Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE 3.3

Final Cooperation with relevant initiatives and projects 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

In this deliverable D3.3 we describe the most important activities related to the contacts and communication with other projects and initiatives and the contributions of the advisory board experts.
For each collaboration, we give a short but precise description of the collaboration established and the information and knowledge exchanged.

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.

SAE INTERNATIONAL

SAE J3016™ LEVELS OF DRIVING AUTOMATION

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

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

WP3 objective is to create a web of collaborations to reach a broad spectrum of directly and non-directly relevant parties to maximise the output value of AVENUE.

The target of task T3.1 “Cooperation of related Initiatives and projects” is to identify relevant initiatives and projects and maintain communication channels, a network of promoting collaborations, knowledge exchange and technology transfer. The task will also valorise the Advisory Board experts, allowing them to have an overview of the project and provide a broader legal, environmental, technical, and societal acceptance requirements perspective.

In this Deliverable D3.3 we describe the activities related to the contacts and communication with other projects and initiatives and the contributions of the advisory board experts.

2 Collaboration with relevant initiatives and projects

All project partners have actively created formal and informal contacts with other projects, initiatives, and related companies, based on their expertise and needs. In the following we present the most important contacts where an active collaboration is/can/will be established. Simple presentations and information given to companies by our partners is not included in this report, considered rather as a dissemination activity.

Starting from the 2nd year of the project and following the successful marketing campaign of the project results, the project became known for its innovation and its success stories, opening the door for the establishment of new collaborations with projects and initiatives. Furthermore, with the advancement of the technical work, we were able to share technologies with other projects, import results and offer our platform for tests.

2.1 European Projects

Our first source and target of collaboration was with other INEA and EU projects. These collaborations were established by Navya and by the University of Geneva (project technical manager and project coordinator respectively). The AVENUE project took contact with the ARCADE support action project, which acts as concentration point for information exchange on mobility related projects. We were present in several events and meetings organised (e.g. EUCAD) and had the opportunity to discuss, present and initiate contacts and collaborations with other related projects and experts.

SHOW

The SHOW project is the most relevant project with the target of AVENUE. There are six (7) common partners in the projects (CERTH, bestmile, NAVYA, UniGe, AVL, VIM, Keolis) working in complementary tasks and domains.

A key point of contact between AVENUE and SHOW is the fact that Geneva is a follower site in SHOW, while being a key site for AVENUE. Via UniGe, all knowledge developed, not only in the Geneva site, but also in the other AVENUE sites, was communicated to SHOW, ranging from use-cases, obstacles and barriers, deployment issues, etc. At the same time many common workshops and webinars were organised with SHOW and AVENUE, with the participation of different common partners.

Furthermore, complementary work profiting both projects is conducted by the common partners and is introduced to both projects. NAVYA develops and validates the on-demand functionalities mainly in the AVENUE project, while road-behaviour (speed, manoeuvrability, traffic complexity, weather conditions, geographical conditions (e.g. slope, etc) is mainly developed in SHOW. The results of both projects are eventually made available and profit both projects.

CERTH and UniGe share also complimentary tasks of the projects in the domain of cyber-security. While in AVENUE we target security for data privacy and identify cyber-threats and protection, in SHOW the target is to define procedures that make cybersecurity of automated functions *efficient* with regard to the vehicle configuration, characteristics of the driving functions and the provided infrastructure, based on the experience gained in AVENUE.

BESTMILE developed in AVENUE the on-demand system (fleet orchestration and management) and the connectivity to the NAVYA APIs, and integrated them in the overall AVENUE architecture, in SHOW. Based on the experience of AVENUE BESTMILE concentrated on the development of a common conceptual system architecture framework that can apply to all types of AVs and use cases.

nIoVe

Thanks to the common partners in the H2020 project nIoVe (CERTH, NAVYA, UniGE, TPG) which targets the cybersecurity for IoT vehicles, we are able to exchange important information in IoT cybersecurity, use of IoT devices and technical issues and identify the implications for public transportation services in AVENUE.

The nIoVe project is using data from the Autonomous vehicles from the AVENUE Meyrin and Belle-idee sites regarding the routes followed, speed, breaking, GPS and 4G signal quality, in order to evaluate site conditions and their impact on the safety and security of the Vehicle IT systems. Furthermore, the AVENUE project, for the validation of the in-vehicle services, installed on-board computer in the some of the Belle-Idee vehicles. We evaluated this on-board computer with use-cases from the nIoVe project, like the V2X communications with the SafeStrip (collecting information on road humidity, etc), V2X communication with traffic lights (to be noted that there are no traffic lights in the Belle-Idee site, so we nIoVe will install temporary traffic lights visible only to the mini-buses, since no authorization can be given for real traffic lights).

LIV.IN

LIV.IN is a project that aims to co-create more responsible approaches to innovation in the areas of smart home and smart health that tackle societal challenges and respond to pressing societal trends. The LIV.IN project test site at Seestadt Aspern, is of high interest for the AVENUE project regarding the smart home (and in extension smart city) infrastructure which is addressing the issues of special needs citizens.

Uniquely, and for the first time, the initiative involves industry leaders that engage with lead users in co-creation processes to create solutions that meet user needs and leverage collective creativity to uncover new business opportunities. Smart mobility for all citizens has been identified, in LIV.IN, as one of the major topics.

Siemens (partner in LIV.IN and AVENUE) has set up a co-creation Lab for identifying user mobility needs and for co-creating solutions for persons with reduced mobility, especially older persons and people with a wide range of disabilities. In this framework, Siemens conducted a series of physical and virtual workshops with interested persons identifying:

- functional requirements for an accessible mobility application and
- relevant (accessibility) information and assistive mobility services

for supporting their mobility.

For co-creating successfully with PRMs, special co-creation methods and tools have been adapted to the special needs of the participants. Results of this workshops were fed into AVENUE WP2 and WP4 as well as into a master thesis at the University of Paderborn. The result of the master thesis was presented in AVENUE as a possible solution to support PRMs in a driverless situation. The outcome of the LIV_IN workshops has been transferred to a standardisation committee for the preparation of a respective norm at the DIN NA063-06-04 "Assistive Technologies" standardisation committee.

Because the LIV_IN Project leader is the Business University in Vienna, closely located to Vienna Seestadt, we had the kind opportunity of a joined intensive evaluation of the auto.Bus - Seestadt project while getting regular updates from students afterwards.

Stimulate

Stimulate is a national project (Germany) for City-compatible mobility using automated minibuses. The aim of the Stimulate project is to test fields of use and the acceptance of autonomous driving in a realistic environment, to discover potential for improvement and to make a contribution to climate and environmental protection. From November 2017, the first autonomous small bus was deployed inthe Virchow Clinic. The Charité Hospital locations with their 268,207 m² and 137,964 m² each have a moderately large test area and offer an ideal test area with their various user streams such as passers-by, passenger cars, delivery vehicles and bicycles. During the pilot project, a total of four autonomous, intelligent electric vehicles was used. Siemens collaborated with the Stimulate project, in the definition of the project's objectives, and the identification of common goals and overlaps.
Furthermore, Siemens participate in the organization of Stimulate and is conducting user tests with the ABSV Berlin (together with BVG and Easymile). The site was a potential replicator site for AVENUE.

FABULOS

Having established contact with the FABULOS project we organised a webinar where we presented the Open Call for replicator and invited the FABULOS partner sites to participate, after explained the targets of AVENUE and the requirements for the replicator sites. However, first due to the procurement process which taking very long, none of the sites were able to confirm if and when they will be able to identify the number of vehicles and the exact site they plan to operate (Finally only Trikala submitted an application for a replicator site, but it was not retained due to lack of precise operation site).
The established contact with ERTICO allowed us to network and present the AVENUE targets to the different events organised (ex. ITS 2019) where we participated.

MOMENTUM

The goal of MOMENTUM is to develop a set of new data analysis methods, transport models and planning support tools to capture the impact of these new transport options on the urban mobility ecosystem, in order to support cities in the task of designing the right policy mix to exploit the full potential of these emerging mobility solutions.
CERTH as a common partner presented the AVENUE test sites as use-cases where MOMENTUM is able to draw information on the needs and operation of Autonomous vehicles. On the other hand, via CERTH, the first results of MOMENTUM for data models and transport models were presented to the partners and taken into account for the AVENUE services.

TRUSTVEHICLE

VIF brought in the contact and information exchange with the H2020 TRUSTVEHICLE (which they coordinate), where issues of safety and security, of interest to AVENUE, are exchanged. VIF also brought in the contact and cooperation with the ECSEL projects AUTODRIVE, PRYSTINE and NEWCONTROL, all concentrating on different security and safety of components and operations for automated vehicles.

Alp.Lab

VIF with its participation in the Austrian test ground ALP.Lab, a sophisticated testing environment for testing and verifying the components and systems of automated driving in diverse and complex scenario, discussed ideas about scenarios for simulation-based safety evaluation of the autonomous shuttles, which were used in AVENUE.

ECOSMILE

Contact was also established with the Intereg project ECOSMILE, which investigates trans-border AVs shuttle services, at the Archamps site (at the French site of the Geneva borders) where an Easymile shuttle operates since 2020. Bestmile is the partner at ECOSMILE providing the fleet management with their driverApp. We have participated in and presented the AVENUE project in different meeting and events organised by ECOSMILE at the Archamps site, and we have exchanged information on service requirements, legal issues, barriers etc. The trans-border barriers faced by ECOSMILE were communicated to the AVENUE project.

TERMINAL

Sales-Lentz also collaborated with the TERMINAL Interreg project, that targets the deployment of Automated electric minibuses in international commuter traffic, between 3 countries: Germany, France and Luxembourg. Data from the Pfaffenthall site are exchanged with the TERMINAL project, as well as information on issues, barriers, and regulatory framework.

BVG site in Berlin

Furthermore Siemens, via their Siemens Berlin office, established collaboration with the BVG site in Berlin, where they operate until the end of 2019 autonomous shuttle services. (And which we invited to join as replicator site, but the requirements set by AVENUE were beyond the anticipated services of BVG).

Ride4All

Siemens established contact and collaboration with the Ride4All project, where an EasyMile mini-bus are integrated into the regular operation of the existing public transport system of Regionalverkehr Ruhr-Lippe GmbH (RLG) and its transport partners. The target of the project is to develop inclusive use (use by everyone) of autonomously driving buses. With the aspects of barrier-free operation and use, the “Design for All” in particular is being developed, conceptualized and evaluated. In detail, the aim is to clarify several key questions, among others, how can I access and operate an autonomously driving bus? Where do I get on?, How do I know if the bus is going to my destination stop? What assistance do I have during the journey in the event of an emergency? The questions become even more important for persons with special needs. In this domain a collaboration is established exchanging ideas and solutions with the AVENUE operators.

HUBCHAIN

Siemens established contacts with the HUBCHAIN project in Osnabrück, started operating in 2020 autonomous vehicle services using one Easymile shuttle for an on-demand service at a 1.1 Km circuit. Similarly, contacts were established with the city of Mainz, where a test site started in 2020 (after a 20 days test in a 800m line in August 2019 with one Navya shuttle) and the with the region of Soest where a trial was made in February 2020. With all these sites Siemens exchanged information and experience from AVENUE, and we investigated if they would be interested (and if they have a strategic plan) to join AVENUE as replicator sites (but none was up to the requirements asked for the AVENUE replicator sites).

HEAT

HEAT, the Hamburg Electric Autonomous Transportation, is a research and development project in which HOCHBAHN, together with other partners (including Siemens), is running a trial of the first driverless minibus service in Hamburg public transport.

Siemens has established collaboration with the HEAT project Exchange of the different targets of the project Heat has a more technical focus including intelligent environment (CAR2X) and does not have a real user focus including user services as the AVENUE. A meeting and a test of the AV had to be cancelled due to COVID.

SURCA

Surca (https://surca.univ-gustave-eiffel.fr/) is French project, with targets the identification of interaction scenarios between autonomous vehicles and other road users (conventional vehicles, motorized two-wheelers, cyclists, pedestrians), with a particular focus on the elderly, and the study of the impact of the posture of the occupants (driver and passengers) of a vehicle in autonomous mode on the risk of injury.
CEESAR main participation was in the studies and simulations for interactions with between drivers and vehicles. It brought into AVENUE the knowledge regarding how other road users (ex. Motorcycle drivers) interact with mini-buses and other vehicles on the road, which was used for a better evaluation and study of the AVENUE AVs and their interaction with other road users.

SCOTT

Virtual Vehicle is coordinator of this H2020 project. We had regular internal discussions on related topics between the different teams working on the projects for Virtual Vehicle, especially on the use-cases related to automated mobility.

InSecTT

European Project InSecTT: Virtual Vehicle is coordinator of this project. We had regular internal discussions on related topics between the different teams working on the projects for Virtual Vehicle, especially on the use cases related to automated mobility.

Ride2Autonomy

SalesLentz participated in the Ride2Autonomy project, whose target was to harmonise research and innovation efforts around automated shuttle solutions by assembling the lessons learned not just from the project’s ten pilot sites from ten EU member states, but also from a number of further sites and national network. This allowed the AVENUE project to exchange knowledge on deployment of AVs, and promote (in both directions) the lessons learned from the rest of the AVENUE deployment sites.

2.2 Collaboration with Industry

Toyota Europe

The first company that contacted us (the project coordinator) was Toyota Europe, in summer 2018, in order to investigate possible cooperation for the forthcoming Tokyo Olympic Games and the idea to use autonomous shuttles for the athletes and visitors.

Easymile

A second company we contacted was Easymile, the second major constructor of Autonomous Shuttles in Europe, in view, first exchange ideas and issues, and then investigate the possibilities to integrate one of their sites as a replicator site in AVENUE. However, in spite many discussions there was finally no common ground for stronger collaboration. Regarding the replicator sites, none of the sites operated by Easymile was advanced enough to be integrated as replicator site (no site had more than 2 vehicles and none had any plans to deploy on-demand, door-to-door services).

OSR Enterprises AG

Following the GIMS 2019 in Geneva, we established contact with OSR Enterprises AG, a Swiss company specialising in platforms for next generation mobility, interested to evaluate if their AI platform can be used in the AVENUE project, where we have identified the need for a 3rd computer for the services.

AKKA technologies

We established also a good collaboration with AKKA technologies, to the AKKA Academy in Geneva, where we collaborated in setting the Sustainable Mobility Hackthon in June 2019. Furthermore, the AVENUE advances were presented in the AKKA Academy.

PSA Autonomous vehicle group

CentralSupelec established collaboration with the PSA Autonomous vehicle group, where common presentations and exchange of issues are taking place in a regular basis.

Hitachi Energy Switzerland Ltd

Hitachi Energy Switzerland is collaborating with the TPG for the installation of recharging stations for the TOSA trolleybus. We established a collaboration to study how recharging stations for automated vehicles can be deployed in the city of Geneva, what are the needs and what technologies might be possible. Furthermore, methods and requirements for energy consumption reduction in automated vehicles were identified based on the experience and studies made by Hitachi (An Horizon Europe project, ENFLATE, was launched for this part).

2.3 Other initiatives

Apart from the above-described collaborations, the project partners have also established close collaboration with different initiatives and stakeholders related to mobility and autonomous vehicles.

NAVYA representing the AVENUE project in different events (ex. the 4th High Level Meeting in Vienna) established connections across different key stake holders (European governments working on AV, European commission related teams), where they presented the AVENUE project and targets and investigated possible future collaborations.

Sales-Lentz, via their participation in the 4th VDV Future Congress Autonomous Driving within Public Transport the established several connections (manufacturers, policy makers, stakeholders, …) allowing then to, from one side promote the project, and from the other side receive feedback and input regarding needs, and legal and regulatory issues.

The project coordinator (**UNIGE**) is active member of the Nomads Foundation Mobility Hub, led by ABB in Geneva, where several mobility actors in Switzerland and France participate, with target the creation of events and initiate contacts and projects in new models of transportation.

The project coordinator is also active participant of the Shift AUTOMOTIVE Forum (a partnership with IFA, Messe Berlin and Palexpo and is supported by the International Telecommunication Union (ITU)), organizing events in on future mobility in different international exhibitions.

In addition, the project coordinator is vice-chair of the ITU Focus Group on Vehicular Multimedia, established to identify the need for new vehicular multimedia standards based on space and terrestrial networks integration. The group will make a proposal for a new standard for Vehicle Multimedia.

Siemens has also established a strong collaboration with associations of PRM e.g. expert group on environment, traffic and mobility of the associations for the blind and visually impaired. This collaboration allows us to recruit PRM who can validate the proposed project solutions, and also provide us needs and requirements for special needs passengers.

Furthermore, strong with the experience gained in the AVENUE project, SIEMES was invited by the City Council of Mainz to act as consultant on the acquisition of autonomous buses for the last mile including PRMs (EMMA).

An ad-hoc non-formal cooperation was setup in Paderborn between the public Transport company "Padersprinter" the University of Paderborn, Siemens, two local technology partners and the local association of blind and low vision people. The background of this project is that all about 100 city busses are equipped with Bluetooth providing real-time info on the vehicle like Bus number, direction etc and allowing to request services like kneeling bus, acoustic door finding signal etc. Moreover, some acoustic traffic lights in Paderborn are equipped with Bluetooth to request pilot signal and acoustic signal for the green light.

Two apps were tested by blind passengers. Interestingly these tests simulated driverless vehicles to some extend in the early corona time, because the bus driver was not addressable for any help (closed first door). Blind persons were completely dependent on the information provided by the mobility apps. We got very helpful feedback for designing mobility apps for persons with reduced mobility.

The test field results were used in AVENUE WP 2 and WP 4 and considered in DIN 13278.

Because Siemens is an active member of the DIN standardisation committee NA063-06-04 "Assistive Technologies" we took the opportunity to transfer the LIV_IN workshop results on smart mobility to this group. We spent a lot of effort on transposing the input to a norm which is going to be published as German Norm DIN 13278 "Smart Mobility for persons with reduced mobility - functional approaches" in summer 2021. An English version is also available.

As a leader of operating autonomous shuttles worldwide, the **Keolis** group (Keolis Lyon being subsidiary) has deployed more than 40 different projects in 10 different countries including Navya and EasyMile autonomous vehicles. The Keolis Lyon experience within AVENUE is then shared with all the stakeholders involved in the other projects as well.

As a leader of the autonomous vehicle manufacturers Navya has built and deployed more than 12à autonomous shuttles worldwide. This vast experience is shared in the project, bringing valuable information on issues and solutions, from the other Keolis sites.

3 Advisory Board Contributions

The advisory board was stabilised with 4 very active members:

Prof. Huei Peng	University of Michigan - MCity project director; Autonomous vehicle deployment under DOT, USA funding
Mr. Arthur van der Wees	Arthur's Legal B.V. - Policy and legal issue related to IT; leading the horizontal topics on trust, data, processing, protection, security, accountability and other strategic, ethical and legal topics for the 5 H2020 Large Scale Pilots
Mr. Benno Nager	Swiss Federal Roads Office Coordinator in charge Automated driving trials in Switzerland Legal expert in traffic technology / ITS innovations project manager
Mr. Sascha Ott	Managing Director IPEK @KIT, Karlsruher Institute of Technology Business development.

Each of the members of the Advisory board made important contributions to the project and from the day they accepted the appointment, they were present to all General meetings (taking place online since May 2020).

Mr. Arthur van der Wees, being a cyber-legal expert, provided us clarifications and insides on issues related to data ownership, usage and protection, GDPR restrictions, European legal and regulatory issues, commenting on issues that should be faced in the implementation of services, and commented on the pertinence of proposed transport and passenger services. Mr van der Wees has also direct contacts with project members, especially for the WP9 recommendations work on legal issues.

Prof. Peng, as director of the MCity project, provided valuable input on the issues and solutions they faced that are similar problems as in AVENUE (like collection of videos for the evaluation of passenger behaviour) and provided technical, legal, and regulatory information regarding the United States. He made many comments in the General meetings regarding services, transport issues and why some vehicle data cannot be extracted from the vehicle. Prof Peng has also provided us access to the data collected in the MCity project and facilitated the establishment of a Twinning with MCity.

Mr Benno Nager joined the Advisory board in fall 2019. He is a key person for the smooth deployment of the Swiss site at Belle-Idee, providing advice and helping to cut “red-tape” at the Swiss Federal Roads Authorities for the realization of the on-demand deployment services. He has regular discussions with the TPG and has strongly promoted the AVENUE project in the Swiss federal authorities as well as in international forums where he participates, as an example of the future mobility solutions.

Mr. Sascha Ott, joined the Advisory board in December 2019 and has provided valuable input and advise in the General meetings on questions of driving issues and road behaviour and methodologies’ suggestions for economic and business analysis. Mr. Ott has regular contact and collaborated with HSPF in WP8 related questions.

4 Conclusions

The above presented collaborations present the most notable contacts and collaborations, where the project partners had regular or re-enforced present or participation. Many other short-term contacts and exploration of further collaborations were also made by all project partners, either without reaching a regular level of collaboration and exchange (due to the fact that either the targets were too distant or in some cases the other project had been completed) or been kept secret due to commercial considerations.
Our collaboration and knowledge exchange with other initiatives, allowed us to learn and integrate the learned knowledge into AVENUE concepts and ideas that we had not considered before, especially for special cases that are not present within the AVENUE deployment sites. This knowledge was also considered for the creation of the roadmap and recommendations.
Our collaborations also allowed the other projects and initiatives to experience the issues that were addressed in AVENUE and adopt them for their further development. Issues like the need for in-vehicle services in the absence of a safety driver, and the complexity of the door-to-door deployment, allowed the other projects to revise their planning and consider solutions for a future deployment.

The collaboration with the other initiatives and projects allowed also to identify the most promising companies and institutions that the different partners would be able to collaborate with after the end of the AVENUE project, towards a commercial deployment. Many of our partners at the end of the project opened up announcing commercial collaborations established during the project and valorising the project results.

As a final conclusion, we consider that our collaboration with other companies, institutions and projects was very successful, allowing the exchange and promotion of ideas experience, promoting and boosting the further European development of mobility solutions with Automated Vehicles.