Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE D7.4

First iteration Keolis Lyon Large Scale Pilot Use Case Demonstration Report

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

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Acronyms

ADS	Automated Driving Systems
AI	Artificial Intelligence
AM	Autonomous Mobility
API	Application Protocol Interface
AV	Autonomous Vehicle
BM	Bestmile
BMM	Business Modelling Manager
CAV	Connected and Autonomous 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

This is the first Deliverable of Task T7.4 - First Iteration Lyon Large Scale Pilot Use Case Demonstration report - which is due in month 16. The main focus of this Task is to describe the setup, authorization processes and foreseen operations including barriers of the Groupama Stadium project in detail.
It will also present what Keolis Lyon is going to do for the second period of the project.

1 Introduction

AVENUE aims to design and carry out full-scale demonstrations of urban transport automation by deploying, for the first time worldwide, fleets of autonomous minibuses in low to medium demand areas of 4 European demonstrator cities (Geneva, Lyon, Copenhagen and Luxembourg) and 2 to 3 replicator cities. The AVENUE vision for future public transport in urban and suburban areas, is that autonomous vehicles will ensure safe, rapid, economic, sustainable and personalised transport of passengers. AVENUE introduces disruptive public transportation paradigms on the basis of on-demand, door-to-door services, aiming to set up a new model of public transportation, by revisiting the offered public transportation services, and aiming to suppress prescheduled fixed bus itineraries.

Vehicle services that substantially enhance the passenger experience as well as the overall quality and value of the service will be introduced, also targeting elderly people, people with disabilities and vulnerable users. Road behaviour, security of the autonomous vehicles and passengers' safety are central points of the AVENUE project.

At the end of the AVENUE project four year period the mission is to have demonstrated that autonomous vehicles will become the future solution for public transport. The AVENUE project will demonstrate the economic, environmental and social potential of autonomous vehicles for both companies and public commuters while assessing the vehicle road behaviour safety.

1.1 On-demand Mobility

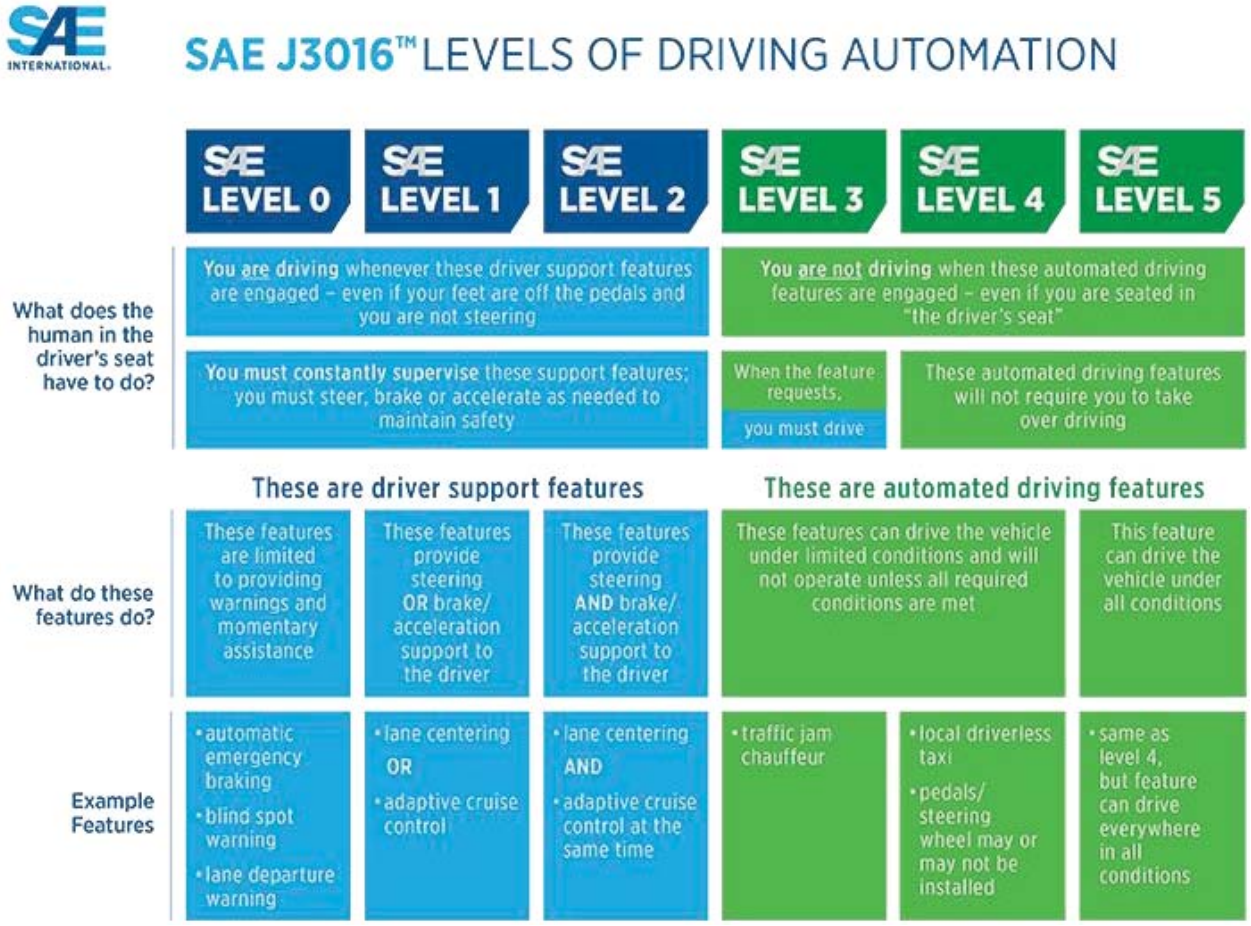
Public transportation is a key element of a region's economic development and the quality of life of its citizens.
Governments around the world are defining strategies for the development of efficient public transport based on different criteria of importance to their regions, such as topography, citizens' needs, social and economic barriers, environmental concerns and historical development. However, new technologies, modes of transport and services are appearing, which seem very promising to the support of regional strategies for the development of public transport.
On-demand transport is a public transport service that only works when a reservation has been recorded and will be a relevant solution where the demand for transport is diffuse and regular transport is inefficient.
On-demand transport differs from other public transport services in that vehicles do not follow a fixed route and do not use a predefined timetable. Unlike taxis, on-demand public transport is usually also not individual. An operator or an automated system takes care of the booking, planning and organization.
It is recognized that the use and integration of on-demand autonomous vehicles has the potential to significantly improve services and provide solutions to many of the problems encountered today in the development of sustainable and efficient public transport.

1.2 Autonomous Vehicles

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

vs Automated was made in AVENUE since, in the current literature, most of the vehicle concepts have a person in the driver's seat, utilize a communication connection to the Cloud or other vehicles, and do not independently select either destinations or routes for reaching them, thus being “automated”. The automated vehicles are considered to provide assistance (at various levels) to the driver. In AVENUE there will be no driver (so no assistance will be needed), while the route and destinations will be defined autonomously (by the fleet management system). The target is to reach a system comprising of vehicles and services that independently select and optimize their destination and routes, based on the passenger demands.

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



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1.2.1 Autonomous vehicle operation overview

We distinguish in AVENUE two levels of control of the AV: micro-navigation and macro-navigation. Micro navigation is fully integrated in the vehicle and implements the road behaviour of the vehicle, while macro-navigation is controlled by the operator running the vehicle and defines the destination and path of the vehicle, as defined the higher view of the overall fleet management.

For micro-navigation Autonomous Vehicles combine a variety of sensors to perceive their surroundings, such as 3D video, lidar, sonar, GNSS, odometry and other types sensors. Control software and systems, integrated in the vehicle, fusion and interpret the sensor information to identify the current position of the vehicle, detecting obstacles in the surround environment, and choosing the most appropriate reaction of the vehicle, ranging from stopping to bypassing the obstacle, reducing its speed, making a turn etc.

For the Macro-navigation, that is the destination to reach, the Autonomous Vehicle receives the information from either the in-vehicle operator (in the current configuration with a fixed path route), or from the remote control service via a dedicated 4/5G communication channel, for a fleet-managed operation. The fleet management system takes into account all available vehicles in the services area, the passenger request, the operator policies, the street conditions (closed streets) and send route and stop information to the vehicle (route to follow and destination to reach).

1.2.2 Autonomous vehicle capabilities in AVENUE

The autonomous vehicles employed in AVENUE fully and autonomously manage the above defined, micro-navigation and road behaviour, in an open street environment. The vehicles are autonomously capable to recognise obstacles (and identify some of them), identify moving and stationary objects, and autonomously decide to bypass them or wait behind them, based on the defined policies. For example with small changes in its route the AVENUE shuttle is able to bypass a parked car, while it will slow down and follow behind a slowly moving car. The AVENUE vehicles are able to handle different complex road situations, like entering and exiting round-about in the presence of other fast running cars, stop in zebra crossings, communicate with infrastructure via V2I interfaces (ex. red light control).

The shuttles used in the AVENUE project technically can achieve speeds of more than 60Km/h. However this speed cannot be used in the project demonstrators for several reasons, ranging from regulatory to safety. Under current regulations the maximum authorised speed is 25 or 30 Km/h (depending on the site). In the current demonstrators the speed does not exceed 23 Km/h, with an operational speed of 14 to 18 Km/h. Another, more important reason for limiting the vehicle speed is safety for passengers and pedestrians. Due to the fact that the current LIDAR has a range of 100m and the obstacle identification is done for objects no further than 40 meters, and considering that the vehicle must safely stop in case of an obstacle on the road (which will be “seen” at less than 40 meters distance) we cannot guarantee a safe braking if the speed is more than 25 Km/h. Note that technically the vehicle can make harsh break and stop with 40 meters in high speeds (40 -50 Km/h) but then the break would too harsh putting in risk the vehicle passengers. The project is working in finding an optimal point between passenger and pedestrian safety.

2 Project homologation

2.1 Ministry authorisation

French government is really interested by AVs project, and is helping operators like Keolis to make this a workable plan. Regarding the requirements of decree **17 of april 2018 « relatif à l'expérimentation de véhicules à délégation de conduite sur les voies publiques »,** Keolis sent authorization dossier with agreement in principle from Lyon Metropole and SYTRAL (Public Transportation Authority). The authorization needed a detailed explanation of the route and roadwork, includes the equipment to control crossroad.

The decree below is the official authorization:

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE ET SOLIDAIRE

Direction Générale de l'Énergie et du Climat

Paris, le 27 MAI 2019

DÉCISION

Décision ministérielle d'autorisation d'expérimentation de la circulation de véhicule à délégation partielle ou totale de conduite n° 2019-19

Le ministre d'État, ministre de la Transition écologique et solidaire ;

Vu le code de la route et notamment ses articles R. 322-3, R. 221-4 et R. 412-6 ;

Vu l'ordonnance n° 2016-1057 du 3 août 2016 relative à l'expérimentation de véhicules à délégation de conduite sur les voies publiques ;

Vu le décret n° 2018-211 du 28 mars 2018 relatif à l'expérimentation de véhicules à délégation de conduite sur les voies publiques ;

Vu l'arrêté du 17 avril 2018 relatif à l'expérimentation de véhicules à délégation de conduite sur les voies publiques ;

Vu la demande d'autorisation d'expérimentation de la circulation de véhicules à délégation de conduite, accompagnée de ses annexes techniques comprenant un questionnaire dûment complété permettant d'éclairer la typologie des essais, le dossier de présentation de l'expérimentation, ainsi qu'un dossier technique du véhicule, présentée le 11 janvier 2019 par la société Keolis ;

Vu les compléments d'information apportés par Keolis les 11 mars et 3 avril 2019 ;

Vu l'avis du ministre de l'intérieur en date du 15 avril 2019 ;

Vu l'avis du directeur général des infrastructures, des transports et de la mer en date du 15 mai 2019 ;

Vu les avis des gestionnaires de voirie du 3 avril et 7 mai 2019 ;

Vu l'avis de l'autorité compétente en matière de police de circulation du 3 avril 2019 ;

Vu l'avis de l'autorité organisatrice des transports du 29 mars 2019 ;

www.ecologique-solidaire.gouv.fr 92055 La Défense cedex – Tél : 33 (0)1 40 81 21 22 – Fax : 33(0)1 40 81 83 59

2.2 Vehicle homologation

After the signature of the decree, we could ask for the official registration document for the 2 vehicles (document below).

Registration document P108 serial number :

Ministère de l'Intérieur

Numéro d'ordre du certificat
10217966762

Certificat Provisoire d'Immatriculation WW DPTC

(circulation à titre expérimental d'un véhicule à délégation partielle ou totale de conduite)

Autorise, pendant sa période de validité, la circulation du véhicule (Article R.322-3 du code de la route).

(A) Numero d'immatriculation	(I)Date du CPI	(B) Date de 1ère immatriculation
WW-625-SV	15/06/2019	15/06/2019

Numéro de la décision ministérielle d'autorisation exceptionnelle : 2019-19
Date de la décision ministérielle d'autorisation exceptionnelle : 27/05/2019

(H) PERIODE DE VALIDITE : du 01/06/2019 au 31/05/2021 INCLUS

attribué à : (C.1) KEOLIS LYON
30807535
19 BOULEVARD MARIUS VIVIER MERLE
69003 LYON

(D.1) Marque	(D.2) Type variante version		(D.3) Dénomination commerciale
NAVYA			
(E) Numéro d'identification du véhicule	(F.1) Masse en charge maximale techniquement admissible (en kg)	(F.2)) Masse en charge maximale admissible du véhicule en service dans l'état membre d'immatriculation (en kg)	(F.3) Masse en charge maximale admissible de l'ensemble en service dans l'état membre d'immatriculation (en kg)
VF9A2C02C1V019108	3450		
(G) Masse du véhicule en service avec carrosserie et dispositif d'attelage (en kg)	(G.1) Poids à vide national	(J) Catégorie du véhicule CE	(J.1) Genre national
(J.2) Carrosserie CE	(J.3) Carrosserie (désignation nationale)		
(P.1) Cylindrée (en cm3)	(P.2) Puissance nette maximale (en kW)	(P.3) Type de carburant	(P.6) Puissance administrative nationale
		EL	
(Q) Rapport puissance/masse en kW/kg (uniquement pour les motocycles)	(S.1) Nombre de places assises, y compris celle du conducteur	(S.2) Nombre de places debout (le cas échéant)	(U.1) Niveau sonore à l'arrêt (en db (A))
	11	4	
(U.2) Vitesse moteur (en mn-1)	(V.7) CO2 (en g/km)	(V.9) Classe environnementale	(X.1) Date de visite technique

(Z.1) à (Z.4) Mentions spécifiques

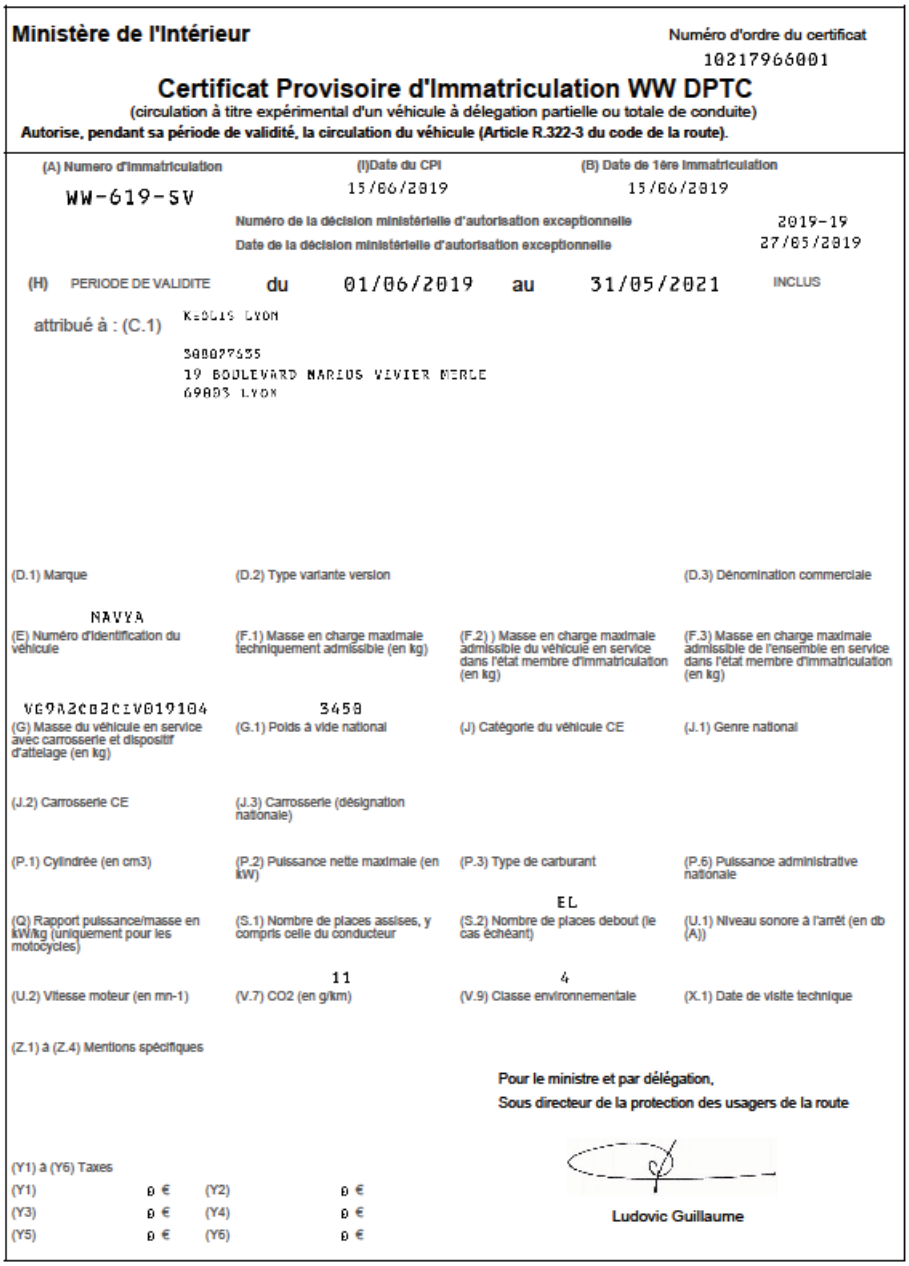
Pour le ministre et par délégation,
Sous directeur de la protection des usagers de la route

Ludovic Guillaume

(Y1) à (Y6) Taxes

(Y1)	0 €	(Y2)	0 €
(Y3)	0 €	(Y4)	0 €
(Y5)	0 €	(Y6)	0 €

Registration document P104 serial number:



Ministère de l'Intérieur

Numéro d'ordre du certificat
10217966001

Certificat Provisoire d'Immatriculation WW DPTC
(circulation à titre expérimental d'un véhicule à délégation partielle ou totale de conduite)
Autorise, pendant sa période de validité, la circulation du véhicule (Article R.322-3 du code de la route).

(A) Numero d'immatriculation	(I)Date du CPI	(B) Date de 1ère immatriculation
WW-619-SV	15/06/2019	15/06/2019

Numéro de la décision ministérielle d'autorisation exceptionnelle : 2019-19
Date de la décision ministérielle d'autorisation exceptionnelle : 27/05/2019

(H) PERIODE DE VALIDITE : du 01/06/2019 au 31/05/2021 INCLUS

attribué à : (C.1) KEOLIS LYON
300027535
19 BOULEVARD MARIUS VIVIER MERLE
69803 LYON

(D.1) Marque	(D.2) Type variante version		(D.3) Dénomination commerciale
NAVYA			
(E) Numéro d'identification du véhicule	(F.1) Masse en charge maximale techniquement admissible (en kg)	(F.2)) Masse en charge maximale admissible du véhicule en service dans l'état membre d'immatriculation (en kg)	(F.3) Masse en charge maximale admissible de l'ensemble en service dans l'état membre d'immatriculation (en kg)
VF9A2C02C1V019104	3458		
(G) Masse du véhicule en service avec carrosserie et dispositif d'attelage (en kg)	(G.1) Poids à vide national	(J) Catégorie du véhicule CE	(J.1) Genre national
(J.2) Carrosserie CE	(J.3) Carrosserie (désignation nationale)		
(P.1) Cylindrée (en cm3)	(P.2) Puissance nette maximale (en kW)	(P.3) Type de carburant	(P.6) Puissance administrative nationale
		EL	
(Q) Rapport puissance/masse en kW/kg (uniquement pour les motocycles)	(S.1) Nombre de places assises, y compris celle du conducteur	(S.2) Nombre de places debout (le cas échéant)	(U.1) Niveau sonore à l'arrêt (en db (A))
	11	4	
(U.2) Vitesse moteur (en mn-1)	(V.7) CO2 (en g/km)	(V.9) Classe environnementale	(X.1) Date de visite technique

(Z.1) à (Z.4) Mentions spécifiques

Pour le ministre et par délégation,
Sous directeur de la protection des usagers de la route

Ludovic Guillaume

(Y1) à (Y6) Taxes

(Y1)	0 €	(Y2)	0 €
(Y3)	0 €	(Y4)	0 €
(Y5)	0 €	(Y6)	0 €

2.3 Tramway crossroad authorization

The most difficult point on our authorization dossier is caused by a modification of traffic lights crossroads with tramway line 3. In France, the competent authority for crossroads between roads and train lines is called STRMTG (Service Technique des Remontées Mécaniques et des Transports Guidés). To be allowed to modify the operation of a train line traffic light, STRMTG has to analyze the security level. Those evaluations could be long, especially because STRMTG is not use to work with AVs and V2X system. For

the Groupama Stadium project, STRMTG sent us the authorization at the end of August, and Lyon Metropole can operate the modification in November. Until this modification is done, a small part of the path will need to be handmade by AVs drivers.

3 Vehicles

3.1 Vehicle selection

Keolis Lyon AVs				
Brand	**Sérial number**	**Vin number**	**Registration number**	**Option**
NAVYA	P104	VG9A2CB2CIV019104	WW-619-SV	Access ramp
NAVYA	P108	VG9A2CB2CIV019108	WW-625-SV	Access ramp

3.1.1 Seat-belts

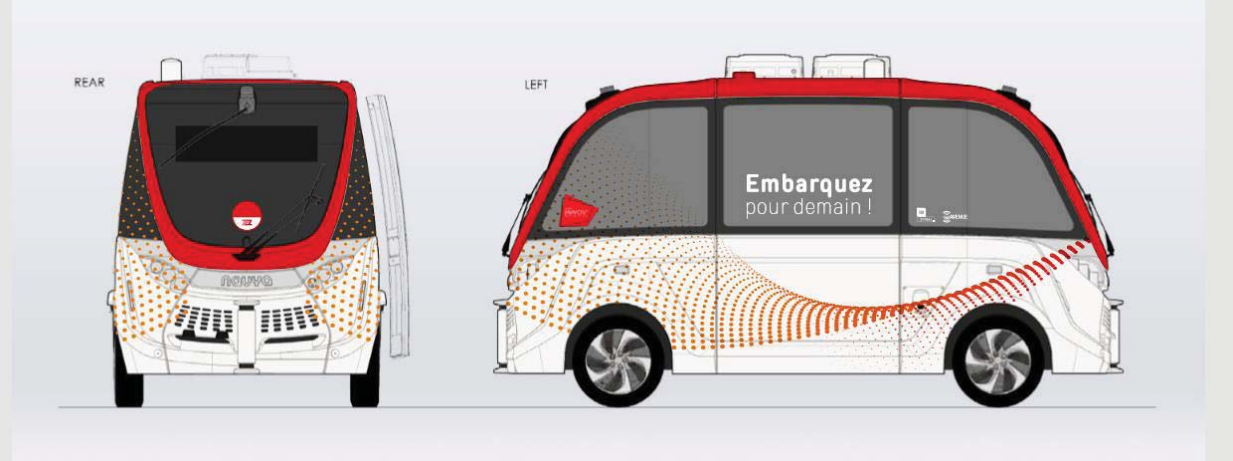
Even if it is not legally imposed For French Public Transportation, Keolis Lyon has opted for the installation of seatbelts. When the safety driver welcome people in autonomous shuttles, they advise passengers to use seatbelt, especially for people facing the route (risk when shuttles break).

3.1.2 Wheelchair ramp

Public transport companies have the duty to offer transport for everyone, including the disabled. The Navya Amra-DL4 is equipped with an automated folding ramp which can be deployed by the safety driver to give access to a wheelchair. Tests have been made to be sure that the automated ramp are comply with the buses gate of the shuttle's itinerary.

3.2 Vehicle Covering

Regarding the SYTRAL willingness to integrate Groupama stadium project into Lyon transport network, the covering chosen reminds the colours of buses, tramway and metro:



Lyon network colours are also used for AVs stops:

H2020 Avenue logo is included in the shuttle's covering:

It’s important to note that the 2 shuttles are the only vehicles having additional branding on the covering. Usually, TCL logo is the only one accepted by SYTRAL.

3.3 Maintenance

The maintenance of vehicles and GNSS base station is entirely done by Navya. Public transport operators have the possibility to carry out in-house maintenance work on their vehicles until a certain maintenance level.

3.4 Supervision

Supervision is divided in two level:

- **Keolis Supervision**: The current supervision is made by Kisio, subsidiary of Keolis Group, in order to help safety drivers to operate, and fixe a short list of dysfunction (GNSS signal lost, doors dysfunction, dashboard dysfunction…)
- **NAVYA supervision**: NAVYA's supervision is contacting by Kisio supervision when a dysfunction can't been solve by themselves. They are needed for deeper manipulation (log extraction, API dysfunction…)

4 Operation

Current pole of people who are involved in the day-to-day operations of the autonomous vehicles.

	Safety Driver (SD)	SD management	SD director	Project manager
MILLET Laurent	X			
VINCIGUERRA Donovan	X			
GIOVANNONE Fabien	X			
FEKIR Nawel	X			
KNOELL Steven	X			
BOUTAYEB Emad	X			
HARGAS Youssef	X			
LIMONES Joseph		X		
ROLLET Amélie		X		
HIPPERT Audrey			X	
BERTONNEAU Jérôme			X	
LAFON Benedicte				X
PATRY Aurélien				X
ZUTTRE Quentin				X

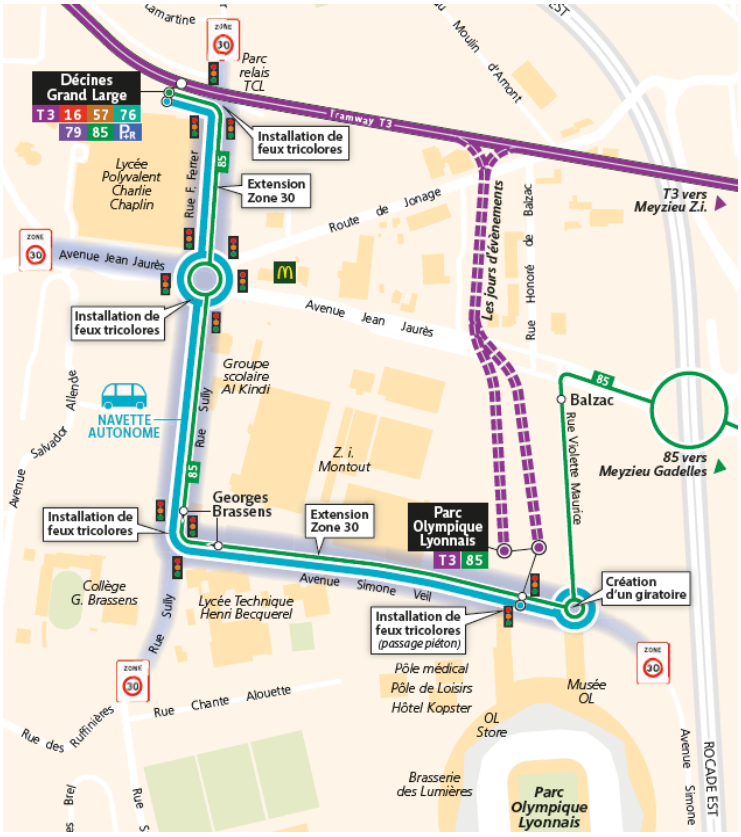
5 Keolis Lyon Test site: Groupama Stadium

The Groupama stadium is the main part of the OL City project, which will also host Hotel, Medical center, Recreation Center, and office building. Most of those new centers of attraction will be inaugurate in 2019 and 2020.

Those different activities will cause small flow of passengers all along the day. In order to accompany the area development, Keolis Lyon will use AVs to strengthen actual buses line 85.

At the beginning of this experimentation, AVs will take along people between T3 tram station and GROUPME Stadium.

In the second part of this experimentation, AVs will integrate a additional itinerary with on demand stop, and door to door services.



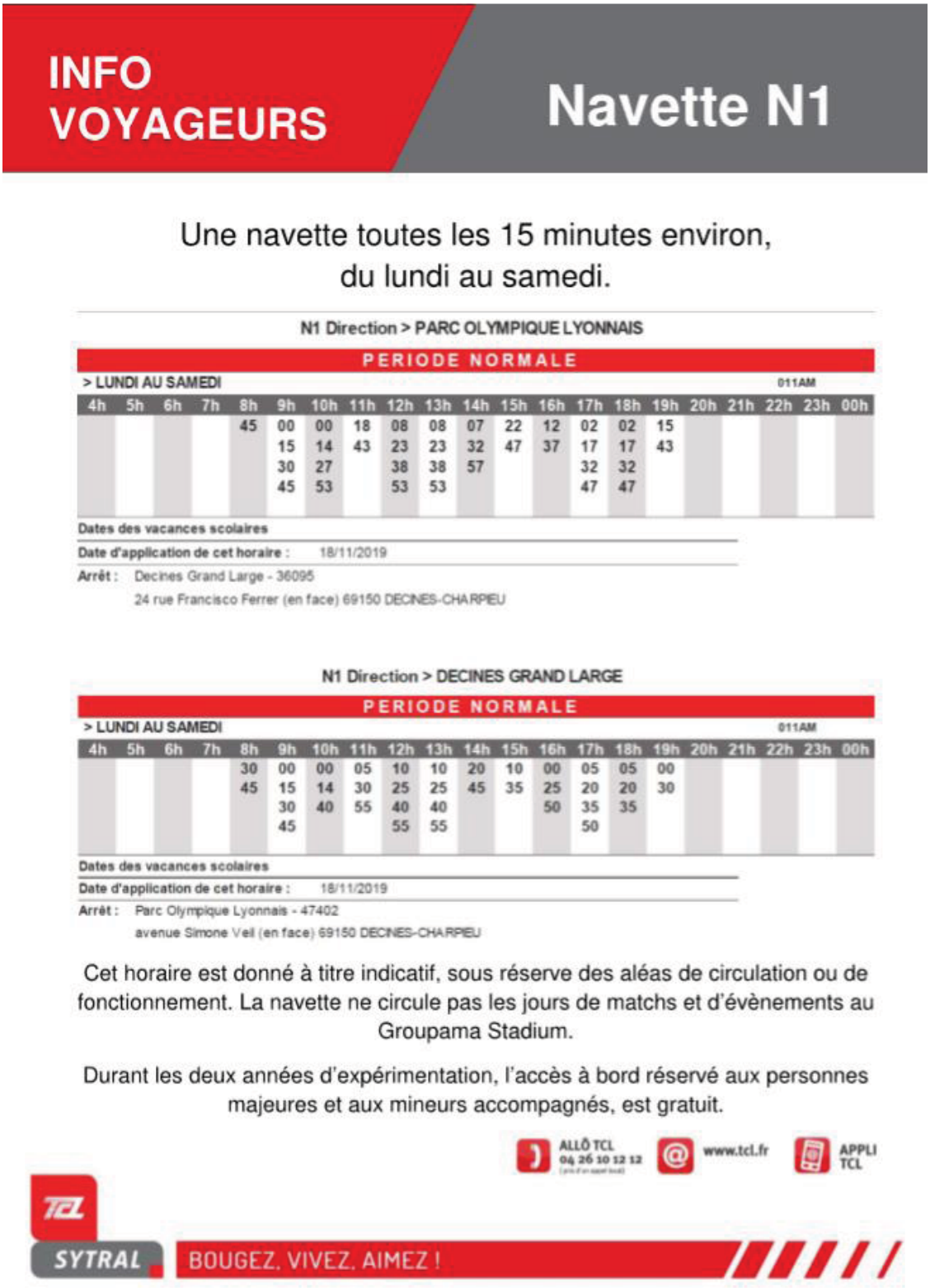
Description :

- 2,6 km round trip
- 3 Crossroads with V2X
- 1 Roundabout with V2X
- High frequentation open road
- 4 schools on the itinerary which cause high pedestrian traffic

Goals :

- Full integration on Public Transport
- Support for OL City development (hotel, restaurant, office)
- Fluid interaction between AVs and urban traffic
- Social acceptance of AVs
- Improve passenger's information

5.1 Timetable



INFO VOYAGEURS

Navette N1

Une navette toutes les 15 minutes environ,
du lundi au samedi.

N1 Direction > PARC OLYMPIQUE LYONNAIS

PERIODE NORMALE

> LUNDI AU SAMEDI

011AM

4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h	00h
				45	00	00	18	08	08	07	22	12	02	02	15					
					15	14	43	23	23	32	47	37	17	17	43					
					30	27		38	38	57			32	32						
					45	53		53	53				47	47						

Dates des vacances scolaires

Date d'application de cet horaire : 18/11/2019

Arrêt : Decines Grand Large - 36095
24 rue Francisco Ferrer (en face) 69150 DECINES-CHARPIEU

N1 Direction > DECINES GRAND LARGE

PERIODE NORMALE

> LUNDI AU SAMEDI

011AM

4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h	00h
				30	00	00	05	10	10	20	10	00	05	05	00					
				45	15	14	30	25	25	45	35	25	20	20	30					
					30	40	55	40	40			50	35	35						
					45			55	55				50							

Dates des vacances scolaires

Date d'application de cet horaire : 18/11/2019

Arrêt : Parc Olympique Lyonnais - 47402
avenue Simone Veil (en face) 69150 DECINES-CHARPIEU

Cet horaire est donné à titre indicatif, sous réserve des aléas de circulation ou de fonctionnement. La navette ne circule pas les jours de matchs et d'évènements au Groupama Stadium.

Durant les deux années d'expérimentation, l'accès à bord réservé aux personnes majeures et aux mineurs accompagnés, est gratuit.

ALLÔ TCL 04 26 10 12 12 (prix d'un appel local) | www.tcl.fr | APPLI TCL

TCL SYTRAL BOUGEZ, VIVEZ, AIMEZ !

5.2 Depot

A garage has been constructed on a Groupama Stadium parking, especially for the AV's need. This garage equipment are:

- Electric outlet for fast recharging (220v – 32Ah)
- Air-conditioning and heat
- Life equipment for safety drivers (café machine, water, locker

5.3 Current status (before AVENUE):

The itinerary connects Tramway 3 line (Décines Grand large stop) and the Groupama Stadium. 100% is open road itinerary, in a high traffic district.
To make this project possible, Keolis Lyon needed a strong partnership with:

- **SYTRAL**: Public Transport Authority in Lyon, SYTRAL and Keolis are linked by a public service delegation contract. In order to integrate this AVs project in the public transport network, a rider describing the project have been signed by SYTRAL and Keolis Lyon
- **Metropole de Lyon:** Responsible of the roads, Metropole de Lyon supervised road works needed by AVs. They are also responsible for the functioning of lightning signal for crossroads, and the implementation of V2X technologies on the itinerary.
- **Olympique Lyonnais:** It is the owner of the Groupama Stadium, one of the most attractive place in Lyon. The goal of this project is to support the economic evolutions of the site. Groupama Stadium expect 1.500.000 visitors other than game days and special events (live show…).

5.4 Objectives (Key Assumptions & Outcomes)

In September 2016, Keolis Lyon was the first PTO to inaugurate an AV services in Confluence Area. After 3 years of this project, 35 000km done and 55 000 passengers, Keolis Lyon needed to increase the difficulties for the Avenue Project. By making the choice of a 100% open road itinerary, Keolis Lyon want to assess the capacity of AVs to bring in normal circulation situations, and continue to build the strategy for the future of AVs in public transport.

With the Groupama Stadium project, the first goal is offering a first and last mile solution, helping users to be connected with mass transit systems (tramway, subways) while testing new connected infrastructure. From such knowledge it would be possible to choose the appropriate sites in the future, regarding the AVs abilities to work with or without connected infrastructure.

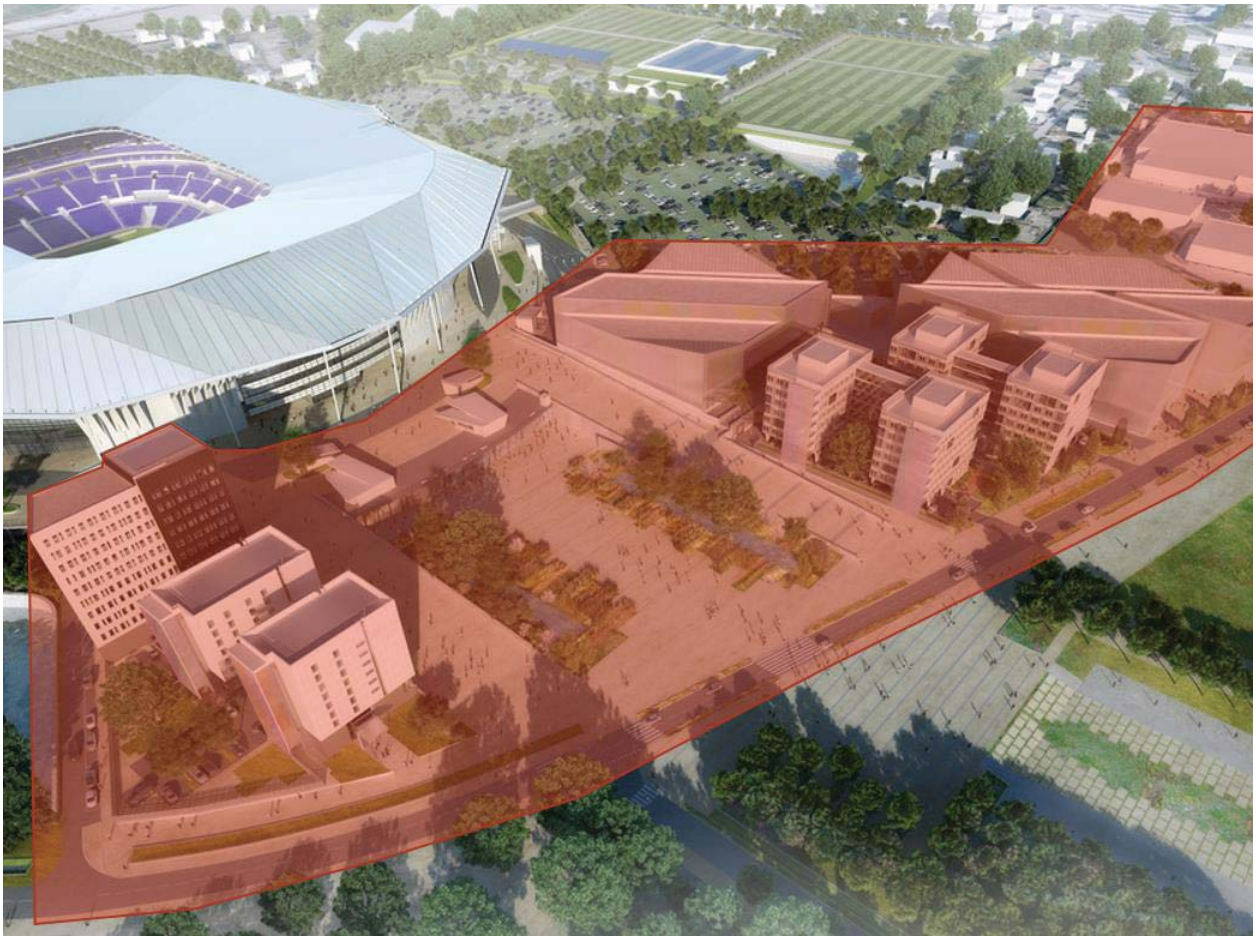
Over time, the services should evolve to be more adaptable, regarding the area is getting change. With the OL City development, OL Group is expecting 1.500.000 visitors/year outside of game days in the area. If this forecast is true, Groupama stadium will need a mass transit solution. A daily service with tramway is already considered, knowing that railway infrastructures are already create. If it happens, we will have to turn AVs services in order to be complementary of tramway services.

Service scenario for Groupama stadium second phase:

- 2 AVs point A ↔ point B when tramway is not running
- 2AVs on demand and door to door into OL City when tramway is running

Focus on the area where on demand transport could be available :

Area size = 16 000m² + 4 000m²
8 buildings will be built
Open hours from 07.00am to 01.00am



5.5 Organisation of the AVENUE trial

5.5.1 Test site (Selection of test site)

5.5.1.1 Tests track

Regarding the difficulties expecting on Groupama Stadium site, Keolis Lyon decided to finance tests on a test track called Transpolis. The tests made where conceptualized in order to create the same issues than AVs would met on Groupama stadium site. Those issues have been classified in five batch of tests:

- Batch 1 : dynamic tests
    - Entrance and quit gate
    - Ramps for handicapped persons
    - Repeatability of braking and decelerations
- Batch 2 : Simulation of overtaking
- Batch 3 : V2X simulation on roundabout (normal and deteriorated situation)
- Batch 4 : Crossroad with V2X – testing with unexpected comportment
- Batch 5: Cohabitation with cycles and pedestrians.

Thanks to this tests site, most of the settings have been done before going on Décines site in order to avoid issues caused by traffic on open road.

5.5.1.1 Choice of itinerary

The itinerary of Groupama stadium project have been chosen for different reasons:

- **High frequentation open road:**

To look ahead a large pool of autonomous vehicles, it is important to know how AVs could be accepted by others road users. At the first tests of AVs, we saw that AVs comportment was too much binary. Every time cars, bikes, or pedestrians was close from AVs, we felt a strong brake. That was uncomfortable inside AVs, and dangerous because that kind of comportment were not understandable by other drivers. We worked with NAVYA on a test site in order to adjust a new Setup of their AVs. Thanks to that Setup, AVs now understand the velocity vector of every object around, and adapt the dynamic comportment.

- **Crossroads and roundabout:**

The itinerary goes through 3 crossroads and 2 roundabouts. It is an opportunity to tests different solutions to pass through those difficulties (with and without V2X). The first statement is AVs can't anticipate enough to pass through big crossroads without V2X help. So, we decided to keep only one small roundabout without V2X system.

Testing V2X system was also interesting because "La Métropole de Lyon" is in charge of crossroads management, and they never had the opportunity to tests application of V2X system. A project team has been created with Keolis Lyon, Metropole de Lyon, Navya and Fareco (Supplier of Lyon Metropole) to think about the different way we could pass through crossroads issues.

This Roundabout is borrowed by more than 35 000 cars/day

- **Economic and social :**

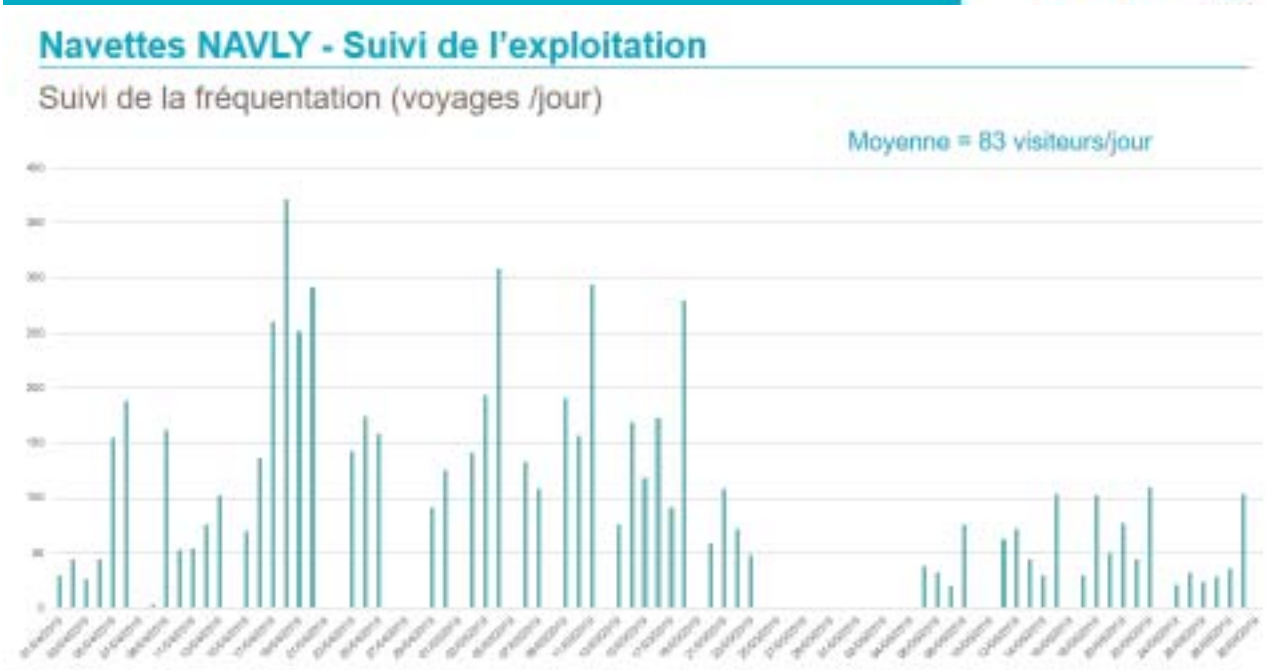
Groupama Stadium has been inaugurated the 9 of January 2016. Many professional buildings have been built, and the area will continue growing. These activities create a new economic attraction, and that will upset all the area. Those changes are creating a daily flow of passengers coming all along the

day in the area, and we thought that AVs could be a good complement of the buses line already serving the area.
Furthermore, the medical center will bring some frail people with reduced mobility, and AVs will offer a helpful new service to them.

5.5.1 Experimentation reporting to SYTRAL

The public service delegation contract between SYTRAL and Keolis Lyon precise that Keolis has to send monthly, quarterly and annually, a reporting of the project. In the first step of the project, we will only use available information's, but in a second time, NAVYA will have to increase his reporting system.

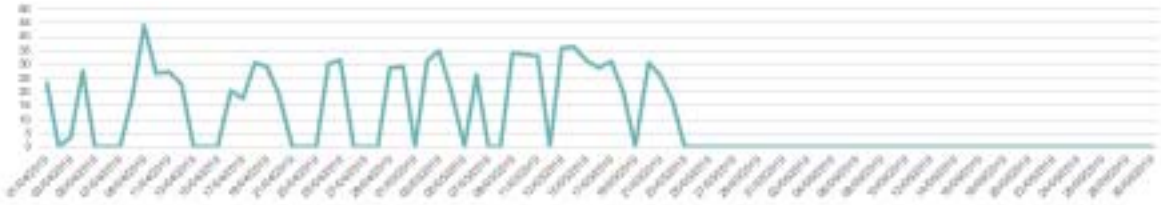
5.5.2 Example of quarterly reporting (based on NAVLY files):



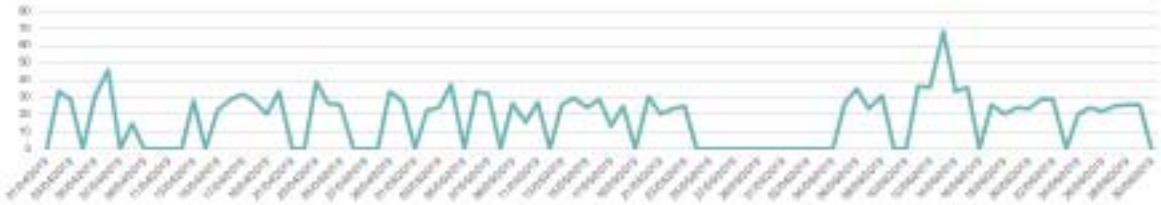
Navettes NAVLY - Suivi de l'exploitation

Distances réalisées par navette (km/jour)

P3



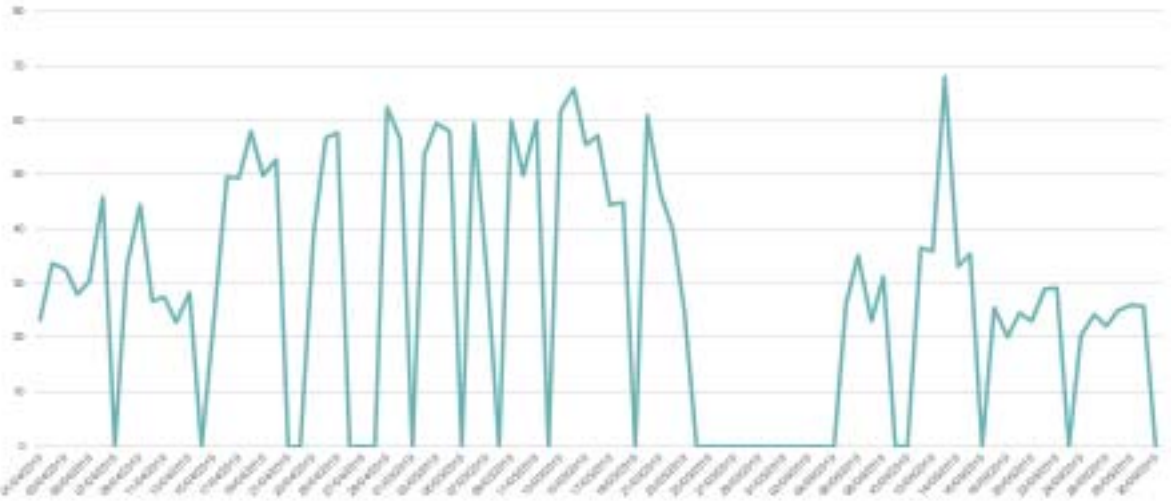
P4



Navettes NAVLY - Suivi de l'exploitation

Distances réalisées totales (km/jour)

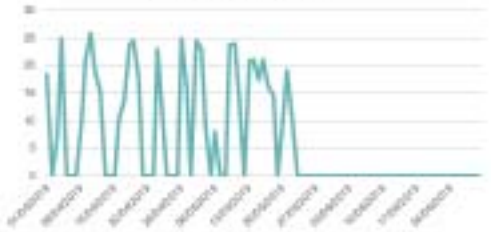
P3 + P4



Navettes NAVLY - Suivi de l'exploitation

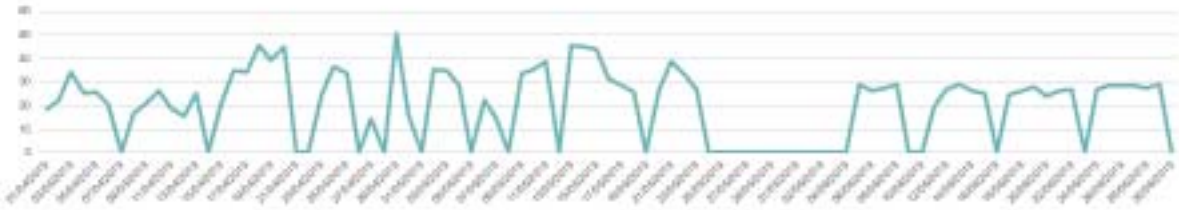
Suivi des consommations énergétique

Conso kW.h P3



Conso kW.h P4

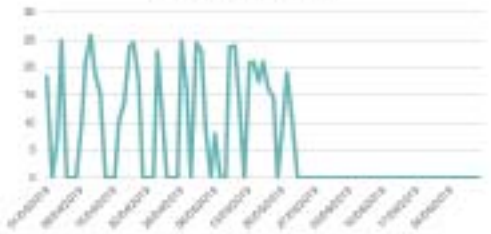
Conso kW.h P3 + P4



Navettes NAVLY - Suivi de l'exploitation

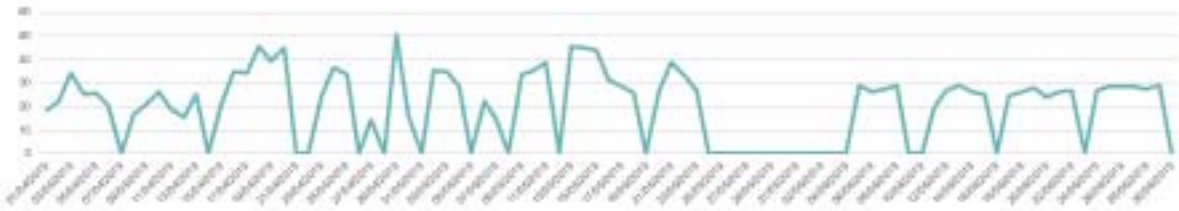
Suivi des consommations énergétique

Conso kW.h P3



Conso kW.h P4

Conso kW.h P3 + P4



Navettes NAVLY - Suivi de l'exploitation

Détail des principaux incidents

Type d'incident	Détail incident	Date	Impact incident	Analyse NAVYA	Action corrective
	Problème température Clim	01/04	nul	-	Maintenance bloc clim
Incident Navette	Sortie de voie	08/04	nul	Mauvais positionnement de la navette dans son path	-
	La navette ne prend pas la charge une fois branchée	12/04	Arrêt temporaire exploitation	Problème de connectique	Intervention NAVYA le 12/04
	Sortie de voie	16/05	nul	En attente rapport NAVYA	-
	Problème récurrent d'avertisseur sonore et non détection d'obstacle	22/05	Arrêt exploitation P3	-	-
	Perte GNSS	22/05	nul	En attente rapport NAVYA	-

Navettes NAVLY – Synthèse Trimestre T1 2019

Taux d'autonomie	Temps d'utilisation	Performance énergétique
93,3%	552 h	0,73 kW.h/km

Fréquentation	Distances parcourues
6 869 voyages	2 484 km

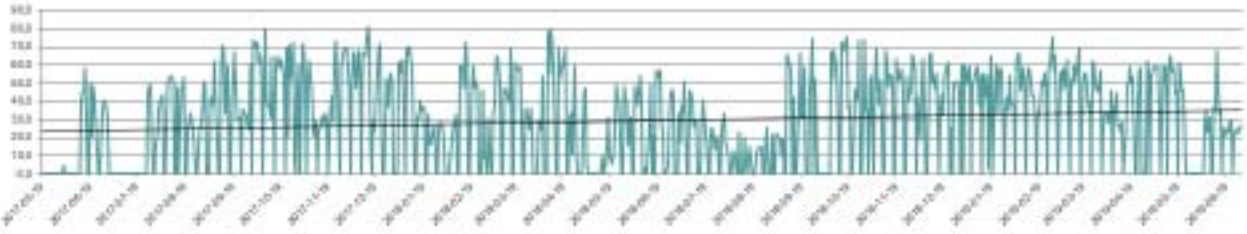
Commentaires :

- *Arrêts d'exploitation causés par les nuits sonores et la fête de la bière*
- *P3 en arrêt d'exploitation depuis le 25/05 suite à des difficultés software et hardware. Un retour aux ateliers NAVYA sera nécessaire pour remettre P3 en exploitation*

Navettes NAVLY – Synthèse depuis Sept 2016

Fréquentation moyenne/jour

Suivi des km réalisés



5.5.3 Operational issues (Status of the operation)

- Operating hours: Monday → Saturday, from 08.30 to 19.30, except game day.
- Peak hours :
  - 08.30 am to 10.00 am
  - 12.00 to 2.00 pm
  - 5.00 to 6.30 pm
- Off Peak hours : AVs every 30 mn
- Peak hours : AVs every 15 mn
- Complementary servicing with Tramway (line 3) and Buses (line 85), except game day

All along the experimentation, operators will be inside AVs in order to:

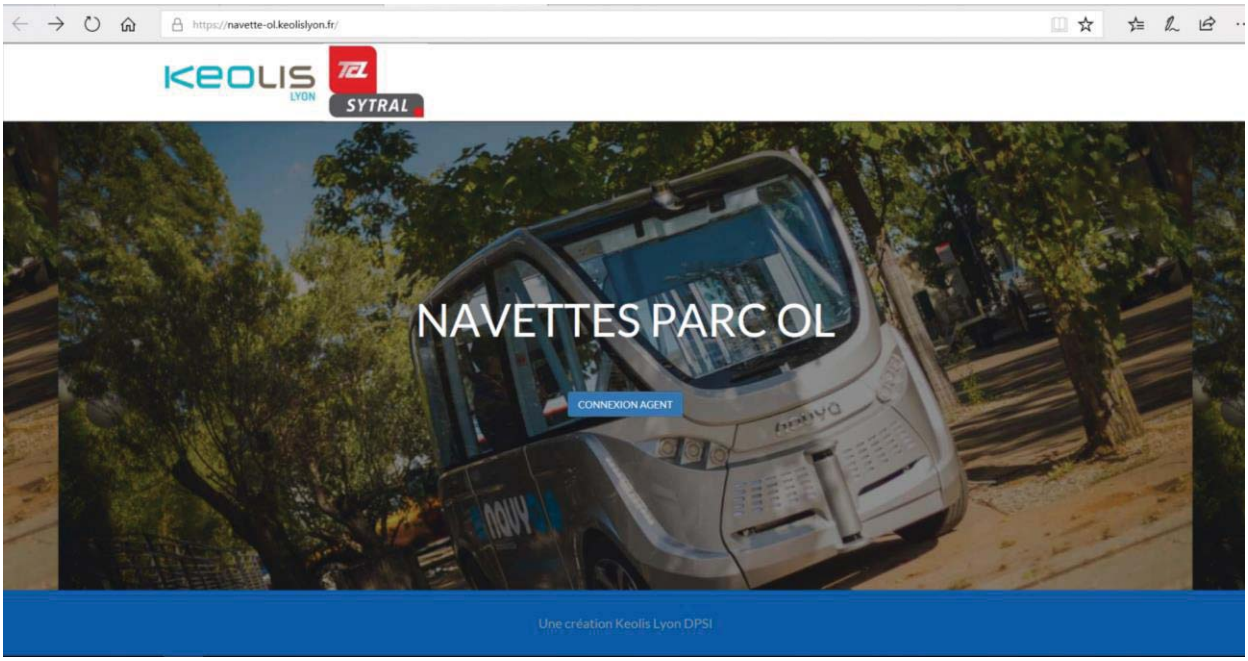
- Welcome passengers inside AVs, and give information's about technologies and current project
- Ensure appropriate safety and security, inside and outside of AVs
- Raise operational information

Keolis Lyon AVs operators are holders of bus driving license.

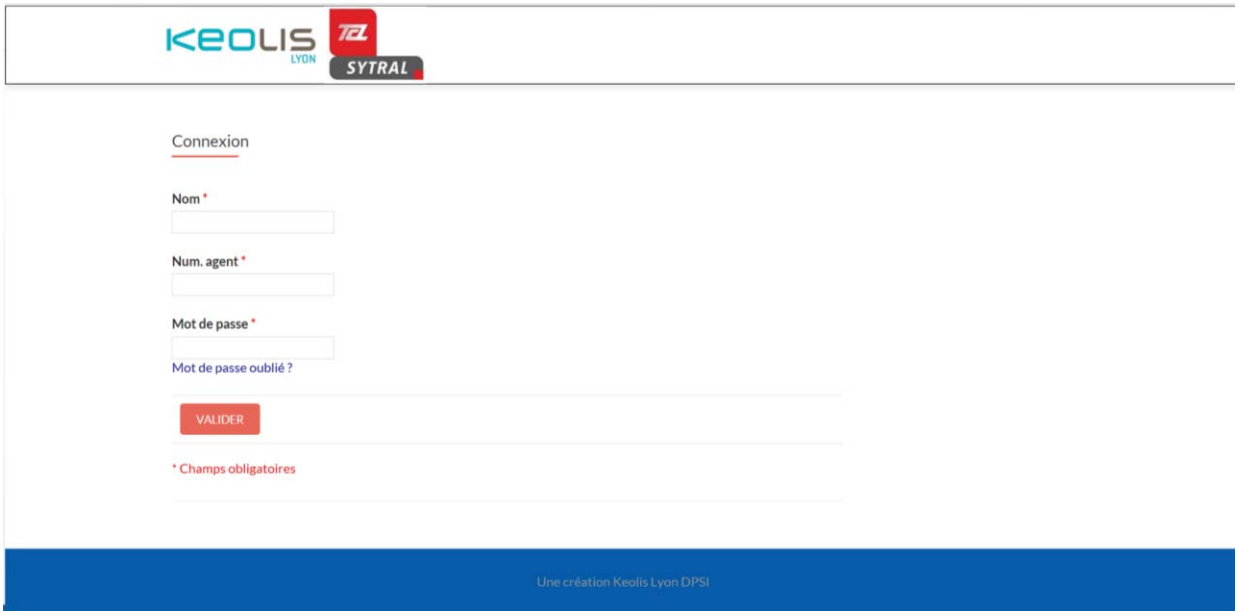
A daily report is automatically sent to Keolis Lyon mailing list. This daily report is based on information's that operators inside AVs put on a dedicate application. Each AVs include 2 digital tablets:

Operator's application screenshots:

Homepage:



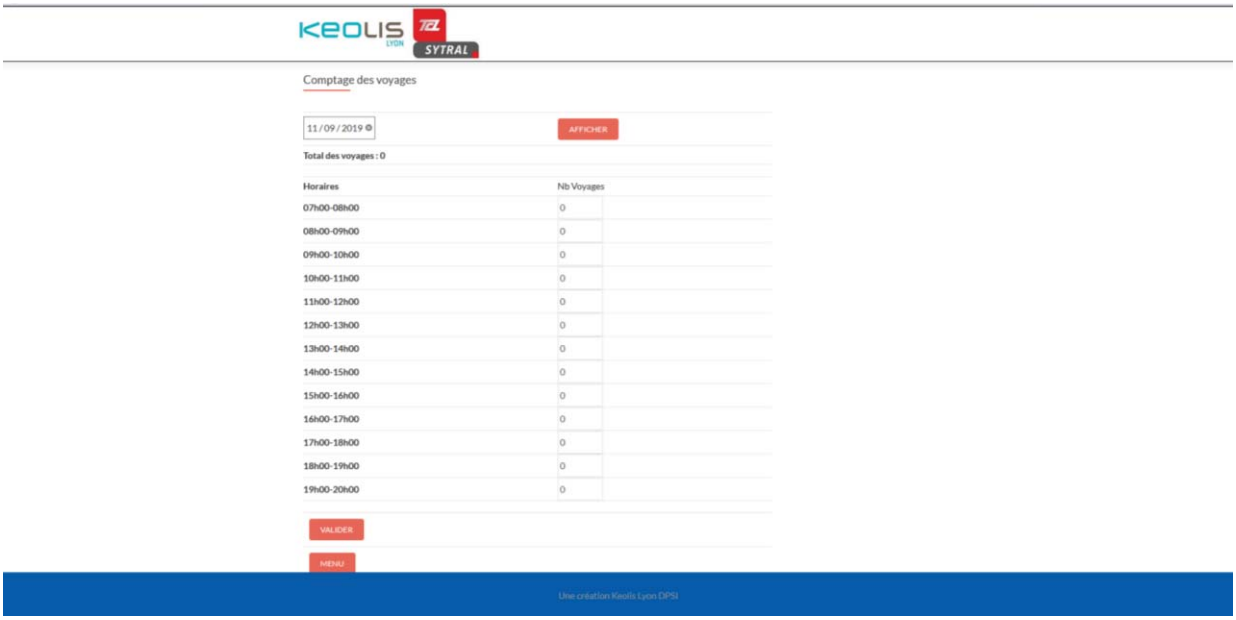
Every operator has a personal login and password:



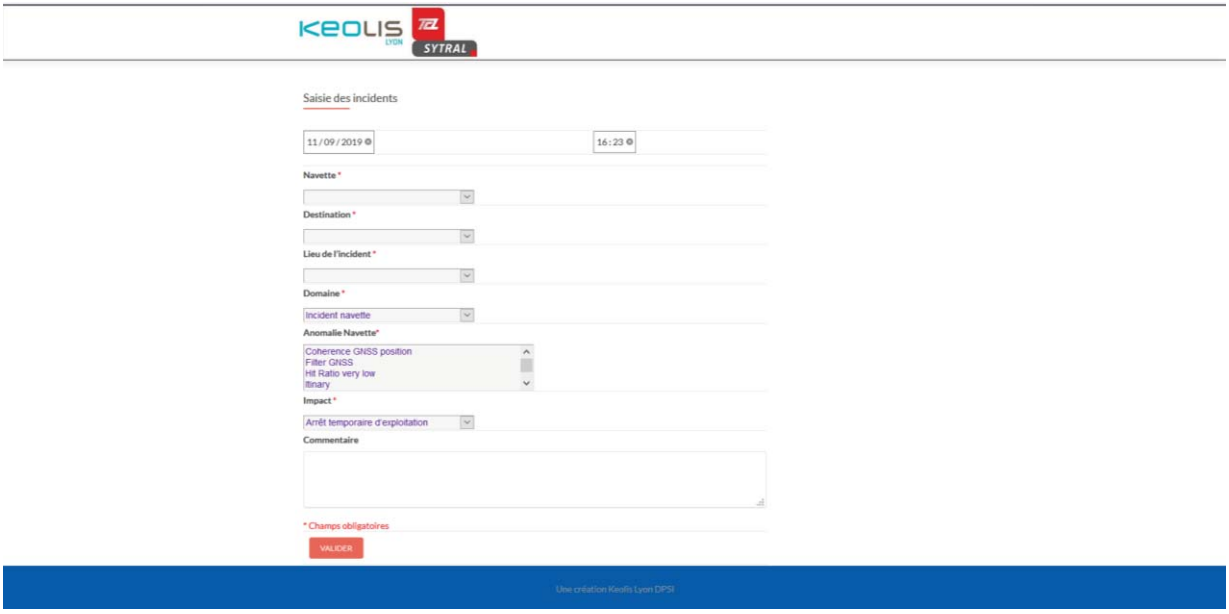
Browsing:

- Frequentation counting
- Capture incident
- See incident

Frequentation counting:



Capture incident:



Requested information's:

- AVs number :
  - P104
  - P108

  Pull-down menu
- Destination :
  - Décines – Grand Large
  - Parc OL

  Pull-down menu

- Place of the incident :
    - Reversal area Décines – Grand Large
    - Bus lane Décines – Grand Large
    - Crossroad bus lane – Ferrer street
    - Ferrer street
    - Roundabout Décines Esplanade
    - Sully street
    - Crossroad Sully street – Simone Veil Avenue
    - Simone Veil Avenue
    - Crossroad Simone Veil Avenue – Groupama Stadium Parking
    - Reversal area Groupama Stadium
    - Groupama stadium parking

Pull-down menu

Comments:

- Free

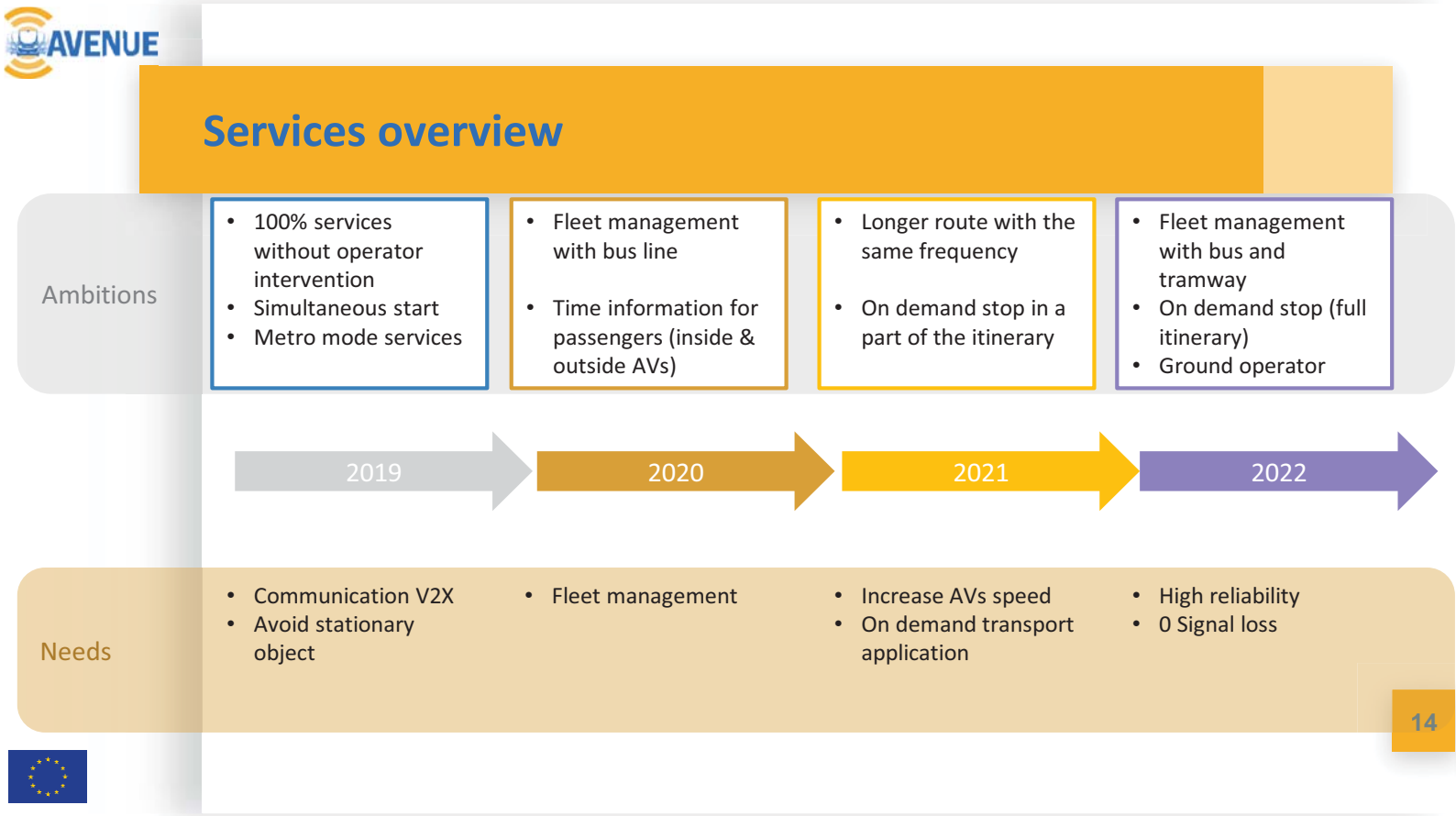
- See incident :

Allow to search incidents day per day

6 Decisions / Next Steps and risks

6.1 Schedule (Timeline/Roadmap)

Keolis Lyon services roadmap:



6.2 Some business model information that arose during this trial

Regarding Keolis Lyon 4 years' experience with AVs, we consider some issues and risk for this market:

- **Political support :**

Political support is a need in different points of view:

  - Territorial public bodies need to authorize PTOs to start AVs project
  - To made ambitious project, PTOs have to modify infrastructure (ex: roadworks, lights signal control…). Those modification are technical jurisdiction of territorial collectivity.

Since 2016, plenty of experimentations has been made in France and all around the world. Territorial public bodies were interested to have AVs project because it gives a modern impression to citizens. But three years after those first projects, the technological level of AVs didn't improve, and most of the new projects are almost the same than project already done. Regarding the maturity level of AVs, and the fact that today AVs project are not effective (numbers of passengers, Security driver always inside AVs, AVs speediness), there is a risk to lose political support. Without these supports, AVs constructor will sell less AVs, earn less money and thus lose capacity to invest in research and development.
For those reason, it seems really important to start a new generation of project, with AVs starting to do things never done before.

- **Disappointment risk :**

When politics invest in AVs project, it is important to make them understand that it is still experimentation. A lot of decision-maker are expecting AVs to offer a real public transport services that is not available right now. If decision-makers who bear AVs project are disappointed, they can turn into AVs opponents.
That's why PTOs who tries to convince doing AVs project have to integrate a technical transparency communication and prepare stakeholders to face a challenge.
Politics is full of bet and promising, and there is too much risk and issues with AVs to let decisions-maker talk about a new service to the general audience.

- **Business model :**

The actual AVs business model keep constructor essential all along the operating time because they oversee vehicles and do maintenance. This is not viable in the long term because PTOs can't depend upon a supplier and invest in a fleet of vehicles with the risk that the fleet can't be operate without constructor.
If AVs become a qualified and approved public transport mode, PTOs should be able to do oversee and maintenance by themselves.

- **Security and safety demonstration :**

To become a standard Transport public, AVs will need to do security and safety demonstration as needed for automatic subway (SOTIF, ISO 26262…). The statement Keolis Lyon made on our industrial partnership with NAVYA, is the security and safety demonstration should be more integrated on the research and development process.

Working alongside with automatic subway, Keolis Lyon know that security and safety demonstration has to influence research and development, and not try to find a way to demonstrate security and safety of something already built.

7 Conclusions

Keolis-Lyon is fully committed it the development of transport services with autonomous vehicles. Following the successful deployment of the NAVLY and Parc OL sites, we are in the process of developing the future use cases. For the Parc OL site we believe that the new tramline is an opportunity to build complementary services with autonomous vehicles in order to improve the integration of this new mobility in the public transportation network.

However, it's important to note that the development of these new services will need a new legal authorisation. Keolis Lyon will have to make some choice to ensure that the future services will be testing in the Avenue project timeline, and not lose too much time in the legal authorisation assessment process. A balance must be found between the innovativeness and the capacity of testing as quickly as possible.