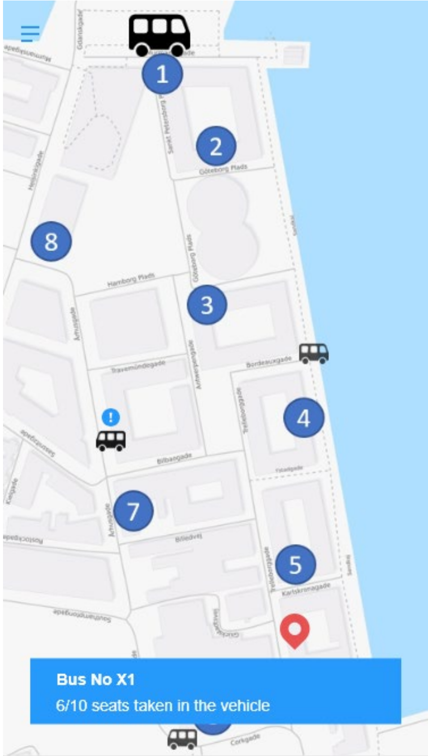


Bus No X3
2/10 seats taken in the vehicle

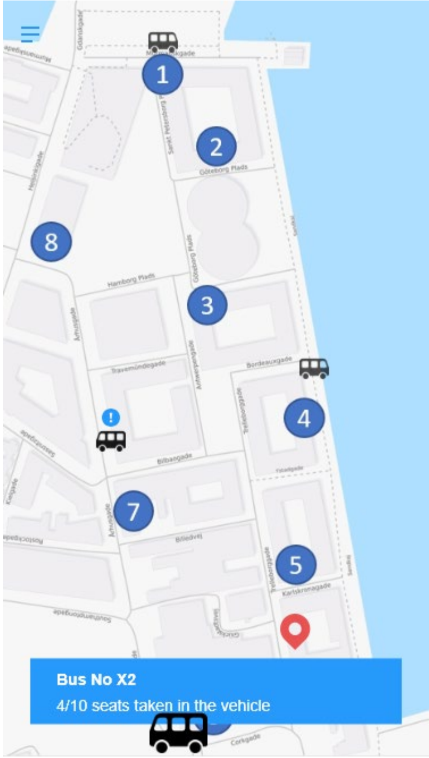


Prototypes



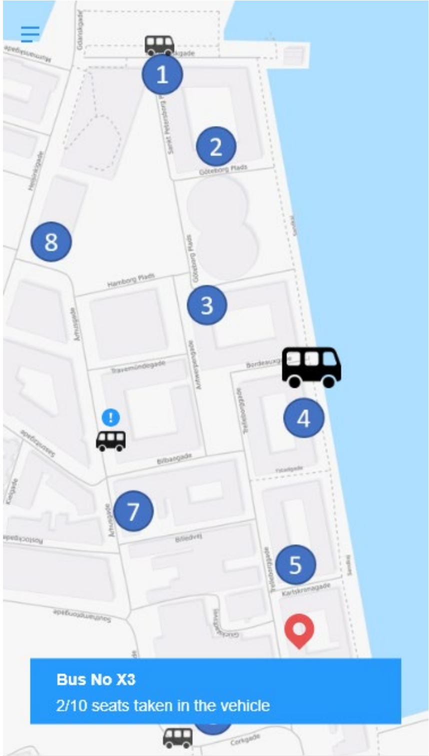


Bus No X1
6/10 seats taken in the vehicle



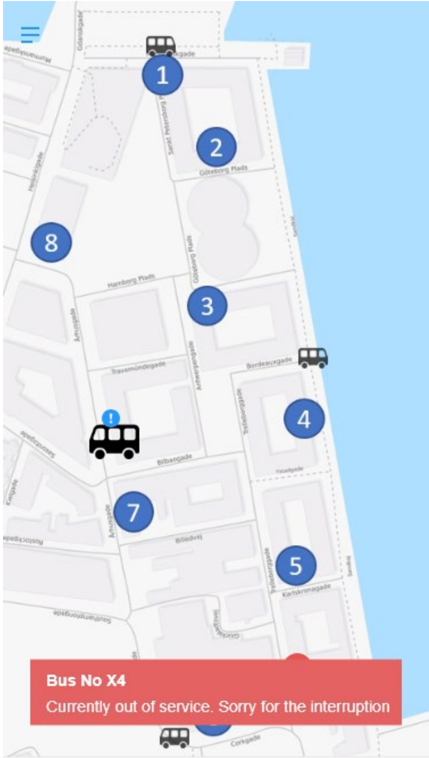
Bus No X2

4/10 seats taken in the vehicle



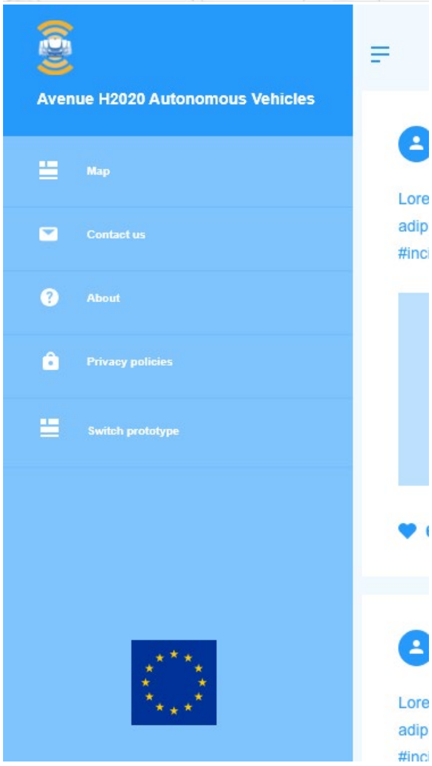
Bus No X3

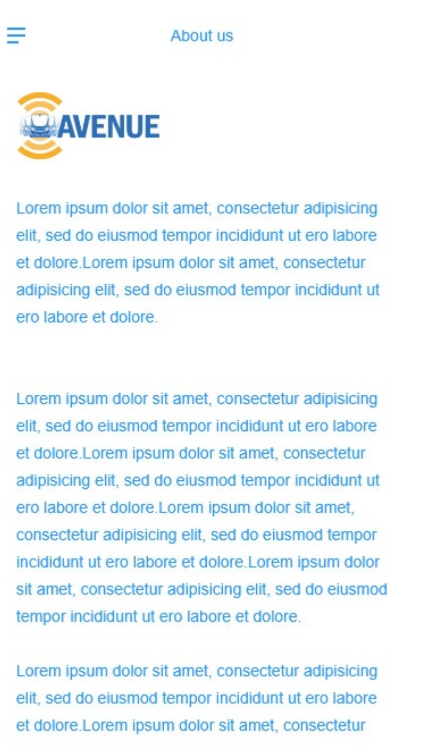
2/10 seats taken in the vehicle



Bus No X4

Currently out of service. Sorry for the interruption





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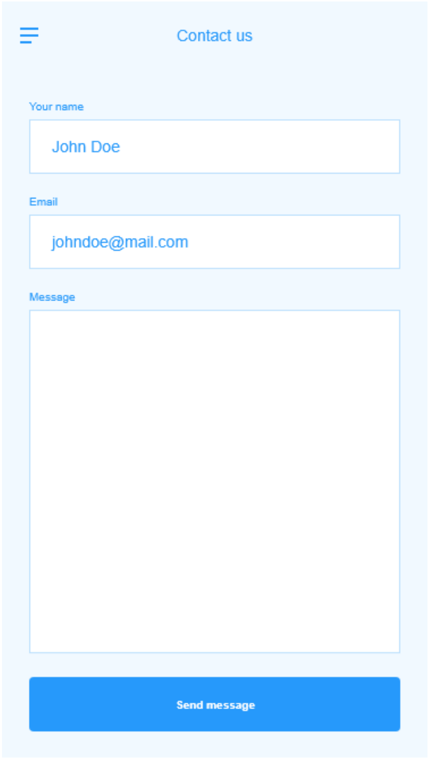
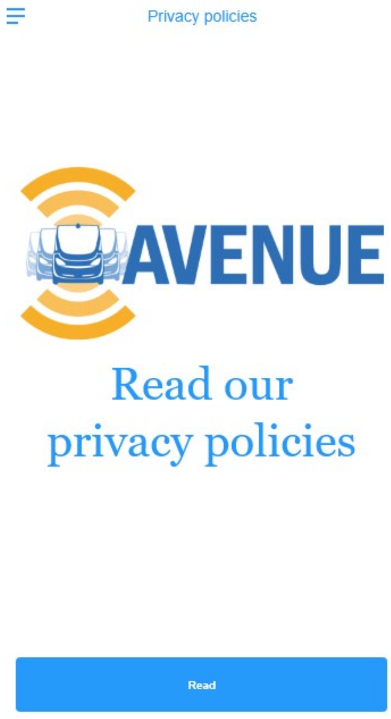


Your name
John Doe

Email
johndoe@mail.com

Message



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