Ref. Ares(2023)6061817 - 06/09/2023

Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE 3.10

Final Twinning with International pilots' report

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

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

Disclaimer

This document reflects only the author's view and the European Commission is not responsible for any use that may be made of the information it contains.

Document Information

Grant Agreement Number	**769033**
Full Title	Autonomous Vehicles to Evolve to a New Urban Experience
Acronym	AVENUE
Deliverable	D3.10 Final Twinning with International pilots' report
Due Date	31.10.2022
Work Package	WP3
Lead Partner	NAVYA, UNIGE
Leading Author	Vedran Vlajki
Dissemination Level	Public

Document History

Version	**Date**	**Author**	**Description of change**
0.1	15.4.2021	Vedran Vlajki	First draft
1.0	15.5.2021	Vedran Vlajki	First completed version
1.1	25.6.2021	Dimitri Konstantas	Review, updates on the current sate
1.2	30.6.2021	Vedran Vlajki	Error corrections
1.3	08.07.2021	Pierre CHEHWAN	Final review
2.1	08.11.2022	Vedran Vlajki, Dimitri Konstantas	Addition of closing activities for D3.10 (section 3)
3.0	04.09.2023	Helfer Laurent	Improvements and corrections

Table of Contents

List of Figures

List of Tables

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

The AVENUE project aims not only to establish and reinforce a formal collaboration and to diffuse the project results and import knowledge from other similar projects, but also to share the platform for common experimentation. On the EU request, the twining initiatives were frozen for the first 18 months of the AVENUE project in view of a global agreement that was under negotiation. However, we had already identified potentially interesting projects with the EU approval, and we started the negotiations for a formal collaboration agreement with the most relevant ones (with a special interest in US government financed DoT projects).

The three retained projects were the US-based MCity (supported by DoT) and Beep projects, and the Singaporean ST Engineering one. This deliverable, which is based on deliverable 3.9, describes the activities and context for the twining with the previously evoked international 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 based 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**), or as Autonomous Vehicle, is a vehicle that can sense 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.

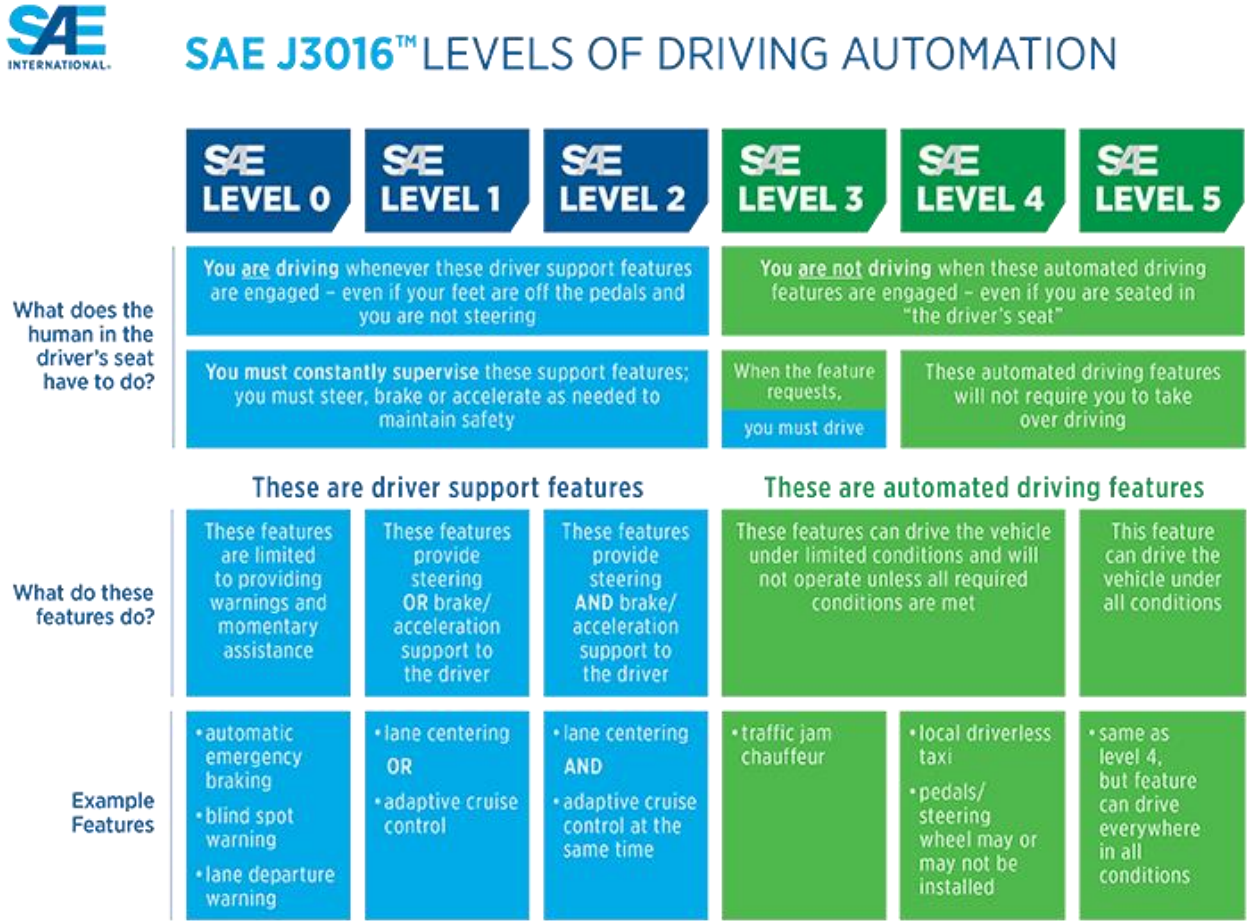

Table 1: *SAE Driving Automation levels (©2020 SAE International)*

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 of 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 considers 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 or wait behind them, based on the defined policies. For example, with small changes in its route the AVENUE minibus 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 minibuses 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 minibuses. Table 2 provides an overview of the AVENEU sites and ODDs.

	Summary of AVENUE operating sites demonstrators							
	TPG		Holo		Keolis	Sales-Lentz		
	Geneva		Copenhagen	Oslo	Lyon	Luxembourg		
Site	Meyrin	Belle-Idée	Nordhavn	Ormøya	ParcOL	Pfaffental	Contern	Esch sur Alzette
Funding	TPG	EU + TPG	EU + Holo	EU + Holo	EU + Keolis	EU + SLA	EU + SLA	EU + SLA
Start date of project	August 2017	May 2018	May 2017	August 2019	May 2017	June 2018	June 2018	February 2022
Start date of trial	July 2018	June 2020	September 2020	December 2019	November 2019	September 2018	September 2018	April 2022
Type of route	Fixed circular line	Area	Fixed circular line	Fixed circular line	Fixed circular line	Fixed circular line	Fixed circular line	Fixed circular line
Level of on-demand service*	Fixed route / Fixed stops	Flexible route / On-demand stops	Fixed route / Fixed stops	Fixed route / Fixed stops	Fixed route/Fixed stops	Fixed route / Fixed stops	Fixed route / Fixed stops	Fixed route / Fixed stops
Route length	2,1 km	38 hectares	1,3 km	1,6 km	1,3 km	1,2 km	2,3 km	1 km
Road environment	Open road	Semi-private	Open road	Open road	Open road	Public road	Public road	Main pedestrian road
Type of traffic	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Pedestrians, bicycles, delivery cars
Speed limit	30 km/h	30 km/h	30 km/h	30 km/h	8 to 10 km/h	30 km/h	50 km/h	20 km/h
Roundabouts	Yes	Yes	No	No	Yes	No	No	No
Traffic lights	No	No	No	No	Yes	Yes	Yes	No
Type of service	Fixed line	On demand	Fixed line	Fixed line	Fixed line	Fixed line	Fixed line	On Demand
Concession	Line (circular)	Area	Line (circular)	Line (circular)	Line (circular)	Line (circular)	Line (circular)	Line (circular)
Number of stops	4	> 35	6	6	2	4	2	3
Type of bus stop	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Bus stop infrastructure	Yes	Sometimes, mostly not	Yes	Yes	Yes	Yes	Yes	Yes
Number of vehicles	1	3-4	1	2	2	2	1	1
Timetable	Fixed	On demand	Fixed	Fixed	Fixed	Fixed	Fixed	On-demand
Operation hours	Monday-Friday (5 days)	Sunday-Saturday (7 days)	Monday-Friday (5 days)	Monday-Sunday (7 days)	Monday-Saturday (6 days)	Tuesday & Thursday Saturday, Sunday & every public holiday	Monday - Friday	Monday – Saturday
Timeframe weekdays	06:30 – 08:30 / 16:00 – 18:15	07:00 – 19:00	10:00 – 18:00	7:30 – 21:30	08:30 – 19:30	12:00 – 20h00	7:00 – 9:00 16:00 – 19:00	11:00 – 18:00 11:00 – 18:00
Timeframe weekends	No service	07:00 – 19:00	No service	9:00 – 18:00	08:30 – 19:30	10:00 – 21:00	No Service	On Suterday only
Depot	400 meters distance	On site	800 meters distance	200 meters distance	On site	On site	On site	500 m distance
Driverless service	No	2021	No	No	No	No	No	No
Drive area type/ODD	B-Roads	Minor roads/parking	B-Roads/minor roads	B-Roads	B-Roads	B-Roads	B-Roads/parking	
Drive area geo/ODD	Straight lines/plane	Straight lines/ plane	Straight lines/ plane	Curves/slopes	Straight Lines/ plane	Straight lines/ plane	Straight lines/ plane	Straight lines / plane
Lane specification/ODD	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Open area
Drive area signs/ODD	Regulatory	Regulatory	Regulatory, Warning	Regulatory	Regulatory	Regulatory	Regulatory	Regulatory
Drive area surface/ODD	Standard surface, Speedbumps	Standard surface, Speedbumps	Standard surface Speedbumps, Roadworks	Frequent Ice, Snow	Standard surface, Potholes	Standard surface	Standard surface	Standard Surrface

Table 2: *Summary of AVENUE operating site (+ODD components)*

1.3 Preamble

The working package 3, which is titled "Cooperation for value creation" aims to gather different stakeholders involved in autonomous vehicle projects to create a web of collaborations to reach a broader spectrum of people and maximize the output value of the AVENUE project.

The task 3.10 targets more specifically 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, the Beep project (both in the USA) and the ST-Engineering project (in Singapore). This deliverable is a report on the twinning efforts with these international pilots.

2 Twining projects and targets

Since the beginning of the project, the AVENUE teams' target was to sign some twining collaboration agreements with international projects (including one or two in the United States and financed by the DoT). Several potentially interesting projects were identified, all internationally, with similar targets as the AVENUE ones. Indeed, in order to select the project we considered that they must have set targets that are as ambitious as those of the AVENUE project. The candidate should also have the same maturity (or at least a rich one) regarding their experience with AMs and an equivalent impact on the AMPT technology landscape.

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 of operation). Very few sites were considering public transportation and even fewer were envisaging some future expansions and/or scaling-up. Only a few of them operated the whole day, each day of the week and for several months. In addition, within many sites the vehicles used were unique prototypes (only 1 or 2 were built as proof of concept). These sites were interested in experimenting with automated vehicle operation rather than transport services. This reduced the number of potential sites to a very small number, particularly when limiting our focus to the sites using "commercially available" AMs (like NAVYA or EasyMile). In late 2020, three sites were finally selected, and formal negotiations started in early 2021.

2.1 Structure of the work

2.1.1 Preparation and prospection

Based on the previously described prerequisites, work was started to prepare the approach toward the stakeholders (which relevant stakeholders? is the AM deployment a one-shot opportunity? which level of maturity? what potential for collaboration?). At the same time, the way to approach these stakeholders was defined as well as the potential collaboration domain and other methodological aspects.

Some work was done with the partners and representatives in the EU as well as with subsidiaries, like NAVYA Corp in the US and NAVYA subsidiary recently created in Singapore to facilitate the launch of these international cooperations.

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 the AVENUE project, and we proposed them to each twining site. In the discussions each site was able to select which domains they were interested in collaborating on and whether there were other domains, not included in our list, that could be of interest for them.

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. 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 domains.

2.1.3 Collaboration methodology

The original idea for the twining collaboration was to organize some site visits and common technical meeting, to write co-authored papers and reports and invite the twining representatives to the AVENUE project's General Meeting sessions. The COVID crisis forced us to modify this plan, removing the possibility of any physical meetings and site visits. Effectively, physical technical meetings were easily replaced with online meetings, but the visits of the demonstration sites remained difficult to organize. One option we have proposed is live online demonstrations, but this does not provide the same experience as a on-site demonstrations. We hope that we will have the chance to organize some site visits in the near future once the COVID restrictions are lifted and the sanitary salutation permits it.

A non-disclosure agreement (NDA) was proposed for each site, so that confidential information could 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, this project had already been identified at the time of the proposal submission and discussion had already started before the official start of the project but the collaboration was frozen at the request of the EU. Our teams 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 its plan to launch an advanced mobility research centre to cultivate the diverse expertise and resources required to realize the potential of emerging mobility technologies, and their commercial and economic viability. The project is using several types of vehicles from different OEM providers. MCity targets and work go beyond technology and

consider all aspects of the future of transportation and mobility, bringing together industry, government, and academia.

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
Logo/Website	https://mcity.umich.edu
Country	USA
Role in the value chain	Advanced research, test facilities, and not only technical but includes also Safety, Efficiency, Accessibility, Commercial, Economic Viability
Operational experiences	Several experiences made with AV vehicles and shuttles, one-of-a-kind test facilities

Table 3 *Identity table - University of Michigan*

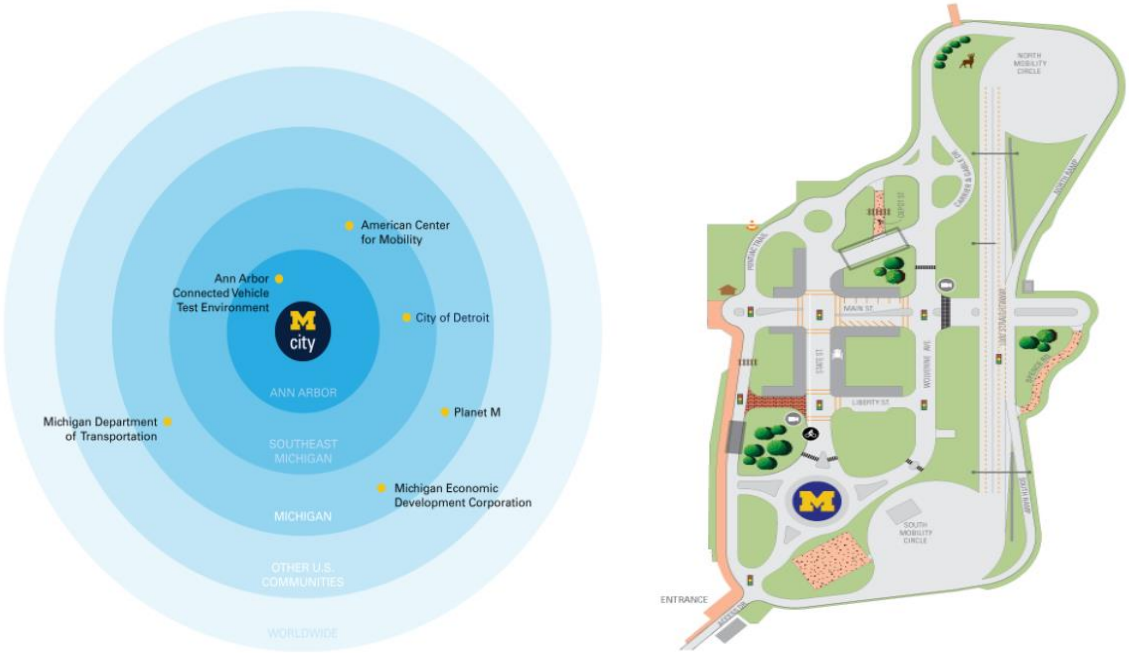

Figure 1 *coverage of MCity and test facilities*

2.2.2 Beep - USA

Beep is a US-based (Florida) company founded in 2019 that aims to provide autonomous mobility solutions. The company delivers the next generation of services for passenger mobility to fleet operators in planned communities and low-speed environments across the public and private sectors. This includes services within medical and university campuses, town centres, transportation hubs and more. From route planning to interactive managed services, Beep's offerings are designed to drive differentiation and innovation.

The Beep system and services provide the intelligence that enables safe, stress-free, and eco-friendly driverless mobility. Their offerings provide customers with turnkey mobility networks for scheduled and on-demand first and last-mile transportation services. Beep is using several types of AMs within their projects. 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 centre 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 demonstration sites across the USA, helping local communities in Jacksonville's Mayo Clinic and Skyway, Port st Lucie residential area, Peoria City, Pinellas County, Hillsborough Area, and on the shores of Nona's Lake (which latter site has received a USD 20 million DoT grant).

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. Market barriers and current blocking points
6. Testing & security
7. Economic impact
8. Sustainability assessment

Identity table	
Name	BEEP
Logo/Website	https://www.go-beep.com
Country	USA
Role in the value chain	Transport Operator
Operational experiences	Several sites on the road with autonomous vehicle: Mayo Clinic Move Nona Jacksonville Transportation Authority Robo Ride Hart PSTA Tradition in Motion

Table 4 *Identity table - BEEP*

2.2.3 ST Engineering - Singapore

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

ST Engineering Smart-City department targets the development of a smarter future by 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 provides smart, integrated mobility solutions in over 40 cities worldwide. Their Public Transport Fleet Management system provides tracking and monitoring of large vehicle fleets and optimizes supply and demand to improve operational efficiency, which is critical to operators (e.g. buses and taxis).

The AGIL autonomous vehicle 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 behaviour to ensure its safe deployment on the road. Powered by advanced connectivity, sensors, and data analytics, the AGIL system provides all-round fleet management enhancements in operational efficiency, fleet visibility, performance evaluation and resource management. ST Engineering is using several types of vehicles from 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
Logo/Website	ST Engineering https://www.stengg.com/en/about/
Country	Singapore
Role in the value chain	Transport Operator & technology leader
Coverage	ASIA Pacific and some other countries like Israel
Operational experiences	Several sites on the road with AMs

Table 5 *Identity table – ST Engineering*

3 Activities from 2021 to the end of the project

During the last period (in the frame of this report), our collaboration with ST Engineering, MCity and Beep were intensified, with mutual visits at the sites and the exchange of information and relevant data. However, the targets, market objectives and overall post-COVID problems drastically changed the interests and directions of our twinning partners and have also limited meetings and demo site visits.

3.1 ST Engineering - Singapore

In 2021 and 2022, a delegation including technical and business development executives of ST Engineering visited on two occasions the Belle-Idée site where we were able to exchange insights from the two sites. Having deployed Navya vehicles at both sites we were able to identify some differences in the passenger needs and business approaches. The issues that were discussed also covered technical obstacles, business development issues, as well as passenger acceptance and legal requirements.

However, mid-2022, ST Engineering stated it was reducing its interest in AMs and by the end of 2022 ST Engineering announced to "withdraw from further autonomous bus development owing to the 'substantial' financial resources required".

3.2 MCity - USA

The collaboration with MCity and exchange of information and data were enabled by the presence of Prof. Huei Peng as a member of the AVENUE advisory board. We received important data from the MCity deployments of public transportation, including passenger feedback, technological adaptations made by MCity to the NAVYA vehicles and business development information for the USA market.

However, in spring 2020, the license for the Navya shuttles operated by MCity expired and the Navya ssssvehicles were decommissioned, putting an end to the AM shared public transportation project. MCity continued with the robo-taxis model (4 sitting passengers or one wheelchair), which however is not compatible with the AVENUE targets.

3.3 Beep - USA

Our closest collaboration and exchange of data, ideas and information was Beep. The collaboration was intensified into a joint partnership. Beep highlighted that "*NAVYA's self-driving shuttles, operated by its partner Keolis, are providing a new mobility option for the visitors to Las Vegas*". By September 2022, Beep deployed 22 Navya vehicles in the USA, with a target of a similar deployment within the AVENUE project. A large number of technological improvements developed for the AVENUE deployments were adopted by Beep in their deployments, like the complex manoeuvring (developed for the Lyon demonstrator), the slow speed follow-up and approach (instead of harsh breakings as identified in the early AVENUE experimentation), the need to reduce the minimal distance with side obstacles (down to 15 cm and developed for the narrow roads of Belle-Idée), etc.