AVENUE

Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE 3.9

Initial Twinning with International pilots report

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Acronyms

ADS	Automated Driving Systems
AI	Artificial Intelligence
AM	Automated Mobility
API	Application Protocol Interface
AV	Automated Vehicle
BM	Bestmile
BMM	Business Modelling Manager
CAV	Connected and Automated Vehicles
CB	Consortium Body
CERN	European Organization for Nuclear Research
D7.1	Deliverable 7.1
DC	Demonstration Coordinator
DI	The department of infrastructure (Swiss Canton of Geneva)
DMP	Data Management Plan
DSES	Department of Security and Economy - Traffic Police (Swiss Canton of Geneva)
DTU test track	Technical University of Denmark test track
EAB	External Advisory Board
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	(Swiss) Federal Roads Office
FOT	(Swiss) Federal Office of Transport
GDPR	General Data Protection Regulation
GIMS	Geneva International Motor Show
GNSS	Global Navigation Satellite System
HARA	Hazard Analysis and Risk Assessment
IPR	Intellectual Property Rights
IT	Information Technology
ITU	International Telecommunications Union
LA	Leading Author
LIDAR	Light Detection And Ranging
MEM	Monitoring and Evaluation Manager
MT	MobileThinking
OCT	General Transport Directorate of the Canton of Geneva
ODD	Operational Domain Design
OEDR	Object And Event Detection And Response
OFCOM	(Swiss) 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
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	(Swiss) Cantonal Vehicle Service
SDK	Software Development Kit
SLA	Sales Lentz Autocars
SMB	Site Management Board
SoA	State of the Art
SOTIF	Safety Of The Intended Functionality
SWOT	Strengths, Weaknesses, Opportunities, and Threats.
T7.1	Task 7.1
TM	Technical Manager
TPG	Transport Publics Genevois
UITP	Union Internationale des Transports Publics (International Transport Union)
V2I	Vehicle to Infrastructure communication
WP	Work Package
WPL	Work Package Leader

Executive Summary

One of the means not only to reinforce the collaborations, diffuse the project results and import knowledge from other similar project, but also to share the platform for common experimentation.
In this sense awe need to establish a formal collaboration.
The twining initiatives were frozen for more the first 18 months, on request of the EU, in view a global agreement that was under negotiations. However we had already identified potentially interesting sites with the ok from the EU, we started the negotiations for a formal collaboration agreement, with the most relevant project, giving a special interest , and with special interest the DoT projects in the USA.
The identified three projects were *MCity* in the USA (A DoT supported project), *beep* in the USA, and ST Engineering at Singapore. In this deliverable we describe the activities and context for the twining with the identified projects.

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 Automated 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 Automated 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 Automated 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 Automated vehicles will become the future solution for public transport. The AVENUE project will demonstrate the economic, environmental and social potential of Automated 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 Automated 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 Fully Automated Vehicles

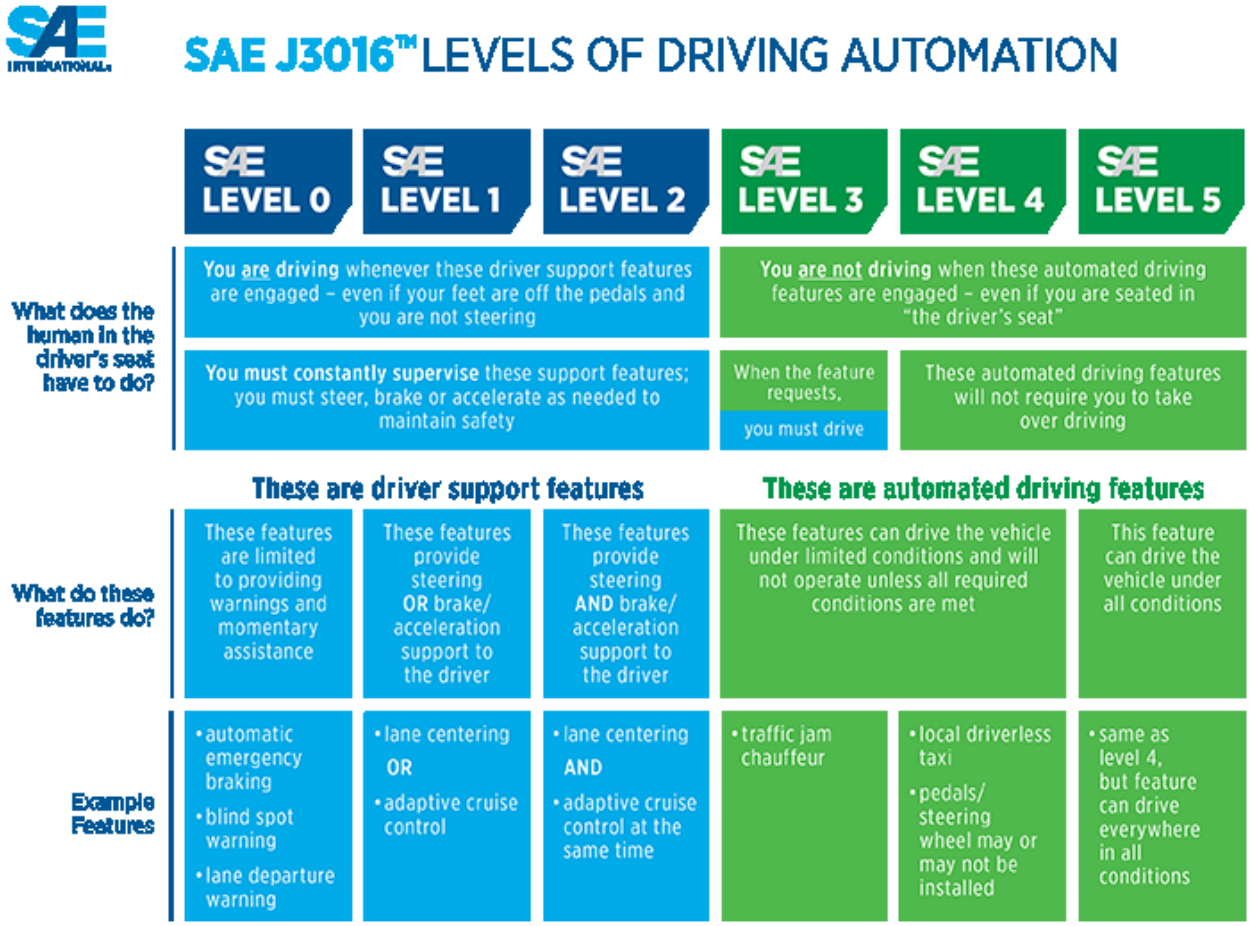
A self-driving car, referred in the AVENUE project as **a Fully Automated Vehicle** (**AV**), also referred as Autonomous Vehicle, is a vehicle that is capable of sensing its environment and moving safely with no human input.

The terms *automated vehicles* and *autonomous vehicles* are often used together. The Regulation 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles defines "automated vehicle" and "fully automated vehicle" based on their autonomous capacity:

- An "automated vehicle" means a motor vehicle designed and constructed to move autonomously for certain periods of time without continuous driver supervision but in respect of which driver intervention is still expected or required
- "fully automated vehicle" means a motor vehicle that has been designed and constructed to move autonomously without any driver supervision

In AVENUE we operate ***Fully Automated minibuses for public transport***, (previously referred as Autonomous shuttles, or Autonomous buses), and we refer to them as simply *Automated minibuses* or *the AVENUE minibuses.*

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



1.2.1 Automated 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 Automated 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 Automated 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 Automated vehicle capabilities in AVENUE

The Automated vehicles employed in AVENUE fully and automatically manage the above defined, micro-navigation and road behaviour, in an open street environment. The vehicles are Automatically capable to recognise obstacles (and identify some of them), identify moving and stationary objects, and Automatically decide to bypass them or wait behind them, based on the defined policies. For example with small changes in its route the AVENUE mini-bus is able to bypass a parked car, while it will slow down and follow behind a slowly moving car. The AVENUE mini-buses 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 mini-buses 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.

Due to legal requirements a **Safety Operator** must always be present in the vehicle, able to take control any moment. Additionally, at the control room, a **Supervisor** is present controlling the fleet operations. An **Intervention Team** is present in the deployment area ready to intervene in case of incident to any of the mini-busses.

1.3 Preamble

Work package 3 “Cooperation for value creation” aims to gather different stakeholders involved in autonomous vehicles projects and to create a web of collaborations to reach a broader spectrum of people to maximize the output value of AVENUE.

Task 3.4 targets the creation of formal collaborations via twining with other non-european projects. Three non-european projects were finally retained for a twining collaboration, the DoT funded MCity project in the USA, the beep project in the USA and the ST-Engineering project in Singapore.

2 Twining projects and targets

From the beginning of the project our target was to sign twining collaboration agreements with international project, where one or two would had been in the USA and supported by the DoT. Several potentially interesting projects were identified, both in the USA and internationally with similar targets as AVENUE.
However, in order to select the site/project we considered that the candidates must have or have set targets that are as ambitious as in AVENUE. At the same time the candidate should have the same maturity or at least a rich one regarding the experience on Automated shuttle and their impact on public transport.
In 2019 and 2020 many sites were operating experimental Automated Vehicle trials, but with limited ambition (simple 1-2 km circle for a few hours). Very few sites were considering Public transportation and even less were considering future expansion and scaling up. Very few sites do operate the whole date, each date of the week and for several month.
In addition in many sites the vehicles uses were unique prototypes (only 1 or 2 were built as proof of concept and further study). These sites were interested to experiment automated vehicle operation, rather than transport services. This reduced the number of potential sites a very small number, and namely sites using “commercially available” mini-buses (like NAVYA or EasyMile).

As a result the number of potentially interesting sites was very limited. In late 2020, three sites were finally selected and formal negotiations started in early 2021.

2.1 Structure of the work

2.1.1.1 Preparation and prospection

Based on the previously described prerequisites, work was started to prepare the approach toward the stakeholders: which relevant stakeholders, does the AV deploimeent is a one shot opportunity or written in their strategy, level of maturity, potential of collaboration, …

At the same time, a preparation of the way to approach was defined and the collaboration domain as well as the methodology was prepared
Work was done with the partners and representatives in EU as well as with subsidiary, like NAVYA Corp in the US and NAVYA subsidiary lately created in Singapore.

2.1.2 Potential collaboration domains

In order to define the areas of collaboration with each twining site, we defined a set of 13 domains that are of major interest to AVENUE, and we proposed them to each twining site. In the discussions each site was able to select to which domains are interested to collaborate and whether are other domains, not included in our list, that can be of interest.
The domains identified by AVENUE and proposed to the twining sites were

1. End User needs (In/Out Services)
2. On-demand and platform
3. Role of the PTO
4. Business models
5. Stakeholders and barriers
6. Regulatory framework and homologation
7. Go TO Market barriers and current blocking points
8. Testing & security
9. Environmental impact
10. Economic impact
11. Social impact
12. Sustainability assessment
13. Potential user survey

Our list being complete and covering all the possible domains of interest, none of the twining sites proposed any new collaboration domain.

2.1.3 Collaboration methodology

The original idea for the twining collaboration was to organize site visits, common technical meeting, write co-authored papers and report and invite the twining representatives to selected General Meeting sessions. The COVID crisis forced us to modify this plan, making away of any physical meeting and site visits. Effectively we physical technical meetings were easily replaced with on-line meetings, but the visits of the sites remain difficult to organize. On option we have proposed is life on-line demonstrations, but this does not provide the same experience as a life, on-site demo. We hope that we will have the chance to organize site visits in the near future once the COVID restrictions are lifted and the sanitary salutation permits it.
Each site was proposed a NDA, so that confidential information can be presented in common meetings. The NDA was adapted for each site, depending on their internal requirements.

2.2 Twining partners

2.2.1 MCity -USA

The first candidate for twining was the **MCity** project . In fact the project had been identified at the time of the proposal submission and discussion had already started before the official start of the project, but were frozen at the request of the EU. We were however able to collaborate with MCity, by including the project director, Prof. Huei Peng, in the AVENUE advisory board.

The MCity project is a DoT funded project operating under the coordination of the University of Michigan. The project started in 2014 when the University of Michigan announced plans to launch an advanced mobility research center and Mcity to cultivate the diverse expertise and resources required to realize the potential of emerging mobility technologies, and their commercial and economic viability.

MCity target and work goes beyond technology and considers all aspects of the future of transportation and mobility, bringing together industry, government, and academia.

MCity is using several type of vehicles and different OEM providers.

The domains of collaboration with MCity are

1. End User needs (In/Out Services)
2. Business models
3. Environmental impact
4. Economic impact
5. Social impact
6. Sustainability assessment

Identity table	
Name	University of Michigan
Site	https://mcity.umich.edu
Country	USA
Role in the value Chaîne	Advanced research, test facilities, and not only technical but includes also Safety, Efficiency, Accessibility, Commercial, Economic Viability
Coverage	In the heart of Detroit, Michigan
Operational experiences	Several experiences made with AV vehicles and shuttles, one-of-a-kind test facilities

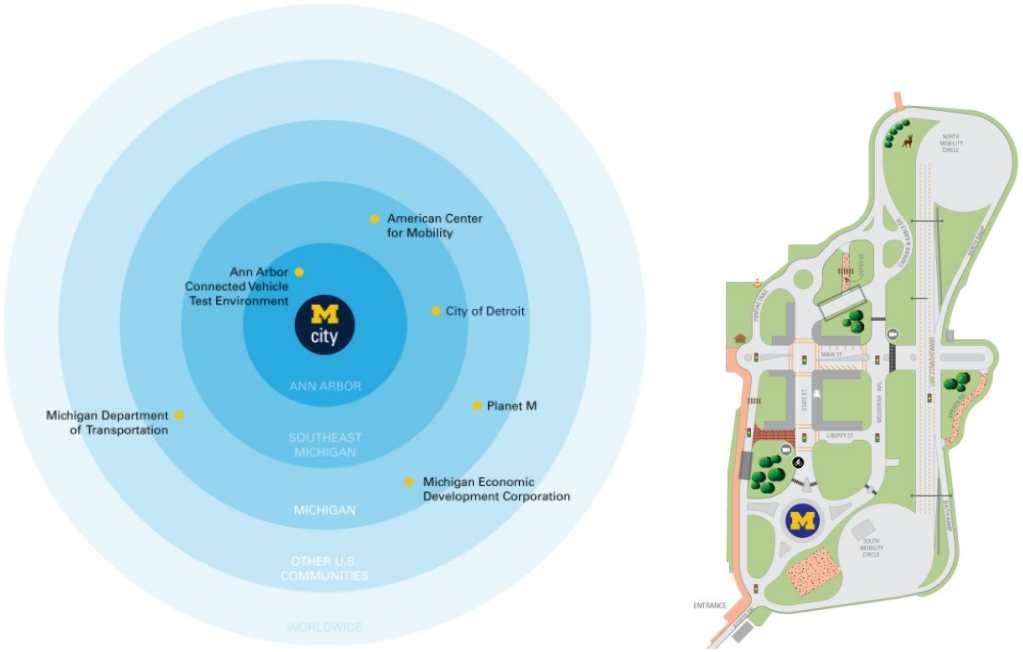


Figure 1 : coverage of MCity and test facilities

2.2.2 Beep - USA

Beep is a USA (Florida) company that provides autonomous mobility solutions founded in 2019.

Beep is an autonomous mobility solution company delivering the next generation of services for passenger mobility to fleet operators in planned communities and low speed environments across the public and private sector, including transportation hubs, medical and university campuses, town centers and more.
From route planning to interactive managed services, Beep's offerings are designed to drive differentiation and innovation, and delight the passengers of our customers.

The beep system and services provide the intelligence which enables safe, stress-free, eco-friendly, driverless mobility. Their offerings provide customers with turnkey mobility networks for scheduled and on-demand transportation services in first-mile, last-mile use cases.

Beep leads the entire launch, oversight, and ongoing management of all aspects for each deployment to deliver a safe, clean, high-quality, autonomous rider experience. Their software and command center always ensure rider safety through continuous monitoring oversight and personal interaction underpinned by the contextual and situational intelligence generated from each trip.

Beep operated in 7 USA sites: Mayo Clinic, Lake Nona, JTA, Tradition , City of Peoria, HART, PSTA. Yo be noted that the Lake Nona site is supported with a 20MUSD DoT grand.

Beep is using several type of shuttles and different OEM providers.

The domains of collaboration with beep are

1. End User needs (In/Out Services)

2. On-demand and platform
3. Role of the PTO
4. Business models
5. Go TO Market barriers and current blocking points
6. Testing & security
7. Economic impact
8. Sustainability assessment

Identity table	
Name	BEEP
Site	https://www.go-beep.com
Country	USA
Role in the value Chaîne	Transport Operator
Coverage	In the heart of Detroit, Michigan
Operational experiences	Several sites on the road with AV shuttles : Mayo Clinic in Florida COVID-19 Route Move Nona Jacksonville Transportation Authority Robo Ride Hart PSTA Tradition in Motion

2.3 ST Engineering - Singapore

Incorporated in 1997, Singapore Technologies Engineering Ltd (ST Engineering), one of the largest companies listed on The Singapore Exchange, is an integrated engineering group specialising in innovative solutions and services in the aerospace, electronics, land systems and marine sectors. A leader in each of these core businesses, ST Engineering leverages its multi-sector capabilities to be a one-stop solutions provider for its customers in over 100 countries.

ST Engineering Smart-City department targets the development of a smarter future, creating connected, resilient and sustainable cities. Their technologies address the connectivity, mobility, security, infrastructure and environmental needs of cities.

In the Mobility sector, ST Engineering provide transportation systems in over 40 cities worldwide, equipping them with smart, integrated mobility solutions. Their Public Transport Fleet Management system, provide tracking and monitoring of large vehicle fleets and optimizing supply and demand to improve operational efficiency, which is critical to operators (e.g. buses and taxis).

The AGIL Autonomous Vehicle (AV) Monitoring and Evaluation System enables real-time monitoring and automated evaluation of AV readiness for various traffic situations and environments. It provides an all-rounded assessment of AV behavior to ensure its safe deployment on the road. Powered by advanced

connectivity, sensors, and data analytics, the AGIL systemprovides all-round fleet management enhancement in operational efficiency, fleet visibility, performance evaluation and resource management.

ST Engineering is using several type of vehicles either buses and shuttles and different OEM providers.

The domains of collaboration with ST Engineering are

1. On-demand and platform
2. Role of the PTO
3. Business models
4. Environmental impact
5. Economic impact
6. Social impact
7. Sustainability assessment
8. Potential user survey

Identity table	
Name	ST Engineering, Division ST Engineering Autonomous Systems (STEAS) Under Smart Cities
Site	ST Engineering https://www.stengg.com/en/about/
Country	Singapore
Role in the value Chaîne	Transport Operator & technology leader
Coverage	ASIA Pacific and some other countries like Israel
Operational experiences	Several sites on the road with AV Buses and shuttles

3 Next steps

Our collaboration with the Twining sites will continue until the end of the project, with common meetings and exchange of information. Possible site visits will be organised if the sanitary situation permits.
A number of common reports will be written, bring experience from all sites and providing a comparison between the sites and their advancements.