Autonomous Vehicles to Evolve to a New Urban Experience

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DELIVERABLE

D4.1 First Iteration Transport Services

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Acronyms

AM	AutonomousMobility
BM	BestMile
EC	European Commission
EU	European Union
MT	MobileThinking
PTO	Public Transport Operator
SLA	Sales Lentz Autocars
T4.1	Task 4.1
TPG	Transport Publics Genevois
WP2	Work Package 2

1. Introduction

The Avenue project is set up to offer on demand door-to-door solutions integrated within existing public transportation services, and evaluates the feasibility of operating autonomous shuttles with routes and schedules based on real-time passenger demand, instead of following fixed itineraries and pre-determined timetables.

Avenue's objective is to showcase these customized transport solutions at demonstrator sites in Copenhagen, Geneva, Luxembourg and Lyon, and later duplicate them in several other European cities.

The Belle-Idée site, Thônex, Geneva, Switzerland with up to 40 possible on demand stops.

Work package **WP4** aims to design, develop, adapt and integrate services to support users of autonomous shuttles 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 shuttle specific transport and passenger services
- Provide services that foster the acceptance of autonomous shuttles by both passengers and people interacting with the vehicle
- Introduce safety related services

The purpose of **task T4.1** is to adapt and integrate existing transport services into Avenue services' platform. Their adaptation and integration into Avenue services ecosystem will depend on the public transport operator and the self-driving vehicle specific requirements, the technical and economic feasibility and the user needs as defined in WP2.

In **deliverable D4.1**, the main focus is on the **identification and adaptation of existing transport services** as used by the four public transport operators as well as the definition of autonomous shuttle specific services.

Each service comes with a description including the public transport operator's priority to implement the service and is divided in transport, in- and out of vehicle services as stated in WP4.

2. Services

2.1. Vehicle dispatching related

On demand door-to-door transport solutions by means of a number of autonomous shuttles serving passengers in a geographic area, require an automatic dispatching system for the planning and allocation of vehicles.

The dispatching solution therefore is the core component of operating autonomous shuttles with routes and schedules based on real-time passenger demand, instead of following fixed itineraries and pre-determined timetables.

With vehicle dispatching, passengers are matched to vehicles according to the order in which passengers book a vehicle and the proximity and availability of vehicles to each passenger's pick-up location. Vehicles may be booked in advance, with priority, individually and in groups depending on the type of service. Passengers can book a vehicle with the use of a mobile phone application, website or via the help of a telephone operator.

The automatized service carries out all of the planning tasks: from allocating vehicles through to reacting to disruptions and cancellations. The service needs to be kept completely up to date in order to provide a complete picture of the current operating situation: fleet status, actual data from the network, in addition to service interval statuses and disruption reports from the vehicles.

The vehicle dispatching service will provide the key information for organising the travel of passengers and allows the operator to optimally manage transport operations.

2.1.1. Basic set of requests

Category	Transport services
PTO service	Autonomous shuttle specific
PTO requirement	High

Development / adaptation	BestMile / Navya / PTO
Technical integration	BestMile / Navya / PTO
Technical requirements	
Reference	

- Sent vehicle One from point A to point D via point B
- Travelling from point A to point B :
    - When does the vehicle arrive in A?
    - How long will it take to travel from A to B?
- What public transport connections are available based on time table and real traffic data
- Minimum waiting time at arrival at Hub connection and/or vehicle waiting time
- Arrival time and trip time notification tolerances
- Time delayed requests

Possible Avenue solutions could be (a mix of):

A platform comprising a set of services or modules capable to match passengers with vehicles that can serve the request, reroute vehicles, optimize their trip and dispatch a vehicle to the requested location.

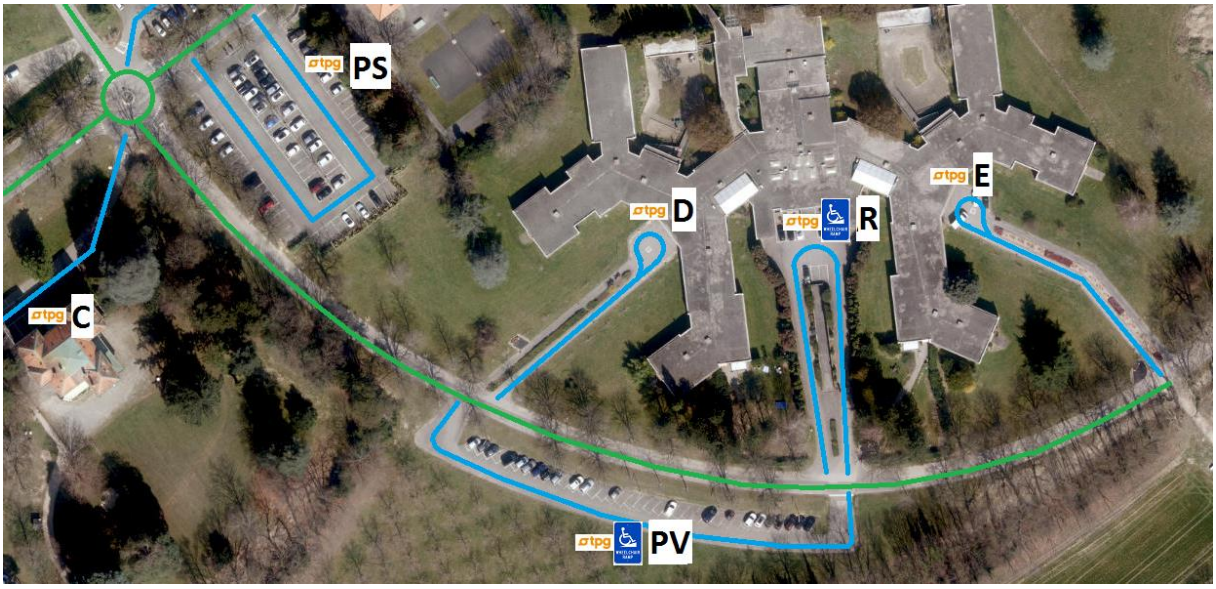
2.2. Bus stop related

A bus stop is a designated place where buses stop for passengers to board or alight from a bus. The construction of bus stops tends to reflect the level of usage, where stops at busy locations may have shelters, seating, electronic passenger information systems and easy access for individuals with disabilities; less busy stops may use a simple pole and flag to mark the location. Bus stops are, in some locations, clustered together into transport hubs allowing interchange between routes from nearby stops and with other public transport modes to maximise convenience.

In order to offer an optimum door-to-door service, the ideal bus stop would be defined by the exact geographical coordinates from the user the moment he/she wishes to board or alight from a bus.

Due to safety issues regarding the prevention of passengers trying to board or alight in hazardous situations as well as the current available technology, and the existing regulatory framework, it is clear that even in the best of situations the vehicle would not be able to just stop anywhere the passenger wants (like with taxis, where a vigilant taxi driver will only stop where it is safe and legal).

One solution that we will test within Avenue is to define multiple virtual and safe stops in a small area. In front of every house in a street or next to every parking space at a parking lot for example. Hence, we want to be able to specify multiple on-demand bus-stops without marking the location.



Belle-Idée site, Thônex, Geneva, Switzerland multiple on-demand bus-stop points and areas

Nb. a parking lot could perhaps be defined as a virtual perimeter for a real-world geographic area.

When looking at the technical perspective, two types of bus stops can be identified:

1. Stop point
   - Bus stop at a designated place with or without infrastructure to mark location
   - Transport hub (connection) possible. Needs stop location information including an identifier, location and live timetable for each stop in order to plan connections

2. Stop area
   - Multiple pre-defined stops in a small area
   - No infrastructure to mark the location at stop location
   - No other possible public transport connections

On-demand door-to-door services require multiple bus stops. This means that we have to define some strategic bus stops with a specific level of infrastructure including for example easy access for individuals with disabilities. The rest of the bus stops will then be “virtual” without marking the location.

For security reasons, the public transport operator always identifies and defines the bus stops in consultations with (local) authorities and in case of private property, the owner of the site.

Bus stops in a stop area are always virtual and most strategic bus stops are of the stop point type.

Stop point bus stops can also be equipped with a charging system in order to recharge the traction batteries of electric vehicles.

2.2.1 Electronic Passenger information system

Category	Transport services / Out-of-vehicle services
PTO service	Existing
PTO requirement	Medium
Development / adaptation	BestMile / MobileThinking / PTO / Siemens
Technical integration	
Technical requirements	
Reference	

Most public transport operators display transport information on electronic screens, especially at busy stop locations. These passenger information systems principally display the time until the next bus arrives as well as the current status of a disruption within the network. Screens are basic and designed to resist.

In order to display more detailed information, more advanced electronic screens are installed, which are expensive and prone to vandalism.

Some operators use ticket vending machines with an electronic screen built-in which could possibly display detailed information. However, ticket vending systems will soon be outdated / removed.

An on-demand door-to-door transport network requires a large number of bus-stops which are mostly virtual and do not have any regular bus-stop infrastructure which means that there is no possibility to install an electronic passenger information system.

Possible Avenue solutions could be (a mix of):

- offer traveller information via a mobile application
- install a fixed electronic screen at a bus-stop with infrastructure

2.2.2. On demand vehicle request

Category	Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	Amobility / BestMile / MobileThinking / PTO / Siemens

Technical integration	BestMile / MobileThinking / PTO
Technical requirements	
Reference	D2.13 – 2.2 – 3.1.2 – 3.3.5

In order to request a bus to stop while you are waiting at a bus stop, you sometimes have to wave your hand at the bus driver to signal that you want to get on the bus.

An autonomous shuttle will not react to this hand gesture simply because it is a driverless vehicle and the available technology doesn't recognize a hand gesture.

Some public transport operators offer a mobile travel application that shows you the nearest bus stop, depending on your GPS location, including information like the way to walk to the stop and the available bus line number(s).

On-demand services require a way to book a vehicle from a bus stop which could be a simple "request autonomous shuttle" button which connects you with the (telephone) helpdesk or confirms you that an autonomous shuttle is on its way. A request button can be powered by batteries but always requires a fixed bus-stop with a certain amount of infrastructure.

Possible Avenue solutions could be (a mix of):

- Install vehicle request button at a bus-stop
- Show nearest bus-stop on a map via a mobile application
- Offer vehicle request button via a mobile application

2.2.3. Special-needs-specific

Category	Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	
Technical integration	
Technical requirements	
Reference	

Bus stop platforms are designed to offer step-free access, to accommodate wheelchairs and to enable the special needs individual to easily enter a vehicle. The visually impaired are guided by a

system of textured ground surface indicators to assist them to a place on the platform where the doors of the vehicle will open. Barrier-free travel is legally defined.

Autonomous shuttles will also stop at bus-stops without any infrastructure. Possible solutions to compensate the absence of a bus-stop platform could be to equip the vehicles with a wheelchair ramp and use a mobile application with audio recordings for the visually impaired to help them find the entrance of the vehicle.

2.2.4. Vending machines

Transport tickets will be processed automatically within several years and vending machines at bus stops will disappear.

Solutions may be to equip vehicles with a vending machine or find a mobile solution to charge passengers for their trip. More on payments in chapter 2.5.

2.3. Vehicle related

Public transport companies equip their vehicles with a device (in French the SAEIV) in order to optimize transport operations. This device is generally set up in an urban transport network in order to locate vehicles and track their operation using different tools such as GPS and an odometer. Traveller information systems are included as well.

For the transport operator, the real-time monitoring of the operation such as follow-up of driver service, punctuality and regularity, enables real-time action to maintain the quality of service of the network.

Real-time calculation of transit times estimated at stops allows travellers to know the time of passage of future buses or trams on various media such as information screens and smartphones through dedicated applications or receiving SMS, etc.

Existing public transport operator's information systems can include the following functionality:

- GPS information
- Passenger counting
- Passenger information on inboard screens
- Radio contact between vehicle supervisor, operator and control room
- Electronic information display in front of vehicle
- Pre-recorded vocal messages

The information is transmitted to the transport operator's system via a live connection. Video streams and vehicle data are mostly transferred separately.

In order to integrate the autonomous shuttle within the existing vehicle fleet it is important that every operator **either** has the possibility to install/connect his/her device in their vehicle(s) **or** has access to several existing systems inside the vehicle. This may require a gateway to be able to push the information.

2.3.1. On demand stop

Category	In-vehicle services / Transport services
PTO service	Existing
PTO requirement	Medium
Development / adaptation	BestMile / MobileThinking / Navya / PTO / Siemens
Technical integration	
Technical requirements	
Reference	D2.13 – 2.2

Currently, within a fixed route system, there are three main kinds of stops: Scheduled stops, at which the bus should stop irrespective of demand; request stops or flag stop, at which the vehicle will stop only on request; and hail and ride stops, at which a vehicle will stop anywhere along the designated section of road on request.

Certain stops may be restricted to "discharge/set-down only" or "pick-up only". Within a fixed timetable transport system, some stops may be designated as "timing points", and if the vehicle is ahead of schedule it will wait there to ensure correct synchronization with the timetable or arrival of another connection. In dense urban areas where bus volumes are high, skip-stops are sometimes used to increase efficiency and reduce delays at bus stops.

One or more stop buttons are located inside the vehicle to inform the driver that the passenger wants to alight from the bus at the next bus stop.

On-demand public transport services allow you to book a vehicle to transport you from point A to B. This means that you already pre-defined the start- and end point of your trip and that you don’t need an on demand stop. That is unless you have to cancel your trip while you are already travelling.

Possible Avenue solutions could be (a mix of):

- Physical stop button inside the vehicle
- Stop button via a mobile application

2.2.2 On demand vehicle request and 2.3.1 On demand stop are very similar

2.3.2. Passenger counting

Category	In-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific

PTO requirement	High
Development / adaptation	BestMile / Certh / MobileThinking / Navya / PTO
Technical integration	BestMile / Navya / PTO
Technical requirements	
Reference	D2.13 – 2.3

An Automated Passenger Counter (APC) is an electronic device available for installation on vehicles which records boarding and alighting data. These systems are being used to help organize and analyse data and to enable to answer questions and solve problems relevant to the mission of an organization.

Transport companies are keen to regulate passenger travelling patterns in order to schedule timely bus, tramway and metro arrivals and departures and design routes accordingly. These patterns also help in the business development and optimize operational costs.

Currently, transport operators have sensors installed at every door in their vehicles, this way every head, mass, volume or unit who board or alight from a vehicle is counted.

For data analyses, transport companies use several ways to take care of the download or transmission of the information, by:

- Radio (live data)
- USB key
- Wifi (when entering depot)

A robotised driverless transport network needs an advanced passenger counting system to estimate the space occupied in the autonomous shuttle in order for the fleet management system to work.

2.3.3. Radio contact

Category	In-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	Amobility / BestMile / Navya / PTO / Siemens
Technical integration	
Technical requirements	
Reference	D2.13 – 3.1.5.5

Bus and tramway drivers have the possibility to contact the public transport operator control room by radio and vice versa.

In driverless mode, a safety driver oversees the autonomous shuttle from a distance. It is desirable that passengers have the possibility to contact this person in case of an emergency. The safety driver can subsequently contact the public transport operators control room.

Existing public transport operator's radio contact services establish a direct connection between the interior of the vehicle and the person overseeing the operation of the vehicle. Interphone services register date, time and ID, and can be combined with video images.

By activating the emergency button, a recorded voice could ask some predefined questions in order to understand the gravity of the situation. In case of a passenger injury, emergency services could be called directly.

2.3.4. Vocal passenger info

Category	In-vehicle services / Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	Amobility / BestMile / Navya / PTO
Technical integration	
Technical requirements	
Reference	D2.13 – 3.1.5.4

Transport operators use **pre-recorded** service announcements in their vehicles which can be played following the GPS position of the vehicle, by the driver or at distance, for example:

- Be aware of pick-pockets
- Stand away from the doors please
- Warning: final stop at next station

We have to make use of this system to optimize user experience and safety measures.

- Welcome on board, please take a seat and attach your seatbelt
- The next stop is "Götenburg Plads", this is a special needs stop, connection Tram 12

Announcements can also include practical and cultural information as well as publicity.

Possible Avenue solutions could be (a mix of):

- Rich information and service announcements via the in-vehicle speaker system
- Rich information and service announcements via a mobile application

2.3.5. In-vehicle display information

Category	In-vehicle services / Out-of-vehicle services / Transport services
PTO service	Existing
PTO requirement	High
Development / adaptation	Amobility / MobileThinking / Siemens
Technical integration	BestMile / MobileThinking / Navya / PTO
Technical requirements	
Reference	

Public transport companies display traveller info on digital screens inside their vehicles. The following information is displayed:

- Name of next (two, three) stops
- Wheel chair accessible symbol
- Time it takes to arrive
- Hub connection(s) bus/tram/metro line numbers
- Other travel information
- Advertisement

An on demand door-to-door transport network requires that the same information is displayed.

2.3.6. Out-of-vehicle display information

Category	Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	Navya / PTO / Siemens
Technical integration	Navya

Technical requirements	
Reference	D2.13 – 3.1.5.6

Information such as a bus-line number, final bus-stop and service announcements are displayed on electronic screens which are visible from the outside of the vehicle. These screens can be mounted in the front, the rear and sometimes the left and right side of the vehicle.

In case a passenger ordered an autonomous shuttle and due to a large number of passengers waiting in the same location more than one vehicle arrives at the same bus stop at the same time. Each passenger thus has to be able to identify the vehicle he or she booked.

In an on-demand transport system each vehicle changes direction on the go; therefore there will never be a final destination nor a predefined route such as: T1 Part-Dieu train station via Debourg.

Hence, we may simply display **an ID** on the outside vehicle information system “Pfaffenthal ONE”

Visually impaired people may receive an audio message from the Application with an indication on how to identify and board the vehicle.

In current vehicles the driver is the contact point between the bus and Vulnerable Road Users (VRU). When a driver sees a pedestrian on the road hesitating or trying to cross the driver may slow down and let the pedestrian cross. This may be done by visual / Gesture communication between the driver and the pedestrian.

Having no driver in an autonomous vehicle, the external screen can be used to exchange with the pedestrian who is hesitating to cross the street. A visual contact can be done by displaying for example “You can cross safely now”.

Public transport operators need to have the possibility to change the information displayed.

2.3.7. Video images

Category	In-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	BestMile / Certh / Navya / PTO
Technical integration	BestMile / Navya / PTO
Technical requirements	
Reference	D2.13 - 3.2

Public transport operators record video images for safety in the event of an incident, aggression or illness for example. Video streams can be stored on a hard-disk or other storage device (blackbox) for a defined moment of time and also live transferred to a control room.

Public transport operators have access to the images from the blackbox.

Due to GDPR regulations, cross border data transfer and display of images other than for a pre-defined group of people is legally not possible in most countries. Others may set up data handling agreements between the involved parties.

GDPR is a regulation in EU law on data protection and privacy for all individuals within the European Union (EU) and the European Economic Area (EEA)

As part of the approval process, public transport operators have to legally define video data transfer, including but not limited to video camera angles, system description including data transfer and storage as well as the people allowed watching the video streams.

Video streams have to be transferred directly between the vehicle and the public transport operator.

When we drive in driverless mode, without a safety driver, a supervisor will probably oversee the running of the shuttles from within an office behind a computer screen. In order to supervise the state of the vehicles and wellbeing of the passengers at distance, a direct live video stream connection needs to be established between the vehicle and the public transport operator.

Video images can also be used in order to estimate the available interior space for vehicle dispatching as well as regarding passenger counting for public transport operator analytics.

Possible Avenue solutions could be (a mix of):

- video stream directly to storage device (blackbox) in vehicle for safety analyses
- video stream directly to transport operator for human supervision at distance
- In-vehicle processing of images for estimation of interior space and counting of passengers

2.3.8. Emergency stop mechanism

Category	In-vehicle services / Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	BestMile / Certh / Navya / PTO / Siemens
Technical integration	
Technical requirements	
Reference	

Passengers and bus drivers have the possibility to stop a vehicle by using the in-vehicle emergency stop mechanism.

Two methods can be anticipated (to check on legal requirements). First method when we drive in driverless mode, without a safety driver on board, a supervisor will probably oversee the running of the autonomous shuttles from within an office behind a computer screen. Hence, public transport operator's need to have the possibility to remotely stop the vehicle in an emergency situation.

A second method can be the installation of an emergency handle that does not require a remote operator mediator, and which will stop the bus instantly.

Remote control of the opening of the doors and switching of the shuttle should also be discussed.

Passengers are able to open the doors mechanically via an emergency device located in the vehicle.

The BestMile operator dashboard had a built-in possibility to remotely stop a vehicle in the first Operator Dashboard version.

Possible Avenue solutions could be (a mix of):

- Passenger awareness regarding the possibility to stop a vehicle in an emergency situation
- Tools for the human supervisor to remotely control some vehicle functions

2.3.9. Special-needs-specific

Category	In-vehicle services / Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	Amobility / Certh / Navya / PTO / Siemens
Technical integration	Navya
Technical requirements	
Reference	

Transport operators deploy vehicles that are designed for people with reduced mobility. They are equipped with an access ramp and fitted inside with tie down points to secure a wheelchair. In-vehicle elements are furnished with a bright colour for the visually impaired. The height of door buttons placements is legally defined.

2.3.10. Wifi

Category	In-vehicle-services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Low
Development / adaptation	Navya
Technical integration	Navya
Technical requirements	
Reference	

Public transport operators offer passengers free internet access via WiFi in some of their vehicles, (via which services can be offered).

Given the introduction of 4G/5G we do not need to equip our autonomous shuttles with WiFi.

2.3.11. Battery charging

Category	Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	BestMile / Navya / PTO
Technical integration	BestMile / Navya / PTO
Technical requirements	
Reference	

Traction batteries of electric vehicles have to be charged between 6-8 hours in order to be able to drive for several hours. This means that at night charging doesn't allow the public transport operator to complete a full service during the day without charging. Hence, electric vehicles are charged via a pantograph or an induction charger at a specific bus stop. Vehicles receive a flash charge or are sent to a specific charging location in order to perform an intermediate recharge at off peak hours.

Some infrastructure providers are also testing solar charging system in the bitumen of the road itself. Collecting the annual energy needed for the shuttle. This collection can be further combined with a flash charging system that can be installed near the bus stops to push flash or micro charging via another system without losing any energy in the process. Such solutions are still under experimentation in some projects and not yet in industrial production.

The transport operator and fleet management software needs to know the state of charge of the vehicle battery. This telemetry data is made available by the vehicle constructor. Public transport operators need to have access to this data as well.

Transport operators use software tools and hourly performance simulations regarding battery capacity and charging for electric busses. We need similar data regarding the autonomous vehicles.

2.3.12. Vehicle statistics

Category	Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	BestMile / Navya / PTO
Technical integration	BestMile / Navya / PTO
Technical requirements	
Reference	

The transport operators need to receive the statistics concerning the choice of transport and traveller frequencies. This info can be extracted from the data stream from the vehicle (with related software to bring out the statistics) in combination with routing data from BestMile.

2.3.13. Vehicle maintenance

Category	Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	BestMile / Navya / PTO
Technical integration	

Technical requirements	
Reference	

Transport operators store their vehicles in depots and workshops where they will be regularly examined, maintained or come in for repair during the hours they are out of service. Most public transport operators have to transport their autonomous shuttles to a workshop for inspection since they are not allowed to use public roads outside their pre-defined route.

Hence, for maintenance purposes we have to receive as much as possible information regarding the technical state of the vehicle in order to plan an intervention, and for example also:

- Tire pressure
- Internal Pc temperature
- Energy consummation
- State of sensors

Full in-house maintenance of vehicles falls outside the scope of WP4.

2.4. Passenger related

Passengers retrieve travel information from websites as well as mobile applications and can contact the public transport operator directly in order to plan or book their trip. Personal advice and travel tools can help to offer the following functionality and information.

2.4.1. Book a ride

Category	Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	MobileThinking / PTO / Siemens
Technical integration	BestMile / MobileThinking / Navya / PTO
Technical requirements	
Reference	D2.13 – 3.3.3

On demand public transport services allow you to book a vehicle to pick you up from either home or a convenient location, take you to a local transport hub or point of interest and vice versa.

Within a fixed timetable **and** pre-defined route transport system, there is no need to order or book a vehicle. On a non-timetable route we can use an on demand service. Bookings can be:

- Private
- Pooling (pick-up on the way)
- Daily/monthly vehicle (pre-booking)
- Reschedule
- Cancel booking

A full on demand door-to-door service enables passengers to make a reservation by requesting to be picked up and dropped off at any bus stop within defined areas and during designated hours.

Reservations could be made by the use of a mobile application, website or via a telephone operator.

Websites as well as applications on a mobile device can be used by:

- Passenger
- Someone who can help the passenger
- Someone strategic at a bus stop (receptionist hotel, etc)
- Assistant at the Help-line (this can also be one of the operators in or outside the vehicle)

Before a booking service will be available the vehicle can either follow a pre-defined route or can be placed at a strategic bus stop.

There is also an increasing need for flexible arrangements of transport that allow passengers to reschedule rides to fulfil work urgency and last minute schedule changes.

2.4.2. Trip planning

Category	Out-of-vehicle services / Transport services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	BestMile / MobileThinking / Navya / PTO / Siemens
Technical integration	BestMile / MobileThinking / Navya / PTO
Technical requirements	
Reference	D2.13 - 3.1.1 – 3.1.3

A journey planner, trip planner, or route planner is a specialised search engine used to find an optimal means of travelling between two or more given locations, sometimes using more than one transport mode.

Searches may be optimised on different criteria, for example fastest, shortest, fewest changes, cheapest. They may be constrained for example to leave or arrive at a certain time, to avoid certain waypoints, etc.

In order to integrate autonomous shuttle services within a transport system we have to at least use one joint bus stop in the transport network which will serve as Hub connection. Live data regarding the network needs to be available at this stop point. A connection between the Avenue planner and the existing public transport operator's trip planner is necessary. Connections with other mobility initiatives should be optional.

The autonomous shuttles have to adjust their schedule in order to synchronize with fixed routes, fixed timetable connections from existing bus and tram lines.

The number of lines and number of Hub connections equals the number of possible connections.

The Avenue dispatching service will only propose the autonomous shuttle network part of the trip and will communicate this information with the existing public transport operator trip planner.

2.4.3. Visualisation path/destination

Category	In-vehicle services / Out-of-vehicle services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	Amobility / BestMile / MobileThinking / Navya / PTO / Siemens
Technical integration	
Technical requirements	
Reference	D2.13 – 2.1

Current transport operator applications and websites show a list with pre-defined routes including bus stops and a fixed time table. In transport terms the so called "thermometer"

With the existing transport operator tools passengers are able to identify:

- Where am I?
- Where is my bus?
- How long will it take for my bus to arrive here (time, km, route)?
- How long will it take for my bus to arrive where I want to go (time, km, route)?
- How much does my travel cost?

Most passengers know the name of their destination or a point of interest nearby (not the name of the bus stop). They are however not able to pinpoint a destination on a map.

Existing transport tools display items (blocks) on a list holding the following information:

- Vehicle (busline) identifier
- Name of stop
- Description of stop
- Wheel-chair-accessible symbol
- Time it takes to arrive
- Hub connection(s) bus/tram/metro numbers

Within the Avenue project we could also display the amount of available space inside de vehicle.

2.4.4. Application specific

Category	Out-of-vehicle services
PTO service	Existing / Autonomous shuttle specific
PTO requirement	Medium
Development / adaptation	BestMile / MobileThinking / PTO / Siemens
Technical integration	BestMile / MobileThinking / PTO
Technical requirements	
Reference	

Existing public transport operators Application functionality:

- Search
- Next to (find the nearest bus stop next to me)
- Planner
- Special needs related
- Tickets (online, Sms)
- Info traffic
- Calendar scheduled bookings
- Favourite bus stops
- History access to past bookings
- SMS notification of booking
- Parameters

Existing public transport operators Application information:

- Contact
- Legal
- Non warranty

- Transport conditions
- Description of the public transport operator
- Description of a specific transport project
- Partners

2.5. Payment related

Category	Transport services / In-vehicle services / Out-of-vehicle services
PTO service	Existing
PTO requirement	Medium
Development / adaptation	Discarded (in WP2)
Technical integration	
Technical requirements	
Reference	

Most public transport requires the purchase of a ticket. Tickets may be bought either in advance, or at the time of the journey. Passengers may be issued with a paper ticket, or a magnetic or electronic card (smart card, contactless smart card). Sometimes a ticket has to be validated, e.g. a paper ticket has to be stamped, or an electronic ticket has to be checked in.

Tickets may be valid for a single trip or valid within a certain area for a period of time. The fare is based on the travelled distance or based on zone pricing and may offer discount for students, elderly, children, and the physically or mentally disabled.

The tickets may have to be shown or checked automatically at the bus stop or when boarding. A proof-of-payment system may allow passengers to enter the vehicles without showing the ticket, but passengers may or may not be controlled by a ticket controller; if the passenger fails to show proof of payment, the operator may fine the passenger.

Multi-use tickets allow travel more than once. In addition to return tickets, this includes period cards allowing travel within a certain area, or during a given number of days that can be chosen within a longer period of time. Period tickets may be for a particular route, or for a whole network. A free travel pass allows free and unlimited travel.

Some operators will use a free of charge autonomous shuttle service or have converted their entire bus networks to zero-fare. Commonly used payment methods are:

- Vending machine tickets
- Annual/monthly/day pass
- Prepaid card

- Sms ticket
- Passes for people with reduced mobility
- National travel passes
- Payasyougo

2.6. Technical integration

Category	Integration to the existing PTO services' platforms
PTO service	Existing / Autonomous shuttle specific
PTO requirement	High
Development / adaptation	BestMile / MobileThinking
Technical integration	BestMile / MobileThinking / PTO
Technical requirements	
Reference	

Modern passenger information systems and journey planners require a standard IT architecture which specifies communication protocols and hardware interfaces to offer full interoperability of IT systems in Public Transport applications. Based on open technology, it needs to give operators and organizing authorities the possibility to use public transport data anywhere in Europe through common mechanisms, standard rules and protocols.

2.7. Next steps

The next steps within **T4.1** will be to determine:

- which services are technically feasible to implement.
- which project partner(s) are going to design, develop and/or adapt the proposed service.
- which project partner(s) are going to technically integrate the proposed service.
- what technical parameters are required to integrate the proposed service.
- the way to integrate the proposed service.
- What is the economical equation if the service is to be commercial

The service development and/or adaptation process is part of WP2 and WP4 Task 2 and 3.

The adaptation and integration process is part of WP4 Task 1 and 4 as well as WP5.